- Groundwater Effects Assessment (Appendix D4). The assessment was undertaken of the potential exposure of environmental values to changes in the groundwater regime as a result of mine development and operations for the proposed project.
- Surface Water Baseline and Modelling Assessment (Appendix D5). The assessment describes the pre-mining surface water environment. The description of the hydrological baseline forms the basis for assessing the potential surface water effects arising from the different mine water affecting activities associated with the proposed project. The assessment also includes hydrological modelling and hydraulic modelling.
- Surface Water Effects Assessment (Appendix D6). The assessment describes the potential exposure of environmental values to changes in the surface water regime as a result of the proposed mine development and operations.
- Waste Rock and Tailings Static and Kinetic Leach Testing (Appendix F2, Appendix F3 and Appendix F5). Kinetic and static leach tests were undertaken to establish solutes that could be expected in leachate from waste structures.
- Hydrogeochemical Study (Appendix D7). Hydrogeochemical assessment involved two components, specifically an assessment of the evolution of water quality within water bodies that would form within pit voids after active mining and dewatering ceases, and an assessment of the fate of solutes that may seep from mine waste storages (e.g. TSFs, WRDs and backfilled pits). The assessments predict the likely effects on environmental values in the project area.
- Site-Wide Water Balance (Appendix D8). The assessment of the proposed project's water requirements for development and operations as an input to the groundwater modelling (Appendix D3) and groundwater effects assessment (Appendix D4).
- Independent Peer Review of Hydrological and Hydrogeological Assessment (Appendix D9). This review considered the outcomes of hydrology and hydrogeology modelling and confirmed suitability and robustness of the approach and outputs. The conclusions of the peer review were incorporated into updated modelling outputs.
- Groundwater Quality Monitoring (Appendix D10). This assessment included the collection of water quality monitoring of thirteen water bores over a six-month period to confirm the baseline groundwater quality conditions of the project area.
- Surface Water Study Update (Appendix D11). This study update provides a brief qualitative assessment of changes to hydrology resulting from the alternative TSF location.
- Hydrochemical Study Update: Assessment of Alternative TSF Location (Appendix D12). This assessment summarises the work undertaken to assess the water-related implications of an alternative TSF location south of Nebo pit. The study assesses the validity of the existing hydrogeochemical study (Appendix D7) findings with respect to the alternative TSF location, specifically the risk posed to the environment by seepage constituents in groundwater.

The proposed project's water supply requirements are detailed in Section 2.5.5.

#### 7.3.3.2 Groundwater

An understanding of groundwater systems and quality was necessary to inform the assessment of groundwater-related project impacts. The findings of the groundwater investigations, testing and studies are summarised in the following sections.

**Groundwater Conceptualisation**

The groundwater system being targeted for the proposed project's water supply is a paleovalley system known as the Kadgo Paleovalley (Figure 7-13). The groundwater flow system of the Kadgo Paleovalley is dominated by throughflow originating from the north-east of the proposed project, meandering through the project area before discharging to Officer Basin sediments approximately 50 km south of the Main Development Area (Appendix D2). The Kadgo Paleovalley is represented by a main arterial paleovalley with multiple smaller arms along its length.

The Musgrave Geological Province, where the proposed project is located, has been heavily modified since the Proterozoic, having been folded, faulted and eroded to form a heavily incised landscape, including the presence of multiple paleovalley systems. During the mid-to-late Tertiary, the eroded landscape and paleochannels were infilled with sedimentary deposits. Figure 7-14 shows a representation of the pre- and post-Tertiary transformation of the Musgrave Province and the development of the paleochannel systems.

The hydrostratigraphy of the groundwater survey area has been defined through a comprehensive program of drilling and testing (Figure 7-15 and Appendix D1). The hydrostratigraphy of the area (including the Kadgo Paleovalley) comprises three hydrostratigraphic units (HSUs) and a series of overlaying geology and confining layers (Figure 7-16). These layers include the Garford Formation and Pidinga Formation in the Kadgo Paleovalley and weathered and fractured basement (Appendix D2).

The following provides a description of the hydrostratigraphy of the Kadgo Paleovalley, and nearby surrounds:

- The Garford Formation HSU is a shallow paleochannel hosted in the Kadgo Paleovalley. The Garford Formation, which is up to 90 m thick, is an unconfined to semi-confined aquifer, consisting of interbedded semi-consolidated alluvial sediments, typically comprising of silty sands and gravels (silty sandstones), minor interbedded clays. Calcrete sequences are rarely present below the water table. Depth to water within the Garford Formation is typically 4 to 9 mbgl. Hydraulic conductivity ranges between 1 to 3 m/d and transmissivity values range between 34 to 100 $m^2$/d. Storativity estimates range from 4 x $10^{-4}$ where semi-confined, and 0.05 to 0.14 where unconfined. The Garford Formation is overlain by Quaternary calcrete, aeolian, fluvial and colluvial sediments ranging between 1 to 15 m in thickness. At times, differentiation between the Quaternary cover and Garford Formation is difficult.

- The lower Pidinga Formation HSU paleochannel hosts a confined to semi-confined aquifer consisting, where present, of interbedded semi-consolidated silts and clays (siltstones and claystones) and coarser alluvial sediments (sandstones and siltstones). The Pidinga Formation is generally between 66-86 m thick and overlies the protozoic bedrock. The Pidinga aquifer is semi-confined, has variable hydraulic properties and is not always present within the Kadgo Paleovalley. Groundwater level in the Pidinga Formation is similar to the Garford (4 to 9 mbgl). Testing of field bores found low hydraulic conductivity. Transmissivity values could be as low as 0.2 $m^2$/d in some locations, however elsewhere ranged from 12 to 16 $m^2$/d. Storativity values could not be ascertained for the Pidinga Formation aquifer due to the lack of observation bores screened within the unit.
- The upper Garford Formation is overlain by Quaternary calcrete, aeolian, fluvial and colluvial sediments generally 0 to 15 m in thickness. At times, differentiation between the Quaternary cover and Garford Formation was difficult. The Quaternary cover is largely unsaturated.
- The Garford Formation and Pidinga Formation are separated by a confining to semi-confining clay layer ranging between 30 to 50 m in thickness encountered between 60 to 90 mbgl.
- Outside of the Kadgo Paleovalley groundwater occurs within the regolith and fractured bedrock aquifer. This shallow aquifer consists of fresh rocks exposed at the surface across the region which have been subjected to millions of years of surface weathering. The weathering has led to the development of a regolith profile controlled by variations in past climatic conditions, surface and sub-surface waterflows, pre-existing weaknesses such as faults and shear zones, and variations in the inherent susceptibility to weathering decomposition. This profile consists of weathered bedrock (saprock) at the surface and fresh, highly fractured bedrock at shallow depths. The depth to water table is consistent with the Garford Formation and typically ranges from 4 to 9 mbgl. This weathered, fractured and water saturated profile extends to a depth of approximately 50 mbgl before the degree and frequency of fracturing decreases within the less weathered basement rocks. The shallow, weathered and/or fractured basement rocks are typically of lower permeability when compared to the channel filled paleochannel system.

The following provides a description of how the proposed project would interact with the HSUs of the Kadgo Paleovalley and surroundings (Figure 7-16):

- The Northern Borefield and Southern Monitoring Bores are located within the Kadgo Paleovalley. Abstraction from the Northern Borefield would be exclusively from the lower Pidinga HSU, however depressurisation of the Pidinga HSU would result in some water from the upper Garford HSU and to a lesser degree the regolith and fractured bedrock aquifer to draw down.
- The western half of the Nebo pit is located within a minor arm of the Kadgo Paleovalley, while the eastern portion of the pit is located in fresh rock. Where Nebo pit intersects the paleochannel only the Garford HSU is present. Mining at Nebo pit would therefore require dewatering of the Garford HSU.

- As the Garford Formation becomes depressurised due to mine dewatering and borefield abstraction the rate of groundwater movement from the adjacent fractured bedrock aquifer into the paleochannel aquifer would increase due to the increasing hydraulic gradient established between the two HSUs. This conceptualisation is similar to other well-understood Proterozoic systems that are drained by palaeochannel aquifers and is supported by the numerical groundwater flow model (Appendix D3).
- The Babel pit is located entirely outside of the Kadgo Paleovalley within fresh rock. In and around Babel pit water is contained in the regolith and fractured bedrock (saprock) aquifer and associated fractures. The depth to the water table in regolith and fractured bedrock (saprock) aquifer is between 2 to 8 mbgl. Mining of the Babel pit may require dewatering of the regolith and fractured bedrock HSU.

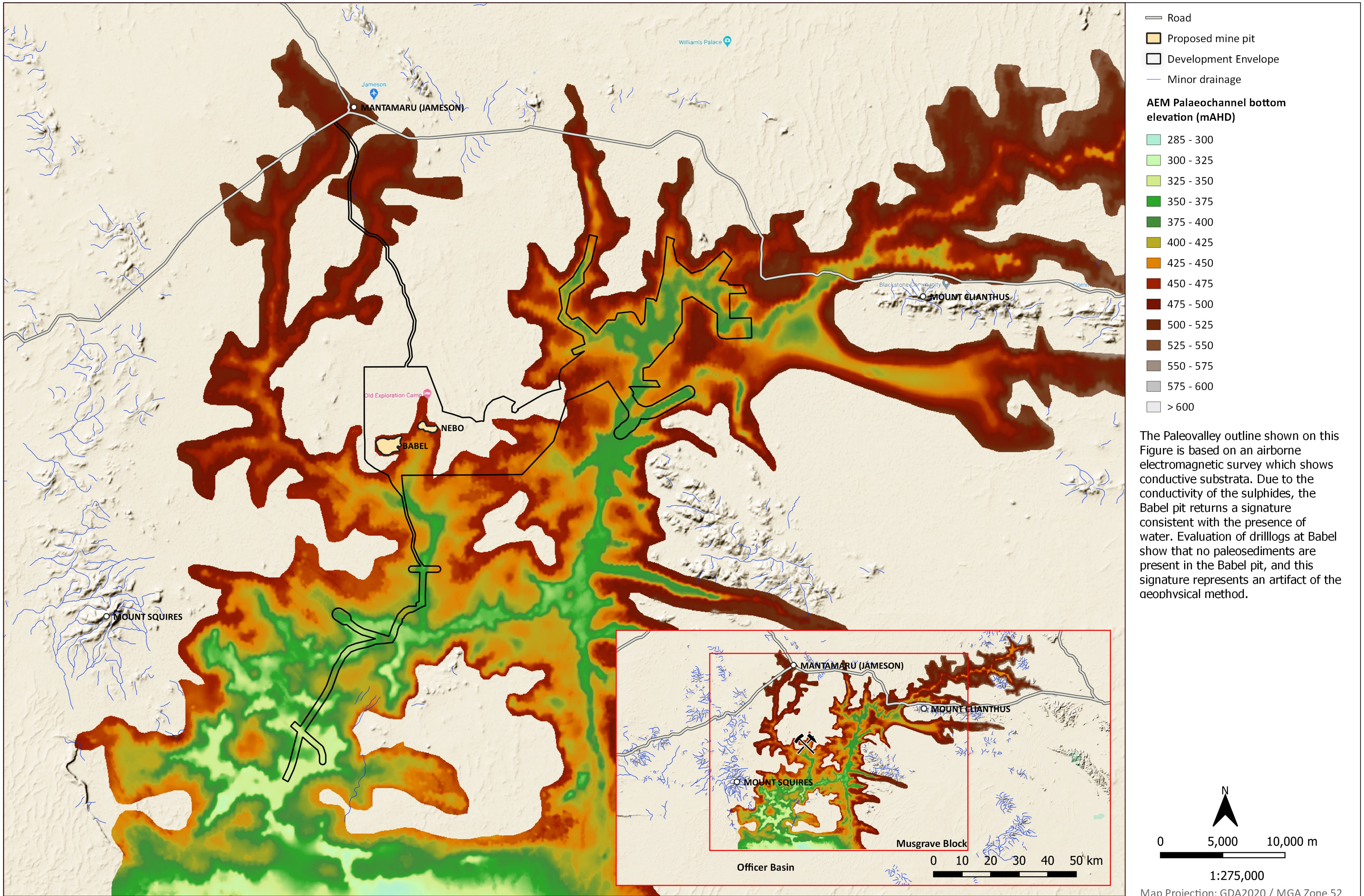


Figure 7-13: Kadgo Paleovalley Extent at the Project Site

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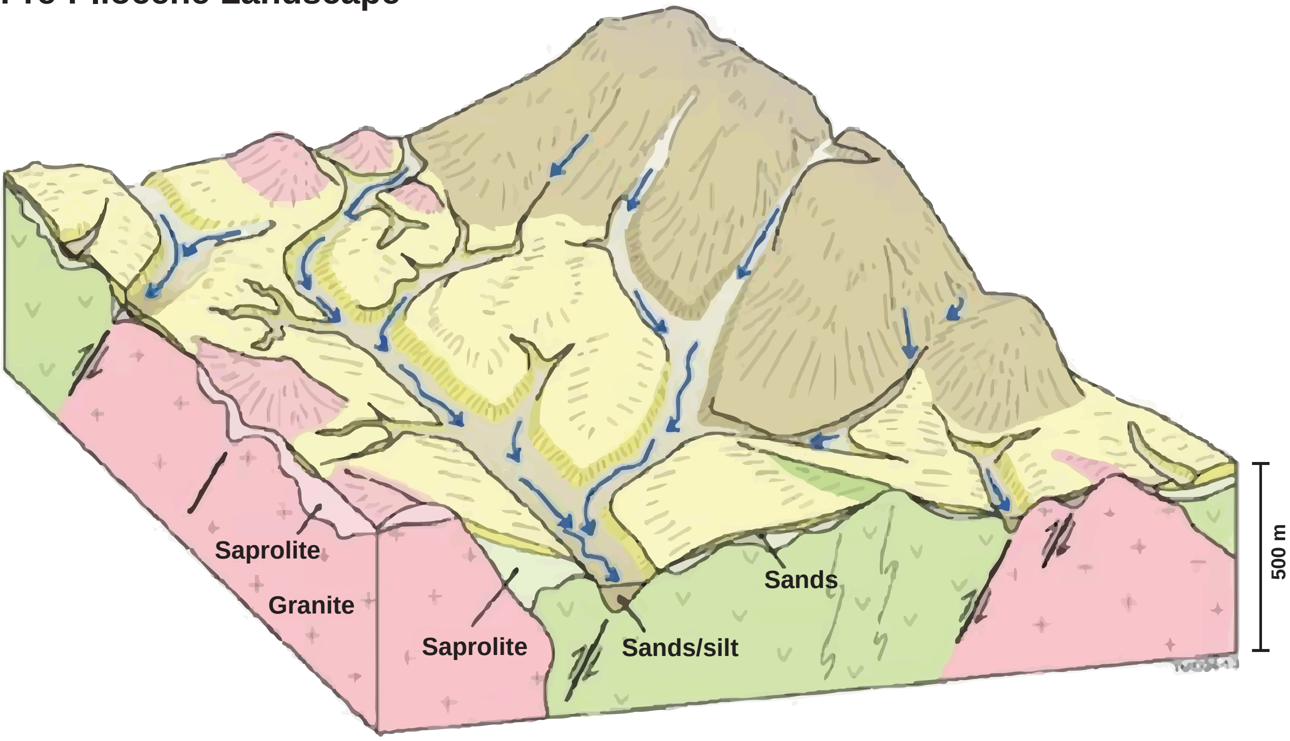
## Pre-Pliocene Landscape




## Modern Day Landscape

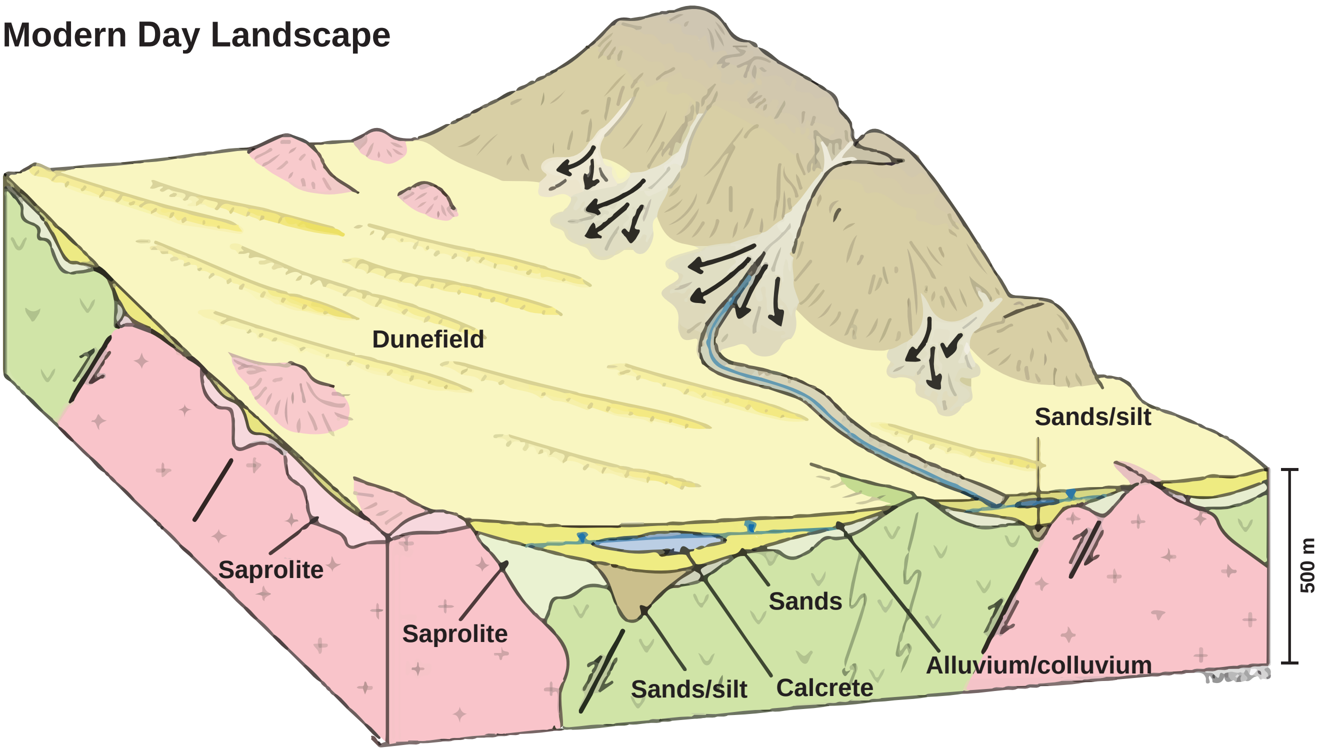
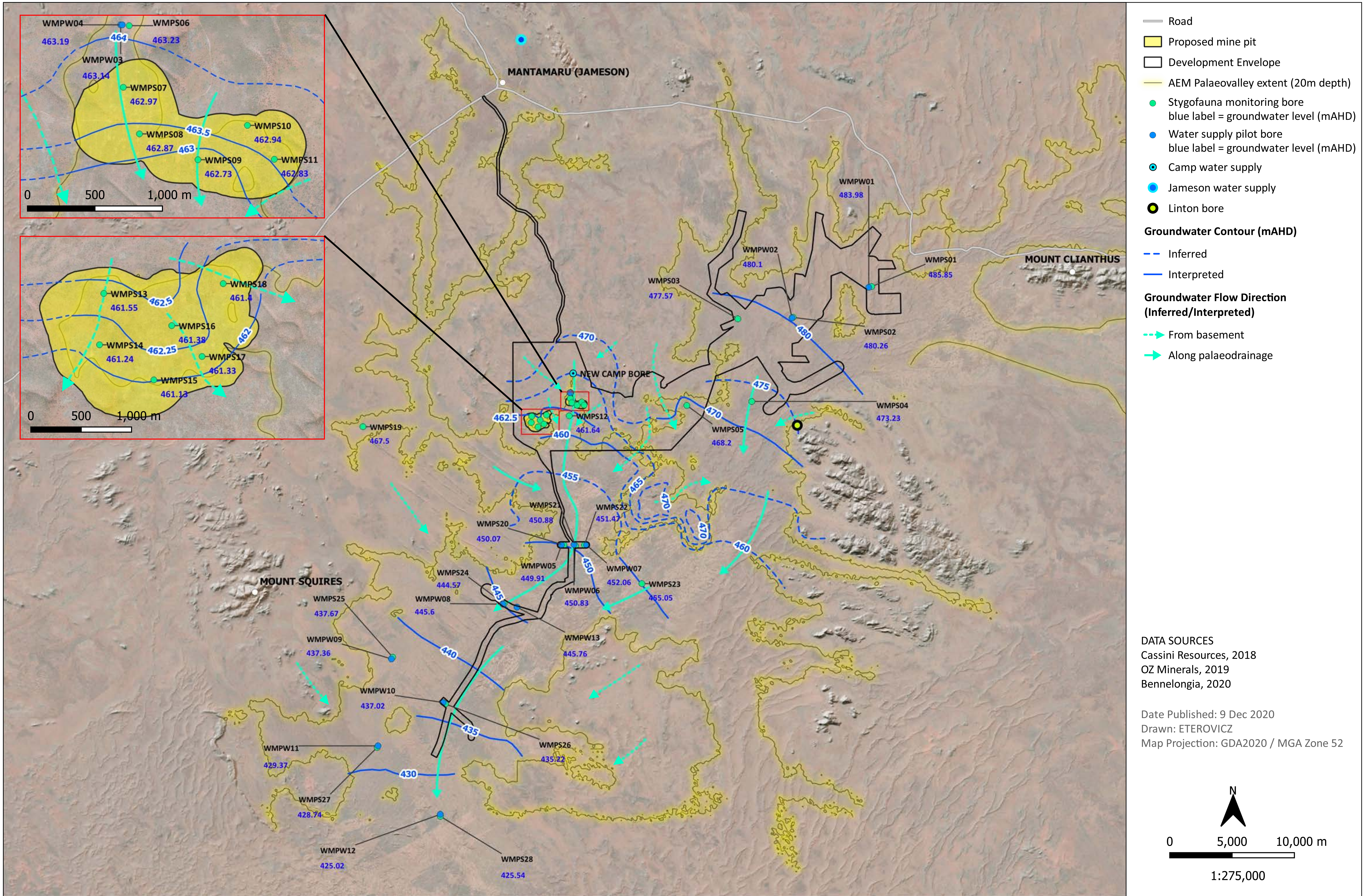



Figure 7-14: Conceptual Paleochannel Development at the Project Site




DATA SOURCES
Cassini Resources, 2018
OZ Minerals, 2019
Bennelongia, 2020

Date Published: 9 Dec 2020
Drawn: ETEROVICZ
Map Projection: GDA2020 / MGA Zone 52

Figure 7-15: Stygofauna monitoring bores and Water supply pilot bores groundwater levels (mAHD)

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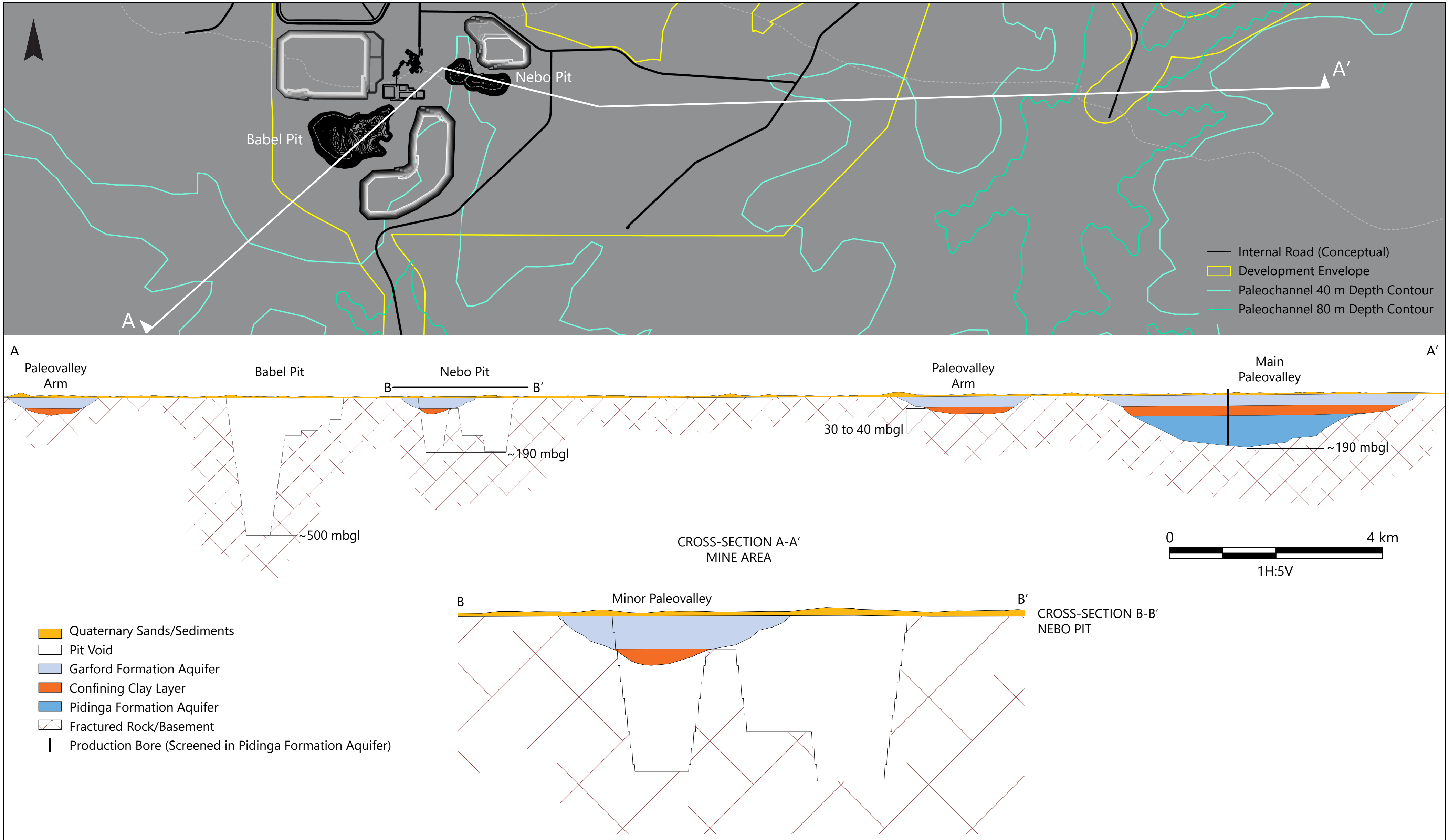


Figure 7-16: Indicative Cross-Section Through Mine Area Showing Paleochannel System

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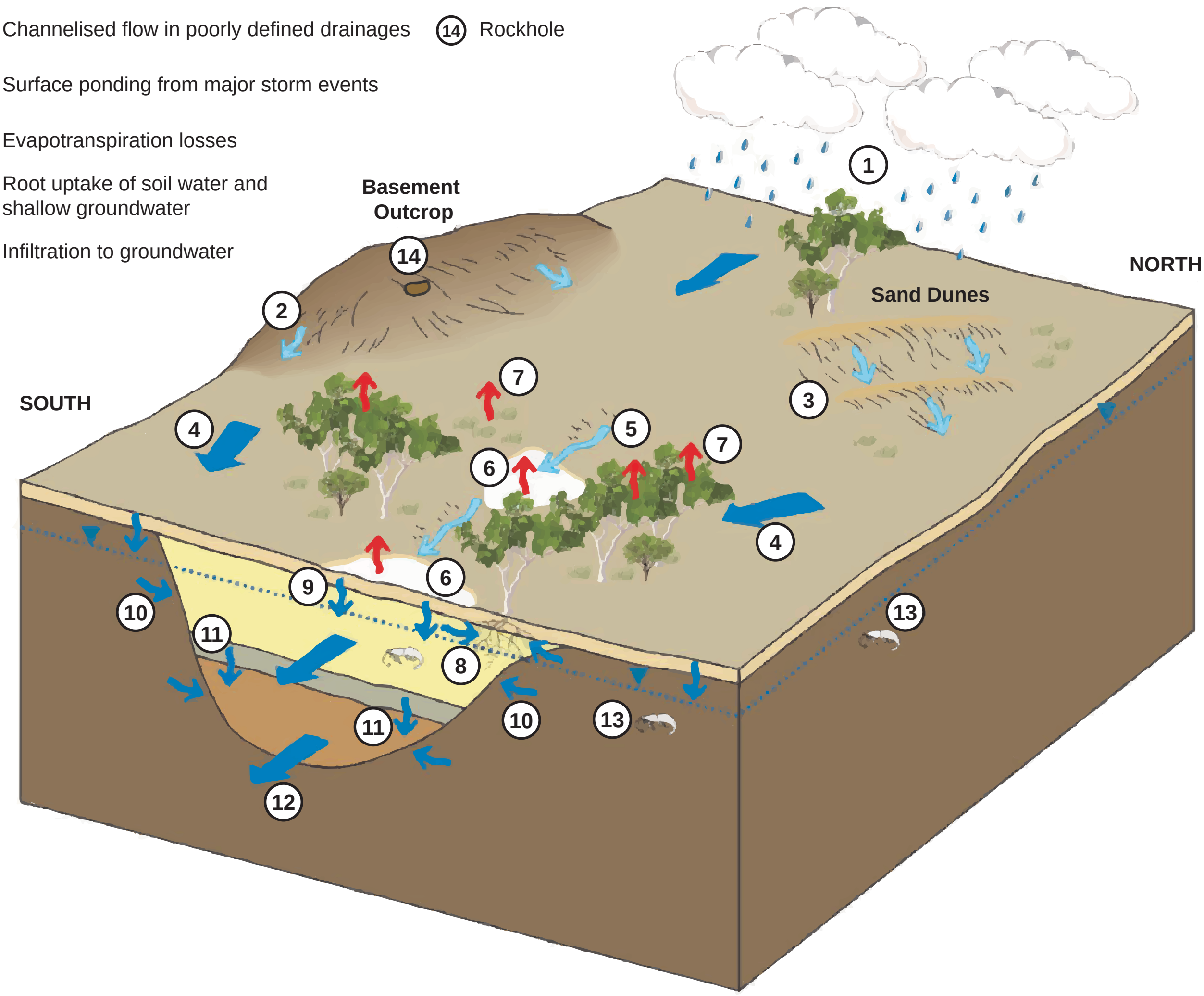
Figure 7-17 presents a conceptual hydrogeological model of the project area. The following describes the most relevant components of the conceptualisation:

1. Rainfall events, sufficient to result in runoff, are infrequent and erratic, usually associated with cyclonic depressions moving south from north-western Australia, or low-pressure cells moving north from the Great Australian Bight.
2. Rainfall runoff from elevated outcropping basement strata is likely to be channelised in colluvial material, possibly with relatively high infiltration on colluvial slopes. These recharge areas, where they exist, are on the margins of the Kadgo Paleovalley system in the project area.
3. Rainfall runoff from dunes is likely to be relatively minimal due to high infiltration rates into the aeolian sands.
4. Sheet flow over relatively flat and gently undulating landscapes is likely to occur during more intense rainfall events.
5. Some potential for channelised flow along ill-defined drainage lines with potential infiltration into underlying paleochannel sediments.
6. Surface ponding in mostly disconnected clay pans likely occurs during and following major storm events.
7. Evaporation losses of surface water (following rainfall events) and evapotranspiration losses from soil water reservoir (vadose zone).
8. Root uptake of soil water, as well as shallow groundwater that is accessible to plants.
9. Infiltration and recharge occurs from surface ponding, channelised flow and general runoff which is likely during and following larger rainfall events.
10. Minor groundwater flow into the paleochannel sediments from the basement strata is likely, but the poor aquifer characteristics likely make this a minor component of the overall water regime compared to surface water infiltration.
11. Groundwater leakage through the clay-rich interbedded zone between the Garford Formation and Pidinga Formation aquifers.
12. Groundwater throughflow down the Kadgo Paleovalley to the south, predominantly through both the Garford Formation and Pidinga Formation aquifers.
13. Stygofauna may be present in both paleochannel sediments and the basement strata (Section 7.4)
14. Rockholes situated on basement outcrops, collecting surface runoff over the outcrop surface.

**HYDROLOGY**

1. Rainfall (storm event)
2. Runoff from rock outcrops
3. Reduced runoff potential from dune fields
4. Sheet flow
5. Channelised flow in poorly defined drainages
6. Surface ponding from major storm events
7. Evapotranspiration losses
8. Root uptake of soil water and shallow groundwater
9. Infiltration to groundwater
10. Minor groundwater inflow from basement strata
11. Groundwater leakage through clay layer
12. Groundwater throughflow down Kadgo Palaeochannel
13. Stygofauna
14. Rockhole




**Legend**

- Water table
- Sheet flow
- Partial channelised flow
- Evapotranspiration
- Infiltration
- Water uptake by plants

**Geology**

- Quaternary sediments
- Garford Formation
- Clayey confirming unit
- Pidinga Formation
- Altered Gabbro Basement Strata

Figure 7-17: Conceptual Hydrogeological Model of the Project Area

### Groundwater Levels and Gradient

A shallow water table is consistently present throughout the landscape's different geological profiles. The water table, across all HSUs has been measured between 2.7 and 14.5 mbgl, with an average water level of 6.5 mbgl and median water level of 6.01 mbgl. The closeness of the average to the median water level illustrates the consistency of the water level across the units. Minimal differences in water table depths have been observed between paleochannel sediments and weathered bedrock aquifer systems. The groundwater measurements, when converted to pressure heads (elevations), show a steady groundwater gradient of approximately 0.1 percent from north to south, which equates to a change of ten vertical metres over ten horizontal kilometres, with flow lines converging southward along the Kadgo Paleovalley (Figure 7-15).

Sixteen pressure transducers were deployed in groundwater monitoring bores across the project area for a period of seven months (18 July 2019 to 23 February 2020) to assess seasonal fluctuations in water table depth. The depth fluctuations across these bores were between 0.08 m and 0.33 m with an average of 0.17 m over this period (Appendix D10).

Water has been intercepted in more than 98 percent of subterranean fauna monitoring bores (in 165 out of 168 monitoring bores), indicating, as expected, that the water table is largely continuous, shallow and laterally extensive.

### Groundwater Recharge

Groundwater recharge occurs predominantly via rainfall infiltration to paleovalley sediments and, to a lesser extent to outcropping and sub-cropping bedrock (Appendix D2). The rate of recharge is constrained by evapotranspiration losses from the soil reservoir. Further, it is predicted that only higher intensity/duration rainfall events that result in surface ponding or ephemeral flow are likely to result in significant recharge, with rainfall from lesser events evaporating prior to or soon after infiltration.

Groundwater recharge rates have been calculated for the proposed project using the chloride mass balance method. Groundwater recharge rates in the project area are estimated to be around 1 mm/yr which is equivalent to approximately 0.5 percent of average annual rainfall (Appendix D2).

### Groundwater Balance

A conceptual water balance has been calculated for the Kadgo Paleovalley sediments to semi-quantify groundwater system inputs and outputs at a sub-regional scale (Appendix D2). The water balance has been calculated for the entire area of the paleovalley sediments, up to the point just before they discharge into the Officer Basin approximately 50 km to the south. The calculation indicates the average groundwater discharge rate from the Kadgo Paleovalley to the Officer Basin is likely in the range 2.3 to 3.1 ML/d.

### Groundwater Modelling

A numerical groundwater flow model was developed for the proposed project (Appendix D3). It is recognised by OZ Minerals that without confidence in the groundwater model, its suitability to make predictions about impacts to environmental values may be flawed. As such, a high degree of effort, has been made to ensure that the model development is robust for this purpose, and includes both independent peer review (Appendix D9) and a range of sensitivity analysis to confirm appropriateness of inputs (Appendix D3).

The numerical groundwater flow model was developed to support the prediction of:

- Potential water supply opportunities and regional drawdown impacts of the proposed water supply borefield in the Kadgo Paleovalley
- Dewatering requirements to inform management at Babel pit and Nebo pit during the life of mine and the consequent impacts to the paleovalley and basement groundwater systems
- Pit lake formation and groundwater recovery post-mining
- Flowlines for assessing the fate of possible leachate that may arise from the proposed TSF and WRDs.

The numerical groundwater model was developed by groundwater consultants, CDM Smith, as follows:

- The model covers an area of 7,942 $km^2$ including Jameson (Mantamaru) and Blackstone (Papulankutja) communities, with the bounds identified through inspection of airborne geophysics (GeoTEM survey) data
- Developed using the MODFLOW-SURFACT software, which was chosen based on its robustness and capability to handle unsaturated and saturated flow
- Recharge was calculated using the chloride mass balance method
- Aquifer testing was undertaken to derive appropriate aquifer properties as inputs to the model, with a summary of the aquifer test analyses presented (Appendix D2)
- Calibrated using data collected from the 28 stygofauna and 13 pilot water bores
- Subject to independent peer review process with findings updated into the model (Appendix D9)
- Uncertainty analysis was undertaken to test the sensitivity of the model to various storage parameters for HSUs.

The final layout of the production bores may vary from that modelled. Given the high degree of conservatism used within the model, minor changes in the number and location of proposed bores would not materially change outcomes regarding security of water supply or predicted groundwater drawdown associated with groundwater abstraction or dewatering.

It was identified that the model would be most sensitive to storage parameters. Uncertainty analysis with a focus on specific storage and specific yield was undertaken to investigate the impact of varying aquifer storage values on modelled drawdown. The uncertainty analysis would also confirm the most reasonable of the modelled aquifer storage parameters and provide confidence in the ability of the Northern Borefield to supply the anticipated life of mine water demand. Modelled parameters for the uncertainty analysis are shown in Table 7-29.

**Table 7-29: Hydrogeological Properties for Uncertainty Analysis**

| Property | Base case | Low storage case | High storage case |
|---|---|---|---|
| Kh – Garford Formation (m/d) | 2.0 | | |
| Kh – Clay confining unit (m/d) | 0.001 | | |
| Kh – Pidinga Formation (m/d) | 3.0 | | |
| Kh – Basement (m/d) | 0.001 | | |
| Kv – Garford Formation (m/d) | 0.2 | | |
| Kv – Clay confining unit (m/d) | 0.0001 | | |
| Kv – Pidinga Formation (m/d) | 0.3 | | |
| Kv – Basement (m/d) | 0.001 | | |
| Ss – Garford Formation (1/m) | 0.0004 | | |
| Ss – Clay confining unit (1/m) | 0.00001 | | |
| Ss – Pidinga Formation (1/m) | 0.00005 | 0.000005 | 0.0005 |
| Ss – Basement (1/m) | 0.000001 | | |
| Sy – Garford Formation | 0.13 | 0.1 | 0.2 |
| Sy – Clay confining unit | 0.01 | | |
| Sy – Pidinga Formation | 0.05 | 0.03 | 0.1 |
| Sy – Basement | 0.005 | | |

Kh – horizontal hydraulic conductivity, Kv – vertical hydraulic conductivity, Ss – specific storativity, Sy – specific yield

The uncertainty analysis demonstrated the effect different aquifer storage properties may have on predicted water management volumes and aquifer drawdown impacts regarding both aerial and vertical extent (Appendix D3). Storage parameters adopted for the model are at the lower end of the likely range and as such, model predictions are likely to be conservative, potentially underestimating yield and overestimating drawdown. This is considered appropriate and in keeping with the precautionary principle.

The numerical groundwater model inputs used were based on outcomes of literature review, aquifer testing, peer review and uncertainty analysis as summarised in Table 7-30.

**Table 7-30: Assumed Hydrogeological Properties used in Modelling**

| Hydrogeological Unit | Horizontal Hydraulic Conductivity Kh (m/day) | Vertical Hydraulic Conductivity Kv (m/day) | Specific Storage (1/m) | Specific Yield (-) |
|---|---|---|---|---|
| Garford Formation | 2 | 0.2 | 4.00e-4 | 0.13 |
| Clay unit | 0.001 | 0.0001 | 1.00e-5 | 0.01 |
| Pidinga Formation | 3 | 0.3 | 5.00e-5 | 0.05 |
| Basement rock | 0.001 | 0.001 | 1.00e-6 | 0.005 |

## Groundwater Quality

A program of groundwater bore quality monitoring was undertaken across the project area (Appendix D10). Key findings relating to the water quality in the groundwater survey area include:

- Sampled groundwater are predominantly of sodium-chloride/bicarbonate type
- Groundwater pH is typically slightly alkaline, ranging from around 7.5 to 8.5 with little variability across the area
- Shallow groundwaters appear to be more alkaline than deeper groundwaters, which may be the result of interactions with shallow calcrete deposits
- Total alkalinity is relatively consistent across the project area and comprise essentially only bicarbonate alkalinity (i.e. no carbonate)
- Groundwater salinity ranges from marginal to brackish (920 to 4,500 mg/L) and is variable across the project area
- The difference between rainwater and groundwater salinity concentrations demonstrates significant evapotranspiration occurs in the project area
- Elevated levels of nitrate between 50 to 130 mg/L were recorded, consistent with high nitrate values as a known local groundwater phenomenon, with nitrate treatment required for the Jameson (Mantamaru) community water supply when operational (personal communication with WA Department of Health, 2018).

The elements generally enriched in the lithologies of the ore zone are recorded at low levels within the local groundwater, with median concentrations of:

- 0.002 mg/L for copper (range 0.001–0.003 mg/L)
- 0.001 mg/L for nickel (range 0.001–0.014 mg/L)
- 0.02 mg/L for zinc (range 0.01–1.4 mg/L).

#### 7.3.3.3 Surface Water

The findings of the surface water investigations, testing and studies are summarised in the following sections.

**Surface Water Catchments**

The proposed project is in the Nullarbor surface catchment within the Western Plateau Australian drainage division as shown in Figure 7-18. The catchment topography of the Development Envelope is characterised by low relief, poorly defined surface water catchments and disconnected ephemeral drainage lines. Topography ranges from highs of around 625 mAHD in the Jameson Range north-east of the Development Envelope, to lows of around 430 mAHD at the southern (Officer Basin) end of the Development Envelope. The typical average gradient across the area is in the order of 0.1 percent falling from north to south. The presence of clay pans and calcrete with a predominantly flat surface, i.e. small surface gradients, means that sheet flow is the dominant form of runoff following significant rainfall events. Sheet flow runoff that occurs following significant rainfall events terminates in disconnected low-lying areas such as playas and sand plains. Surface water is unlikely to move between catchments (Appendix D5).

The local surface water catchment and sub-catchment boundaries are shown in Figure 7-19.

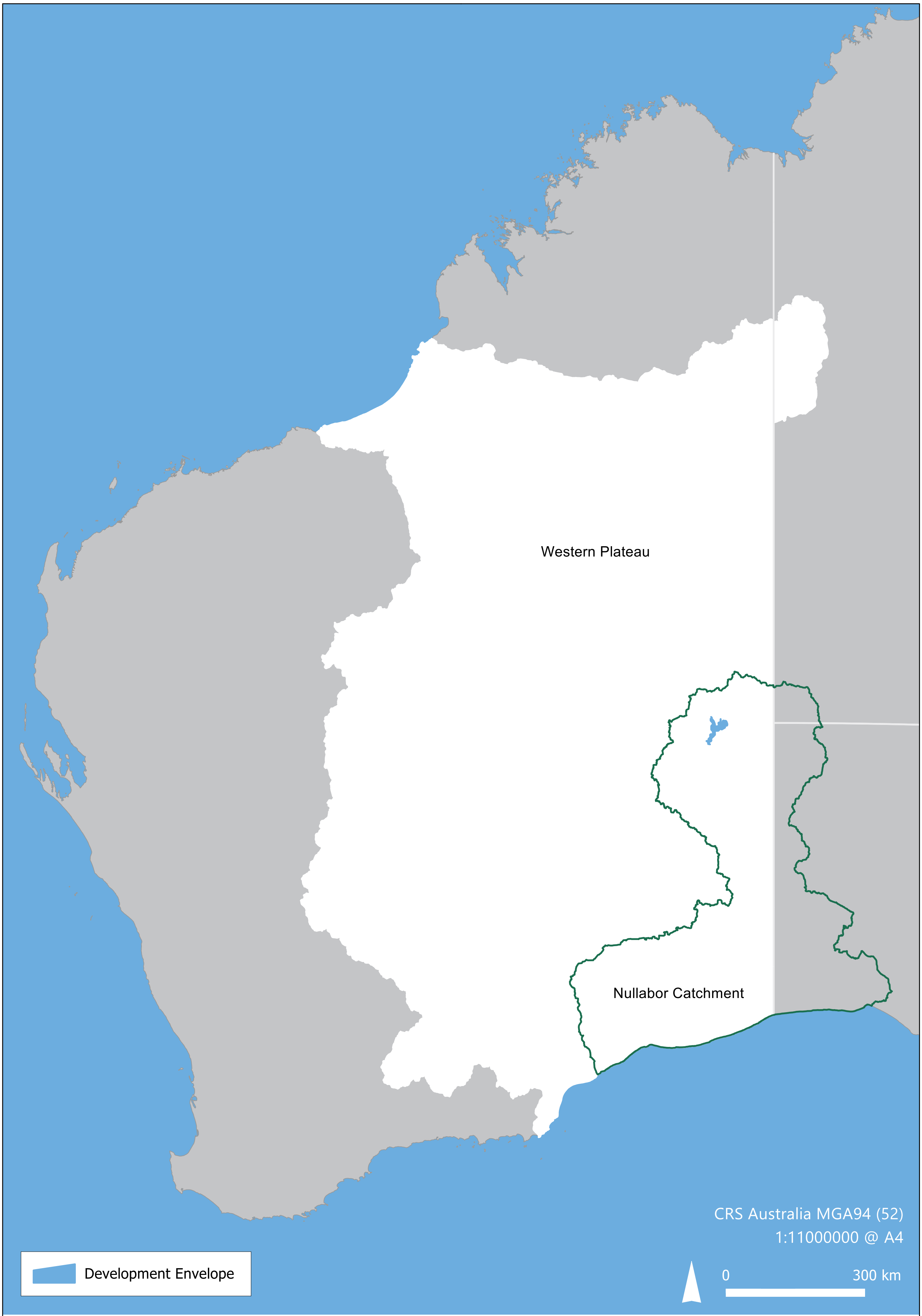



Figure 7-18: Project Location within Australian Surface Water Catchments

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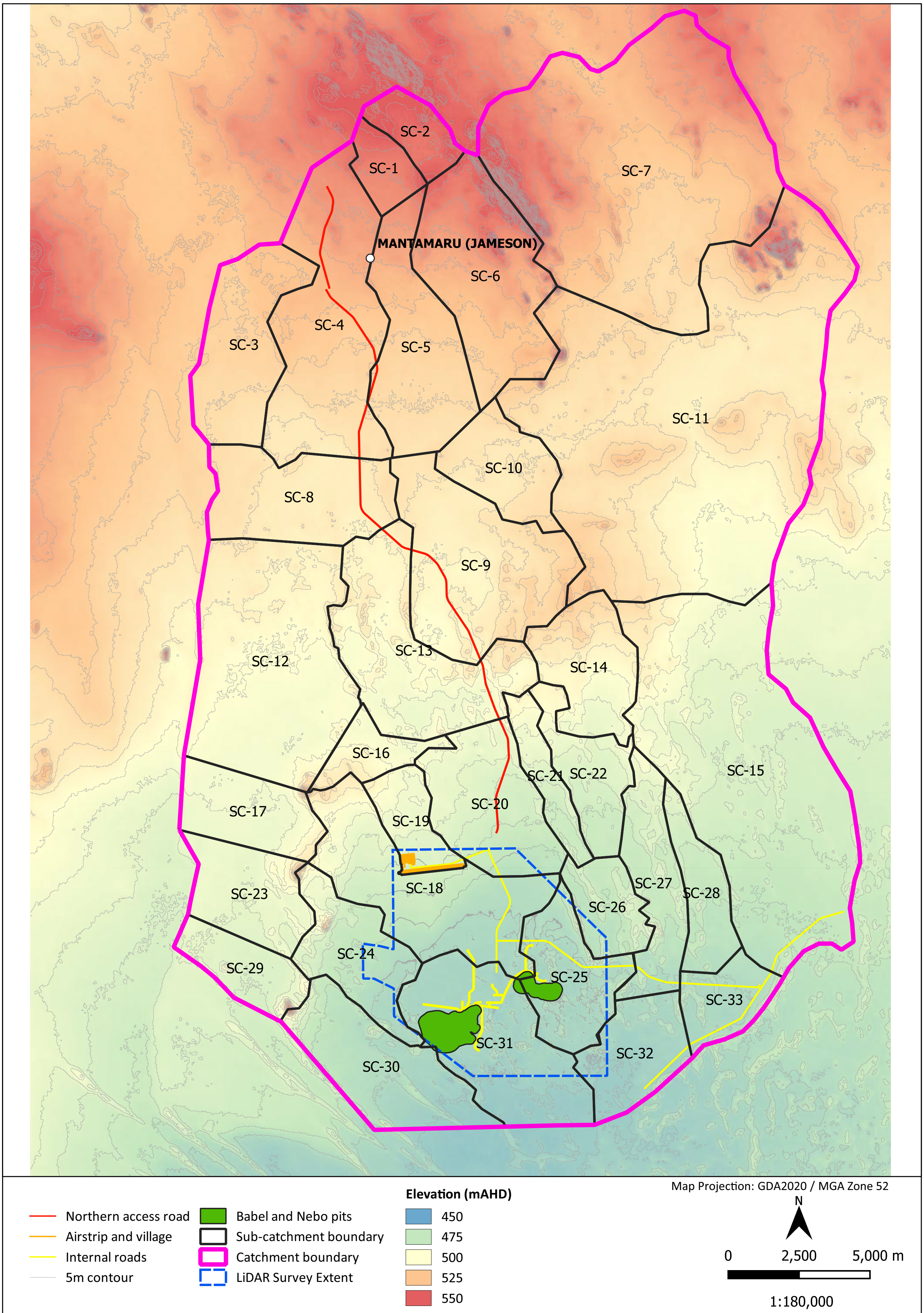


Figure 7-19: Catchments within the Immediate Project Area

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### Hydrology and Modelling

A hydrological assessment was undertaken to produce flood hydrographs for input to hydraulic model simulations. These hydraulic model simulations predict flood characteristics such as inundation depth, flood extent, and flow velocities. Rainfall modelling inputs were derived from the four nearest Bureau of Meteorology (BoM) climate stations. The hydrological assessment, hydrological modelling and hydraulic modelling is detailed in Appendix D5.

A major rainfall event occurred at the proposed project site in early January 2020 post-completion of the hydrological assessment. Rainfall intensity data was recorded, samples collected and observations relating to surface water ponding were made (Appendix A.6 of Appendix D5). Analysis of the data indicated that the event was between a 1 percent AEP and 5 percent AEP depending on the nominated critical duration. Observation showed only very shallow sheet flow, consistent with, but lower than, the hydraulic model results. Review of the rainfall event validated model parameters and indicated the model results are conservative, with predicted flows and flood depths likely overstated. This is considered appropriate in keeping with precautionary principles.

### Surface Water Quality

The project area does not have defined watercourses, ephemeral streams or discernible drainage channels, with observed rainfall events typically resulting in sheet flow conditions when runoff is generated. Thus, there are limitations on the ability to collect surface water quality samples to define water chemistry.

As a proxy for surface water runoff, rainfall samples were collected where possible and analysed to provide a level of baseline knowledge for future comparison of surface water sample results. Two rainfall samples were collected from the project area from a rainfall event in late November 2018 and a single rainfall sample was collected in early January 2020. Table 7-31 summarises the results of the subsequent laboratory analysis.

**Table 7-31: Measured Surface Water Quality in the Project Area**

| Analyte | Units | Core Farm | Laydown | Camp |
|---|---|---|---|---|
| | Sample date | 19/11/2018 | 19/11/2018 | 04/01/2020 |
| pH | pH Units | 6.5 | 6.4 | 6.3 |
| EC (µS/cm) | µS/cm | 33 | 29 | <2 |
| Carbonate | mg/L | <1 | <1 | <1 |
| Bicarbonate | mg/L | 7 | <5 | <5 |
| Total alkalinity | mg/L | 6 | <5 | <5 |
| Chloride | mg/L | <1 | <1 | <1 |
| Sulphate | mg/L | 2 | 2 | <1 |
| Nitrate, $NO_3$ | mg/L | 6.4 | N.A. | 0.2 |

| Analyte | Units | Core Farm | Laydown | Camp |
|---|---|---|---|---|
| Nitrite, $NO_2$ | mg/L | <0.05 | N.A. | N.A. |
| Calcium | mg/L | 3.3 | 2.8 | <0.2 |
| Magnesium | mg/L | 0.3 | 0.2 | <0.1 |
| Sodium | mg/L | 0.8 | 0.7 | 0.7 |
| Potassium | mg/L | 0.8 | 0.7 | 0.7 |

#### 7.3.3.4 Groundwater and Surface Water Interactions

Groundwater is relatively shallow throughout the project area (Figure 7-16 and Figure 7-17) and typically ranges between depths of 2.7 to 8 mbgl, although there are elevated areas where groundwater levels can be more than 22 mbgl.

Despite the shallow nature of groundwater in the project area, no permanent or semi-permanent wetlands, seeps, springs or partially saturated playas have been identified. OZ Minerals has consulted with Ngaanyatjarra People to understand whether there are springs located within the project area or the broader landscape. The Ngaanyatjarra People did not identify any springs, however indicated there are two rock holes located near to the Development Envelope. An assessment of the potential for interaction between these rock holes and groundwater was undertaken which demonstrated that the rock holes are surface water features that do not interact with groundwater (Appendix D5).

Whilst groundwater recharge is expected to occur across the project area, groundwater discharge is only likely to occur either to the Officer Basin sediments and/or where plants are able to access and transpire groundwater or the water table is shallow enough to allow evaporative losses via capillary rise.

### 7.3.4 Potential Impacts

The EPA Guidance for inland water provides several mechanisms ('issues') for consideration during the EIA process, specifically:

- Variable knowledge of groundwater and surface water systems
- Surplus water discharge to creeks and wetlands
- Reduced groundwater and surface water quality due to diffuse source impacts
- Creation of mine pit lakes
- Waste structures, including tailings storage facilities
- Aquifer recharge
- Growing abstraction in poorly understood regions.

A systematic assessment of how the proposed project interacts with the environment through changes to inland waters was undertaken, with consideration to the identified EPA issues (Appendix A2). In particular, the assessment aimed to confirm the potential for the proposed project's activities to interact with the environment that may result in direct, indirect or cumulative impacts to inland water-related environmental values. Based on this assessment the following potential impact events were identified:

- Groundwater abstraction during operations resulting in reduced availability and access to groundwater for current or future beneficial groundwater users. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively.
- Mine dewatering during operations resulting in reduced availability and access to groundwater for current or future beneficial groundwater users. Note potential impacts to GDEs and stygofauna area addressed in Section 7.1.5 and Section 7.4.5, respectively.
- Localised groundwater drawdown in perpetuity due to net evaporation of water from open pit lakes resulting in reduced availability and access to groundwater for future beneficial users. Note potential impacts to GDEs and stygofauna area addressed in Section 7.1.5 and Section 7.4.5, respectively.
- Altered surface water flows due to project infrastructure resulting in adverse physical changes to local or regional hydrology as a result of increased/decreased flow velocities, erosion, flooding and sedimentation. Note potential impact to flora and vegetation, fauna habitats and landforms as a result to change in surface flows are addressed in Section 7.1.5, Section 7.2.5 and Section 7.4.5, respectively.
- Contamination of groundwater due to seepage from mine landforms resulting in irreversible reduction in beneficial use. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively.
- Contamination of groundwater due to accidental spills of hazardous materials resulting in adverse impacts to current and future beneficial users. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively.
- Contamination of surface water due to deleterious solutes and/or sediments in runoff (from operational areas including waste) resulting in adverse impacts to current and future beneficial users. Note potential impacts to flora and vegetation, landforms and fauna habitat are addressed in Section 7.1.5, Section 7.2.5 and Section 7.6.5, respectively.
- Contamination of groundwater due to poor pit lake water quality post-closure resulting in adverse impacts to future beneficial users. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively.
- Reduction in health, richness and abundance of terrestrial fauna due to poor water quality that develops in pit lakes post-closure.

### 7.3.5 Assessment of Impacts

Each potential impact event identified in Section 7.3.4 was assessed to understand the mechanism by which impacts may occur, and to determine the inherent (unmitigated) risk of each potential impact.

Using the consequence and likelihood tables in the EIA Framework (Appendix A3), it was determined that the inherent risk of any of the potential impact events not meeting the EPA Objective for Inland Waters as a result of the proposed project were Low or Medium (Table 7-32 to Table 7-36), thereby not considered to require any specific avoidance and mitigations to meet the EPA's Objective for Inland Waters. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP (Section 7.3.6).

#### 7.3.5.1 Lowering of Groundwater Levels due to Borefield Abstraction and Mine Dewatering

The numerical groundwater flow model developed for the proposed project (Appendix D3) was used to predict the potential impacts of groundwater drawdown associated with the combined effects of mine dewatering, borefield abstraction, net evaporation losses from pit lakes and to make predictions relating to post-closure pit lakes.

There are no wetlands or other groundwater bodies of State, national or international importance within the West Musgrave region.

**Third-Party Users and Community Water Use**

Except for Jameson (Mantamaru) community water supply, and Linton Bore outstation groundwater bore (Figure 7-20) groundwater in the project area is not currently accessed by other water users. Settlements and communities are centralised and there are no pastoral activities within the Ngaanyatjarra Lands.

It is considered unlikely that additional potable supplies will be abstracted from areas within the local aquifer systems in the foreseeable future, nor that regional groundwater will be used for pastoral activities.

There are currently no other mining or other large projects that use groundwater located within 450 km of the project area. The proposed project does not preclude access to groundwater by other future groundwater users, subject to demonstration that such access would not compromise environmental values.

### *Jameson (Mantamaru) Water Supply*

Jameson (Mantamaru) community utilises an existing groundwater supply using two groundwater bores approximately 3.7 km north-north-east of the township (bores 120319121 and 120319122) (Figure 7-20). Data attained for these bores notes that water is contained within undifferentiated fractured rock from 20 to 50 m depth and therefore is most likely not from the paleochannel deposits. Water levels recorded at the time of construction in July 1997 were around 19.2 mbgl.

Groundwater flow modelling (Appendix D3) indicates that the predicted 0.5 m drawdown contour will not reach the Jameson (Mantamaru) community (26 km directly from the Development Envelope and 50 km upstream along the paleochannel), and therefore is unlikely to impact the Jameson town water supply (Section 7.3.5). This result has been replicated through a sensitivity analysis, whereby aquifer parameters (mainly storativity and specific yield) of the Garford aquifer and Pidinga aquifer were altered to present a range for potential outcomes, each indicating that no interaction between the proposed project's water abstraction and community water supply. The Jameson (Mantamaru) water supply has, for the purpose of the WMP study been conservatively assumed to draw water from paleochannel aquifers, however publicly available bore completion details indicate that it draws water from a fractured rock aquifer further north of Jameson (Mantamaru) thereby adding an additional layer of precaution to the impact assessment outcomes.

### *Linton Bore*

Linton Bore, shown on Figure 7-20, is thought to have been drilled in the 1950s to enable remote travel through the area, however no well completion details are available in any publicly available records. In the 1970s the Linton Bore area was considered as an option for community settlement as an alternative to Jameson (Mantamaru), however a decision was made to instead settle in Jameson (Mantamaru). Linton Bore is still frequently visited and considered by Ngaanyatjarra People to be highly significant owing to its proximity to the ethnographically important Cavanaugh Ranges.

Linton Bore was dipped in late September 2020 and indicated a water table depth of 11 mbgl, and an end of hole depth of approximately 15 mbgl. By comparison, the continual water table depths recorded in the paleochannels in the Northern Borefield and Nebo range between 6.01 mbgl and 7.96 mbgl at similar elevations. This variation in depth between the paleochannel and Linton Bore is not conclusive with respect to the potential for connectivity. As such, precautionarily it would be best assumed that a connection between the borefield's aquifer system and Linton Bore is possible, and that Linton Bore may experience up to 2 m of drawdown based on modelled contours. Should this level of drawdown occur it is expected that there would remain 2 m of available water in the bore. This being said, it is highly likely that Linton Bore is hosted in either the Garford paleochannel or weathered and fractured saprock systems, where there is known to be a significant vertical aquifer system greater than 40 mbgl. Should water at Linton Bore indicate an effect from borefield operation a deeper bore can be drilled to further access the vertical aquifer system and ensure a continuous water supply at this location.

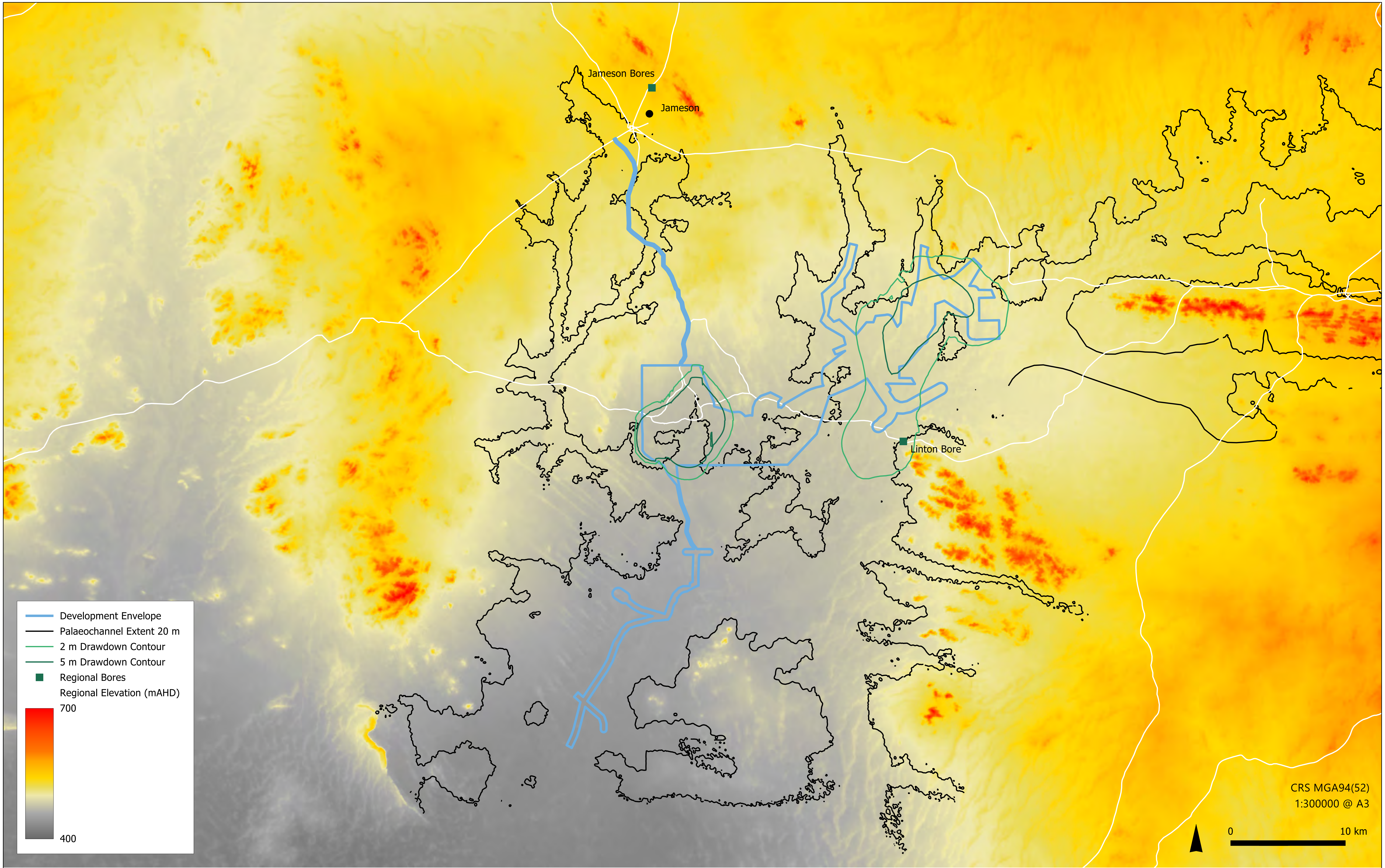


Figure 7-20: Location of Jameson Community Water Supply in Relation to the Project

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### Borefield Abstraction

Abstraction of groundwater from the Northern Borefield would be from the deeper Pidinga Formation. As there is a confining clay layer between the Garford Formation and underlying Pidinga Formation, depressurisation of the Pidinga Formation is buffered at the surface. Drawdown of the water table (Garford Formation) occurs slowly and to a much lesser extent than depressurisation of the target Pidinga Formation aquifer. Figure 7-21 illustrates predicted water table (Garford Formation aquifer) drawdown contours at the end of operations and Figure 7-22 illustrates the predicted drawdown contours in the (confined) Pidinga Formation aquifer at the same time. The following are the key outcomes of the drawdown modelling:

- Drawdown due to groundwater abstraction from the Northern Borefield is predicted to be contained mostly within the extent of the paleochannel system to the east of the proposed mine, with drawdown predicted to extend a relatively small distance into the bounding basement groundwater system.
- The maximum predicted water table drawdown (i.e. within the overlying Garford Formation aquifer) as a result of operating the Northern Borefield (i.e. pumping from the Pidinga Formation aquifer) is approximately 5 m, due to the Garford Formation aquifer continuing to drain to the depressurised Pidinga Formation aquifer below it.
- Water levels in the Northern Borefield are expected to return to within 10 percent of their steady state within 10 to 20 years following cessation of water abstraction.
- There is no overlap between the drawdown of the mine pit voids and the Northern Borefield.

There are no other existing, and little potential for significant future, groundwater users within the drawdown area of the Northern Borefield. Localised lowering of the water table during operations and post-closure, during the period of recovery, would not affect other users. Impacts of localised drawdown associated with borefield abstraction on vegetation, specifically GDEs, is addressed in Section 7.1.5. Impacts of localised drawdown associated with borefield abstraction on stygofauna is addressed in Section 7.4.5.

### Mine Dewatering

Dewatering would be required from both pits to allow safe mining. Dewatering would occur from the Garford Formation for the Nebo pit and from the fractured rock aquifer from both the Babel pit and Nebo pit.

Modelling was conducted to predict the effect of mine pit voids on groundwater during the period of mine operations and into the future i.e. post closure. Key outcomes of drawdown modelling are described below for both operations and post closure.

### *Groundwater Drawdown from Mine Pit Dewatering During Operations*

The following are the key outcomes of the drawdown modelling for operations:

- The cone of drawdown around the mine pits during operations is most influenced by the dewatering of Nebo pit due to the presence of the Garford Formation paleochannel aquifer, whereas the Babel pit is hosted within weathered basement (saprock) and fractured bedrock with inherently lower porosity.
- Drawdown around the mine pits largely follows the paleochannel approximately north and south of Nebo pit, with a maximum drawdown depth at depths equal to the total depth of the mine pits themselves. The drawdown extends into the surrounding basement rock up to a distance of 3 km to the east and west of the pits (Figure 7-21).
- There are no existing, and low potential for significant future, groundwater users within the drawdown area associated with mine dewatering during operations.

### *Groundwater Drawdown from Mine Pit Dewatering Post Closure*

The largest probable mine-related groundwater drawdown is associated with the post-closure pits. As such, potential impacts to vegetation, specifically GDEs and stygofauna are based on the post-closure drawdown projections and are detailed further in Section 7.1.5 and Section 7.4.5, respectively. Localised lowering of the water table post-closure would not affect other users.

Due to the high net evaporation rate at the site, pit voids that are not backfilled are predicted to act as groundwater sinks in perpetuity. Two closure scenarios were modelled to guide the proposed project's development planning, specifically:

- Both Babel pit and Nebo pit voids left open at closure
- Babel pit left as a pit void, Nebo pit backfilled to above the water table.

Scenarios were modelled for the full life of mine and 1,000 years post-closure in order to capture the 'steady state' or 'in perpetuity' drawdown effects of the open pits. The modelling indicated that drawdown associated with the Nebo pit void in perpetuity result in broad drawdown contours (Figure 7-23). This is due to Nebo pit being partially located in a paleochannel, resulting in a relatively flat drawdown cone of depression with a wide-ranging areal extent, whereas Babel pit is located outside of the mapped paleochannel in less permeable saprock and basement rock resulting in a steeper drawdown cone of depression, with a lesser areal extent. As a result of this assessment, the base case for the proposed project was refined to incorporate backfilling of the Nebo pit with either tailings and/or mine waste to precautionarily minimise the areal extent of in perpetuity drawdown. Consideration of drawdown assuming backfilling of Nebo pit found that:

- Localised lowering of the water table post-closure is unlikely to affect other regional groundwater users (e.g. community, agriculture or other mining projects)

- There is low potential for significant future groundwater users within the mine pit drawdown area post-closure
- Impacts of localised drawdown associated with mine dewatering on vegetation, specifically GDEs and stygofauna is addressed in Section 7.1.5 and Section 7.4.5, respectively
- Impacts associated with formation of a pit lake are addressed in following subsections.

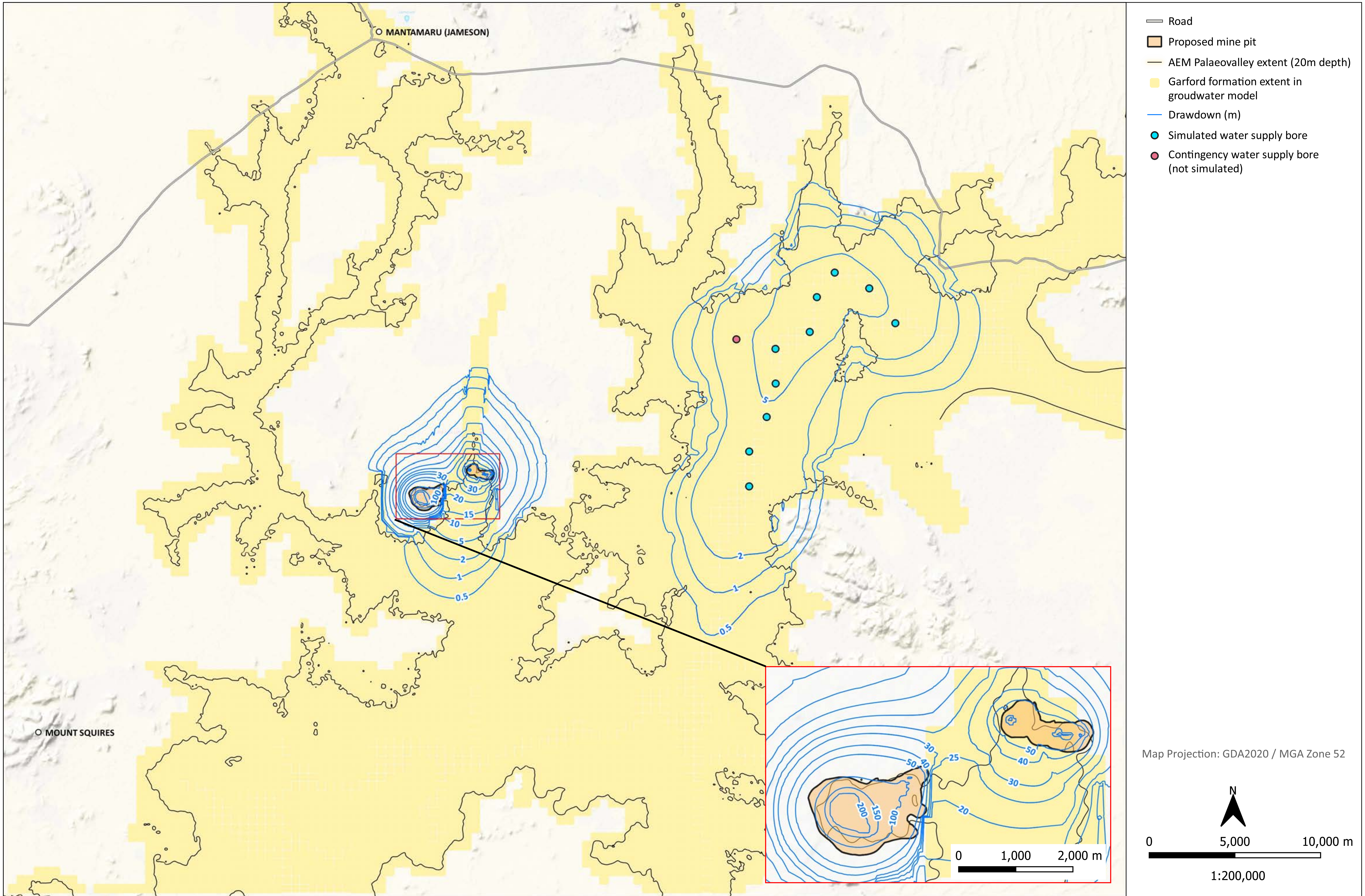


Figure 7-21: Predicted Drawdown of the Water Table (Garford Aquifer) at the Cessation of Mining

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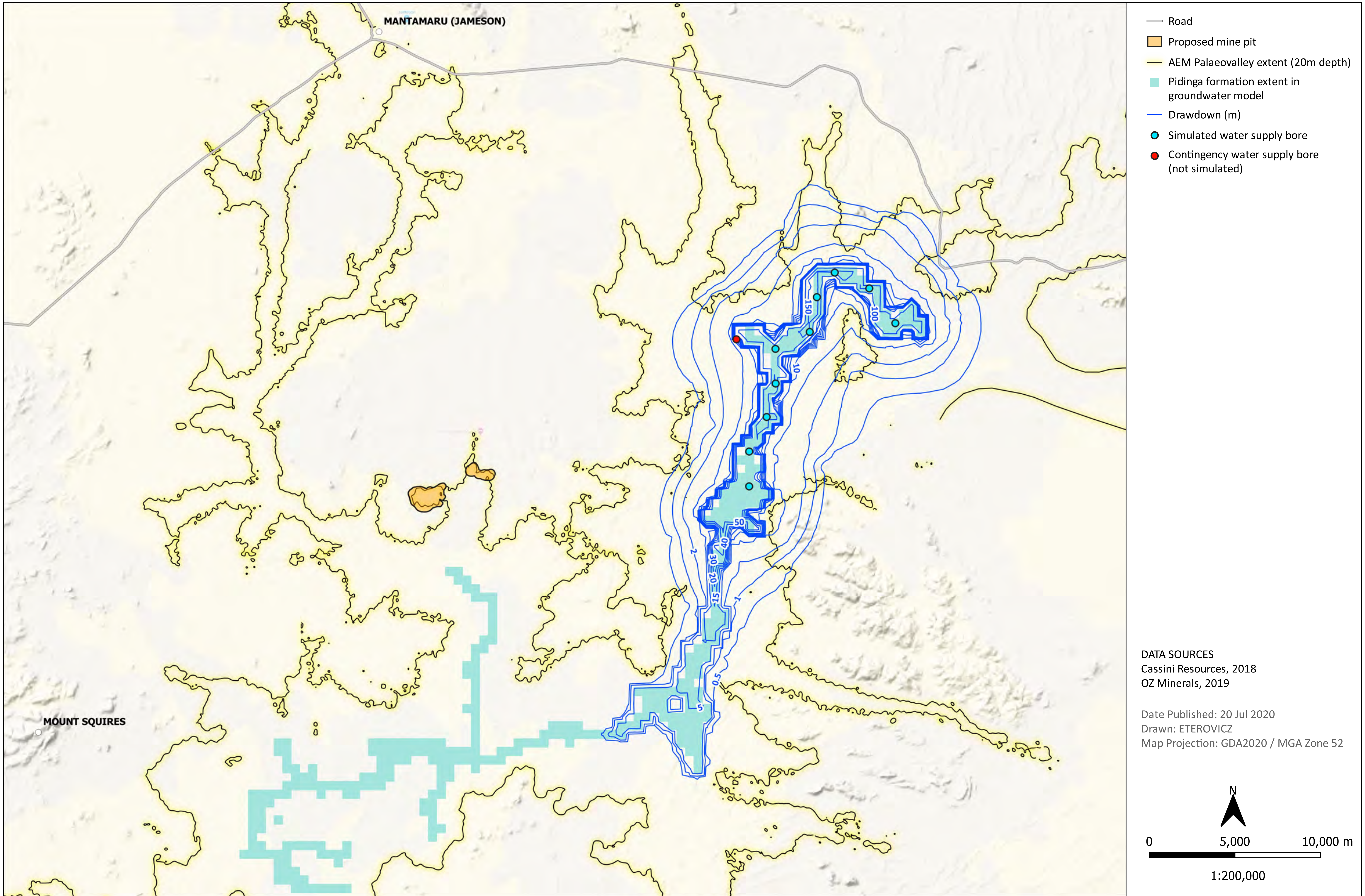


Figure 7-22: Predicted Drawdown in the Confined Pidinga Formation at the Cessation of Mining

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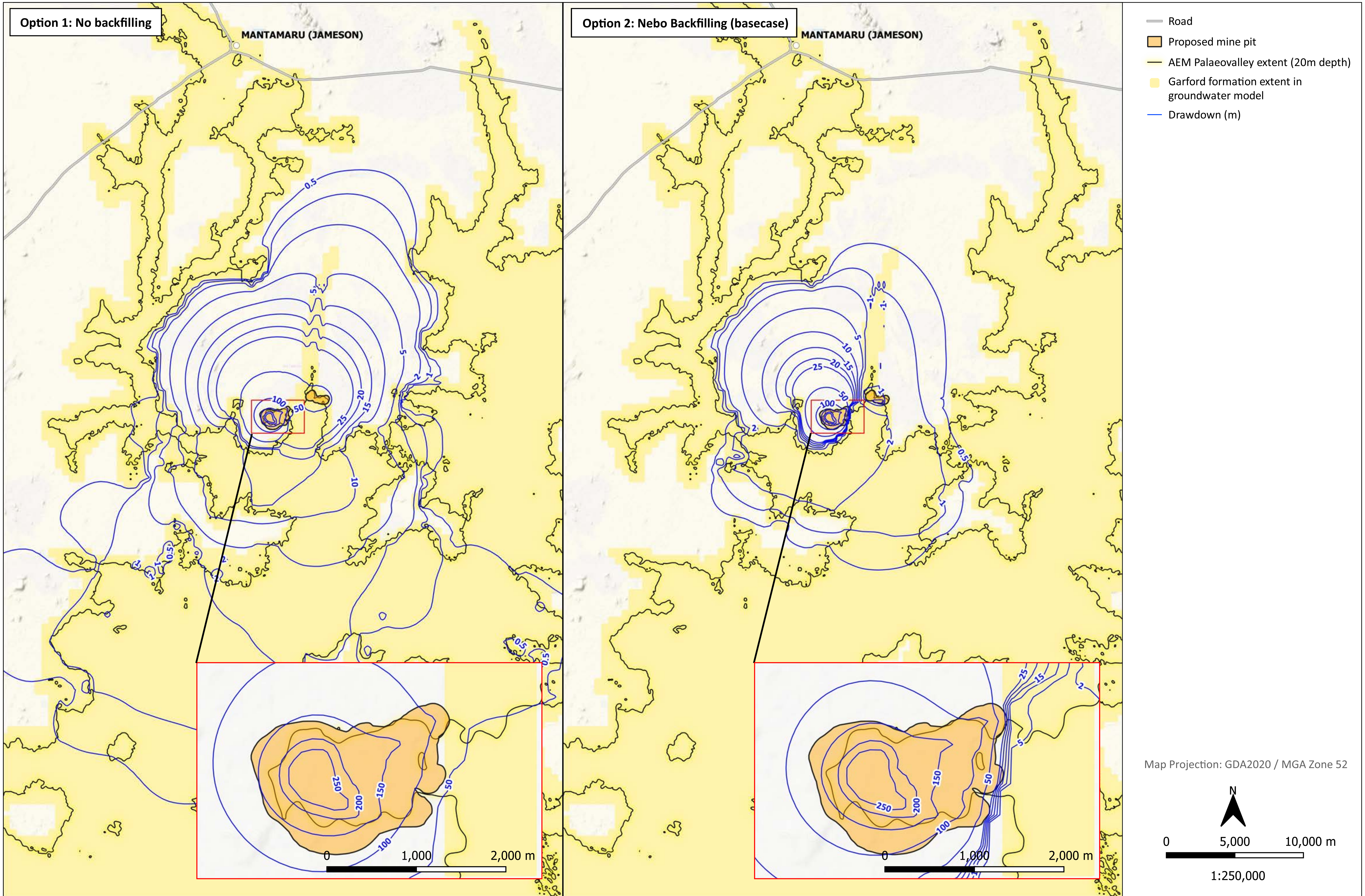


Figure 7-23: Predicted Drawdown of the Water Table (Garford Aquifer) at Full Recovery (New Steady State) for the Two Closure Alternatives

The assessment of inherent (unmitigated) risk of groundwater abstraction and mine dewatering during life of mine and in perpetuity resulting in localised lowering of groundwater levels is provided in Table 7-32.

The assessment of inherent (unmitigated) risk of localised groundwater drawdown during operations and in perpetuity resulting in adverse impacts to existing and future beneficial users are provided in Table 7-32 and were determined to represent Low or Medium risks. Section 7.3.6 presents avoidance and mitigation measures to further reduce the risk to ALARP.

**Table 7-32: Assessment of Inherent Risk – Potential Impacts of Groundwater Drawdown as a Result of Abstraction and Mine Dewatering[4]**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Groundwater abstraction during life of mine resulting in reduced availability and access to groundwater for current or future beneficial groundwater users | Unlikely | Minor | Low | Groundwater modelling indicates that groundwater drawdown is predicted during the life of mine as a result of water abstraction. Groundwater modelling parameters are conservative as demonstrated by the uncertainty analysis (and therefore represent a worst case). If storage parameters are found to be less conservative, drawdown observed over the life of mine would be less than predicted. No beneficial groundwater users have been identified within the vicinity of the drawdown contours |
| Mine dewatering during life of mine resulting in reduced availability and access to groundwater for current or future beneficial groundwater users | Unlikely | Minor | Low | |
| Localised groundwater drawdown in perpetuity due to net evaporation of water from open pit lakes resulting in reduced availability and access to groundwater for future beneficial users | Possible | Moderate | Medium | Should no mitigation measures be in place, both Babel pit and Nebo pit voids would develop pit lakes, and due to connectivity of the Nebo pit void with the relatively highly transmissive paleochannel sediments coupled with high evaporation, the drawdown cone of depression would extend tens of kilometres. Given the absence of current beneficial users in this area, the residual risk is reduced. The available regional water resources ensure that future beneficial users would retain access to alternative and nearby sources, and as such the overall risk is considered not significant |

[4] Note: This impact assessment is based on potential beneficial users. Impacts of localised drawdown associated with mine dewatering on vegetation, specifically GDEs and stygofauna is addressed in Section 7.1.5 and Section 7.4.5

#### 7.3.5.2 Modification to Surface Hydrology

Surface waters are not collected for use by third parties in the project area. There are no rivers, lakes or dams in the region.

The hydrologic and hydraulic model results (Appendix D5) indicate the following in relation to baseline surface water dynamics:

- Runoff is typically only expected for large, low frequency (low AEP) events with >5 percent AEP events predicted to generate little to no runoff
- If runoff does occur (for large, low frequency events (5 percent AEP or less)), sheet flow is expected to be the dominant form of runoff across the broader project area because there are no well-defined channels
- There are areas within the mine infrastructure where rainfall runoff would collect and flow following intense rainfall events, particularly where there is a succession of interconnected low-lying terrains that form ill-defined drainages
- Ponding across extensive areas is expected to occur due to the common presence of minor depressions (typically terminal) in the terrain and the associated lack of well-formed drainages available to transport water away
- The area between the two proposed pits, from north to south, would form a natural flow path during major flood events.

Modelling indicates that diversion of storm flows, as required, around the Main Development Area should have no significant effect on total flows, depths (Figure 7-24) or velocities (Figure 7-25) upstream or downstream of the Development Envelope (Appendix D6). Further it has been identified that infiltration arising from smaller, relatively frequent rainfall events, that do not generate runoff, is likely to be the primary source of water to sustain environmental water requirements for flora, vegetation and fauna habitats. As such, the minor shadowing that is predicted for large, lower frequency rainfall events is not predicted to have an impact on environmental values.

Following the initial surface water modelling (Appendix D6) undertaken to support project design and the impact assessment, an alternative TSF location has been considered. While surface water modelling for this alternate TSF location has not occurred, a qualitative assessment of the revised TSF location has. The revised TSF location is expected to slightly increase the volume of water that may pass between the two pits from north to south during large, low frequency events of 5 percent AEP or less (Appendix D11). However, this revised project layout has not changed the risk profile to environmental values for the reasons state above.

The assessment of inherent (unmitigated) risk resulting from an increase or decrease in surface water flows (and potential changes to flow velocities, erosion, flooding and sedimentation) is provided in Table

7-33 and was determined to represent a Low risk. Section 7.3.6 presents avoidance and mitigation measures to further reduce the risk to ALARP.

**Table 7-33: Assessment of Inherent Risk – Potential Impacts of Increase or Decrease in Surface Water Flows**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Altered surface water flows due to project infrastructure resulting in adverse physical changes to local or regional hydrology as a result of increased/decreased flow velocities, erosion, flooding and sedimentation | Likely | Insignificant | Low | Studies demonstrate that runoff only occurs as a result of high intensity, low frequency rainfall events (<5% AEP) and that any runoff that does occur is likely to be as sheet flow. Velocities are relatively slow, and erosion potential is also low. Changes to velocities as a result of the proposed project infrastructure are unlikely to have an impact on environmental values. Similarly, although increases to flood depths are likely to occur as a result of proposed project infrastructure, flooding would not persist in the landscape for any extended time and increases in depth is unlikely to have an impact on environmental values |

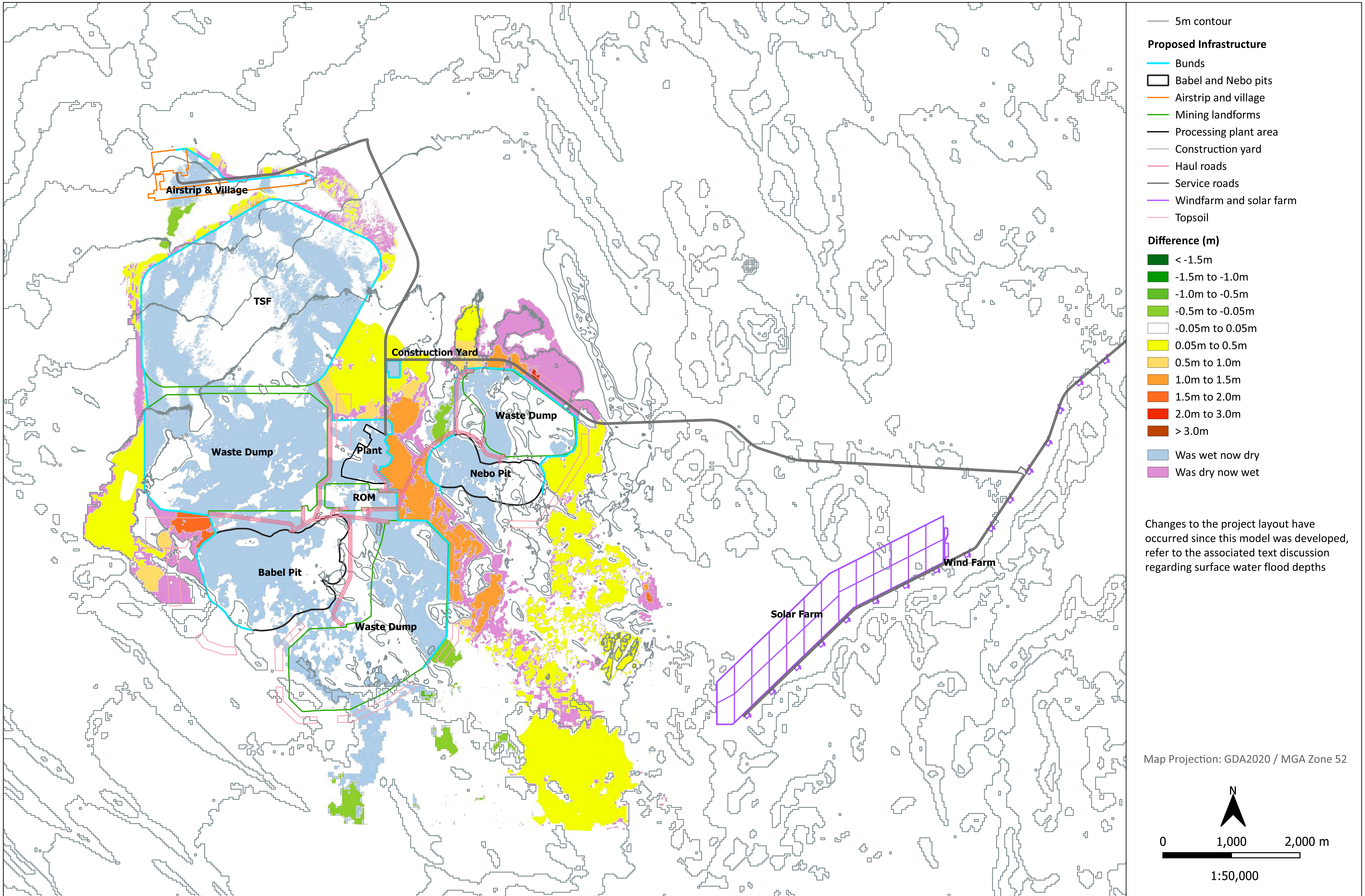


Figure 7-24: Pre- and Post-Development Changes to Surface Water Flood Depths (1% AEP Event)

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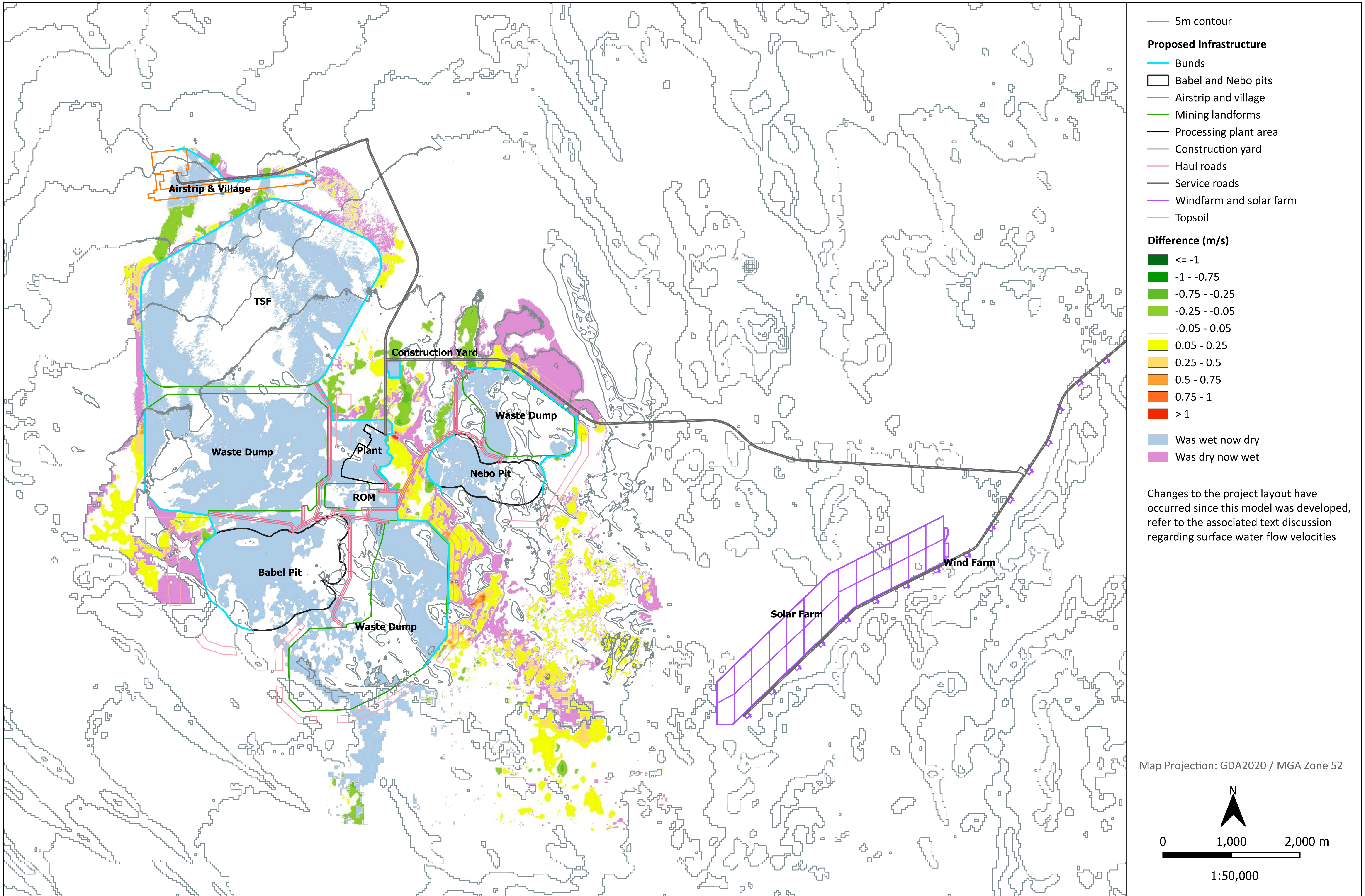


Figure 7-25: Pre- and Post-Development Changes to Surface Water Flow Velocity (1% AEP Event)

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#### 7.3.5.3 Change to Groundwater Quality Due to Seepage from Waste Landforms

Geochemical characterisation of tailings and waste rock (static and kinetic) has been undertaken with results described in Section 7.5.3. Results provide information on solutes that could be expected in leachate from waste landforms. This indicates the following potential soluble parameters of environmental concern in mine waste:

- Waste rock and ore – aluminium, antimony, cadmium, cobalt, copper, iron, manganese, molybdenum, nickel, sulphate, selenium and zinc
- Tailings – copper, manganese, nickel and sulphate.

A hydrogeochemical study was undertaken to predict the movement of these potential solutes originating from landforms and their concentrations over time (Appendix D7). This study identified that the key mechanisms affecting changes in concentration of these chemicals as a result of the proposed project are:

- Increased magnitude of source: exposure of PAF materials (waste rock and pit walls) to atmosphere and lowering of the water table would increase the solute load to groundwater
- Evapo-concentration: concentration of solutes in the pit lake would increase the concentration of dissolved solutes
- Precipitation: key precipitates would be hydroxides and carbonates of copper, nickel, selenium, silver and tellurium. Precipitation may occur as leachates interact with groundwater within aquifers and within the pit lake
- Decreased hydraulic conductivity surrounding the pit and beneath the WRDs: it is considered likely that reduced hydraulic properties from compaction and in situ precipitation of reaction products may mitigate the scale of direct effects
- Dilution: quantities of dissolved solutes may not alter the quality of the groundwater by any measurable amount given the low solubility of the minerals reported in the ore and waste, and the flow rate of water through the primary receiving aquifers; the Garford and Pidinga aquifers within the Kadgo Paleovalley or the fractured rock aquifer outside of the paleovalley.

The geochemical transit model developed for the hydrogeochemical study demonstrated that the vertical migration of solutes through the unsaturated profile significantly reduced the load of dissolved solutes to groundwater. Even limiting the potential attenuating media to calcite (iron oxides in situ were excluded, iron oxides were only considered as precipitates from the solution), there was enough attenuation by the aquifer matrix to reduce the concentrations of the elements of most concern. Further, the lateral model demonstrated that dilution and additional attenuation through sorption on the aquifer matrix significantly reduces the concentrations of dissolved solutes sourced from the wastes to acceptable levels relatively close to solute generating sources (within tens to hundreds of metres). As a result:

- All leachate from the Nebo WRD and backfilled Nebo pit is predicted to be below concentrations of concern at the point of entry to the water table.
- Seepage from the TSF (for both locations assessed) and Babel WRDs is predicted to be above concentrations of concern at the point of entry to the water table, however concentrations decrease significantly due to adsorption within metres, as the solutes move through the soil matrix and as such meet acceptable guideline limits within short distances from the structures themselves; within tens to hundreds of metres.

The geochemical transit modelling indicated that concentrations of solutes from waste landforms were reduced through adsorption to levels below the relevant criteria within tens to hundreds of metres. As a precautionary measure, the numerical groundwater model was used to undertake particle tracking to predict the potential fate of any leachate that may enter the water table from beneath the proposed TSF, WRDs and the backfilled Nebo pit. Particle tracking was performed on the post-mining recovery (new steady state) model (Appendix D4). Figure 7-26 presents the predicted particle tracks, showing:

- The flowfield beneath the northern (Babel) WRD are captured by Babel pit
- The flowfield beneath the southern (Babel) WRD is also captured by Babel pit
- The flowfield beneath the ROM pad and low-grade ore stockpiles are captured by Babel pit
- The greater part of the flowfield from the beneath the TSF, Nebo WRD and part of the flowfield from beneath the eastern WRD and through the backfilled Nebo pit is predicted to also be captured by Babel pit, but part of the flowfield is also predicted to migrate to the south of the project and join the regional paleochannel system; however these solutes will be below concentrations of concern.

A geochemical reactive transport model was developed, and several scenarios were assessed to predict potential effects and inform management measures. The modelled scenarios considered multiple waste landform positions across the project area and included backfill options for the pits (filled with waste rock or tailings). A conservative approach was taken in by using the maximum recorded concentrations from the kinetic leach experiments combined with a maximum likely seepage rate from WRDs and the maximum hydraulic conductivity of the paleochannel to assess a worst-case scenario. The scenarios included an assessment of pit lake water quality evolution for 1,000 years post closure for the Babel pit (noting that the Babel pit is predicted to be a hydraulic sink for groundwater post closure. Therefore, the increased solute concentrations present in the final lake would be unlikely to leave the void given the low hydraulic conductivity of the basement lithologies and the potential for precipitation to occur in situ).

Results of this assessment demonstrate that impacts to environmental values due to solutes from waste landforms are limited to those where humans may have direct contact with seepage liquors (e.g. pit walls and waste landform external batters).

The assessment of inherent (unmitigated) risk for contamination of groundwater due to seepage from mine landforms resulting in adverse impacts to environmental values including existing and future beneficial users is provided in Table 7-34 and was determined to be a Medium risk. Section 7.3.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-34: Assessment of Inherent Risk – Potential Impact Resulting from Contamination of Groundwater Resulting from Mine Landforms**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Changes to groundwater quality due to seepage from waste landforms resulting in irreversible reduction in beneficial use | Possible | Moderate | Medium | Geochemical testing has indicated that less than 10% of waste rock material is PAF and that leachate is likely to be benign. However, if PAF waste rock is not encapsulated it is possible that deleterious solutes would seep from waste landforms and enter the groundwater in concentrations that would potentially impact existing and future water users. The hydrochemistry study has demonstrated that through natural attenuation processes that groundwater quality contamination would be highly localised (i.e. be attenuated to within acceptable guideline limits within tens to 100s of metres from the source), and unlikely to result in a significant impact to existing and future groundwater users |

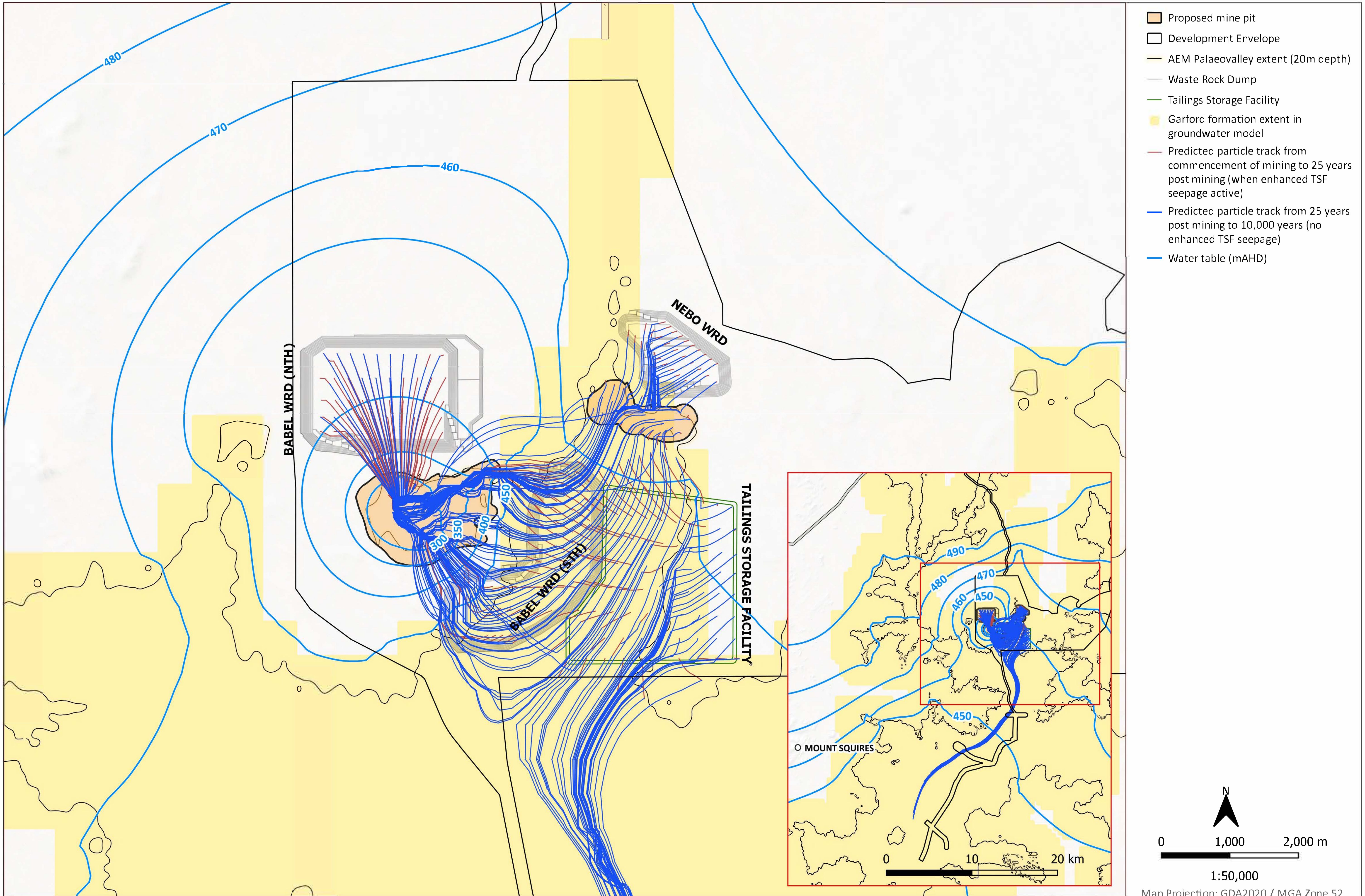


Figure 7-26: Predicted Seepage Fate Particle Tracks (Steady State)

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#### 7.3.5.4 Change in Surface Water Quality

There is not expected to be any overall change to disconnected ephemeral drainage behaviour of the overall catchment and salinity concentrations would continue to be dominated by water pooling and evaporating cycles. However, there would be localised increases and decreases in salinity as the likely pooling locations (e.g. clay pans) change with placement of built and linear infrastructure.

Increase in sediment loads carried by surface flow due to construction is considered probable. Sedimentation at low lying locations has the potential to impact vegetation. Erosion control measures would be considered in the design of constructed facilities such as TSF, WRDs, stockpiles and bunds. Sediment control would be required to limit impacts associated with water quality.

Section 7.5.6 details controls relating to the containment of potentially leachate generating landforms and processes (e.g. TSF, WRDs, processing plant, WWTP and hazardous material storage areas).

The assessment of inherent (unmitigated) risks of contamination of surface water due to accidental spills of hazardous materials, solutes or sediment resulting in adverse impacts to current and future beneficial users is provided in Table 7-35. These risks were determined to be Medium Risks. Section 7.3.6 presents avoidance and mitigation measures to further reduce the risk to ALARP.

**Table 7-35: Assessment of Inherent Risk – Potential Impact Resulting from Contamination of Surface Water**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Contamination of groundwater due to accidental spills of hazardous materials resulting in adverse impacts to current and future beneficial users | Unlikely | Minor | Low | Surface water within the Development Envelope is disconnected (i.e. no defined waterways) and occurs infrequently for short durations only following significant rainfall events. Contamination of surface waters is likely to occur infrequently, be highly localised, given the size of rainfall events required to get surface water flows, with affected areas small, given low surface water flow velocities |
| Contamination of surface water due to deleterious solutes and/or sediments in runoff (from operational areas including waste) resulting in adverse impacts to current and future beneficial users | Possible | Moderate | Medium | If left unmitigated AMD generation from stockpiled pyrite-violarite may occur following as little as one or two rainfall events which are sufficiently heavy to generate net percolation through the exposed material. Any such seepage would have a high concentration of metals and metalloids that could contact the receiving environmental values if left unmitigated. |

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| | | | | Solute fate modelling has demonstrated that these solutes would be quickly attenuated in the environment, and thus any impact would be localised and short term.<br>As presented in the surface hydrology Section 7.3.5.2, runoff is only expected to be generated during large, infrequent rainfall events. In addition, the TEQ Section 7.5 has demonstrated that waste materials are physically stable. As such, impacts due to sediments in runoff are likely to be localised and infrequent. |

#### 7.3.5.5 Mine Void Water Bodies (Pit Lakes)

The proposed project includes two open pits: Nebo pit and Babel pit. During operations, there is potential for water to collect in these open pits, either through direct rainfall collection or via groundwater inflows. To allow safe mining, collected water would either be used for dust suppression, or be pumped to contact water ponds for use either in the processing plant or disposal to the TSF. During operations, overland surface water flows would be diverted around the pits using bunds and/or drains to prevent excess water ingress.

As described in Section 7.3.5.1, the proposed project includes backfilling of Nebo pit to a level above the water table for closure. Subsequently, no water body would develop in the Nebo pit void post-closure. It is predicted that a permanent pit lake would develop in the non or partially backfilled Babel pit post-closure. Due to the high net evaporation rate, the Babel pit lake would be a groundwater-driven pit lake with negligible surface water input (Appendix D7).

Water quality in the Babel pit lake is predicted to get increasingly saline to saturation (Appendix D7). In addition, evapo-concentration is likely to result in the pit lake water containing concentrations of some elements above acceptable levels for stock water as nominated in relevant water quality guidelines. Due to the arid environment of the project area, there is a potential that fauna would seek out the water for drinking, negatively affecting fauna health. The epilimnion (upper layer) of the pit lake is predicted to not be acidic, have low concentrations of trace elements and high dissolved oxygen. Trace metals are predicted to be distributed to the deepest layer, thereby mitigating contact with environmental values. Salinity is expected to slowly increase over time at a rate of approximately 20 to 25 mg/L/year (e.g. to around 15,000 mg/L after 1,000 years) and this may affect primary productivity in terms of algal growth, over the long term, although this would reduce the risk of biomass attracting fauna. Saline water is also likely to be a deterrent for fauna.

The nature of the post-closure pit (i.e. steep rocky slopes and no defined 'beach' style area to enable easy access for drinking) would pose a natural impediment to fauna access, particularly by large animals (mammals), as would exclusion bunds.

The assessment of inherent (unmitigated) risk for contamination of groundwater due to poor pit lake water quality post-closure and impacts to terrestrial fauna due to poor water quality that develops in pit lakes post-closure are provided below in Table 7-36 and determine to represent Low risks. Section 7.3.6 presents avoidance and mitigation measures to further reduce the risk to ALARP.

**Table 7-36: Assessment of Inherent Risk – Contamination of Groundwater due to Poor Pit Lake Water Quality Post Closure**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Contamination of groundwater due to poor pit lake water quality post-closure resulting in adverse impacts to future beneficial users | Unlikely | Moderate | Low | Studies have shown that although solutes do concentrate over time in pit lakes, the pits act as in perpetuity groundwater sinks due to the high net evaporation |
| Reduction in health, richness and abundance of terrestrial fauna due to poor water quality that develops in pit lakes post-closure | Possible | Minor | Low | As the epilimnion (upper layer) of the pit lake is predicted to be non-acidic, have low concentrations of trace elements and high dissolved oxygen and trace metals are predicted to be distributed to the deepest layer, there is unlikely to be any impact to fauna. Salinity is expected to increase over time (1,000 years) and this may affect primary productivity in terms of algal growth, over the long term and provide a deterrent for fauna |

### 7.3.6 Mitigation Measures

As described in Section 7.3.5, the inherent (unmitigated) risk of any of the identified potential impact events not meeting the EPA Objective for Inland Waters as a result of the proposed project were Medium or Low, and were therefore not considered to require any specific avoidance and mitigation to meet the EPA's Objectives relating to Inland Waters. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP, these avoidance and mitigation measures are shown in Table 7-37.

**Table 7-37: Mitigation Measures for the Inland Waters Environmental Factor**

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual risk |
| Groundwater abstraction during life of mine resulting in reduced availability and access to groundwater for current or future beneficial groundwater users. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively | **Measures to Avoid**<br>• Nil<br>**Measures to Minimise**<br>• Drill additional large diameter bore holes to allow for further pump testing to increase certainty in supply characteristics. This data will be used to further calibrate the hydrogeological model and would feed into water licensing and incorporated into the associated groundwater operating strategy required by DWER before water abstraction can commence.<br>• A water level trigger value would form part of the Groundwater Operating Strategy in the 5C licence to confirm the outcomes of hydrogeological modelling. Where material variations occur between modelling and actual results the numerical model would be revised, and impacts reassessed as part of the abstraction license<br>• Apply appropriate bore spacing in borefield design to minimise extent of potential drawdown to any identified significant values<br>• Manage bore pumping rates to minimise extent of potential drawdown to any identified significant values<br>• Minimise some borefield abstraction by utilising dewatered water from mine pits to supplement project water supply<br>• Maximise water recovery from tailings dam<br>• Should water at Linton Bore indicate an effect from borefield operation a deeper bore can be drilled to further access the vertical aquifer system and ensure a continuous water supply at this location | Unlikely | Minor | Low |

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual risk |
| Mine dewatering during operations resulting in reduced availability and access to groundwater for current or future beneficial groundwater users. Note potential impacts to GDEs and stygofauna area addressed in Section 7.1.5 and Section 7.4.5, respectively | **Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low |
| Localised groundwater drawdown in perpetuity due to net evaporation of water from open pit lakes resulting in reduced availability and access to groundwater for future beneficial users. Note potential impacts to GDEs and stygofauna area addressed in Section 7.1.5 and Section 7.4.5, respectively | **Measures to Avoid**<br>• Backfill Nebo pit to greatly reduce the potential drawdown extent<br>**Measures to Minimise**<br>• Nil<br>**Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low<br>Backfilling Nebo pit with either waste rock or tailings significantly reduces the extent of the drawdown. Although drawdown associated with Babel pit remains 'almost certain', the scale and hence consequence of the potential impact is significantly reduced. |
| Altered surface water flows due to project infrastructure resulting in adverse physical changes to local or regional hydrology as a result of increased/decreased flow velocities, erosion, flooding and sedimentation. Note potential impact to flora and vegetation, fauna habitats and landforms as a result to change in surface flows are addressed in Section 7.1.5, | **Measures to Avoid**<br>• Inclusion of cross-drainage and water diversion bunds in design to maintain existing catchments and flow paths where practicable<br>**Measures to Minimise**<br>• Rock armouring of mine landforms where higher velocity flows may occur<br>• Adaptive management of physical mitigation measures such as bunding, diversion drains, cut-off drains and sediment basins during construction and operations | Unlikely | Insignificant | Low |

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual risk |
| Section 7.2.5 and Section 7.6.5, respectively | **Measures to Rehabilitate**<br>• Identify and remediate areas of scour/erosion during the life of the proposed project<br>• Decommissioning of proposed project infrastructure to reinstate pre-development catchments and flow paths where practicable and as appropriate<br>• Appropriate consideration of hydrological processes in closure design<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Changes to groundwater quality due to seepage from waste landforms resulting in irreversible reduction in beneficial use. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively | **Measures to Avoid**<br>• Appropriate design of waste landforms specifically encapsulation of problematic waste rock material and minimisation of PAF oxidation<br>**Measures to Minimise**<br>• Development of under drainage (TSF) and seepage collection systems where necessary<br>• Where required, a series of stepped downstream monitoring stations would be monitored to identify any potential elevation of solutes beyond acceptable levels. Where elevated solutes are identified an adaptive management plan would be followed and may include an investigation of the solute source, with remediation as appropriate. Should the problem persist, interception bores could be considered. These protocols would be further developed, and form part of the Environmental Protection Act Part V process required by DWER<br>• Ongoing monitoring of groundwater quality during operations<br>• Compacted WRD base, calcrete neutralising capacity<br>**Measures to Rehabilitate** | Unlikely | Minor | Low |

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual risk |
| | • Appropriate design and implementation of cover designs to manage long term infiltration and subsequent seepage<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Contamination of groundwater due to accidental spills of hazardous materials resulting in adverse impacts to current and future beneficial users. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively | **Measures to Avoid**<br>• Appropriate design of chemical and hydrocarbon storages in accordance with relevant guidelines and Australian Standards<br>**Measures to Minimise**<br>• Ongoing monitoring of groundwater quality during operations<br>• Appropriate storage area construction and management<br>• Appropriate spill management and mitigation kits and procedures<br>**Measures to Rehabilitate**<br>Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low |
| | **Measures to Avoid** | Unlikely | Moderate | Low |

<table>
<tr><th rowspan="2">Potential Impact Event</th><th rowspan="2">Mitigation</th><th colspan="3">Residual Risk</th></tr>
<tr><th>Likelihood</th><th>Consequence</th><th>Residual risk</th></tr>
<tr><td rowspan="3">Contamination of surface water due to deleterious solutes and/or sediments in runoff (from operational areas including waste) resulting in adverse impacts to current and future beneficial users. Note potential impacts to flora and vegetation, landforms and fauna habitat are addressed in Section 7.1.5, Section 7.2.5 and Section 7.6.5, respectively</td><td>• Appropriate design of waste landforms, specifically encapsulation of problematic waste rock material and minimisation of PAF oxidation<br>• Appropriate consideration of rainfall and runoff through the proposed project design process to mitigate potential effects of flow concentration and point discharge and include appropriate erosion protection measures as appropriate<br>• Inclusion of cross-drainage and water diversion bunds in design to maintain existing catchments and flow paths where practicable</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Measures to Minimise</td></tr>
<tr><td>• Physical mitigation measures such as bunding, diversion drains, cut-off drains and sediment basins during construction and operations<br>• Rock armouring of mine landforms where higher velocity flows may occur<br>• Ongoing monitoring including water sampling from undisturbed surface water catchments when rainfall events make this possible. This would confirm baseline assumptions and give a meaningful basis for ongoing impact assessment<br>• Establishment of appropriate trigger levels for runoff from catchments that are potentially impacted by the proposed project<br>• Ongoing sampling from catchments that are potentially impacted by the proposed project and adaptive management of physical mitigation measures</td></tr>
</table>

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual risk |
| | **Measures to Rehabilitate**<br>• Cover designs will consider, where required, managing the risk of long-term infiltration and subsequent seepage<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Contamination of groundwater due to poor pit lake water quality post-closure resulting in adverse impacts to future beneficial users. Note potential impacts to GDEs and stygofauna are addressed in Section 7.1.5 and Section 7.4.5, respectively | **Measures to Avoid**<br>• Backfill Nebo pit to prevent one of the potential pit lakes from forming<br>**Measures to Minimise**<br>• Update modelling with field data from ongoing monitoring during the operational phase of the proposed project<br>**Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Rare | Minor | Low |
| Reduction in health, richness and abundance of terrestrial fauna due to poor water quality that develops in pit lakes post-closure | **Measures to Avoid**<br>• Backfill Nebo pit to prevent one of the potential pit lakes from forming<br>**Measures to Minimise**<br>• Construct exclusion bund to limit access to the pit lake<br>**Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low |

### 7.3.7 Predicted Outcome

The predicted outcome was determined in accordance with the EIA Framework developed for the Proposal (Appendix A3), and was based on the assessment of impacts (Section 7.3.5) and the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e). The results of this assessment are presented in Table 7-38.

Based on this assessment, the Proposal was assessed as having no significant or irreversible impact on inland waters-related environmental values and the EPA Objective for inland waters 'To maintain the quality of groundwater and surface water so that environmental values are protected' would be met should the Proposal be implemented.

**Table 7-38: Assessment of Impact Significance – Inland Waters**

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Values, sensitivity and quality of the impacted environment which is likely to be impacted | The identification and assessment of Inland Water related values, their sensitivity and quality has been considered during the commissioning and undertaking of the WMP specialist study program. The following was concluded in relation to key values:<br>Groundwater:<br>• There are no Ramsar wetlands of international importance within the West Musgrave region, and no MNES have been identified that have potential to be impacted by the proposed project with respect to inland waters<br>• The community water supply occurred well outside projected water table impacts e.g. Jameson community water supply<br>• One community bore (Linton Bore) used from time to time when occurs within the 2 m drawdown contour of the proposed modelled water table drawdown near to the proposed borefield<br>• There are no current groundwater users that overlap with the existing modelled drawdown contours<br>Surface Hydrology:<br>• No surface water values of significance were identified within the impact footprint<br>Other values reliant on inland waters are assessed separately in this document under other Environmental Factor assessments including GDEs detailed in Flora and Vegetation, Landforms and Stygofauna | Not Significant |
| Extent (intensity, duration, magnitude and footprint) of the likely impacts | The total extent of impacts has been assessed through numerical modelling of groundwater drawdown over time and surface water drainage systems. Groundwater models included model outputs relating to end of mine life (circa 26 years), and post closure steady state (i.e. projections 1,000 years post closure)<br>The largest modelled extent of groundwater and surface water effects have been used in predictions of impact significance to environmental values (e.g. terrestrial GDEs, subterranean fauna, potential beneficial users and social surroundings). | Not Significant |
| The consequence of the likely impacts (or change). | The consequences of various inland waters related impact events have been assessed using a risk-based framework which included specifically designed consequence criteria for the Inland Waters Environmental Factor assessed using specifically designed consequence criteria for this Environmental Factor. A summary of the risk assessment is provided in Section 7.3.5. Both the inherent and residual risks to Inland Waters as a result of the proposed project were assessed as being Low and Medium and as such were considered not significant | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| The resilience of the environment to cope with the impact or change | Whilst the proposed project would have a localised (direct) impact, this would not be of a magnitude to significantly or irreversibly affect the resilience of any identified inland waters related environmental values to cope with those impacts (e.g. current or future water users). Some localised reduction in the availability of water may be apparent around the mine pits during life of mine and post-closure, however the paleochannel represents a regional formation to which the proposed project will have a small areal impact, and availability to access this larger system will remain<br>The borefield has been modelled to ensure it can withstand sustained pumping using conservative estimates for the life of the project. Upon cessation of borefield operation, groundwater has been modelled to return to within 10% of its steady state levels within 10 to 20 years | Not Significant |
| Cumulative impacts with other existing or reasonably foreseeable activities, developments and land uses | There are no other existing or reasonably foreseeable activities, developments or land uses proposed within the areas potentially impacted by the proposed project, which may have a cumulative impact upon inland waters and their associated values. The proposed project represents the only significant development for approximately 450 km | Not Significant |
| Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment | Connections and interactions between project (sources) and the receiving environment (environmental factors and their associated values) were considered using an SPR assessment, indirect impact assessment and subsequent risk assessment. The impact assessment is presented in Section 7.3.5. This SPR, indirect impact assessment and risk assessment allowed for an assessment of interactions between the various and overlapping elements of the proposed project<br>Key connection between inland waters relate to hydrochemistry and to receiving environmental values including GDEs, Landforms and Stygofauna. All of these values have taken into consideration the combined impacts of changes to surface and groundwater, and the combined impacts relating to hydrochemistry<br>Resultantly, no unacceptable impacts to Inland Waters and their relevant values due to multiple or overlapping project sources were identified | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| The level of confidence in the predictions of impacts and the success of proposed mitigation | Detailed baseline studies have been undertaken to inform the understanding of the existing surface water and groundwater environments. Surface water and groundwater effects assessments were undertaken using standard industry methods and models and calibrated with actual monitoring results wherever possible. The methods, inputs and outputs were subject to sensitivity analysis and independent peer review and any feedback incorporated back into the models. Models used to make impact predictions were considered by an independent peer review of Inland Waters specialist studies as conservative<br><br>The largest modelled extent of potential groundwater impacts at end of operations and post closure (1,000 years projection) were used when making predictions about potential impacts<br><br>While all efforts were made to increase the confidence in impact predictions, and conservative estimates of impacts have been used for the purpose of the present impact assessment, some inherent uncertainty exists for all models. Ongoing work to calibrate the groundwater model will continue to occur prior to water abstraction licenses are applied for, this will include further large diameter bore drilling and pump testing. Following the results of this further drilling and testing the model will be updated to reduce any uncertainty inherent to the model. These additional model calibrations would be included in any future water licensing and incorporated into the associated groundwater operating strategy required by DWER | Not Significant |
| Public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment. | OZ Minerals developed and implemented a detailed and thorough stakeholder engagement program which included relevant Ngaanyatjarra People, the Ngaanyatjarra Council, relevant Shires, government, and some special interest groups. The focus of this engagement program was on high interest and high influence stakeholder groups, particularly land rights holders. Engagement activities included project briefings, attendance by the Ngaanyatjarra Council to regulator meetings, numerous community meetings, a number of large heritage surveys, and a third-party environmental peer review of the Section 38 Referral submission and associated specialist studies on behalf of the Ngaanyatjarra People to ensure their interests and concerns relating had been appropriately considered, and a dedicated on-country consultation with relevant West Musgrave Traditional Owners relating to the outcomes of this EP Act Part IV impact assessment. A summary of consultation is provided within a consultation-specific record (Appendix A4) and project-specific consultation register (Appendix A5)<br><br>During dedicated on-country consultations relevant West Musgrave Traditional Owners raised the concern of impacts to the availability and quality of the community water supply at Jameson (Mantamaru), and of the difficulty in understanding the complexities of the groundwater modelling. It was explained to the Traditional Owners using posters and sketches that the modelled drawdown of the proposed project is a significant distance from Jameson (Mantamaru), that Jameson (Mantamaru) is up gradient from the proposed project and therefore | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | receives its water before it reaches the project area, and that Jameson (Mantamaru) water is sourced from a shallow fractured rock aquifer which represents a different aquifer system than is being targeted by the proposed project. Finally, that the combination of this information gives OZ Minerals high confidence that there would be no impact on the community water supply<br><br>All areas identified by Traditional Owner, Ngaanyatjarra Council and other stakeholders relating to potential impacts inherent to Inland Water related values have been considered in this assessment | |

## 7.4 Subterranean Fauna

### 7.4.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) lists the following as their objective for subterranean fauna.

To protect subterranean fauna so that biological diversity and ecological integrity are maintained

In the context of this factor and objective, the EPA defines ecological integrity as the composition, structure, function and processes of ecosystems and the natural range of variation of these elements (EPA, 2016d).

For the purposes of this assessment, subterranean fauna are defined as fauna which live their entire lives below the surface of the earth. They are divided into two groups:

- Stygofauna – aquatic and living in groundwater
- Troglofauna – air-breathing and living in caves and voids.

Subterranean fauna often display evolutionary adaptations to underground life, particularly reduced pigment and reduced, poorly functioning or non-existent eyes. Other morphological and physiological adaptations, such as vermiform bodies, elongate sensory structures, loss of wings, increased lifespan, a shift towards longer-term breeding strategy with fewer offspring (K-selected) and decreased metabolism, reflect the habitats occupied by subterranean species (Gilbert and Deharveng, 2002).

There are both invertebrate and vertebrate subterranean species, although within Western Australia, invertebrates predominate and include crustaceans, insects (cockroaches and beetles), arachnids (spiders, pseudoscorpions), myriapods (millipedes), worms and gastropod snails. Stygofauna communities are often dominated by crustaceans whereas troglofauna can include a wide range of taxonomic groups.

The presence of subterranean fauna is strongly linked to geology and hydrogeology and the availability of suitable micro-habitats, e.g. air-filled voids, or caves above the water table for troglofauna, and aquifers that are not hypersaline for stygofauna. This assessment recognises these inherent links.

### 7.4.2 Policy and Guidance

Subterranean fauna can be protected under the following State and Commonwealth legislation:

- *Environment Protection and Biodiversity Conservation Act, 1999* (Cth)
- *Environmental Protection Act, 1986* (WA)
- *Biodiversity Conservation Act, 2016* (WA).

In addition to Commonwealth and State legislation, the following policy and guidance statements were considered in the design of flora and vegetation surveys and in the assessment for subterranean fauna:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA, 2020e)
- EPA Environmental Factor Guideline – Subterranean Fauna (EPA, 2016d)
- EPA Environmental Factor Guideline – Inland Waters (EPA, 2018b)
- Technical Guidance – Sampling methods for subterranean fauna (EPA, 2016e)
- Technical Guidance – Subterranean fauna survey (EPA, 2016f).

### 7.4.3 Receiving Environment

#### 7.4.3.1 Studies and Survey Effort

The following studies and surveys, relating to subterranean fauna, were undertaken to systematically characterise the hydrological regimes, groundwater quality, subterranean fauna community and habitat preference and availability, with this information used to assess potential impacts to subterranean fauna associated with the proposed project:

- Subterranean Fauna Assessment (Appendix E1). Baseline and targeted subterranean fauna surveys were undertaken for the upper Garford Aquifer within the Kadgo Paleochannel as well as the fractured rock aquifer to characterise the subterranean faunal community and habitat. Three dedicated drilling and sampling programs have been undertaken at WMP between 2018 and 2020 for the purpose of characterising subterranean fauna assemblages and habitats (Figure 7-27). The drilling and sampling program consisted of 168 dedicated stygofauna monitoring bores and 102 dedicated troglofauna bores with, approximately 430 series of net samples for stygofauna (consisting of six net hauls at each bore), approximately 450 troglofauna traps, and 240 bore scrapes (consisting of 240 x four sets of scrapes) for troglofauna undertaken over a two-year period. Of the 168 dedicated stygofauna bores 115 were located within the groundwater drawdown impact area and 53 outside. Of the 102 dedicated troglofauna bores 59 were located within the mine voids and 43 outside. The spatial extent and location of stygofauna and troglofauna sampling are shown on Figure 7-28 and Figure 7-29.

- Subterranean Fauna Habitat Assessment (Appendix E2). A semi-quantitative assessment of physicochemical and geological parameters was undertaken to determine and map 'preferred geological habitat' for subterranean fauna at and surrounding the WMP.
- Groundwater Baseline Assessment (Appendix D2). The assessment describes the pre-mining groundwater environment within the Kadgo paleochannel (consisting of the upper Garford and lower Pidinga aquifer formations) and the fractured rock aquifers that are located in all directions around the Kadgo system. The description of the groundwater baseline forms the basis for assessing the potential groundwater effects arising from the different mine water affecting activities associated with the proposed project (Section 7.3.3.2).
- Numerical Groundwater Modelling (Appendix D3). A groundwater model was developed to predict drawdown extent and dewatering requirements of mining activities at Babel and Nebo pits over the life of mine. The numerical model also simulates the water supply potential and drawdown extent of a proposed water supply borefield in the Kadgo Paleovalley to the north-east of the proposed mine (the Northern Borefield). Groundwater recovery post-mining and closure planning was also assessed as part of this study (Section 7.3.3.2).
- Independent Peer Review of Hydrological and Hydrogeological Assessment (Appendix D9). This review considered the outcomes of hydrology and hydrogeology modelling and confirmed suitability and robustness of the approach and outputs. The conclusions of the peer review were incorporated into updated modelling outputs.
- Groundwater Quality Monitoring (Appendix D10). This assessment included the collection of water quality monitoring of thirteen water bores over a six-month period to confirm the baseline groundwater quality conditions of the project area (Section 7.3.3.2).

Sampling of subterranean fauna has inherent limitations given the available sampling methods and the current state of knowledge on the ecology and taxonomy of stygofauna and troglofauna (EPA, 2016e). Sampling currently shows a bias to within mining tenure and therefore regional representation is not well understood. Uncertainties and limitations include:

- Constrained sampling: Subterranean fauna sampling is likely to underestimate the true ranges of most species since it is spatially constrained. Drill holes are usually only available for sampling within the tenements of the proponent and often only in areas considered prospective for mining.
- Sampling methods: Inability of animals to enter a borehole due to bore hole quality and development. Physical factors may influence the ability of a borehole to yield animals, including cementing and compaction of the borehole walls and fractures during drilling, or the silting of holes and fractures during or after drilling. The collapsing of pore spaces during the drilling process is likely to be more prevalent in bores above the water table where hydrostatic pressures are not present to keep those pore spaces open.
- Low abundance species: Reliable definition of the ranges of low abundance species requires extensive sampling. Maurer (1990) has shown however that despite a general trend for low abundance species to have smaller ranges than abundant species, many low abundance species can

and do have widespread, patchy occurrence. Thus, few direct inferences can be drawn about the likely ranges of species collected in the Project area from few samples, particularly species collected as singletons. The likely ranges of these species are most accurately defined using the known ranges of related species (surrogates) and the potential continuity of the surrounding habitat (EPA, 2016f).

- Incomplete and inconsistent taxonomy: Most species recorded within the Project area are undescribed and are only known from within it. Given the complexities of taxonomic identification and the significant numbers of undescribed species there exists a possibility that the same undescribed species may be collected at different locations by different organisations, however may be known by different informal names. This contributes to the difficulty of determining accurate species ranges.

Notwithstanding these uncertainties and limitations, rigor has been applied to sampling, data interpretation and impact assessment for the Proposal as evidenced by the significant number of dedicated boreholes drilled (e.g. 168) and sampled (430 sets of five stygofauna hauls, 450 troglofauna traps and 230 sets of four troglofauna scrapes), the large and extensive spatial and temporal scale of the study and the significant geological database used to make assertions on the nature of subterranean fauna habitat.

Overall, the extent of subterranean fauna sampling and habitat assessment within the proposed impact areas is considered sufficient for the purposes of impact assessment and to meet the requirements of the EPA guidance (EPA, 2016e and 2016f).

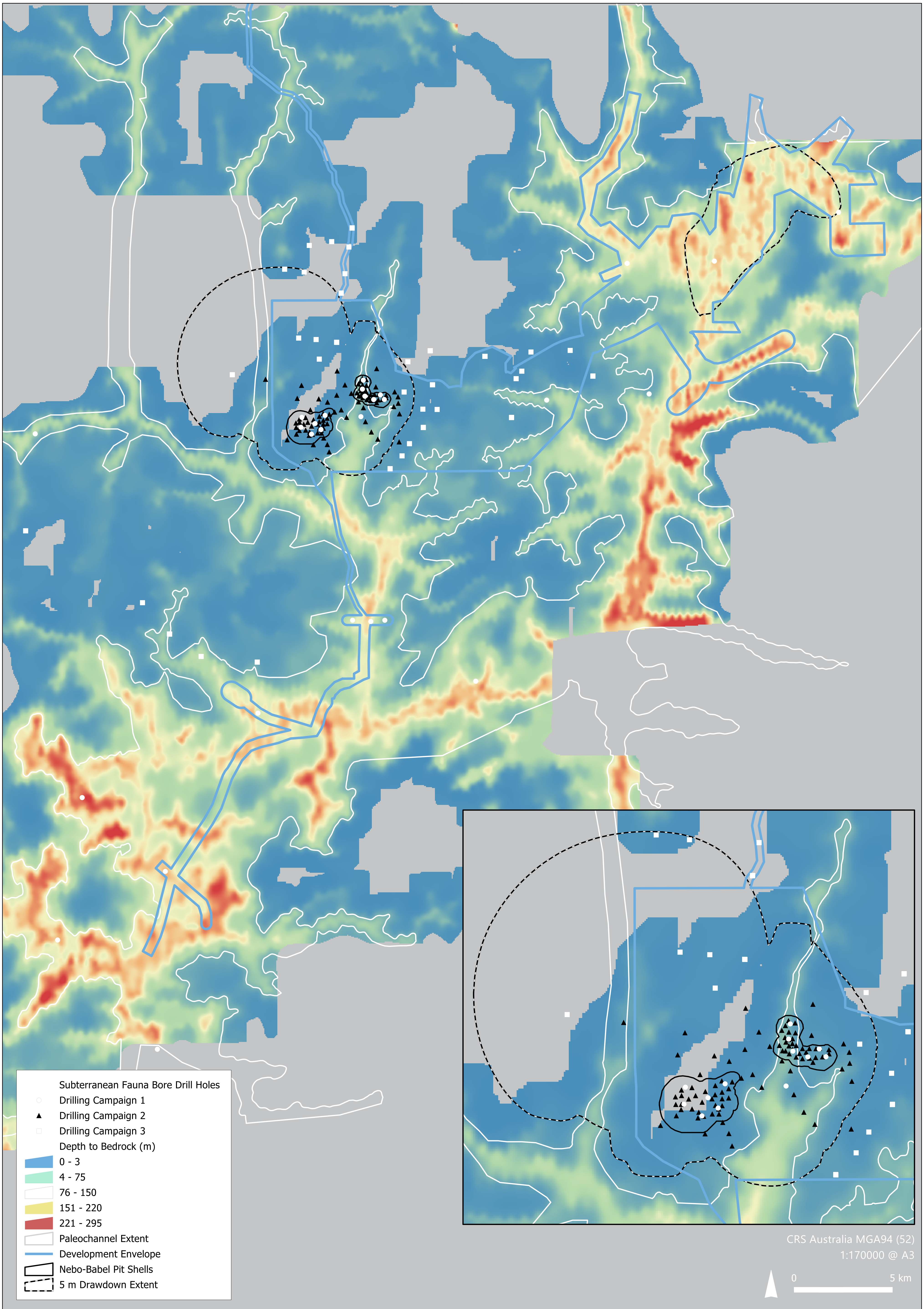



Figure 7-27: Locations of the Three Subterranean Fauna Drilling Campaigns

WEST MUSGRAVE COPPER AND NICKEL PROJECT

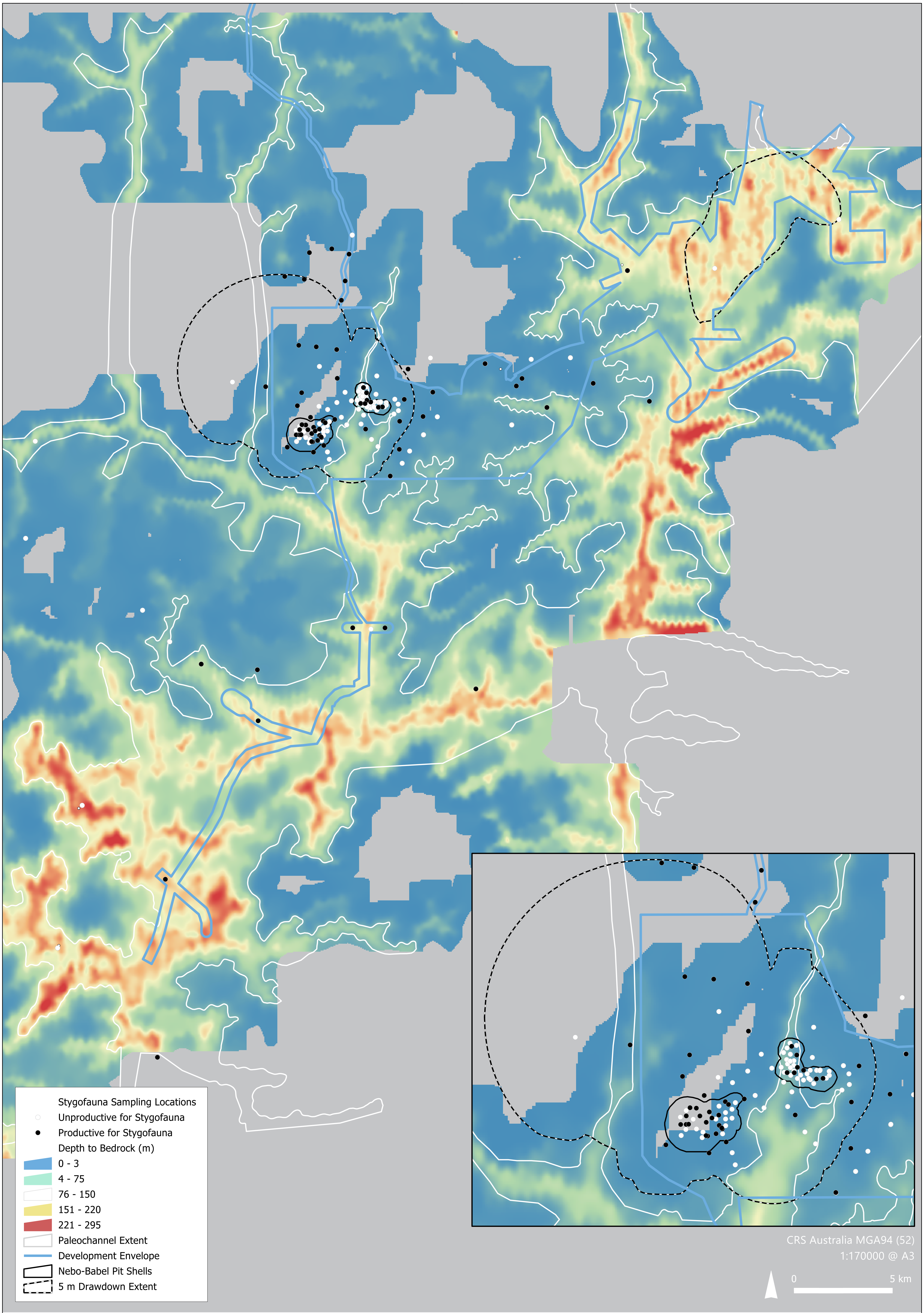



Figure 7-28: Spatial Extent and Location of Stygofauna Sampling Conducted for the WMP

WEST MUSGRAVE COPPER AND NICKEL PROJECT

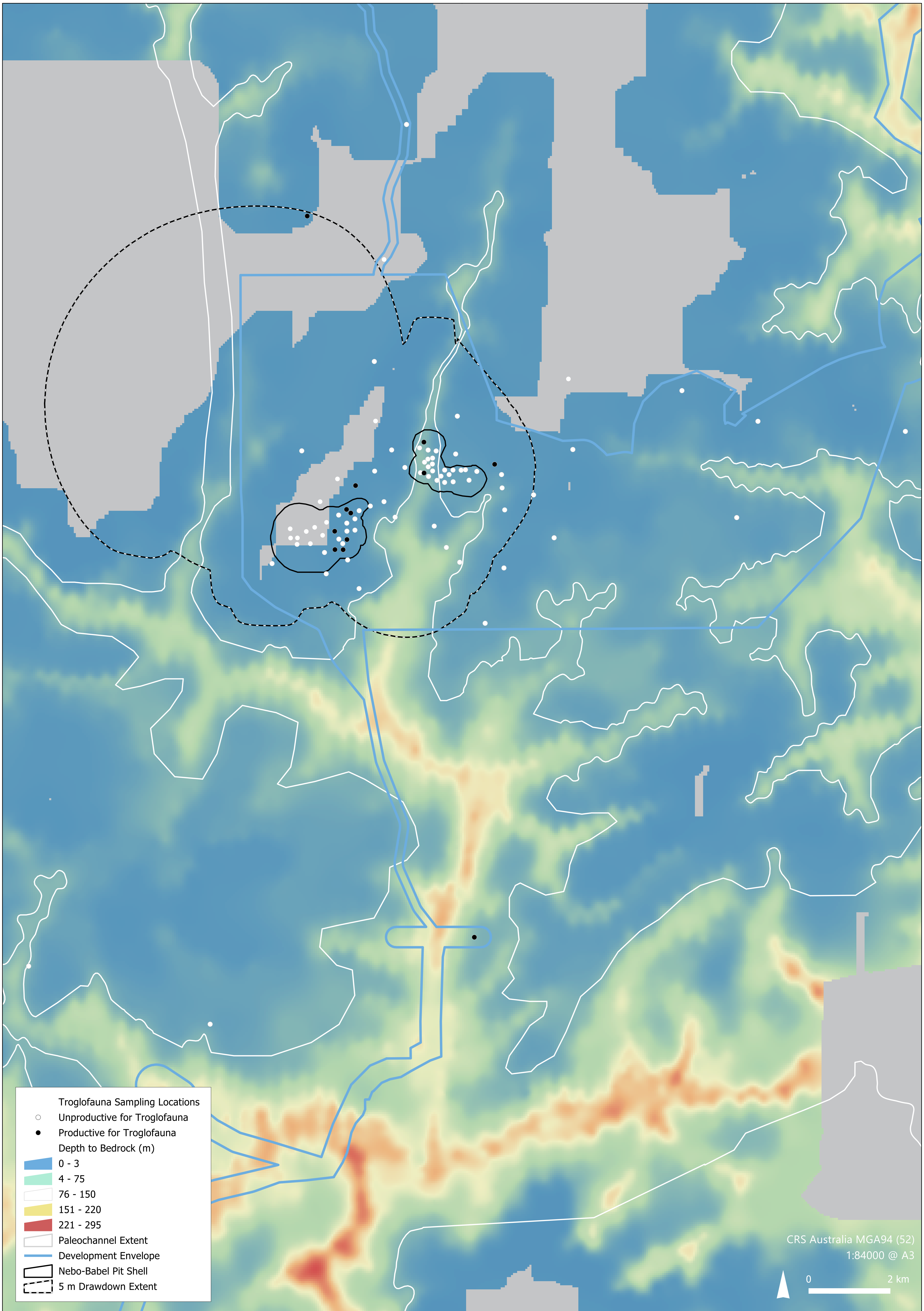



Figure 7-29: Spatial Extent and Location of Troglofauna Sampling Conducted for the WMP

WEST MUSGRAVE COPPER AND NICKEL PROJECT

#### 7.4.3.2 Subterranean Fauna Habitat

Subterranean fauna habitat is predominantly determined by the availability of cavities and spaces within the different lithologies and unconsolidated materials (e.g. regolith or gravels), and potential for water, oxygen and nutrient infiltration and movement.

Several geological units are recognised as providing core habitat for subterranean fauna as they characteristically form fractures, interstices, cavities and vugs, which allows for fauna dispersal and nutrient infiltration. These units include limestone karstic systems, calcrete, alluvium (particularly when associated with paleochannel aquifers), gravels and fractured rock aquifers (EPA, 2016f) In the case of stygofauna, this is further refined to lithologies that occur below the water table, and for troglofauna lithologies above the water table. A detailed study and evaluation of subterranean fauna habitat at the proposed project is presented in Appendix E2 and summarised below.

**Basis of Evaluating Subterranean Fauna Habitats**

The mapping of subterranean fauna habitat was undertaken by collating and interrogating the following datasets:

- Geophysical datasets were assessed to map the paleochannel extents and their vertical profiles, and regolith thickness across the project area. The geophysical datasets included:
    - Airborne Electromagnetic (AEM) data which can detect variations in the conductivity of the ground to a depth of several hundred meters. The conductivity response in the ground is commonly caused by the presence of electrically conductive materials such as saline water, graphite, clays and sulphide minerals. AEM data are processed and interpreted and commonly used to determine the depth of an unconformity between sedimentary/regolith cover and the underlying basement rocks and the location of groundwater resources, such as fresh or saline aquifers.
    - Gravity and magnetics data are commonly used to determine thickness of sedimentary and/or regolith cover sequences overlying basement rocks, due to marked contrasts in density and magnetic susceptibility between cover sequences (e.g. regolith) and basement. At the WMP both airborne and ground, gravity and magnetics datasets were collected and used in this study.
    - Passive seismic data were collected specifically for the groundwater study and were used in conjunction with the above datasets to help better constrain depths and profiles across the paleochannels. Processing of the passive seismic data thickness and shear wave velocity of loosely consolidated, transported regolith or highly weathered regolith zones (e.g. paleochannel fill) above basement rocks can be estimated from these data.
    - LIDAR and gravity data were used to produce a digital elevation model for the WMP.
- Hydrological and hydrogeological data and numerical models including aquifer information and water quality data (Appendix D1 to Appendix D5).
- Published geological and regolith maps from the Geological Survey of WA.

- OZ Minerals' geological maps and cross-sections developed from the existing database.
- Drill logs and stratigraphic cross-sections based on more than 3,100 drill holes and more than 350,000 m of drilling.
- A digital elevation model to identify units associated with valleys and drainage systems.
- 3D geological models for the deposits and prospects within the WMP area.
- 3D geophysical models including paleochannel architecture.

### Regional Geology

The West Musgrave region has been relatively stable tectonically for millions of years, under climatic regimes that have ranged from tropical to arid. Aside from minor younger sills and dykes, the bulk of the crystalline igneous and metamorphic rocks in the terrane are more than one billion years old. Fresh rocks exposed at the surface across the region have been subjected to millions of years of surface weathering, leading to the development of a regolith profile which is controlled by variations in past climatic conditions, surface and sub-surface water-flows, pre-existing weaknesses such as faults and shear zones, and variations in the inherent susceptibility of the underlying rocks to weathering decomposition. Consequently, a regolith profile is present over this region, including paleochannels which have been infilled with channel fill material such as gravels, sands, and clays.

Paleochannels were cut into the basement strata within the Kadgo Paleovalley that underlies much of the WMP area (Figure 7-13). During the mid to late Tertiary, the eroded landscape and paleochannels were infilled with sedimentary deposits. Figure 7-13 provides a graphic representation of the present-day terrain. The now buried paleochannels comprise sands, silts, clays and calcretes, with the sand sequences representing an important hydrogeological structure and potential groundwater target. A 10 to 20 m thick clay band separates a lower sequence (the Pidinga Formation) from an upper sequence (the Garford Formation). A thin, but widespread layer of Quaternary colluvial, alluvial and aeolian sediments blankets the paleovalley topography.

The types of geological/regolith environments (e.g. submerged fractured, near surface rocks, and above water table continuous calcrete stratigraphy) and abundance of shallow, fresh to brackish groundwater aquifers in the region represent ideal subterranean fauna habitat. Subterranean fauna is therefore expected to be widespread throughout the West Musgrave region. Appendix E2 considered multiple geological and physiochemical datasets and has supported this assertion.

### Presence of a Water Table

A defining feature of stygofauna habitat is that it must be below the water table. To this end, the following describes the presence of a water table in the proposed project area. A shallow water table is consistently present throughout the landscape's different geological profiles including the paleochannel sediments, regolith and fractured bedrock discussed below. The water table, across all hydrostratigraphic units has been measured between 2.7 and 14.5 mbgl, with an average water level of 6.5 mbgl and median water level of 6.01 mbgl. The closeness of the average to the median water level illustrates the consistency of the water level across the units. Minimal differences in water table depths have been observed between paleochannel sediments and weathered bedrock aquifer systems. The groundwater measurements, when converted to pressure heads (elevations), show a steady groundwater gradient of approximately 0.1% from north to south, which equates to a change of ten vertical metres over ten horizontal kilometres, with flow lines converging southward along the Kadgo Paleovalley (Figure 7-15).

Sixteen pressure transducers were deployed in subterranean fauna monitoring bores across the project area for a period of seven months (18 July 2019 to 23 February 2020) to assess seasonal fluctuations in water table depth. The depth fluctuations across these bores were between 0.08 m and 0.33 m with an average of 0.17 m over this period.

Water has been intercepted in more than 98% of subterranean fauna monitoring bores (in 165 out of 168 monitoring bores), indicating, as expected, that the water table is largely continuous, shallow and laterally extensive.

The following provides a summary of the current understanding of the water table at the WMP:

- The water table depth is consistent throughout the WMP, irrespective of the substrate geology type it occurs at an average depth of about 6.5 mbgl.
- The water table is shown to fluctuate between around 0.1 m and 0.3 m, indicating relatively stable water levels throughout most of the year.
- The consistently shallow groundwater across all geology, and a shallow hydraulic gradient provides confirmation of a highly interconnected subsurface porosity and/or fracturing across the landscape, which satisfies one of the key conditions required to support stygofauna habitats across an expansive landscape.

### Radiological Influences

At other sites in Western Australia, the presence of radioactive minerals in geological units have resulted in a subterranean fauna that is highly unique. This is also believed to increase the likelihood of restricted species.

Sampling of rock materials associated with the proposed WMP was undertaken, and shows that uranium and thorium concentrations are in the range of 0.05 – 3.6 mg/kg and 0.04 – 26 mg/kg, respectively across all type of geological materials including waste rocks/bedrocks, ore and low-grade ore.

Total uranium and thorium concentrations were used to calculate head-of-chain activity concentrations of naturally occurring uranium and thorium series radionuclides in materials within the proposed project. Based on maximum total uranium and thorium concentrations, maximum head-of-chain activity concentrations are 0.05 Bq/g and 0.11 Bq/g for $^{238}U$ and $^{232}Th$ series radionuclides, respectively and are similar to ambient conditions. For comparison, the activity concentration of total uranium in 'normal' soil is about 0.03 Bq/g.

The tailings analysis indicated a uranium concentration of less than 1 mg/kg, which is lower than average for crustal rock, even in unmineralised areas. Subsequently, it is concluded that the tailings contain no more uranium than might be expected in the rocks and soils of the surrounding area.

Given the inherent extremely low levels of radioactive minerals and concentrations present in the proposed project area, these are not considered to present a controlling factor or influence the presence, absence or species richness of stygofauna and troglofauna at the WMP.

### Influence of Mineralisation and Groundwater Chemistry

The mineralogy and chemistry of the basement rock (gabbronorites) hosting the Nebo and Babel deposits only differ from other gabbronorites, which are widespread throughout West Musgrave, in the presence of low volume percentages of copper and nickel bearing sulphides. This mineralogical difference could theoretically yield a difference in the overlying regolith composition and/or groundwater chemistry, however a review of both geological logs and water chemistry showed no difference in either the degree of fracturing or water chemistry inside or outside of the mineralised areas.

As such, it is concluded that mineralisation has no bearing on either the degree of, and frequency of fractures in basement rocks that may constitute subterranean fauna habitat, or on groundwater chemistry compared to non-mineralised areas. The presence of mineralisation is therefore not considered a controlling factor on the presence of potentially restricted stygofauna or troglofauna for the WMP.

### Depth of Fracturing (Vertical Habitat)

All diamond drill core collected during multiple exploration campaigns at the WMP have been analysed for Rock Quality Designation (RQD). RQDs represent the degree of, and frequency of rock fracturing in a length of drill core. This measurement is relevant to subterranean fauna in that it provides a quantitative measure of underground fracturing. Further detail relating to RQD designation is provided in Appendix E2.

RQD data from the geological database, totalling 25,354 samples from 195 diamond drill holes, was reviewed inside (e.g. inside of the Babel and Nebo deposits) and outside of the impacted areas (up to 13 km from the impacted area). The data was reviewed in four depth intervals (0 to 20 m, 20 to 30 m, 30 to 40 m and 40 to 50 m) below ground level to evaluate two questions:

- Is there a statistical difference in fracturing inside impacted areas (e.g. within the proposed mine pit, and associated groundwater drawdown contours) compared to outside this area?
- To what vertical depth do high frequencies of fractures extend, i.e. what depths may constitute potential vertical subterranean fauna habitat?

A full description of the analysis and results for RQD analysis are presented in Appendix E2, including a review in the frequency and degree of fracturing at varying depth intervals up to 50 mbgl. The key conclusions of the RQD analysis were:

- There is no statistical difference in the degree and frequency of fractures inside and outside of the potentially impacted areas up to a distance of 13 km from the impacted areas.
- A high degree and frequency of fracturing occurs in all drill holes to a depth of 40 mbgl and is statistically indifferent between weathered and highly fractured basement (saprock) and coarse-grained gravels and sand channel fill within paleochannels. This high degree and frequency of fracturing is thought to reflect the relatively homogenous weathering profile of the near surface geology over many millions of years which is typical of Tertiary sediments and Proterozoic rocks. These two geological profiles make up the majority of the WMP area and region (as described further below).
- Based on these results it is concluded that depths of up to 40 mbgl are considered to represent suitable subterranean fauna habitat. Beyond 40 mbgl the degree and frequency of fracturing decreases, and beyond 50 mbgl relatively few fractures occur, especially within the weathered and highly fractured basement (saprock).

### Stygofauna Habitat

Noting the statistically homogenous nature of water quality, depth to water table, and the degree and frequency of fracturing in the top 40 mbgl, geology is concluded to be the primary controlling factor for the presence, absence, and distributions of subterranean fauna at WMP.

The detailed study and evaluation of stygofauna habitat at the project compared various geology profiles with the presence and absence of stygofauna. Through this analysis three distinctive geological profiles were identified, these include:

**Type S1 Weathered and highly fractured basement (saprock)**: Below the transported cover at depths of approximately 3.5 to 5 mbgl depth are fractured saprock (incipiently weathered rock) with minor clays/oxides on joints (Plate 7-1). This zone generally persisted to 50 mbgl before unfractured, fresh, dry rock was reached. Calcrete was very rarely found below the water table.

**Type S2 Coarse-grained gravels and sand channel fill within paleochannels**: Below the transported cover at depths of approximately 3.5 to 5 mbgl depth are weakly-consolidated, channel fill gravels, sands, and silts (Plate 7-1). This zone generally persisted to 30 to 40 mbgl and was underlain by either fractured saprock followed by unfractured fresh rock or well-developed in-situ or a transported saprolite horizon consisting of compact clays, silts and sands with no obvious fractures. Calcrete was very rarely found below the water table.

**Type S3 High clay, sand and silt content (e.g. saprolite)**: Below the transported cover at depths of approximately 3.5 to 5 mbgl depth is a well-developed, in-situ or transported saprolite horizon consisting of compact clays, sand and silt with no obvious voids or fractures (Plate 7-1). A mottled clay saprolite zone may be present below this, with the saprolite eventually giving way to joint-weathered fresh rock. The clay/sand saprolite horizon was observed to 50 mbgl and in some cases it may represented incised channel fill. It was commonly developed over large paleochannels, and generally formed a component of Type S2 profiles.

Of these geological profiles, Types S1 (weathered and highly fractured bedrock (saprock)) and Type S2 (coarse-grained gravels and sand channel fill within paleochannels) were found to characteristically form fractures, interstices, cavities and vugs below the water table, which allow for fauna dispersal and nutrient infiltration and thus provide core habitat for stygofauna (i.e. productive for stygofauna). The third geological profile, Type S3 (high clay, sand and silt content (e.g. saprolite)) is more tightly bound, preventing fractures, interstices, cavities and vugs from forming and thus creating an unfavorable habitat for stygofauna. Borehole examples of Type S1, Type S2 and Type S3 geological profiles are presented in Plate 7-1.

Based on the understanding of the geological profiles identified as preferred habitat for stygofauna, the WMP geological database was analysed to develop a map of surface geology showing the presence of productive habitats in geological profiles Type S1 and Type S2 and unproductive habitats in geological profile Type S3 (Figure 7-30). This data was then combined with available vertical habitat as determined from RQD data as described above, to provide an estimate of habitat volume. The following assumptions have been made for the availability of vertical stygofauna habitats:

- Available vertical habitat has been assumed to extend from 10 mbgl to 40mbgl. While average water depth has been shown to be 6.5 mbgl, 10 mbgl has been used for the purpose of impact assessment to allow for potential fluctuations in depth across the landscape.
- All three habitat classifications are represented between 10 mbgl and 40 mbgl.
- Available horizontal stygofauna habitat based on a detailed assessment of the drill hole database, were bounded by areas where sufficient drill hole data was available (e.g. no projections were made beyond the extent of available drill hole data) (Figure 7-30). Analysis of the drill hole database indicates that Type S3 geological profiles are generally found within the deepest parts of the paleochannels, whereas shoulders of the paleochannels and smaller tributaries (<50 mbgl) consist primarily of Type S2 geological profiles. Therefore, based on this assessment:
    - All paleochannel tributaries were classified as Type S2 productive habitat.
    - Central parts of large paleochannels were classified as Type S3 habitat (unproductive) and outer parts as Type S2 (productive) habitat.
    - Fifty percent of the mapped paleochannel area (the outer margins which are relatively shallow) represents Type S2 (productive) habitat).
    - Fifty percent of the mapped paleochannel area (the central portion which is generally the deepest) represents Type S3 (unproductive) habitat.

Based on the drill hole geological logs in the database, this approach is likely to overestimate unproductive Type S3 habitat, and underestimate productive Type S2 habitat, which is suitably precautionary for the purpose of impact assessment.

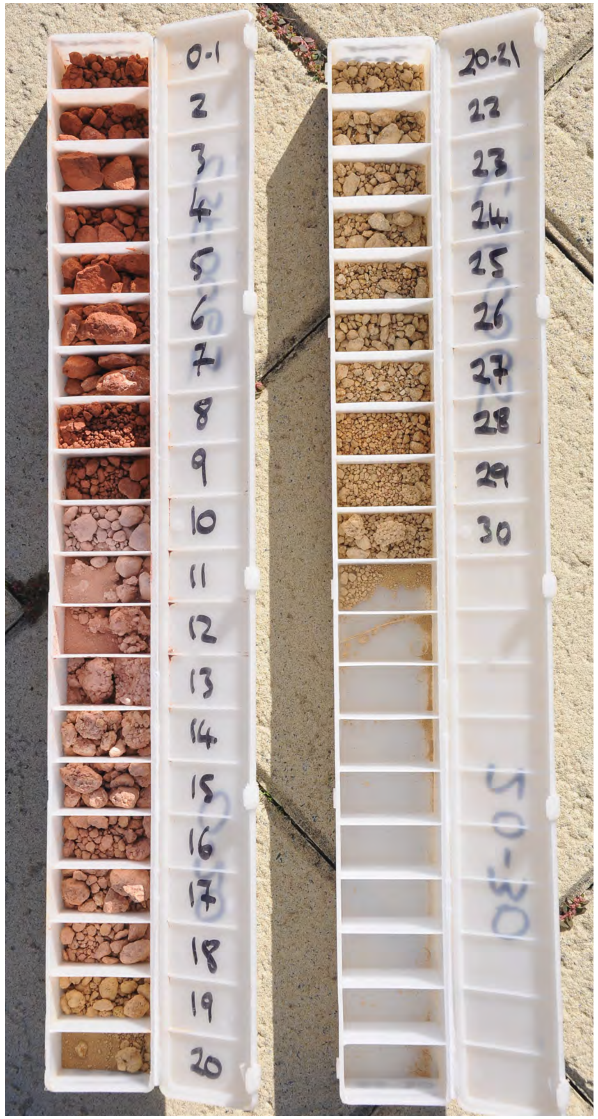
Area of habitat and an inferred volume of habitat is presented in Table 7-39.

**Table 7-39: Spatial Extent and Inferred Volume of Stygofauna Habitat**

| Habitat Classification | Area of Habitat (ha) | Inferred Volume of Habitat ($m^3$) |
|---|---|---|
| Type S1 | 373,184 | 111,955,200,000 |
| Type S2 | 52,954 | 15,886,200,000 |
| Type S3 | 24,484 | 7,345,200,000 |

**TYPE S1**
Weathered and Highly Fractured Basement (Saprock)

**TYPE S2**
Coarse-grained Gravels and Sand Channel Fill within Paleochannels



**TYPE S3**
High Clay, Sand, and Silt Content (Saprolite)

Plate 7-1: Borehole Examples of Type S1, Type S2 and Type S3 Geological Profiles

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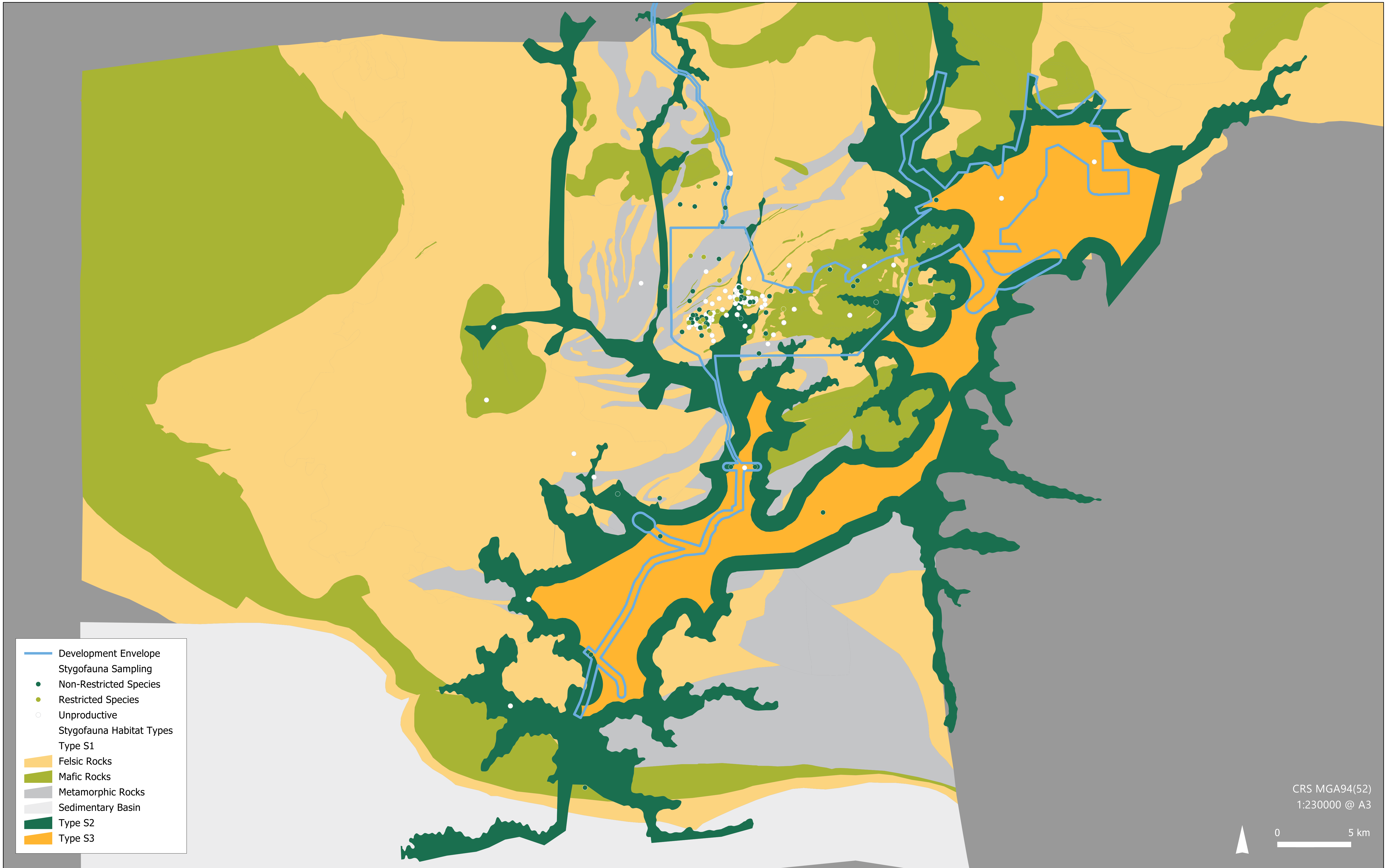


Figure 7-30: Spatial Extent of Potential Stygofauna Habitat Across the Greater Region

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### Troglofauna Habitat

Like stygofauna, core habitat for troglofauna is also a function of available spaces within the rock formations, along with the ability to maintain a consistently high humidity and the potential for nutrient input from surface systems (Dole-Oliver *et al.*, 2009).

Geological units recognised as primary troglofauna habitat include karstic limestone systems, calcrete, banded iron formations, channel iron deposits, alluvium/colluviums in valley fill areas and weathered or fractured sandstones above the water table. Physical characteristics common to these formations again include fractures, caverns, vugs, or interstices of sufficient size to physically accommodate troglobitic fauna. Many of these formations include lithologies with important hydrological functions, such as impeding layers and clay lenses which store infiltrated water from recharge events and maintaining humidity in the system (EPA, 2016f). The detailed study and evaluation of troglofauna habitat at the project area identified the following three distinctive geological profiles (Appendix E2).

**Type T1 Calcrete:** A profile consisting of calcrete. Calcrete is calcium-rich duricrust, a semi-hardened to hardened layer that occurs within or below transported cover and forms semi-continuous horizon that varies from several tens of centimetres to several metres in thickness. As the calcrete layer was formed through the presence of a historic water table, it is understandable that it exists as a semi-continuous horizon across the landscape. Calcrete formation and occurrence is independent of the underlying rock type and is ubiquitous across the broader project area above all geology types. All calcrete was found above the water table (Plate 7-2).

**Type T2 Weathered and highly fractured basement (saprock)**: Below the transported cover at depths of approximately 3.5 to 5 mbgl are fractured saprock (incipiently weathered rock) with minor clays/oxides on joints (Plate 7-2). This zone generally persists to 50 mbgl before unfractured, fresh, dry rock is reached. The uppermost part of Type T2 profile occurs above the water table in most instances outside of the mapped paleochannel areas, and there are areas where the Type T2 horizon is exposed at the surface.

**Type T3: Coarse-grain channel fill, representative of paleochannels**: Below the transported cover at depths of approximately 3.5 to 5 mbgl are weakly-consolidated, channel fill gravels, sands, and silts (Plate 7-2). This zone generally persists from 30 to 40 mbgl is underlain by either fractured saprock followed by unfractured fresh rock or well-developed in-situ or a transported saprolite horizon consisting of compact clays, silts and sands with no obvious fractures. The uppermost part of Type T3 profile occurs above the water table at the margins or shoulders of the paleochannels.

**Type T4: High sand and silt content (e.g. saprolite)**: Below the transported cover at depths of approximately 3.5 to 5 mbgl are a well-developed, in-situ or transported saprolite horizon consisting of compact clays, sand and silt with no obvious voids or fractures (Plate 7-2). A mottled clay saprolite zone may be present below this, with the saprolite eventually giving way to joint-weathered fresh rock. The clay/sand saprolite horizon was observed to 50 mbgl and may in some cases represent incised channel fill. Type T4 is generally developed in the central parts of the large paleochannels and in those instances, this horizon is found above the water table.

Of these geological profiles Types T1 (calcrete), Type T2 (weathered and highly fractured basement (saprock)) and Type T3 (coarse-grain channel fill, representative of paleochannels) were found to characteristically form fractures, interstices, cavities and vugs above the water table, which allow for fauna dispersal and nutrient infiltration and thus provide core habitat for troglofauna at the project. The fourth geological profile Type T4 (high sand and silt content (e.g. saprolite)) is more tightly bound, preventing fractures, interstices, cavities and vugs from forming and thus creating an unfavorable habitat for Troglofauna. Borehole examples of Type T1, Type T2, Type T3 and Type S4 geological profiles are presented in (Plate 7-2).

Based on the understanding of the geological profiles identified as preferred habitat for troglofauna, the WMP geological database was analysed to develop a map of surface geology, based upon a defined area surrounding the open pits, showing the presence of productive habitats in geological profiles Type T1, T2 and T3. It should be noted that no Type T4 (unproductive) habitat extended to surface based upon the defined area that was mapped surrounding the pits (Figure 7-31).

This data was then combined with RQD data to estimate habitat volume. The following assumptions have been made for the assessment of vertical troglofauna habitats:

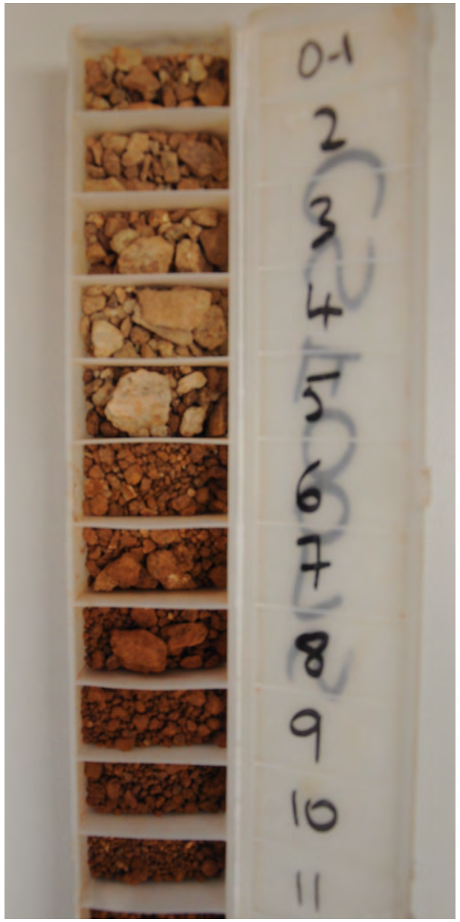
- Transported cover near surface (0–1 mbgl) was considered as non-prospective habitat.
- A water table depth of 6.5 mbgl was assumed for the purpose of this assessment i.e. it is assumed that troglofauna are not present anywhere below 6.5 mbgl.
- Available vertical troglofauna habitat of 5.5 m above the assumed water table (i.e. bounded between the base of the transported cover of 1 mbgl and above the water table of 6.5 mbgl) for Type T1, Type T2 and Type T3 habitats, interspersed with small, negligible pockets of T4 habitat.
- Available horizontal troglofauna habitat based on a detailed assessment of the drill hole database, and bounded by areas where sufficient drill hole data was available (e.g. no projections were made beyond the extent of available drill hole data) (Figure 7-31).

In addition, calcrete thickness (Type T1 habitat), based upon bore logging data, is generally 2 m thick below which a combination of Type T2 and Type T3 habitats occur in a proportion of 90:10. This has been reflected in the inferred volume of habitats.

Area of habitat and an inferred volume of habitat is presented in Table 7-40.

**Table 7-40: Spatial Extent and Inferred Volume of Troglofauna Habitat**

| Habitat Classification | Area of Habitat (ha) | Inferred Volume of Habitat ($m^3$) |
|---|---|---|
| Type T1 | 3,671 | 73,420,000 |
| Type T2 | 494 | 142,806,500 |
| Type T3 | 35 | 14,773,500 |




**TYPE T1**
Calcrete


**TYPE T2**
Weathered and highly fractured basement (saprock)


**TYPE T3**
Coarse-grain channel fill representative of paleochannels


**TYPE T4**
High sand and silt content (saprolite)

Plate 7-2: Borehole Examples of Type T1, Type T2, Type T3 and Type T4 Geological Profiles

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Figure 7-31: Spatial Extent of Potential Troglofauna Habitat Across the Greater Region

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### 7.4.3.3 Subterranean Faunal Assemblage

A total of 1,489 specimens (including higher order identifications) of subterranean fauna have been recorded within the project and surrounding area, including 1,451 stygofauna specimens and 38 troglofauna specimens. The subterranean faunal assemblage is discussed in the following sections and detail is provided in Appendix E1.

#### Stygofauna

From the 1,451 stygofauna specimens collected, a total of 27 stygofauna species were identified, including copepods (seven species), annelid worms (six species), syncarids (five species), ostracods (five species), amphipods (two species), isopods (one species) and nematodes as shown in Table 7-41.

Of these 27 species, only two have previously been collected outside of the project area. These include:

- Nematode worm (Nematoda sp) which belongs to a group of stygofauna that are not assessed in EIA in Western Australia due to poor taxonomic frameworks and difficulties in identification.
- Cyclopoid copepod species complex *Dussartcyclops uniarticulatus* s.l. which is also known from the Laverton area, however as a species complex, it is possible that specimens constitute a new species.

The remaining 25 species are only known from the project and surrounding area, nine of which are singletons (either only one specimen or multiple specimens collected from a single hole). Singleton species include:

- Two annelid worms:
  - Enchytraeidae `BOL034` (3 bundle all seg, short sclero)
  - Phreodrilidae `BOL035` (AP DVC)
- A single syncarid - Parabathynellidae gen. nov. 1 `BSY204`
- Two harpacticoid copepods:
  - *Schizopera* `BHA270`
  - *Dussartstenocaris* `BHA269`
- Four ostracods:
  - Candonidae `BOS1369`
  - Cypridopsinae `BOS1176A`
  - Ostracoda `BOS1171`
  - Candonidae `BOS1172`.

The nine singletons were collected from seven different holes. The remaining 16 species have known linear distributions ranging from approximately 700 m to 42 km around the project area (Table 7-41).

According to Bennelongia (Appendix E1), the stygofauna community has strong Yilgarn connections in terms of its species composition, but there is also evidence of central Australian connections in the two species of ostracod, Candonidae 'BOS1369' and Candonidae 'BOS1172' that appear to belong to an undescribed genus from the Northern Territory, whilst the occurrence of Protojaniridae 'sp. B02 has only one described Australian representative from eastern Australia. This is not surprising due to the location of the proposed project between these areas and the understudied nature of stygofauna within the region.

The distribution of stygofauna within the project and surrounding areas is shown in Figure 7-32, with an example of some of these species shown in Plate 7-3.

**Table 7-41: Stygofauna Collected from the WMP and Surrounding Area**

| Higher Group | Family | Lowest Identification | Linear Range | Distribution |
|---|---|---|---|---|
| **Worms** | | | | |
| Enchytraeida | Enchytraeidae | Enchytraeidae \`BOL033\` (3 bundle, short sclero) | 19 km | West Musgrave |
| | | Enchytraeidae \`BOL034\` (3 bundle all seg, short sclero) | Singleton | West Musgrave |
| | | Enchytraeidae \`BOL053\` (4 bundle, fat) | 3 km | West Musgrave |
| | | Enchytraeidae \`BOL055\` (2 bundle, long thin) | 6 km | West Musgrave |
| Haplotaxida | Phreodrilidae | Phreodrilidae \`BOL035\` (AP DVC) | Singleton | West Musgrave |
| | | Phreodrilidae \`BOL056\` (SVC) | 42 km | West Musgrave |
| **Crustaceans** | | | | |
| Amphipoda | Bogidiellidae | *Bogidiella* sp. B08 | 35 km | West Musgrave |
| | Chitoniidae | *Yilgarniella* sp. B05 | 35 km | West Musgrave |
| Isopoda | Protojaniridae | Protojaniridae sp. B02 | 35 km | West Musgrave |
| Syncarida | Parabathynellidae | *Atopobathynella* \`BSY182\` | 33 km | West Musgrave |
| | | *Atopobathynella* \`BSY183\` | 22 km | West Musgrave |
| | | *Atopobathynella* \`BSY184\` | 11 km | West Musgrave |
| | | *Parabathynellidae gen. nov. 1 \`BSY204\`* | Singleton | West Musgrave |
| | | *Parabathynellidae gen. nov. 1 sp. B13* | 40 km | West Musgrave |
| Cyclopoida | Cyclopidae | *Dussartcyclops uniarticulatus* s.l. | 630 km | Species complex - also known from the Laverton area. |
| | | *Pilbaracyclops* sp. B08 (nr fiersi) | 35km | West Musgrave |
| Harpacticoida | Canthocamptidae | *Australocamptus* \`BHA252\` | 4km | West Musgrave |
| | Miraciidae | *Schizopera* \`BHA270\` | Singleton | West Musgrave |
| | Parastenocaridid | *Dussartstenocaris* \`BHA269\` | Singleton | West Musgrave |

| Higher Group | Family | Lowest Identification | Linear Range | Distribution |
|---|---|---|---|---|
| | | *Dussartstenocaris* sp. B10 | 31 km | West Musgrave |
| | | *Dussartstenocaris* sp. B11 | 0.7 km | West Musgrave |
| Popocopida | Candonidae | *Candonopsis* \`BOS1182\` | 10 km | West Musgrave |
| | | Candonidae \`BOS1369\` | Singleton | Undescribed genus also occurring in NT |
| | | Candonidae \`BOS1172\` | Singleton | West Musgrave. Likely to be same genus as 'BOS1369' |
| | Cyprididae | Cypridopsinae \`BOS1176A\` | Singleton | West Musgrave |
| | | *Ostracoda* \`BOS1171\` | Singleton | West Musgrave |
| **Primitive Worms** | | | | |
| Nematoda | - | Nematoda sp. | Widespread | Not assessed in EIA |


Figure 7-32: Distribution of Stygofauna at the WMP and Surrounding Area

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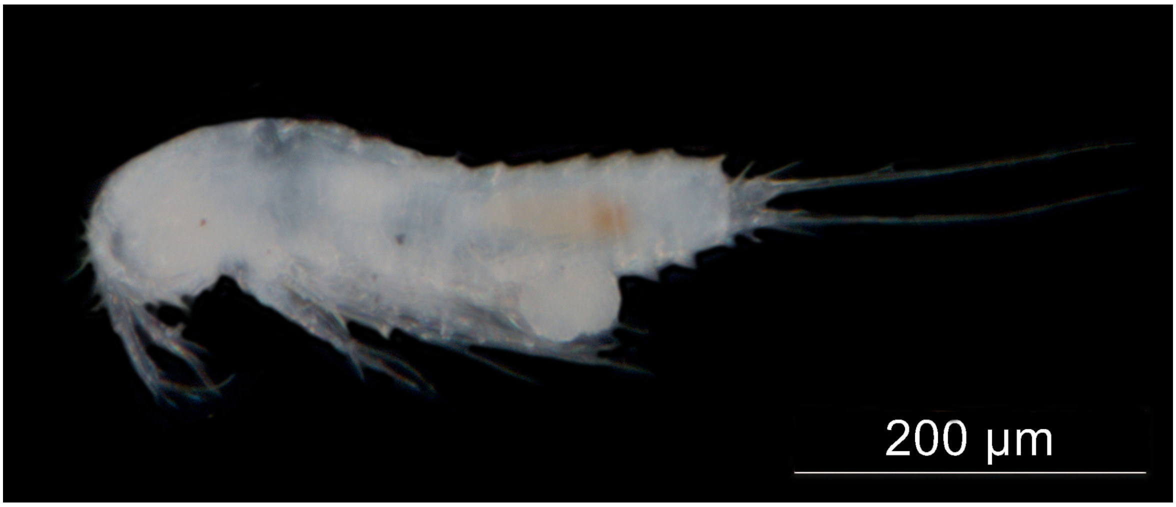
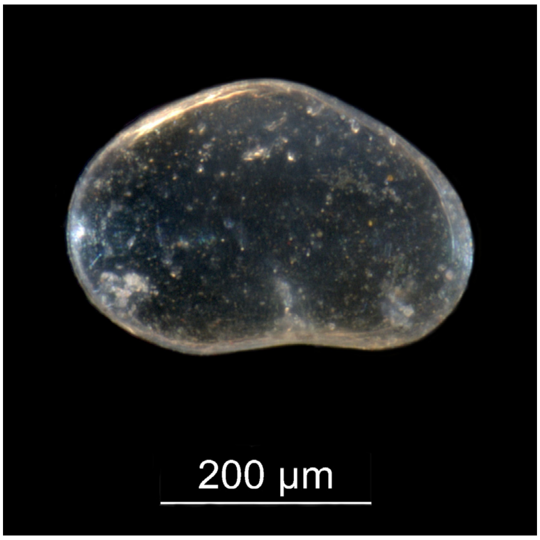



*Australocamptus* 'BHA252'


Enchytraeidae 'BOL033' (3 bundle, short sclero)


Images courtesy of Bennelongia

*Yilgarniella* sp. B05

Cypridopsinae 'BOS1176A'

Plate 7-3: Stygofauna Found at the WMP

### Troglofauna

From the 38 troglofauna specimens collected, ten troglofauna species were identified, including symphylans (four species), diplurans (three species), beetles (one species), centipedes (one species) and pauropods (one species) as shown in Table 7-42.

All ten of the troglofauna species collected are currently only known from the project area, eight of which are considered to be singletons consisting of:

- Three diplurans:
  - Parajapygidae sp. B43 (*Parajapyx swani* group)
  - Projapygidae `BDP147`
  - Projapygidae `BDP183`.
- One centipede (*Cryptops* `BSCOL057`)
- One pauropod (Pauropodidae `BPU077`)
- Three symphylans:
  - *Symphyella* `BSYM087`
  - *Symphyella* `BSYM089`
  - *Symphyella* `BSYM090`.

The eight singletons were collected from eight different holes. The remaining two troglofauna species, Ptinella `BCO179` and Hanseniella `BSYM088`, have known linear distributions of approximately four and 11 km respectively (Table 7-42). According to Bennelongia (Appendix E1), the troglofauna community is considered to be relatively depauperate with groups that typify rich Pilbara communities in mineralised rock being absent (e.g. schizomids, cockroaches, spiders, pseudoscorpions) as were isopods, which typify Yilgarn communities.

The distribution of troglofauna within the project area is shown in Figure 7-33 within an example shown in Plate 7-4.

**Table 7-42: Troglofauna Collected from the WMP and Surrounding Area**

| Higher Group | Family | Lowest Identification | Linear Range | Distribution |
|---|---|---|---|---|
| **Crustaceans** | | | | |
| Diplura | Parajapygidae | Parajapygidae sp. B43 (*Parajapyx swani* group) | Singleton | West Musgrave |
| | Projapygidae | Projapygidae `BDP147` | Singleton | West Musgrave |
| | | Projapygidae `BDP183` | Singleton | West Musgrave |
| Coleoptera | Ptiliidae | *Ptinella* `BCO179` | 4 km | West Musgrave |
| Scolopendrida | Cryptopidae | *Cryptops* `BSCOL057` | Singleton | West Musgrave |
| Tetramerocerata | Pauropodidae | Pauropodidae `BPU077` | Singleton | West Musgrave |
| Cephalostigmata | Scutigerellidae | *Hanseniella* `BSYM088` | 11 km | West Musgrave |
| | | *Symphyella* `BSYM087` | Singleton | West Musgrave |
| | | *Symphyella* `BSYM089` | Singleton | West Musgrave |
| | | *Symphyella* `BSYM090` | Singleton | West Musgrave |

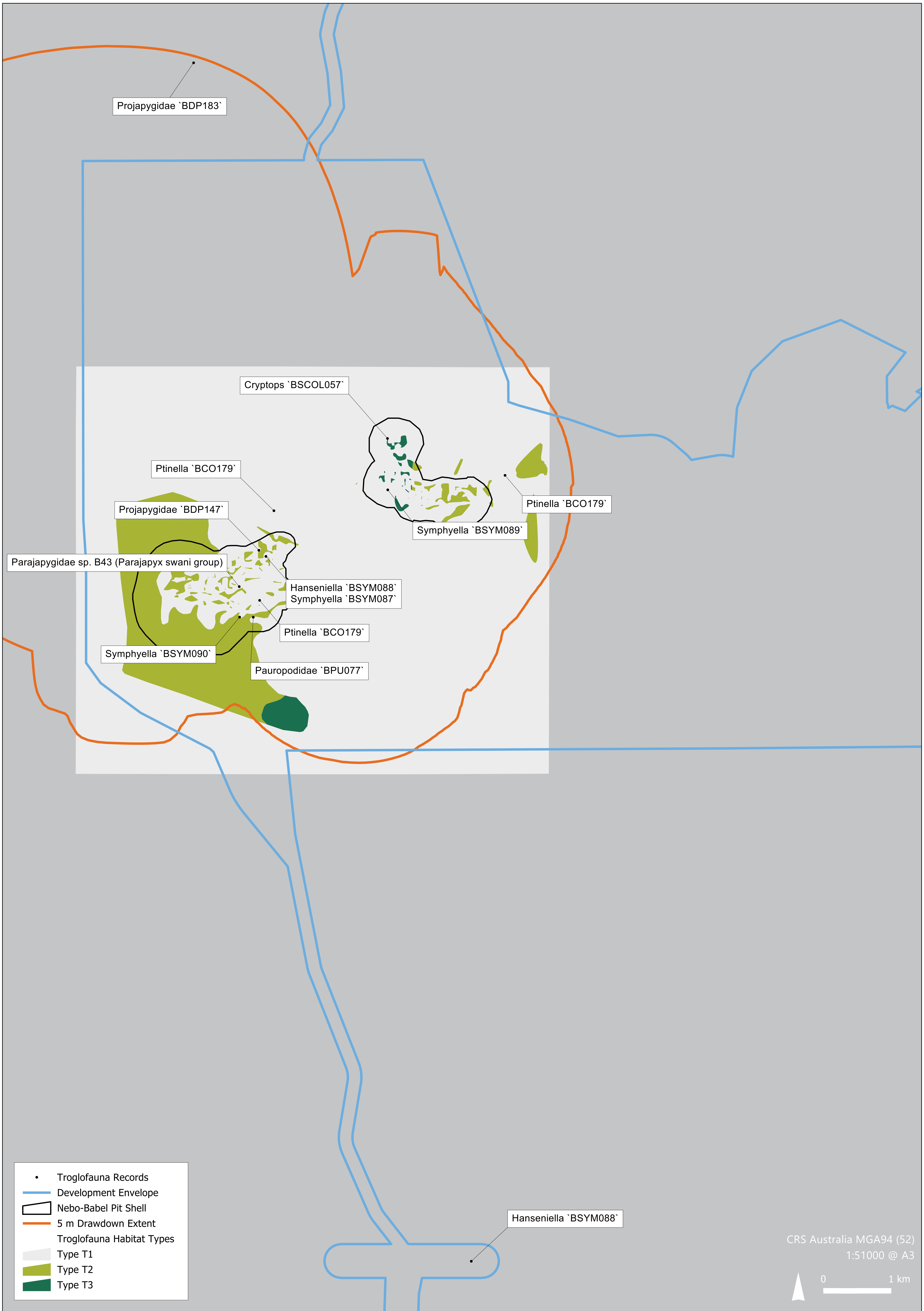



Figure 7-33: Distribution of Troglofauna at the WMP and Surrounding Area

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Image courtesy of Bennelongia

**Projapugidae 'BDP147'**

Plate 7-4: Troglofauna Found at the WMP

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### 7.4.4 Potential Impacts

The EPA Guidance for subterranean fauna provides several mechanisms ("issues") for consideration during the EIA process, specifically:

- Short range endemism – vulnerable through their limited ability to move
- Determining presence of subterranean fauna habitat – difficulty in determining the extent of habitat present and habitat connectivity
- State of Knowledge – gaps in knowledge regarding habitat requirements and natural history of subterranean fauna
- Vouchering – data being made available to enable specimen identifications to be verified
- Defining species – species can be difficult to define
- Climate change – cumulative impacts of the Proposal and changing climate.

A systematic assessment of how the proposed project interacts with the environment through subterranean fauna was undertaken, with consideration to the identified EPA issues (Appendix A2). In particular, the assessment aimed to confirm the potential for the proposed project's activities to interact with the environment, resulting in direct, indirect, or cumulative impacts to subterranean fauna and their related ecosystem processes. Based on this assessment the following potential impacts were identified:

- Loss or reduction in abundance of stygofauna species and habitat due to changes in groundwater levels resulting from mining (Section 7.4.5.1).
- Loss or reduction in abundance of stygofauna species and habitat due to changes in groundwater levels resulting from groundwater abstraction from the Northern Borefield (Section 7.4.5.1).
- Loss or reduction in abundance of troglofauna species and/or troglofauna habitat as a result of mining (Section 7.4.5.2).
- Indirect impacts to subterranean fauna (Section 7.4.5.3) including:
    - Water quality changes resulting in reduction and/or alteration of stygofauna habitats.
    - Changed habitat structure through blasting which may cause voids to collapse resulting in a reduction in subterranean fauna habitats.
    - Reduced energy sources through the clearing of vegetation and placement of wastes and mineral waste stockpiles leading to a reduction in organic inputs into the subterranean environment.
    - Ingress of pollutants such as hydrocarbons which may result in a reduction in the quality of subterranean habitats.

### 7.4.5 Assessment of Impacts

Each potential impact event identified in Section 7.4.4 was assessed to understand the mechanism by which impacts may occur and, using the consequence and likelihood tables in the EIA Framework (Appendix A3), determine the inherent (unmitigated) risk of each potential impact event.

Using the consequence and likelihood tables in the EIA Framework (Appendix A3), it was determined that the inherent risk of any of the identified potential impact events not meeting the EPA Objective for Subterranean Fauna as a result of the proposed project were Low or Medium (Table 7-45, Table 7-49 and Table 7-50), and are therefore not considered to require any specific avoidance and mitigation measures to meet the EPA's Objective for Subterranean Fauna. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP (Section 7.4.6).

A full characterisation of the distribution and abundance of subterranean fauna for any particular project is not practicable, and as such other deterministic steps to confirm the likelihood of occurrence more regionally have been accepted by the EPA, and widely employed by industry. EPA have recognised through their Technical Guidance (EPA, 2016) that the assessment of subterranean fauna is often more complex than for other biodiversity factors due to limited knowledge of species distributions and habitat requirements and due to the inherent challenge of characterising assemblages using available survey techniques.

A significant number of dedicated drill holes were developed and subsequently sampled for the presence of subterranean fauna. Increasing sampling effort over time has resulted in reductions in the total numbers of species that were initially thought to be potentially restricted. Based on this trend it can reasonably be assumed that the number of potentially restricted species would likely reduce with further sampling effort. In recognition of the challenges of characterising subterranean fauna assemblages, EPA has identified the need to adopt a more strategic and risk-based approach for the assessment of impacts to subterranean fauna (EPA, 2012). This approach focuses on utilising information on the distribution and population structure of widespread species (species surrogates) and the extent of relevant habitat (physical surrogates) to demonstrate landscape connectivity.

Surrogates can augment available sample data, particularly where a reasonable amount of sampling is unlikely to reveal the full range of a species because of demonstrated low capture rates in the habitat sampled. The use of surrogates together with the information gathered during baseline surveys, aims to raise the level of confidence in the predictions of impacts and provide sufficient confidence that the environmental objective can be met.

Following the habitat evaluation summarized in Section 7.4.3.2 and Appendix E2, it was shown through the statistically homogenous water quality, depth to water table, and high degree and frequency of fracturing in the top 40 mbgl across most geological profiles of the project area that connectivity across the landscape is probable. Based on these conclusive results, habitat is considered a useful surrogate to augment with catch data to make inferences on the probability of regional occurrences of subterranean fauna.

#### 7.4.5.1 Loss or Reduction in Stygofauna Species and/or Habitat

The spatial context of this assessment includes both those areas where stygofauna habitat may be directly removed through the development of open pit mines and as a result of groundwater drawdown resulting from mine pit dewatering and borefield abstraction.

To determine the full extent of impacts resulting from development of an open pit mine, mine dewatering and borefield abstraction, a numerical groundwater model was developed (Appendix D3). Emphasis was placed on the accuracy of this model to ensure that it could be used to make accurate predictions regarding potential impacts to stygofauna. To this end, the model has been subject to a peer review and range of sensitivity analysis to ensure that the model was conservative for the purpose of impact assessment.

The numerical groundwater model makes projections of groundwater drawdown associated with mine dewatering and borefield abstraction. The numerical model outputs included water table contours for two scenarios which include the end of mine life, and at steady state e.g. the time taken to reach a new groundwater equilibrium following mine closure. The worst-case scenarios were then identified for both scenarios and used for the purpose of subterranean fauna impact assessment. Further details relating to the numerical groundwater model can be found in Section 7.3.3.2.

OZ Minerals has examined geological and hydrological information to determine an appropriately conservative groundwater level which has been used as an acceptable amount of change likely to ensure the persistence of reasonable volumes of stygofauna habitat. The nominal groundwater drawdown level established for the current Proposal is 5 m, ensuring that at least 25 m of interconnected habitat will remain in places for stygofauna to move into.

Due to high net evaporation from pit lakes following mine closure modelling has shown that groundwater levels affected by mine pit dewatering will be slow to return to a steady state (Section 7.3.5.1), and in some areas the groundwater contours will relax to an area much greater than the end of mining groundwater contours. As such this impact assessment has combined the worst case 5 m groundwater drawdown contour from both the end of mine life and long-term steady state to illustrate the ultimate extent for potential impact to subterranean fauna (Figure 7-34). This has been defined to be the impact area for stygofauna and has been used to informing the impact assessment in the areas near to the mine pits.

The worst-case scenario for the borefield occurs at the end of mine life (e.g. year 26). Following cessation of borefield abstraction groundwater levels in the Northern Borefield are predicted to return to within 10% of their pre-mining levels within 10 to 20 years. As such the 5 m groundwater contour at the end of mine life was adopted as the worst-case scenario for the borefield (Figure 7-34). There is no overlap between the groundwater contours between the borefield and the mine pit dewatering, and as such no cumulative impacts on groundwater drawdown.

Using the groundwater contours discussed above, the area and inferred volume of stygofauna habitat loss associated with mine pit voids and the Northern Borefield were calculated. This calculation is conservatively based on the following assumptions:

- The full 30 m of vertical stygofauna habitat is taken for the area within the 5 m drawdown contour for the mine pit void and associated drawdown as shown in Figure 7-34 (i.e. permanent loss).
- The full 5 m of vertical stygofauna habitat is taken for the Northern Borefield drawdown contour as shown in Figure 7-34.

Both area (ha) and an inferred volume ($m^3$) of habitats to be impacted are presented in Table 7-43.


Figure 7-34: Worst Case 5 m Groundwater Drawdown Contour

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**Table 7-43: Spatial Extent and Inferred Volume of Stygofauna Habitat Within Impact Areas**

| Habitat Classification | Area of Habitat (ha) | Inferred Habitat Volume ($m^3$) | Area of Habitat Impacted (ha) | | Inferred Volume of Habitat Impacted ($m^3$) | | Percentage Habitat Impacted (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mining Voids | Northern Borefield | Mining Voids | Northern Borefield | Mining Voids | Northern Borefield | Total |
| Type S1 | 373,184 | 111,955,200,000 | 7,881 | 68 | 2,364,300,000 | 3,400,000 | 2.1 | 0.003 | 2.1 |
| Type S2 | 52,954 | 15,886,200,000 | 1,224 | 600 | 367,500,000 | 30,000,000 | 2.3 | 0.2 | 2.5 |

The impact assessment focuses on those species considered to be potentially restricted to within the impact area (represented by the worst case 5 m drawdown contour). Of the 27 known stygofauna species collected, 21 were recorded from both inside and outside or only outside of the impact area. While individuals of these species will be impacted by the proposed project, no changes to their conservation status are predicted given their wider distributions. As such, these have not been considered further in this assessment.

The remaining six species, the locations they were collected from and the number of individuals collected are shown in Table 7-44 and Figure 7-35 discussed in more detail in the following sections.

**Table 7-44: Potentially Restricted Stygofauna Species within the Impact Area**

| Lowest Identification | Linear Range | Number of Individuals Collected | Habitat Collected From |
|---|---|---|---|
| Enchytraeidae \`BOL034\` (3 bundle all seg, short sclero) | Singleton | 1 | Type S2 |
| Enchytraeidae \`BOL053\` (4 bundle, fat) | 3 km | 2 | Type S1 and S2 |
| Phreodrilidae \`BOL035\` (AP DVC) | Singleton | 1 | Type S1 |
| *Australocamptus* \`BHA252\` | 4 km | 6 | Type S1 |
| *Dussartstenocaris* sp. B11 | 0.7 km | 4 | Type S1 |
| Cypridopsinae \`BOS1176A\` | Singleton | 1 | Type S2 |

### Enchytraeidae ‘BOL034\` and Enchytraeidae ‘BOL053\`

One specimen of Enchytraeidae ‘BOL034\` was collected from a location within the paleochannel that runs through the Nebo pit whilst two specimens of Enchytraeidae ‘BOL053\` were collected from locations within the mine void impact area resulting in both species being assessed as potentially restricted (Figure 7-36).

When the genus was assessed against all available subterranean taxonomic records from the project two further species of the same genus were shown to be recorded both inside and outside of the impacted areas:

- Enchytraeidae ‘BOL055\` has a linear distribution of six kilometers and has been collect three times both inside and outside of the impact area (Figure 7-36).
- Enchytraeidae ‘BOL033\` has a linear distribution of 19 km and has been collect 27 times both inside and outside the impact area. In addition two specimens, with a linear distance of 18 km have been shown to be the same species through genetic analysis (Figure 7-36).

Utilising biological (morphological and genetic) and physical habitat as surrogates, it can be concluded that there is continuity of habitats of at least 19 km for Enchytraeidae species and it can be reasonably assumed that Enchytraeidae ‘BOL034\` and *Enchytraeidae* ‘BOL053\` will also occur and persist outside of the proposed project’s impact area.

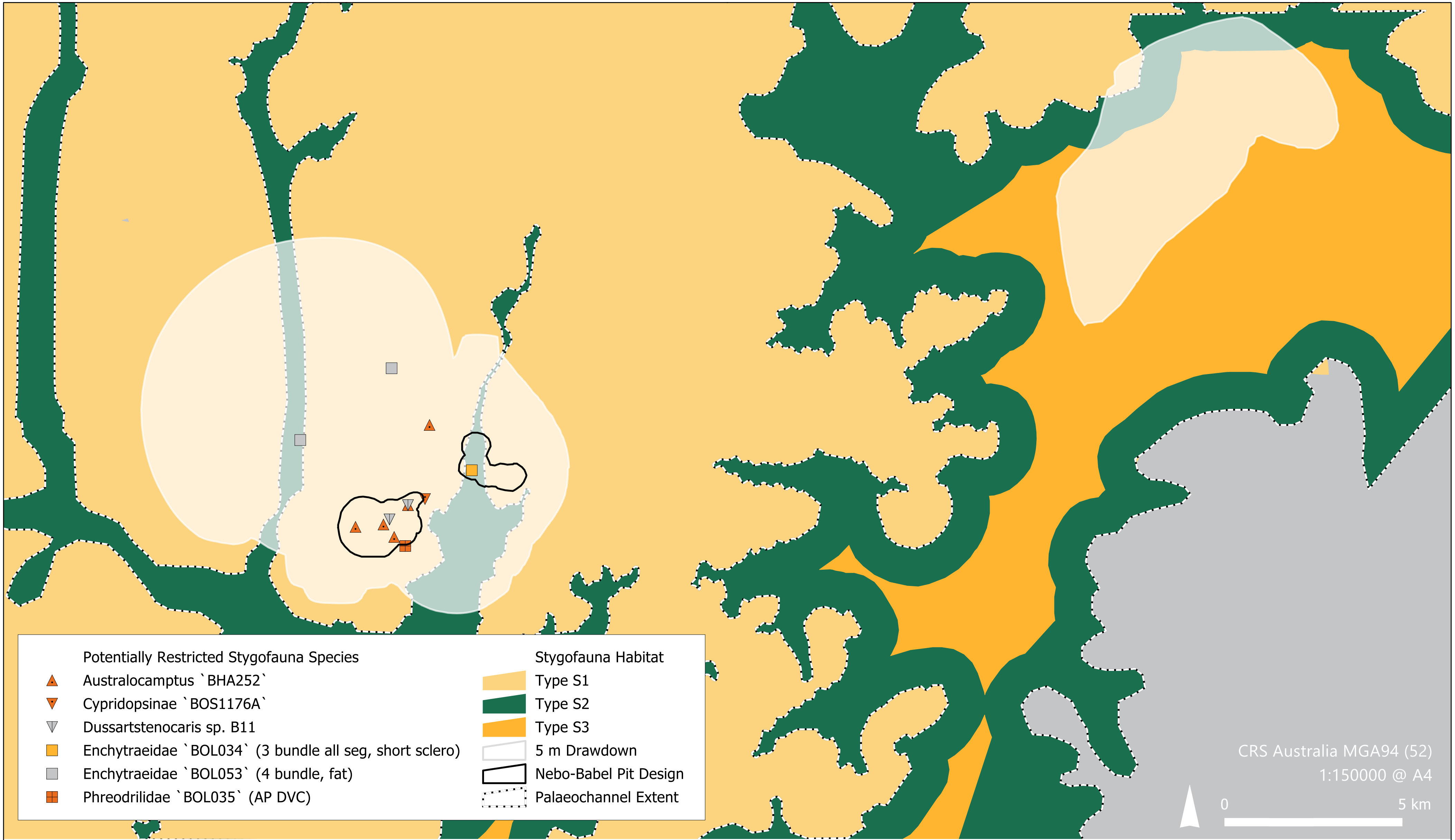


Figure 7-35: Distribution of Potentially Restricted Stygofauna at the WMP over Potential Habitat

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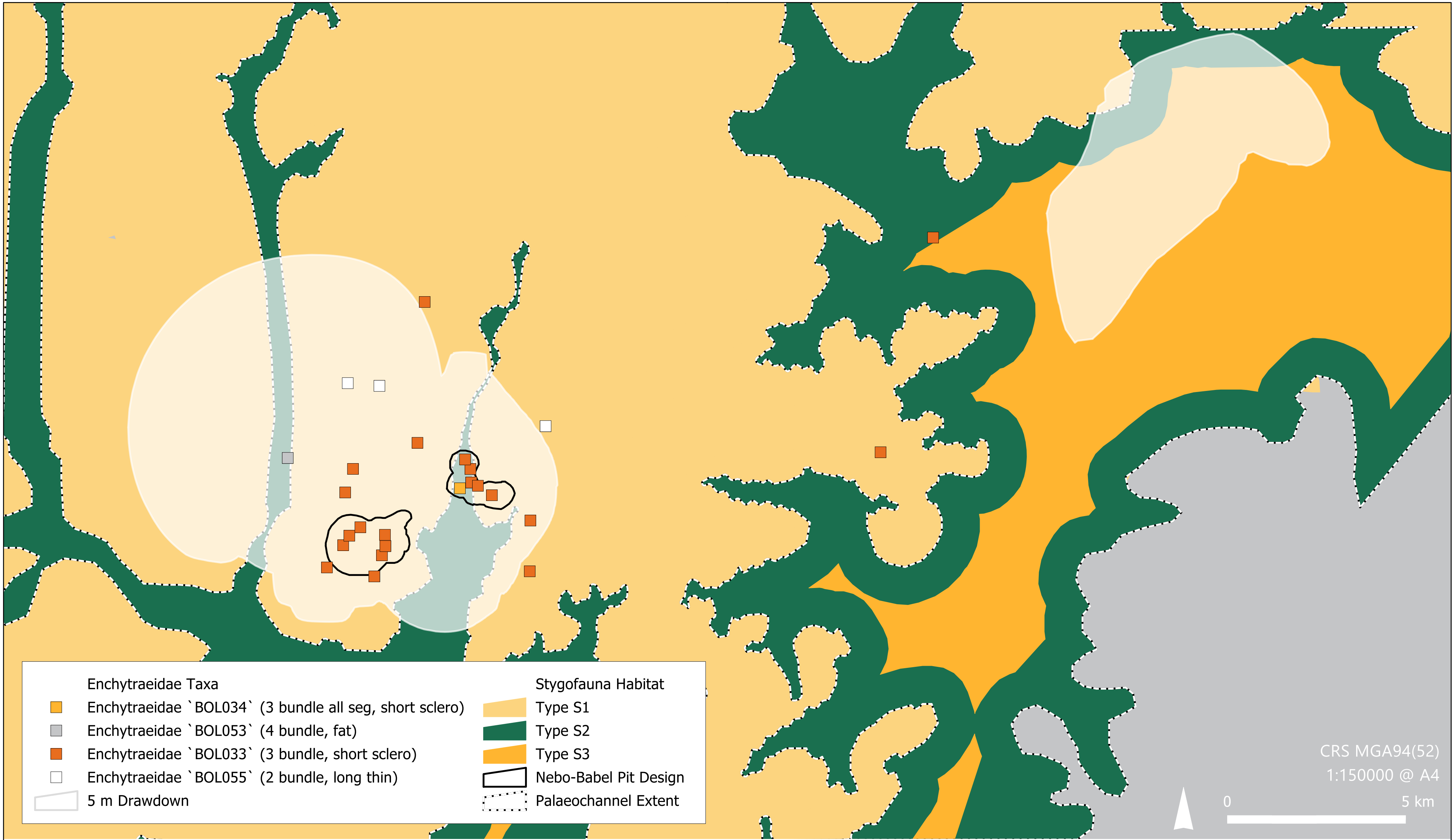


Figure 7-36: Distribution of Enchytraeidae at the WMP over Potential Habitat

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### Phreodrilidae 'BOL035`

One specimen of Phreodrilidae 'BOL035` was collected from a location on the edge of the Babel pit footprint, within the mine void impact area resulting in this species being potentially restricted. (Figure 7-37).

When the genus was assessed against all available subterranean taxonomic records from the project a further species of the same genus was shown to be recorded both inside and outside of the impacted areas Phreodrilidae 'BOL056` has a linear distribution of 42 km and has been collect four times across the WMP region (Figure 7-37) indicating a high likelihood of broad scale connectivity for this genus.

Utilising biological and physical habitat as surrogates for Phreodrilidae 'BOL035`, it can be concluded that there is continuity of habitats of at least 42 km for Phreodrilidae species and it can be reasonably assumed that Phreodrilidae 'BOL035` will occur and persist outside of the proposed project's impact area.

### Australocamptus 'BHA252`

Six specimens of *Austrolocamptus* 'BHA252` were collected from five different bores. Of these specimens, five were located within the Babel pit, with the remaining specimen located within the mine void impact area approximately 4 km from the Babel pit (Figure 7-38).

Closer examination of the individual collected within the mine void impact area shows that it occurs within the 15 to 20 m drawdown contour. As vertical habitat has been shown to extend for approximately 30 m within Type S1 habitat (weathered and highly fractured bedrock (saprock)), approximately 35 - 50% of habitat will remain for this species. Additionally, as discussed in Section 7.4.3.2, it has been shown that Type S1 habitats are extensive and interconnected across the landscape.

Using habitat as a surrogate for *Austrolocamptus* 'BHA252` it can be concluded that there is a high likelihood of continuity of habitats of at least 4 km for *Austrolocamptus* 'BHA252` and it can be reasonably assumed that the species will also occur and persist in areas beyond the proposed project's impact area.

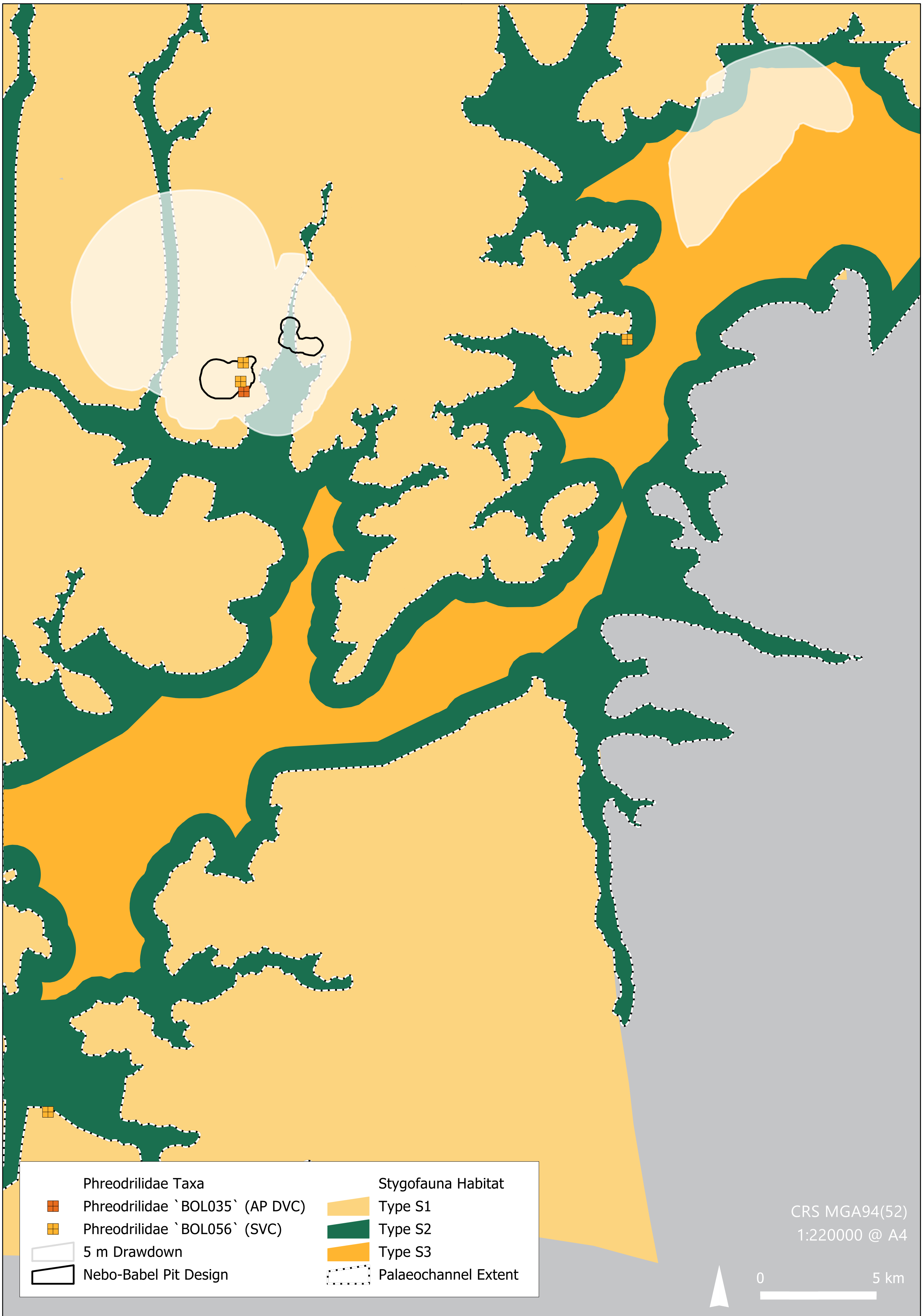


Figure 7-37: Distribution of the Phreodrilidae at the WMP over Potential Habitat

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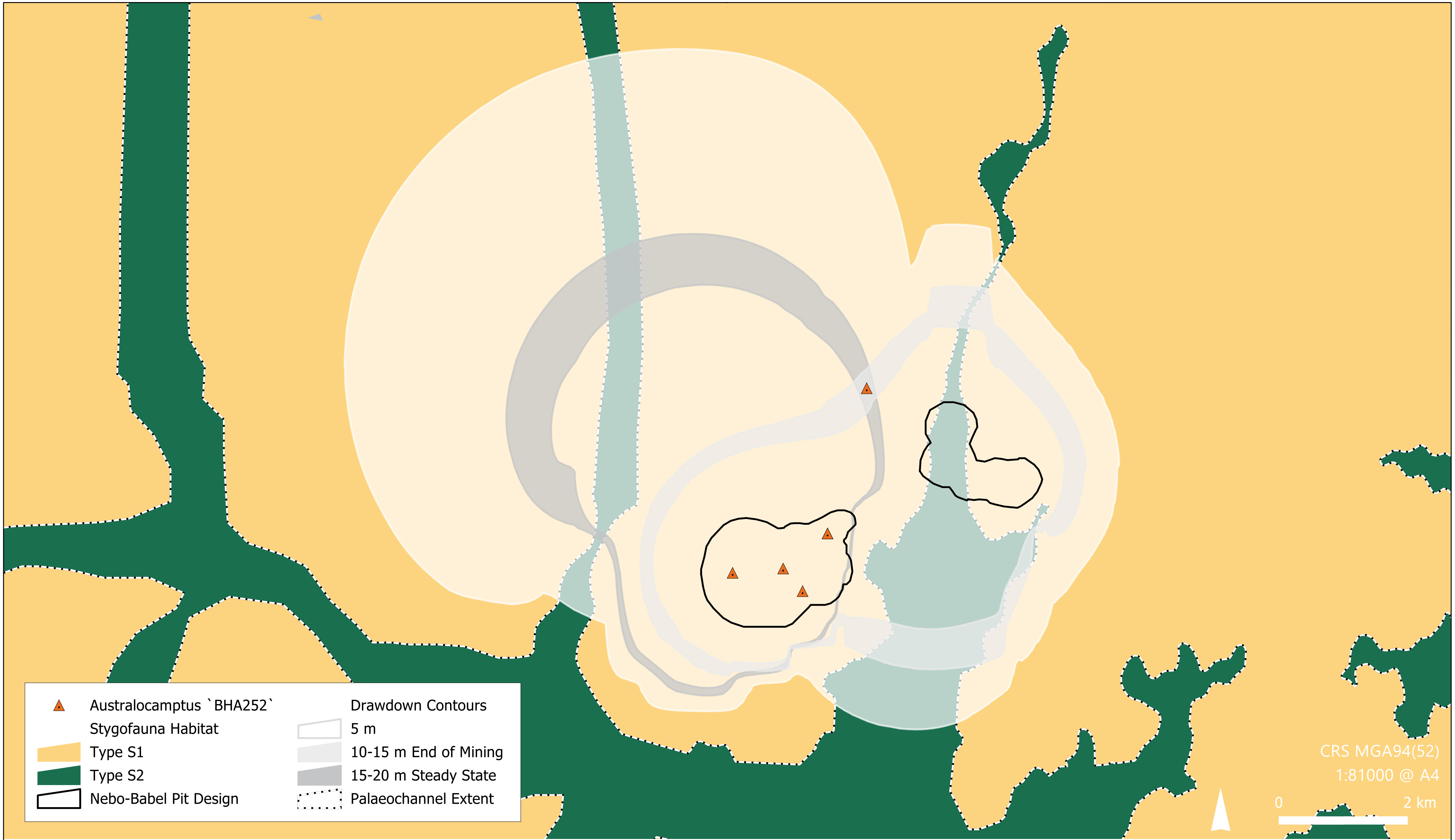


Figure 7-38: Distribution of Australocamptus 'BHA252' at the WMP over Potential Habitat

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### Dussartstenocaris sp. B11

Four specimens of *Dussartstenocaris* sp B11 were collected from two locations within the Babel pit resulting in this species being assessed as potentially restricted (Figure 7-39).

When the genus was assessed against all available subterranean taxonomic records from the project two further species of the same genus were shown to be recorded both inside and from multiple areas outside of the impacted areas:

- *Dussartstenocaris* sp B10 has a linear distribution of 31 km and has been collect 14 times across the WMP area (Figure 7-39).

Utilising biological and physical habitat as surrogates for *Dussartstenocaris* sp B11, it can be concluded that there is continuity of habitats of at least 31 km for the *Dussartstenocaris* genus and it can be reasonably assumed that the species will occur and persist outside of the proposed project's impact area.

### Cypridopsinae `BOS1176A`

One specimen of *Cypridopsinae* 'BOS1176A` was collected from a bore on the edge of the Babel pit footprint resulting in this species being potentially restricted (Figure 7-40). This species was only collected in the form of a single valve (shells) and thus DNA sequencing was not possible. Further the capacity for morphological identification was limited and therefore the identification is precautionary. Other cypridopsid species in Western Australia are widespread and given the highly fractured an interconnected nature of geological habitats within the project area it is likely that this species has a more widespread distribution (Appendix E1).

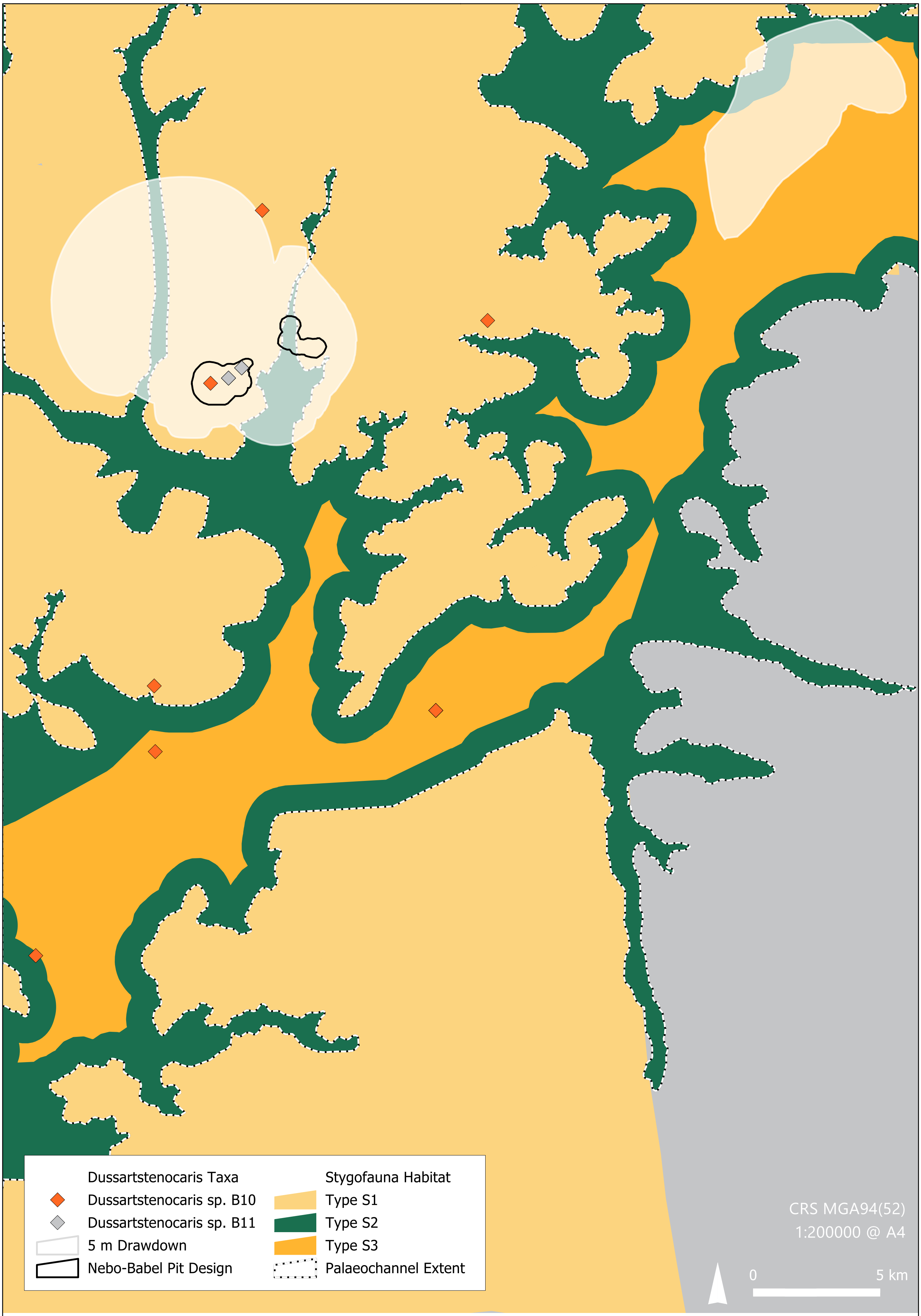


Figure 7-39: Distribution of the Dussartstenocaris at the WMP over Potential Habitat

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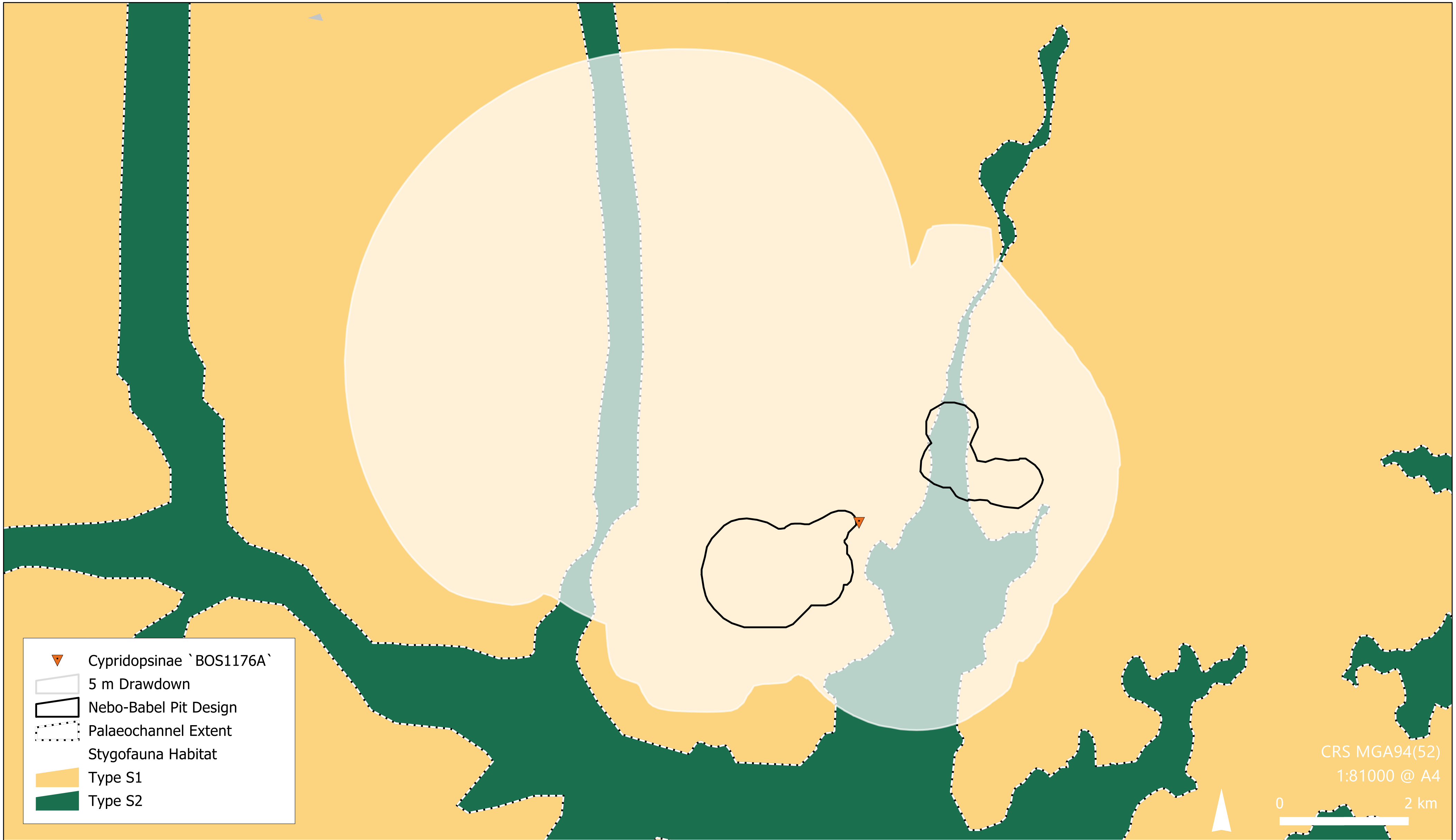


Figure 7-40: Distribution of Cypridopsinae 'BOS1176A' at the WMP over Potential Habitat

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The assessment of inherent (unmitigated) risk of the loss or reduction in abundance of stygofauna species and/or habitat is provided in Table 7-45, and was assigned a Low risk. Section 7.4.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-45: Assessment of Potential Impact of Loss or Reduction in Stygofauna Species and/or Habitat**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Loss or reduction in abundance of stygofauna species and/or habitat from the Northern Borefield impact area | Rare | Insignificant | Low | No known potentially restricted stygofauna species occur within the Northern Borefield Impact Area.<br>In addition, a comprehensive geological analysis of potentially available habitat has shown that where drawdown occur there is likely to be up to 30m of vertical stygofauna habitat. In the event of the maximum modelled drawdown of 5m in the central areas of the northern borefield more than 80% of vertical habitat would remain and as such provide sufficient refuge for stygofauna throughout the borefield life. |
| Loss or reduction in abundance of stygofauna species and/or habitat from the mine void impact area | Unlikely | Minor | Low | Utilising biological habitat surrogates it can be concluded that there is continuity of habitats for stygofauna and that the likelihood is high that they are located and will persist outside of the proposed project's impact areas. Further, the total percentage of habitat loss within the mining impact area is low (~3%) compared to inferred available stygofauna habitat. |

#### 7.4.5.2 Loss or Reduction in Troglofauna Species and/or Habitat

The spatial context of this assessment includes the troglofauna habitat which is directly impacted by the proposed open pits (i.e. the area to be mined). Open pit dimensions are presented in Table 7-47 and shown on Figure 7-41. The dimensions provided in Table 7-46 reflect the most conservative, largest and reasonably foreseeable economic pit shells. Further mine optimisation, based on future drilling results, copper and nickel prices, refined operating costs and a range of other variables, may reduce the size of the ultimate pit shell compared to the assessed dimensions.

**Table 7-46: Open Pit Characteristics for the Nebo Deposit and Babel Deposit**

| Approximate Dimensions (m) | Nebo Pit | Babel Pit |
|---|---|---|
| Width (m) | Up to 500 | Up to 2,200 |
| Length (m) | Up to 2,100 | Up to 1,400 |
| Depth (m) | Up to 270 | Up to 520 |
| Average depth to water (m) | 6.5 | |

The area and inferred volume of troglofauna habitat loss associated with the open pits have been calculated based on an assumption that the full 5.5 m of vertical troglofauna habitat (e.g. the area below the 1m of transported cover, and above the 6.5 mbgl water table) is taken over the area of the open pit footprint as shown in Figure 7-41. Both area (ha) and an inferred volume ($m^3$) of troglofauna habitats to be impacted are presented in Table 7-47.

**Table 7-47: Spatial Extent of Probable and Inferred Troglofauna Habitat Within Impact Areas**

| Habitat Classification | Area of Habitat (ha) | Inferred Volume of Habitat ($m^3$) | Area of Habitat Impacted (ha) | Inferred Volume of Habitat Impacted ($m^3$) | Percentage Habitat Impacted (%) |
|---|---|---|---|---|---|
| Type T1 | 3,671 | 73,420,000 | 309 | 6,180,000 | 8.4 |
| Type T2 | 494 | 142,806,500 | 179 | 19,578,500 | 13.7 |
| Type T3 | 35 | 14,773,500 | 8 | 1,521,500 | 10.3 |

Table 7-47 shows that the predicted percentage habitat loss compared with the total mapped extent of those habitat types is small (~11% overall) and sufficient habitat is likely to be available in the surrounding landscape for troglofauna to persist.


Figure 7-41: Open Pit Dimensions over Potential Habitat

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Of the ten known troglofauna species collected at the WMP, three were recorded from both inside and outside or only outside of the mine pit footprints. While individuals of these species may be impacted by the proposed project, no changes to their conservation status are predicted given their wider distributions and as such were not considered further as part of this impact assessment.

The remaining seven troglofauna species, the locations they were collected from and the number of individuals collected are shown in Table 7-48 and Figure 7-42.

**Table 7-48: Potentially Restricted Troglofauna at the WMP**

| Lowest Identification | Linear Range | Number of Individuals Collected | Habitat Collected From |
|---|---|---|---|
| Parajapygidae sp. B43 (*Parajapyx swani* group) | Singleton | 2 | Type T1 and T2 |
| *Cryptops* \`BSCOL057\` | Singleton | 1 | Type T1 |
| Projapygidae \`BDP147' | Singleton | 1 | Type T1 and T2 |
| Pauropodidae \`BPU077\` | Singleton | 1 | Type T1 and T2 |
| *Symphyella* \`BSYM087\` | Singleton | 1 | Type T1 and T2 |
| *Symphyella* \`BSYM089\` | Singleton | 1 | Type T1 and T3 |
| *Symphyella* \`BSYM090\` | Singleton | 1 | Type T1 and T2 |

To assess the likelihood that these seven species may be restricted to the impact area, the habitat from which they were collected from was comprehensively evaluated, and described below.

This is consistent with the EPA's (2012) review of subterranean fauna assessment in WA, which highlights the limitations and inherent difficulty in conclusively demonstrating that subterranean fauna species recorded within the disturbance footprint of development projects also occur outside the footprint.

This review acknowledged the difficulties associated with the common lack of evidence and identified acceptable methods to demonstrate the likely distribution of species including geological information indicating continuity between the impact zone and areas beyond the impact zone to indicate that species are unlikely to be confined within the impact zone. This approach has been used in this assessment to demonstrate the likely wider distribution of troglofauna species recorded from the proposed open pits.

The habitat type from which these species were recorded represents the most common and widespread geological profiles at the WMP consisting of Type T2 (weathered and highly fractured basement (saprock)) overlain by up to two meters of Type T1 (calcrete) habitats. A review of data has shown that there are no notable geological, geochemical or hydrogeological features within the deposits that may result in a spatially restricted or specialised habitat type inherent to the area of the mine pits (Figure 7-42).

Two troglofauna species were shown to have linear distributions of 4 km to 11 km thus supporting the use of habitat as a surrogate. This distribution of troglofauna species indicates that connectivity among the landscape is likely:

- *Hanseniella* `BSYM088` was collected three times from two different locations inside and outside of the impact area. This species has a linear range of 11 km and is found within Type T1 and T2 habitat types (Figure 7-43).
- *Ptinella* `BCO179` was collected three times from three different locations inside and outside of the impact area. This species has a linear distribution of 4 km and is found within Type T1 habitat (Figure 7-44).

The assessment of inherent (unmitigated) risk of loss or reduction in abundance of troglofauna species and/or habitat is provided in Table 7-49, and was determined to represent a medium risk. Section 7.4.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-49: Assessment of Potential Impact of Loss or Reduction in Abundance of Troglofauna Species and/or Habitat**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Loss or reduction in troglofauna species and/or habitat. | Almost Certain | Minor | Medium | There will be some loss of potentially restricted troglofauna species however habitat characterisation has identified that sufficient, connected habitat will remain surrounding the impact area for these species. The presence of some troglofauna species both inside and outside of the impact area with linear distributions of between 4 and 11 km supports the habitat study by indicating likely geological connectivity. |


Figure 7-42: Distribution of Potentially Restricted Troglofauna at the WMP over Potential Habitat

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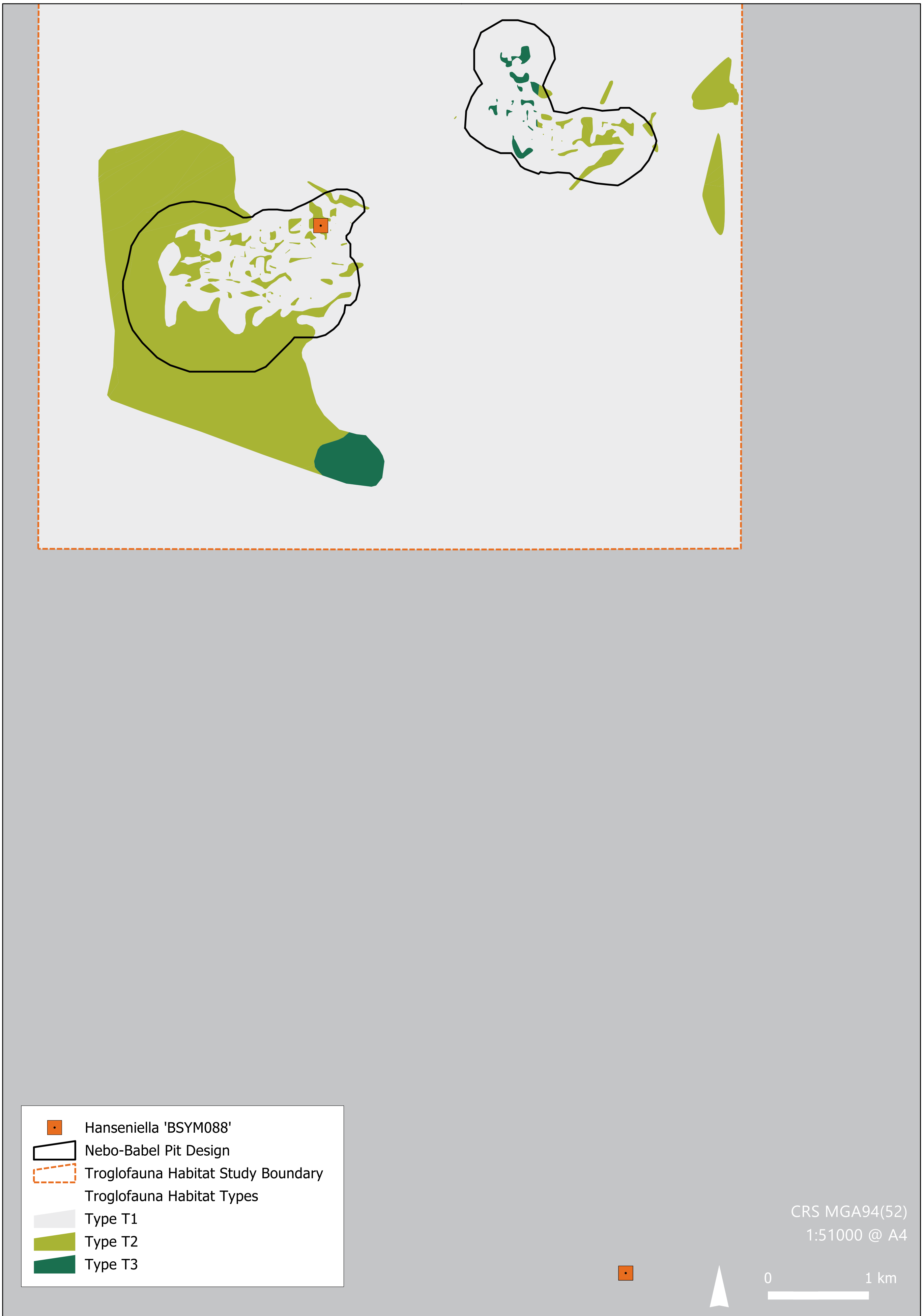


Figure 7-43: Distribution of Hanseniella 'BSYM088' at the WMP over Potential Habitat

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Figure 7-44: Distribution of Ptinella `BCO179` at the WMP over Potential Habitat

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#### 7.4.5.3 Indirect Impacts to Subterranean Fauna

Current scientific knowledge of the indirect impacts of reduced habitat quality (as distinct from direct habitat removal due to mining and associated activities) is limited. Nevertheless, some general predictions of the risk associated with indirect impacts to subterranean fauna have been assessed and are presented in the following sections.

**Water Quality Changes (Stygofauna)**

Changes in water quality, and in particular changes in salinity, have the potential to result in reductions in available stygofauna habitat.

It is not predicted that implementation of the proposed project will results in changes to salinity of groundwater, and the implementation of mitigation measures, and the nature of the interactions of AMD with the underlying rock, will ensure that groundwater quality changes as a result of AMD will not occur, and thus stygofauna habitat will not be altered.

**Percussion from Blasting**

Blasting and vibration may have an indirect effect on stygofauna and troglofauna through reducing or altering underground structure (usually via rock fragmentation and collapse of voids). It is also possible that blast impacts could detrimentally affect some individuals directly through concussion. However, both types of effects are likely to dissipate rapidly with distance from the pit and blasting is not considered to be a significant impacting activity beyond the pit boundary.

**Clearing of Vegetation and Waste Landform Construction**

Clearing and the placement of waste landforms may reduce inputs of nutrients and dissolved organic matter to subterranean habitats as a result of reduced organic matter on the surface and potentially reduced rainfall recharge. Rainfall may run off stockpiles in addition to and/or rather than infiltrating through, them creating a shadow of reduced energy and nutrient sources, which may reduce the quality of habitat. These indirect impacts may reduce the quality of habitat but are not considered to be a significant impacting activity for the proposed project.

#### Contamination

The potential exists for the subterranean environment to be degraded by spills of hydrocarbons and other chemical reagents. Contamination is likely to be localised and will be minimised by engineering and management practices to ensure the containment of hydrocarbons and other chemical reagents.

The assessment of inherent (unmitigated) risk of indirect impacts to stygofauna is provided in Table 7-50 and was assigned a Low risk. Section 7.4.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-50: Assessment of Potential Indirect Impacts to Subterranean Fauna**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Indirect impacts to subterranean Fauna | Unlikely | Minor | Low | Indirect impacts are unlikely to result in reduced habitat quality and a corresponding lowering in subterranean fauna densities due to both the limited sources of impacts and the restricted spatial extent of these sources. |

### 7.4.6 Mitigation Measures

As described in Section 7.4.5, the inherent risk associated with the assessed subterranean fauna potential impact events were assessed as Low to Medium and would not require any further mitigation to meet EPA's Objective for subterranean fauna. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP. These avoidance and mitigation measures are shown in Table 7-51.

**Table 7-51: Mitigation Measures for the Subterranean Fauna Environmental Factor**

<table>
<tr><th rowspan="2">Potential Impact Event</th><th rowspan="2">Mitigation</th><th colspan="3">Residual Risk Assessment</th></tr>
<tr><th>Likelihood</th><th>Consequence</th><th>Residual Risk</th></tr>
<tr><td>Loss or reduction stygofauna species and/or habitat</td><td rowspan="2">Measures to Avoid<br>• Groundwater abstraction in the Northern Borefield will only occur from the Padinga Aquifer.<br>Measures to Minimise<br>• Apply appropriate bore spacing in borefield design to minimise extent and depth of potential drawdown.<br>• Pit dewatering minimised to that required to safely access below water table resources.<br>• Groundwater will be abstracted compliant with an approved Groundwater Licence and Operating Strategy, which will include the development of trigger and threshold levels for groundwater quality and levels.<br>• Develop and implement a water reuse and recycling program to minimise abstraction of groundwater.<br>• Updating/recalibration of groundwater models at least annually for the first five years reducing to tri-annually should no difference be observed between predicted and actual modelling.<br>Measures to Rehabilitate<br>• Backfill Nebo pit to reduce the potential drawdown extent post closure.<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b).</td><td>Rare</td><td>Minor</td><td>Low</td></tr>
<tr><td>Loss or reduction of troglofauna species and/or habitat</td><td>Almost Certain</td><td>Minor</td><td>Medium</td></tr>
<tr><td>Indirect impacts to subterranean fauna</td><td>Measures to Avoid<br>• Nil<br>Measures to Minimise<br>• Clearing and/or disturbance to remain within the approved Development Envelope.<br>• Appropriate design of waste landforms specifically encapsulation of PAF waste rock and minimisation of oxidation to prevent changes to groundwater quality.<br>• Appropriate design of hazardous material storages in accordance with relevant guidelines and Australian Standards.</td><td>Unlikely</td><td>Minor</td><td>Low</td></tr>
</table>

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| | • Construction and maintenance of surface water drainage systems to control and contain runoff from mining areas and divert clean stormwater away from pits and other mining disturbance areas.<br>• Construction of TSF as per approved designs to minimise seepage.<br>• Monitoring of groundwater quality during operations.<br>• Provision of e spill kits and implementation of spill management procedures. | | | |
| | **Measures to Rehabilitate** | | | |
| | • Preparation and regular update of a Mine Closure Plan consistent with DMIRS Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |

### 7.4.7 Predicted Outcome

The predicted outcome was determined in accordance with the EIA Framework developed for the Proposal (Appendix A3), and was based on the assessment of impacts (Section 7.4.5) and the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e). The results of this assessment are presented in Table 7-52.

Based on this assessment, the Proposal was assessed as having no significant or irreversible impact on subterranean fauna and the EPA Objective for subterranean fauna 'To protect subterranean fauna so that biological diversity and ecological integrity are maintained' would be met should the Proposal be implemented.

**Table 7-52: Assessment of Impact Significance – Subterranean Fauna**

| EPA Considerations for Significance | Summary of Impact Assessment Outcomes | Impact Outcome (Significant/ Not Significant) |
|---|---|---|
| Values, sensitivity and quality of the impacted environment which is likely to be impacted | The identification and consideration of values has been considered during the commissioning and undertaking of the specialist study program. The following was noted in relation to key subterranean fauna values:<br>• No subterranean TECs, or PECs occur within the Development Envelope or a 100 km radius<br>• No Threatened or Priority subterranean fauna were recorded within the Development Envelope<br>• Subterranean fauna habitat within and adjacent to the Development Envelope is widespread. Unlike other areas, habitat is not confined to paleovalley systems. As such, no specific subterranean habitat was considered to provide conditions that may result in potential species restrictions<br>• Some habitat loss is likely as a result of project activities, however subterranean fauna habitat is widespread and interconnected within the Project area, and the impacted area is sufficiently small that only a low percentage of overall subterranean fauna habitat or individual species is predicted to be impacted (Appendix E2).<br>Based on the above, OZ Minerals believes that should the Proposal be implemented it would not significantly impact the value, sensitivity and quality of the environment | Not Significant |
| Extent (intensity, duration, magnitude and footprint) of the likely impacts | The proposed project would result in the loss of up to 2.3% of mapped stygofauna habitat and up to 11.8% of mapped troglofauna habitat. A precautionary approach has been taken which overestimates the loss of habitat, meaning the worst-case impact has been assessed. The extent, magnitude and footprint are therefore considered to be small within a vastly undisturbed and under-surveyed area and would not be significant in the broader scale<br>The duration of impacts has been considered, with duration identified to be much less for impacts associated with groundwater drawdown from the Northern Borefield compared to the mine voids. The largest modelled extent of potential groundwater impacts (e.g. end of mine life, and in-perpetuity modelled extent) were combined and used to inform this impact assessment<br>With consideration of modelled extent, the resultant risk of adverse impacts to subterranean fauna has been assessed as Low | Not Significant |

| EPA Considerations for Significance | Summary of Impact Assessment Outcomes | Impact Outcome (Significant/ Not Significant) |
|---|---|---|
| The consequence of the likely impacts (or change) | The consequences of various subterranean fauna related impact events have been assessed using a risk-based framework which included specifically designed consequence criteria for the subterranean fauna Environmental Factor. The results of the risk assessment, provided in Section 7.4.5, determined any need for further mitigation measures. Both the inherent and residual risks to subterranean fauna as a result of the proposed project were assessed as being Low and Medium and as such were considered not significant | Not Significant |
| The resilience of the environment to cope with the impact or change | The comprehensive subterranean habitat assessment (augmented with both sampling and biological surrogates) has shown that subterranean habitats are common, widespread and continuous between impacted and non-impacted areas and as such provide strong evidence to support the likelihood of species wider presence and connection. Significant available habitat therefore provides refuge for species persistence as a result of impacts associated with the proposed project | Not Significant |
| Cumulative impacts with other existing or reasonably foreseeable activities, developments and land uses | There are no other existing or reasonably foreseeable activities, developments or land uses proposed within the areas potentially impacted by the proposed project, which may have a cumulative impact upon subterranean fauna and their associated values. The impact assessment is presented in Section 7.4.5 and the SPR assessment was undertaken to support the Proposal is provided in Appendix A2<br>The proposed project represents the only significant development for approximately 450 km | Not Significant |
| Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment | Connections and interactions between project (sources) and the receiving environment (environmental factors and their associated values) were considered using a SPR assessment and subsequent risk assessment. This SPR and risk assessment allowed for an assessment of interactions between the various and overlapping elements of the proposed project<br>Key connection between subterranean fauna relate to geological, geochemical and hydrogeological aspects. All of these values have taken into consideration the combined impacts of changes to these combined impacts and considered in the present impact assessment<br>Resultantly, no unacceptable impacts to subterranean fauna and their relevant values due to multiple or overlapping project sources were identified | Not Significant |
| The level of confidence in the predictions of impacts and the success of proposed mitigation | In the absence of characterising the full subterranean fauna assemblage, there remains inherent uncertainty in predicted outcomes. However, OZ Minerals have drastically increased confidence in predictions of impact assessment outcomes by: | Not Significant |

| EPA Considerations for Significance | Summary of Impact Assessment Outcomes | Impact Outcome (Significant/ Not Significant) |
| --- | --- | --- |
| | • Conducting a dedicated study campaign consisting of 168 dedicated stygofauna monitoring bores and 102 troglofauna bores. The survey effort amounted to approximately 430 series of net samples for stygofauna (consisting of six net hauls at each bore), approximately 450 troglofauna traps, and 240 bore scrapes (consisting of 240 x four sets of scrapes) for troglofauna over a two-year period. Of the 168 dedicated stygofauna bores, 115 were located within the groundwater drawdown impact area and 53 outside. Of the 102 dedicated troglofauna bores, 59 were located within the mine voids and 43 outside.<br>• Using 3,200 drill holes and 350,000 m of drill core and geophysical techniques to identify and map subterranean fauna habitats<br>• Undertaking detailed studies relating to potential indirect impacts such as groundwater drawdown. Where uncertainty was apparent peer reviews and uncertainty assessments were undertaken to increase confidence in predictions (e.g. groundwater drawdown extent, and numerical groundwater modelling)<br><br>OZ Minerals has a moderate to high level of confidence in the subterranean fauna characterisation and the predictions of project related impacts. The proposed avoidance and mitigation measures represent those currently accepted within the industry and have a high probability of success | |
| Public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment | OZ Minerals developed and implemented a detailed and thorough stakeholder engagement program which included relevant Ngaanyatjarra People, the Ngaanyatjarra Council, relevant Shires, government, and some special interest groups. The focus of this engagement program was on high interest and high influence stakeholder groups, particularly land rights holders. Engagement activities included project briefings, attendance by the Ngaanyatjarra Council to regulator meetings, numerous community meetings, a number of large heritage surveys, and a third-party environmental peer review of the Section 38 Referral submission and associated specialist studies on behalf of the Ngaanyatjarra People to ensure their interests and concerns relating had been appropriately considered, and a dedicated on-country consultation with relevant West Musgrave Traditional Owners relating to the outcomes of this EP Act Part IV impact assessment. A summary of consultation is provided within a consultation-specific record (Appendix A4) and project-specific consultation register (Appendix A5)<br><br>No concerns relating to subterranean fauna were highlighted by Traditional Owners during dedicated consultation activities<br>All areas identified by Traditional Owner, Ngaanyatjarra Council and other stakeholders relating to potential impacts inherent to subterranean fauna values have been considered in this assessment | Not Significant |

## 7.5 Terrestrial Environmental Quality

### 7.5.1 EPA Objective

The EPA's overarching Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) lists the following as their objective for terrestrial environmental quality.

To maintain the quality of land and soils so that environmental values are protected

Environmental value is defined under the EP Act as a beneficial use, or an ecosystem health condition. The beneficial uses of good quality soil are primarily agriculture, maintaining drinking water quality, recreation and cultural values. Ecosystem health values that are supported by soils include biodiversity, water quality and seed banks

In the context of this factor and objective, the EPA's primary focus is the fundamental link between soil quality and the protection of ecological and social values that good soil quality supports (EPA, 2016g). Other factors such as discharges to waters and impacts to flora and vegetation, subterranean fauna and terrestrial fauna are discussed in Flora and Vegetation (Section 7.1), Inland Waters (Section 7.3), Subterranean Fauna (Section 7.3.7) and Terrestrial Fauna (Section 7.6) factors, respectively.

### 7.5.2 Policy and Guidance

Terrestrial Environmental Quality is protected under the following State legislation:

- *Environmental Protection Act, 1986* (WA)
- Environmental Protection (Unauthorised Discharges) Regulation, 2004 (WA)
- *Contaminated Sites Act, 2003* (WA).

In addition to State legislation, the following policy and guidance statements were considered in the impact assessment for terrestrial environmental quality:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA, 2020e)
- EPA Environmental Factor Guideline – Terrestrial Environmental Quality (EPA, 2016g)
- Guidelines on Tailings Dams – planning, design, construction, operation and closure (ANCOLD, 2019)
- Guidelines on the Consequence Categories for Dams (ANCOLD, 2012)
- Guidelines on the safe design and operating standards for tailings storage (DMP, 2013a)
- Code of Practice – Tailings storage facilities in Western Australia. Resources Safety and Environment Divisions (DMP, 2013b)
- Statutory guidelines for mine closure plans (DMIRS, 2020a).

### 7.5.3 Receiving Environment

#### 7.5.3.1 Studies and Survey Effort

The following studies and surveys, relating to terrestrial environmental quality, were undertaken to systematically characterise the proposed project's potential impacts to the terrestrial environment:

- Soil and landform study (Appendix F1). A baseline study of the land systems, landforms and key soil types potentially affected by the proposed project. The aims of the soil and landform study were to:
  - identify potential impacts from soil and landform disturbance (e.g. heritage sites and landforms of conservation value or scientific interest)
  - identify suitable construction and rehabilitation materials to support mine closure planning.
- Static waste rock and low-grade ore geochemistry assessment (Appendix F2). A systematic and rigorous assessment of key waste rock types and low-grade ores to be generated by the development of the Nebo and Babel deposits, focusing on potential environmental hazards (e.g. acid and neutral metalliferous drainage, saline drainage and erosivity). The assessment used 'static' laboratory tests that provide a 'snapshot' of the environmental behavior of the materials as opposed to 'kinetic' tests, which generate information about the potential rates of chemical reactions involving the materials (e.g. rates of acid-generating and acid-neutralising reactions).
- Kinetic waste rock and low-grade ore geochemistry assessment (Appendix F3). The kinetic assessment built on the knowledge developed in the static waste rock and low-grade ore geochemistry assessment. The assessment focused on waste rock types and materials to be stockpiled (e.g. low-grade ore) or which may generate acidic and/or metalliferous seepage. With a primary aim to inform mining risk, planning and development of an effective closure strategy, the kinetic study involved long-term laboratory leaching tests (at least twelve months upon completion) to understand:
  - which materials would require special management
  - timeframes associated with any special management (e.g. safe stockpiling durations).
- Landform risks relating to long-term erosional stability (Appendix F4). The study identified the potential for long-term waste landform stability, accounting for the erosivity of waste rock and soils that would be used during decommissioning and rehabilitation for closure. The primary aim was to identify landform design parameters, reducing the risk of soil contamination, loss of growth medium and exposure of stored tailings and/or encapsulated mine waste materials within the landforms.
- Static and kinetic tailings geochemical characterisation (Appendix F5). Similar to the static and kinetic waste rock and low-grade ore assessments, metallurgical process trial residues representing tailings from the proposed project were assessed using static and kinetic laboratory tests. The primary aims of the study were to:
  - identify whether the tailings would require any special management due to their environmental behavior (e.g. generation of acidic/neutral metalliferous seepage)

- inform design parameters of TSFs to effectively minimise environmental impacts
- inform mine closure planning.

### 7.5.3.2 Soils

The project area is situated within the Western Desert Ranges Province soil-landscape region of the Government of Western Australia's Department of Primary Industries and Regional Development's system, formerly Department of Agriculture and Food WA; DAFWA – Soil Groups. The Desert Ranges Province has been described at the regional level as sandplains and dunes (with hills and ranges surrounded by wash plains) on granitic and volcanic rocks of the Musgrave Complex and sedimentary rocks of the Amadeus Basin (Tille, 2006).

#### Soil Types

The following three physically and chemically distinct soil types were identified within the study area (Appendix F1):

- Red (aeolian) deep sand, including low vegetated dunes (DAFWA Soil Group 445)
- Red (aeolian) shallow sand overlying hardpan, typically calcrete (DAFWA Soil Group 423)
- Calcareous stony soils (DAFWA Soil Group 202).

These soil types are further described in Table 7-53 and their distribution within the study area is shown in Figure 7-45).

**Table 7-53: Soil Types within the Study Area**

| Soil Type | Description | Characteristics | Representative Photograph |
|---|---|---|---|
| Red Deep Sand<br>(DAFWA Soil Group 445) | Red deep sand occurs as sandplain and dune sequences in topographically elevated areas within the study area. It is differentiated from the other two soil types by having a minimum of 600 mm of aeolian siliceous sand (no upper limit) as A and B1 horizons overlying nodular, gravelly or massive calcrete or silcrete.<br>Deep red sand is widely distributed to the north of the proposed Babel and Nebo pits, but also occurs as low dunes overlying the calcrete plain. | • Little evidence of significant accumulation of humified organic matter in the surface (A horizon) profile<br>• Little to no gravel lag at the surface<br>• A partly bleached surface, resulting in an orange-brown colour compared to a deeper red-brown (especially when deep or moist) colour of underlying sand<br>• Spinifex (*Triodia* spp.) and grasses as the dominant vegetation types, with minor leaf litter and very little woody debris<br>• The A horizon material is typically a non-calcareous (siliceous) loamy sand, grading into a deep (>500 mm) sandy loam B1 horizon<br>• Soil fabric consistent with very good vertical drainage (infiltration) |  |
| Red Shallow Sand<br>(DAFWA Soil Group 423) | Red shallow sand is defined as the soil type comprising a cover of non-calcareous (siliceous) aeolian A and shallow B1 horizon of less than 600 mm in depth. The corresponding B2 horizon is defined by the presence of calcrete (or silcrete) gravels and cobbles, or as indurated calcrete sheet (or silcrete) as a distinct C horizon.<br>Drainage is generally rapid, except for locations where the siliceous A and B1 horizons are shallow (<300 mm) and overlie an indurated calcareous or siliceous hardpan.<br>Saturation of the siliceous horizon may occur following heavy rainfall events, followed by overland (sheetwash) flow. | • Little evidence of significant accumulation of humified organic matter in the surface (A horizon) profile<br>• Occasional calcareous or siliceous rounded to sub-angular gravel lag at the surface<br>• Mixed vegetation types with variable amounts of leaf litter and woody debris. Spinifex is dominant at locations with good drainage, while Mulga, grasses and mixed shrubs also occur, particularly on shallow sandy profiles overlying indurated hardpan<br>• The A horizon material is typically a non-calcareous (siliceous) loamy sand, grading into a shallow (<300 mm) sandy loam B1 horizon<br>• A calcareous B2 horizon containing nodular, gravelly or laminar calcrete |  |

| Soil Type | Description | Characteristics | Representative Photograph |
|---|---|---|---|
| Calcerous Stony Soil<br>(DAFWA Soil Group 202) | The dominant soil type at locations in which the aeolian sand soil cover is thin (or non-existent) is a calcareous stony soil. This soil type is considered to be remnants of a weathered calcrete/silcrete peneplain formed within a broad palaeodrainage feature.<br>This is the dominant soil type within the footprints of the proposed Babel and Nebo pits. | • Little evidence of significant accumulation of humified organic matter in the surface (A horizon) profile<br>• A very thin (<200 mm) yellowish-brown cover of aeolian sand with minor rounded, friable calcrete gravels<br>• A B1 horizon comprising rounded to sub-angular, friable calcrete gravels in a yellow-brown sandy loam matrix<br>• A B2 horizon comprising weakly cemented calcrete gravels in a grey calcareous sandy clay matrix<br>• Root penetration limited mainly to the A and B1 horizons |  |

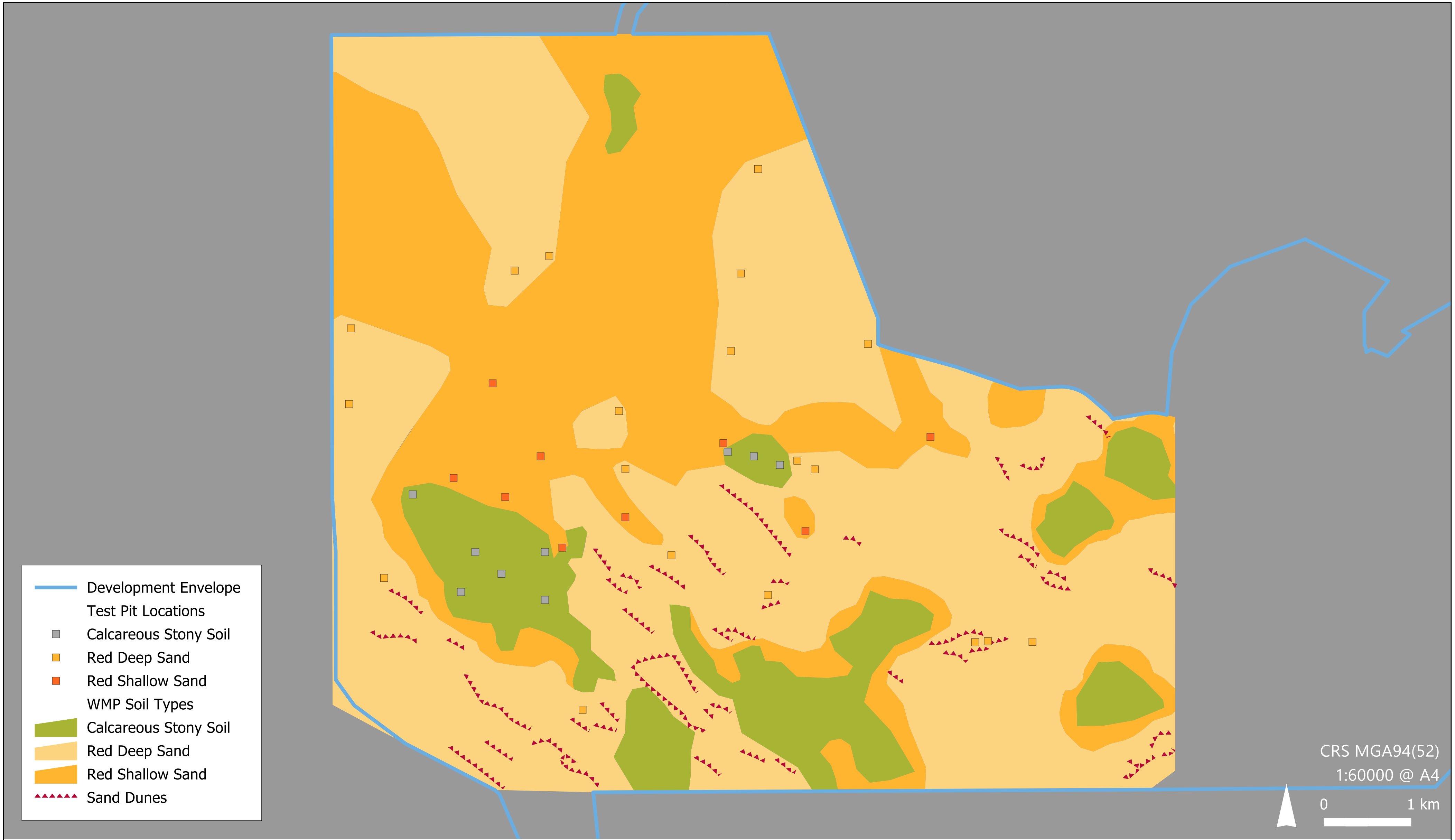


Figure 7-45: Distribution of Soil Types in the West Musgrave Region

WEST MUSGRAVE COPPER AND NICKEL PROJECT

### Soil Chemical and Physical Properties

The three soil types are related, in that they represent varying depths of aeolian sand deposition over a calcrete/silcrete hardpan peneplain. Characteristics of the aeolian sand covers for these three soil types are:

- Variable pH, ranging from 5.3 (strongly acid) to 8.6 (strongly alkaline) and topsoil pH values typically decrease with increasing depth of the sandy B1 horizons
- Topsoils and the red aeolian sands (Soil Groups 445 and 423) are siliceous and non-calcareous, while the surface calcareous stony soil (Soil Group 202) is slightly calcareous due to presence of minor calcrete gravels
- Very low salinity because of good drainage
- Non-sodic
- Soil texture grading from sand to loamy sand to sandy loam, with silt and clay contents increasing with depth
- Very low gravel contents
- Reasonable strength for sandy soil because of slightly elevated silt and clay contents (i.e. compared to coastal aeolian soil types in the south-west of WA)
- Slight risk of clay dispersion based on a typical Emerson Class of 3
- Low organic carbon and total nitrogen concentrations, which are typical of sandy soils in arid and semi-arid regions of WA (Purdie, Tille and Schoknecht, 2004)
- Concentrations of bio-available nutrients within the 'Typical' range of unfertilised WA soils (Purdie et al., 2004).

Underlying calcrete/silcrete subsoil materials are characterised by:

- Strongly alkaline pH values (8.3 to 9.1)
- Highly calcareous, particularly nodular, gravelly and indurated calcretes
- Low salinity
- Non-sodic
- Soil texture grading from loamy sand to (gravelly) sandy clay loam
- Low to slight risk of clay dispersion, based on a typical Emerson Class of 3 for siliceous aeolian subsoils and Class 4 for calcareous subsoils.

#### 7.5.3.3 Waste Rock and Low-Grade Ore Materials Characterisation

Non-mineralised waste rock, ore and mineralised waste (sub-ore-grade, but otherwise enriched with respect to ore-forming minerals) from the Babel and Nebo deposits can broadly be classified by weathering extent into oxide (heavily weathered), transition (partially weathered), fresh rock (unweathered) and pyrite-violarite zone material. The pyrite-violarite zone incorporates violarite, a reactive secondary sulphide mineral formed through the partial weathering of pentlandite nickel ore.

**Geochemical Characterisation**

The static assessment was based on 146 samples, comprising 98 samples of non-mineralised waste, 27 samples of mineralised material from the pyrite-violarite weathering zone and 21 samples of low-grade to ore-grade material. Approximately half of the samples were taken from drill cores within the proposed Babel (66) and Nebo (80) deposit pit shells. Samples were selected to achieve representation of nine key lithologies and four weathering zones (oxide, transitional, pyrite-violarite and fresh) within each deposit. The following lithologies (readily distinguishable types of rock) were included in the assessment:

- Barren gabbronorite, mineralised gabbronorite
- Dolerite
- Mineralised breccia
- Monzonite
- Orthogneiss
- Variably textured gabbronorite, oxide-apatite gabbronorite and special gabbronorite
- Massive sulphides (ore).

Ten composite samples were selected for inclusion in the kinetic assessment. These were selected from both Nebo and Babel deposits and represent waste rock, mineralised waste, low-grade ore and ore-grade material that may be stockpiled. Sample selection focused on higher risk materials to address sources of uncertainty in the initial static geochemical assessment. The key findings of the assessments are discussed in the following sections.

**Mineralogy and Acid Forming Risk**

A static geochemical assessment of the Babel and Nebo waste rock and low-grade ore was undertaken in 2019 (Appendix F2). Mineralogical analysis results were generally consistent with knowledge of the local and regional geology. In terms of acid formation risk, the key mineralogical findings were minor to moderate abundance of potentially acid-forming sulphide minerals, particularly pyrrhotite, and typically limited presence of carbonate minerals (calcite and dolomite) that provide rapid acid neutralisation capacity (ANC). Less readily reactive ANC associated with silicate minerals is considered to provide most of the ANC across most lithologies.

Samples were tested to determine their potential to generate and neutralise acid during weathering. Materials were subsequently classified as PAF, NAF or 'uncertain' (neither certainly NAF or PAF), considering the net balance between acid generating potential and ANC.

Total sulphur concentrations, which are broadly proportional to sulphide content, were highly variable within and between lithologies, ranging from less than 0.01 percent to 2.4 percent. Most of the sulphur (93 percent) in fresh and transitional samples was present in potentially oxidisable forms associated with sulphide minerals such as pyrrhotite. Analysis of moderately sulfidic samples indicated variable reactivity, with samples from the pyrite-violarite and transition zones being more reactive than fresh rock samples.

The majority of the non-mineralised waste rock samples were classified as NAF (94 NAF, 15 PAF and 16 samples as 'uncertain'). In contrast, the majority (16 of 21 samples) of the ore grade and low-grade ore (i.e. mineralised) samples were classified as PAF, which is consistent with their relatively higher average total sulphur concentrations.

Most oxide samples (20 out of 22) were classified as NAF and the results indicate that non-mineralised oxide materials carry a minimal acid formation risk.

Except for oxide and orthogneiss (results strongly indicate NAF), which forms the major portion of fresh rock waste to be mined (74 percent of all waste), segregating PAF and NAF fresh/transitional waste according to lithology may be impractical. This is because acid formation risk classification was not particularly consistent for all samples within other lithologies in either deposit. The preference is, therefore, for mining segregation based on a total sulphur cut-off value for waste rock. Comparison of results from multiple complimentary test methods showed strong agreement with a cut-off value where materials with total sulphur (S) equal to or greater than 0.7 percent S are managed as PAF across all lithologies. Whilst a sulphur content below 0.7 percent S does not, on its own, guarantee a material will be benign, analysis of numerous samples of waste rock containing less than 0.7 percent S indicated a low risk of generating neutral metalliferous drainage, a low risk of generating acidic conditions and a low risk of containing elevated levels of radionuclides, supporting the use of a 0.7 percent S as a cut-off for categorisation as PAF.

Table 7-54 shows the tonnages of PAF and NAF waste materials estimated for each of the lithologies within the proposed pits, based on the 0.7 percent total sulphur cut-off value. Note that these tonnages reflect estimates for the largest expected economic pit shells. Whilst the amount and proportions of each type of waste vary from those presented in the static and kinetic geochemical assessments (Appendix F2 and Appendix F3), which reflected a previous pit shell optimisation (as of July 2019), the proportion of PAF materials to be mined are very similar.

The tonnage breakdown demonstrates that 93 percent of all waste rock to be mined would be NAF, which would report to the WRDs. Ore grade rock would report to tailings after being processed and the majority of copper and nickel extracted (Section 2.5.2 to Section 2.5.4), and mineralised waste or pyrite-violarite material (seven percent) would be either processed as ore or treated in the same manner as PAF waste.

Table 7-54 shows that:

- About 93 percent of the total waste proposed to be mined would be managed as NAF based on application of a 0.7 percent S cut-off grade
- The majority of the PAF waste rock to be generated from the proposed project is present in the Babel deposit (85,613,512 t or 81 percent of the total PAF waste)
- Based on relative masses to be mined and screening at >0.7 percent total sulphur, the lithologies considered to present the most significant acid formation risk are variably textured gabbronorite, sub-ore grade mineralised gabbronorite and mineralised breccia, still noting that lithology alone cannot be used for segregation of NAF and PAF materials
- Orthogneiss represents about 74 percent of NAF waste proposed to be mined
- There is considerable surplus of competent NAF benign waste rock for use in constructing waste containment structures (e.g. PAF containment cells, rock armour) that may be incorporated into the ongoing project design and closure strategy.

Kinetic testing of PAF units was undertaken to build upon the knowledge gained from the static test work. No kinetic testing was undertaken on NAF rock because multiple lines of evidence including significant static geochemical testing of representative lithology units (Appendix F2) indicate their low reactivity and low potential to cause environmental harm. Kinetic testing is resource-intensive and, as recognised best practice, is only useful where there is an indication of potential risk from static testing or a reasoned expectation of reactivity. Unless waste rock is reactive (i.e. with potential to yield increasing leachability), kinetic testing is considered unlikely to reveal seepage risks that are not identified using static tests. This approach is consistent with the most recent DMIRS guidelines for materials characterisation (DMP, 2016).

Results from the first nine months of kinetic test work are summarised below and included in their entirety as Appendix F3. As of November 2020, kinetic testing of waste rock, mineralised waste and ore composites has been completed for up to 18 months, however a final report remains pending. A preliminary review of the additional kinetic data yielded no unexpected results in relation to trends identified in the interim report, which was based on the initial nine months of kinetic test results discussed below. Extrapolation to site-specific conditions will be revisited in the updated report, although it should be noted that long-term trends in site area rainfall/evaporation were already considered in the interim report projections. The kinetic testing results from the first nine months indicate that:

- Nebo ore and mineralised waste rock is more reactive than equivalent material from Babel with similar sulphur content

- The pyrite-violarite and/or transitional zone material is significantly more reactive than underlying fresh rock
- Without effective management (Section 7.5.6), fresh (unweathered) mineralised waste and low/high grade ore material from the pyrite-violarite zone of Nebo, and transitional waste rock (gabbronorite) from Babel are highly reactive with potential to generate AMD within a short period (order of one year) once mined, consistent with the static assessment results. This material would generally be treated as ore, and as such would either be processed or otherwise encapsulated in the same manner as PAF
- Non-mineralised and low-grade ore forms of gabbronorite (variably textured and barren forms) and marginal breccia from Babel (excluding pyrite-violarite zone), which comprise most of the Babel PAF (64 percent), present a low risk of producing AMD. This finding is significant, as most of the non-mineralised waste classified as PAF (static assessment) is to be mined from Babel.

**Table 7-54: Summary of NAF and PAF Waste Rock by Deposit and Lithology**

| Lithology | NAF (<0.7% Sulphur) (t) | PAF (>0.7% Sulphur) (t) | Total (t) |
|---|---|---|---|
| **Babel** | | | |
| Transported Cover | 31,234,093 | 0 | 31,234,093 |
| Orthogneiss | 937,883,115 | 2,736,256 | 940,619,371 |
| Barren Gabbronorite | 5,424,196 | 2,347,811 | 7,772,008 |
| Variably Textured Gabbronorite | 129,740,802 | 47,348,214 | 177,089,017 |
| Marginal Breccia Zone | 9,556,049 | 4,604,935 | 14,160,984 |
| Mineralised Gabbronorite | 13,817,344 | 28,392,283 | 42,209,627 |
| Special Gabbronorite | 219,127 | 184,013 | 403,140 |
| **Total Babel Waste** | **1,127,874,727 (93%)** | **85,613,512 (7%)** | **1,213,488,239** |
| **Nebo** | | | |
| Transported Cover | 46,545,607 | 0 | 46,545,607 |
| Orthogneiss | 135,926,192 | 1,135,366 | 137,061,558 |
| Barren Gabbronorite | 2,491,826 | 76,732 | 2,568,558 |
| Oxide-Apatite Gabbronorite | 3,193,831 | 245,527 | 3,439,358 |
| Dolerite | 12,847,058 | 824,494 | 13,671,551 |
| Monzonite | 729,809 | 65,959 | 795,768 |
| Massive Sulphide | 364,357 | 125,339 | 489,697 |
| Variably Textured Gabbronorite | 10,315,861 | 11,396,324 | 21,712,185 |
| Marginal Breccia Zone | 13,526,564 | 5,903,456 | 19,430,021 |
| Mineralised Gabbronorite | 991,620 | 941,527 | 1,933,147 |
| **Total Nebo Waste** | **226,932,726 (92%)** | **20,714,724 (8%)** | **247,647,450** |
| **Total Waste** | **1,354,807,453 (93%)** | **106,328,236 (7%)** | **1,461,135,689** |

### Saline and Acidic Drainage

Potential seepage from NAF waste rock placed at the ground surface is expected to be circum-neutral to moderately alkaline and low in salinity. It is not considered to present a significant environmental risk to the relatively fresh aquifers in the project area.

In the absence of oxidation, only ore grade mineralised breccia collected from the pyrite-violarite weathering zone is likely to generate mildly acidic (pH 4.2), marginally saline (TDS 690 mg/L) and slightly metalliferous (with respect to copper and nickel) drainage.

Results of kinetic testing indicated that:

- High-grade pyrite-violarite ore is likely to generate saline (and acidic) seepage if exposed to percolation during high rainfall events. The saline drainage risk was found to be considerably lower for Nebo pyrite-violarite low grade ore
- Leachates from all other samples were non-saline, indicating seepage from the other materials tested is unlikely to impact local land or water resources
- Risks from saline drainage are generally minimal compared to those associated with potential for AMD, with leachate salinity within the range for groundwater in all samples except the high-grade pyrite-violarite ore.

### Element Enrichment and Solubility

Based on static assessment results, potential for metalliferous drainage based on elemental enrichment and solubility under different pH conditions is summarised as follows:

- Despite expected enrichment in copper and nickel, relatively few samples produced water leachates containing significantly elevated copper and nickel concentrations under typically pH neutral conditions. The small number of samples giving elevated water leachate concentrations were predominantly collected from the pyrite-violarite weathering zone, which can variably contain residual acidity due to oxidation that occurred prior to analysis.
- Overall, the results of leachate assessment under acidic conditions indicate that PAF waste rock and ore grade material has the potential to generate leachate containing elevated concentrations of (in particular) aluminium and nickel if acidic conditions were allowed to prevail. The highest concentrations of leached nickel were obtained from the pyrite-violarite weathering zone.
- Although Babel and Nebo deposit samples indicated general enrichment with respect to silver and selenium, the relatively low concentrations of these elements in water and acetic acid leachates indicate that they are unlikely to present a significant risk of contaminating groundwater. Mild oxidation leaching test results indicated a higher risk of selenium being released under oxidising conditions. This potential was further investigated as part of kinetic studies. Tellurium although variably enriched in the rock was not found to be in a mobile form and is unlikely to present a significant environmental risk.

- Several samples of waste rock were slightly enriched in barium, cadmium and chromium. Leachate results generally indicated that waste rock seepage would not contain significantly elevated concentrations of these metals. Low-grade mineralised breccia results indicated enrichment in cobalt, pyrite-violarite zone samples of this lithology has potential for production of elevated concentrations of cobalt in pore waters.

Results from kinetic testing, which focused only on the minority proportion (7 percent of waste rock) materials carrying appreciable acid formation risk, found that:

- As expected for materials from an area with copper-nickel mineralisation, these were the most frequently elevated metals/metalloids in leachates. Other species present in leachates at elevated concentrations (exceeding freshwater ecosystem protection guideline values or similar screening levels) included aluminium, arsenic, cadmium, cobalt, chromium, lead, manganese, selenium, silver, thallium, uranium and zinc.
- The primary elements of concern potentially present in seepage were copper, cadmium, cobalt, nickel and selenium in leachates from samples that produced acidic leachate during the kinetic leaching trial. These elements were variably present in leachates at concentrations exceeding the less conservative ANZECC livestock drinking water default guideline values (DGVs) and were in some cases present at high concentrations (e.g. up to 5,500 mg/L nickel) given the strong rates of oxidation and release.
- Apart from copper and nickel, leachates from samples that did not generate acidic leachate during the trial contained relatively low concentrations of all other metals and metalloids assessed.

Importantly, these findings relate to the relatively minor proportions of PAF waste rock, low-grade ore and pyrite-violarite materials to be mined from the proposed deposits (approximately 7 percent of all waste rock), some of which may be processed and subsequently report to tailings (see following section). Kinetic results generally confirmed the acidic and metalliferous drainage risks identified during the static waste rock and low-grade ore geochemical assessment (Appendix F2). The knowledge gained from kinetic assessment has been used to effectively manage these materials to minimise environmental impacts (Section 7.5.4).

### Physical Characterisation

Samples of non-mineralised, highly weathered (oxide) and moderately weathered transition zone waste material were analysed for parameters to characterise their likely physical characteristics and to assess their potential as a growth medium for rehabilitation of mine waste landforms (Appendix F4). These included sodicity and fines content, which indicate the risk of erosion and dispersion. The selected samples comprised mineralised gabbronorite from the oxide zone, two samples of variably textured gabbronorite from the transition and oxide weathering zones and samples of orthogneiss and mineralised breccia from the oxide zone. The purpose of this study effort was to confirm the availability of material for rock armouring the outer slopes of the WRDs and support considerations for rehabilitation. This survey effort has confirmed the suitability and availability of materials for this end.

Overall, it is noted that, based on the project geology and environmental setting, the volumes of non-mineralised waste rock expected to contain both dispersive clays and high sodicity is expected to be limited. Some lithologies (transition zone variably textured gabbronorite, and oxide zone orthogneiss and mineralised breccia) may however contain moderate proportions of silt (12–16 percent), which may be susceptible to erosion during rainfall events if placed on slopes. Both oxide and transitional material form a very small proportion of total waste and would not be considered for use in rock armouring.

Landloch (Appendix F4) concluded based on these results that it can be assumed that oxide and transitional wastes are potentially problematic in terms of structural decline and as such should be selectively placed, however further test work may inform its usefulness for lining PAF cells due to lower permeability properties.

#### 7.5.3.4 Tailings Material Characterisation

Geochemical assessment of three metallurgical process trial residues, produced from ore composites representing various periods of production, was undertaken in two phases: static and subsequently kinetic laboratory tests (Appendix F5). In many cases the results from the kinetic characterisation phase supersede those from static testing (e.g. water leachate data), as the kinetic tests are considered more representative of actual geochemical behaviour under environmental conditions.

Slightly different static testing approaches were applied to tailings and waste rock/ore since they have different material properties, environmental risk profiles and management requirements. In particular, peroxide leaching was undertaken for waste rock to increase certainty over an appropriate PAF sulfur cut-off grade.

The key findings from the assessment are summarised as:

- All samples contained moderate total sulphur concentrations, ranging between 1.29 percent and 1.61 percent sulphur, predominantly in the form of pyrrhotite (3–4 percent of the tailings by mass) as opposed to other sulphur-containing minerals such as pyrite.
- All samples had relatively low ANC due to limited content of sparingly soluble carbonate minerals (dolomite and magnesite).
- Whilst all three tailings samples were classifiable as PAF using static acid base accounting methods, kinetic leaching trials demonstrated that the tailings are unlikely to generate acidic seepage during the life of the project with significant lag periods for acid generation if this occurs at all, specifically:
    - After twelve months, leachate from all three samples remained moderately alkaline (pH 7.8–8.0) and no net acidity was detected in any leachate.

  - Trends in concentrations of alkalinity, calcium and magnesium in leachates were consistent with dissolution of carbonate minerals, dolomite and magnesite present in the tailings during acid neutralising reactions.
  - Sulphide oxidation rates and release rates of nickel (key species) were diminishing for unsaturated columns over the course of the experiment. This trend is expected to continue based on formation of insoluble mineral phases that limit further reaction.
  - Estimated sulphide oxidation rates indicated that, even under the most conservative assessment scenarios, the topmost layer of tailings is highly unlikely to generate acidic seepage for at least two years, if at all. When factoring in operational considerations (e.g. continual deposition of fresh tailings and installation of covers preventing net percolation during decommissioning), the risk of the tailings generating net acidic seepage is very low.
- Matching results from static water leach tests, the kinetic trials indicated that the tailings seepage would be non-saline (fresh to slightly brackish), like the groundwater in the project area.
- Both kinetic and static leaching assessments indicate that the primary elements of potential concern in the tailings seepage are copper and nickel. Cobalt, although present, was at concentrations significantly lower than for nickel (10 to 200-fold) and hence any measures applied to limit nickel and copper release would also control for cobalt and other metals/metalloids.
- Overall, the kinetic leachate data indicate that risks of generating neutral metalliferous drainage are increased if the tailings are stored under saturated conditions (under a head of water), particularly if periodic loss of full saturation occurs.
- Solubility behaviour under unsaturated tailings storage conditions indicated that leachate copper concentrations would be relatively stable over long timescales, whereas nickel concentrations are likely to decrease following final tailings deposition and therefore the associated environmental risk would also decline over time. Overall, the release of copper and nickel as a percentage of total metal content in the tailings was low over 12 months of leaching. Solute fate modelling was undertaken to support the assessment of potential impacts to receptors, presented in Section 7.3 Inland Waters.

Overall, the characterisation results indicate that the tailings arising from the proposed project's activities would carry a relatively low risk profile in terms of AMD potential. Any net seepage of neutral metalliferous drainage is expected to contain only relatively low concentrations of copper and nickel.

### 7.5.4 Potential Impacts

The EPA Guidance for terrestrial environmental quality provides several mechanisms ('issues') for consideration during the EIA process (EPA, 2016g), specifically:

- Land use practices causing erosion impacts to soil quality
- Land use practices causing salinity impacts to soil quality
- Acid Sulphate Soils

- Agricultural practices causing impacts to soil structure and quality
- Waste structures, including tailing storage facilities, and in particular:
  - the appropriate siting of waste structures in a catchment
  - the nature of the materials stored in the waste structures, as there is the potential for erosion, oxidisation of acid forming materials, and metals and other elements to impact soil quality
  - the 'co-disposal' of large waste rock material in disused pits, which has the potential to create an artificial and unusual soil structure potentially rendering areas of land sterile (while recognising the potential benefits of back filling disused pits)
  - the availability of suitable material to encapsulate (and neutralise) waste which could cause soil contamination
  - the design, monitoring, and management of waste structures to avoid environmental impacts, taking into account appropriate standards.

A systematic assessment of how the proposed project interacts with the environment through changes to terrestrial environmental quality was undertaken, with consideration to the identified EPA issues (Appendix A2). In particular, the assessment aimed to confirm the potential for the proposed project's activities to interact with the environment that may result in direct, indirect or cumulative impacts to terrestrial environmental quality-related environmental values. Based on this assessment the following potential impact events were identified:

- Inappropriate disposal of mine waste rock causing land contamination through acid, saline or neutral mine drainage (Section 7.5.5.1)
- Stockpiling of mineralised waste causing land contamination through acid, saline or neutral mine drainage (Section 7.5.5.2)
- Inappropriate disposal of processing wastes (tailings) causing land contamination through acid, saline or neutral mine drainage (Section 7.5.5.3)
- Erosion of material from the surface of constructed landforms causing land contamination (Section 7.5.5.4)
- Accidental spills and leaks of hydrocarbons, processing reagents and other hazardous materials causing land contamination (Section 7.5.5.5)
- Discharge of inadequately treated sewage effluent from wastewater treatment plant(s) (WWTPs) causing land contamination (Section 7.5.5.6)
- Loss of topsoil availability and/or viability due to erosion, compaction or inappropriate handling and storage (Section 7.5.5.7).

### 7.5.5 Assessment of Impacts

Each potential impact event identified in Section 7.5.4 was assessed to understand the mechanism by which impacts may occur and, using the consequence and likelihood tables in the EIA Framework (Appendix A3), determine the inherent (unmitigated) risk of each potential impact event.

Using the consequence and likelihood tables in the EIA Framework (Appendix A3) two impact events were considered to have High inherent (unmitigated) risk, while all others presented a Low or Medium risk of not meeting EPA's Objective for Terrestrial Environment Quality (Table 7-55 to Table 7-61). The High inherent (unmitigated) risks were considered to require further avoidance and mitigation measures to ensure the EPA's Objective for Terrestrial Environment Quality could be met. OZ Minerals has identified a number of avoidance and mitigation measures for these two high risks, and all other Terrestrial Environment Quality risks to reduce the risk of potential impacts to ALARP (Section 7.5.6).

#### 7.5.5.1 Inappropriate Disposal of Mine Waste Rock Causing Land Contamination

As discussed in Section 7.5.3, some waste rock and stockpiled mineralised waste would be PAF and thus has potential to release AMD, saline discharge (SD) or neutral metalliferous discharge (NMD) to the environment if not managed appropriately. Segregation of NAF and PAF material for long-term waste management based on application of a 0.7 percent S cutoff grade would minimise risks associated with PAF materials. Application of this cutoff grade results in approximately 7 percent of mine waste from Babel and Nebo being PAF. The lithologies considered to present the most significant acid formation risk are variably textured gabbronorite, mineralised gabbronorite and marginal breccia zone materials.

OZ Minerals proposes to manage waste rock through the standard industry practice of selective placement of PAF waste in above-ground WRDs on a base of compacted NAF rock above the highest point of any potential surface water flows, with coverage of a suitably thick layer of NAF material (i.e. encapsulation of the PAF material). The minimum thickness of the NAF layer(s) cover would be determined by rainfall, evaporation and the physical properties (particle size and permeability testing) of the possible covering materials and would be suitably designed to minimise ingress of rainwater and oxygen.

There is a surplus of competent benign waste rock available for use in constructing waste containment structures, minimising the potential for land contamination.

The assessment of inherent (unmitigated) risk of the inappropriate disposal of mine waste rock causing land contamination is provided in Table 7-55, and was precautionarily assigned a High risk. Section 7.5.6 presents mitigation measures to reduce the risk to a level where EPA's Environmental Objective for Terrestrial Environmental Quality would be met.

**Table 7-55: Assessment of Potential Impact of Inappropriate Disposal of Mine Waste Rock**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Inappropriate disposal of mine waste rock causing land contamination through acid, saline or neutral mine drainage | Likely | Moderate | High | Less than 10% of all mine waste rock is PAF.<br>Should no mitigation be put in place, or materials are inappropriately disposed of, this waste has the potential to result in leachates containing contaminants being released from waste landforms to the environment. Solute fate modelling (Section 7.3.5.3) has demonstrated that these solutes would be quickly attenuated in the environment, and thus any impact would be localised and short term.<br>Although there are few identified downstream environmental values that would be significantly impacted by a downstream excursion of solute this risk has been assigned a precautionary consequence of Moderate resulting in a high inherent risk. |

### 7.5.5.2 Stockpiling of Unprocessed Mineralised Waste Causing Land Contamination

Three different types of mineralised waste would be stockpiled pending future processing for each deposit separately containing:

- Mineralised waste from the pyrite-violarite weathering zone
- Sulfidic mineralised waste excluding material from the pyrite-violarite weathering zone
- Oxide mineralised waste.

As these stockpiles may remain in place for extended durations, OZ Minerals has identified risk factors associated with seepage that may be generated by each stockpile type. This was achieved by considering the approximate composition of each mineralised stockpile based on proportions of key lithologies in combination with the geochemical assessment results (Section 7.5.3.3). In addition, the results of static and kinetic leachate testing were considered and metals/metalloids of potential environmental significance that have potential to be environmentally mobile were highlighted for each stockpile. These elements were those frequently present in leachates at concentrations exceeding health-based water quality guidelines including those for livestock drinking water and non-potable groundwater uses, as well as consideration of freshwater aquatic guidelines.

The following key points were identified when taking the above factors into consideration:

- The indicated order of reactivity rate and hence seepage risk is pyrite-violarite > fresh rock mineralised waste rock > mineralised oxides. In addition, based on static testing and kinetic testing, Nebo material is also generally more reactive than Babel material for otherwise similar sulphur contents, noting that over 80 percent of the PAF waste for the proposed project would comprise lower risk material from the Babel pit, and that substantial amounts of competent NAF waste rock would be available for encapsulation and construction.
- Stockpiles of oxide mineralised waste have a low risk of generating acidic drainage but may produce neutral drainage containing mildly elevated concentrations of a range of metals and metalloids.
- Pyrite-violarite zone material from both deposits would react rapidly, meaning that the time period between placement and generation of AMD would be much shorter than for other stockpiled materials. AMD generation from stockpiled pyrite-violarite may occur following as little as one or two rainfall events which are sufficiently heavy to generate net percolation through the exposed material. Any such seepage would have a high concentration of metals and metalloids and it is therefore proposed that the pyrite-violarite zone material would either be processed or managed as PAF.

The assessment of inherent (unmitigated) risk of stockpiling of unprocessed mineralised waste causing land contamination is provided in Table 7-56, and was precautionarily assigned a High risk. Section 7.5.6 presents mitigation measures to reduce the risk to a level where EPA's Environmental Objective for Terrestrial Environmental Quality would be met.

**Table 7-56: Assessment of Potential Impact of Stockpiling of Mineralised Waste**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Stockpiling of mineralised waste causing land contamination through acid, saline or neutral mine drainage | Likely | Moderate | High | If left unmitigated AMD generation from stockpiled pyrite-violarite may occur following as little as one or two rainfall events which are sufficiently heavy to generate net percolation through the exposed material. Any such seepage would have a high concentration of metals and metalloids that could contact the receiving environmental values if left unmitigated.<br>Solute fate modelling (Section 7.3.5.3) has demonstrated that these solutes would be quickly attenuated in the environment, and thus any impact would be localised and short term.<br>Although there are few identified downstream environmental values that could be significantly impacted by a downstream excursion of solute |

| | | | | |
|---|---|---|---|---|
| | | | | this risk has been assigned a precautionary consequence of Moderate resulting in a High inherent risk. |

#### 7.5.5.3 Disposal of Processing (Tailings) Waste Causing Land Contamination

Kinetic test results have shown tailings would have relatively low reactivity and low potential to form acidic or hazardous metalliferous seepage (Section 7.5.3). Tailings seepage is predicted to be fresh to brackish and circumneutral to slightly alkaline, and to contain low concentrations of metals and metalloids of potential environmental concern. Whilst dissolved copper and nickel concentrations are slightly elevated in comparison to freshwater ecosystem protection trigger values (95 percent) (ANZG, 2018), these are not anticipated to present a significant contamination risk to land if seepage is managed.

In addition, kinetic study results do not indicate a benefit in limiting surface tailings exposure to oxygen during operations by maintaining a water cover. In fact, overall the kinetic leachate data indicate that risks of generating neutral metalliferous drainage (elevated copper, nickel, cobalt and uranium) are increased if the tailings are stored under saturated conditions, particularly if periodic loss of full saturation occurs. The TSF design has thus been tailored towards minimising tailings supernatant residence time in the TSF before return to the process circuit for re-use.

The assessment of inherent (unmitigated) risk of the disposal of processing (tailings) wastes causing land contamination is provided in Table 7-57, and was determined to represent a Low risk. Section 7.5.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-57: Assessment of Potential Impact of Disposal of Processing (Tailings) Wastes**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Inappropriate disposal of processing wastes (tailings) causing land contamination through acid, saline or neutral mine drainage | Unlikely | Minor | Low | Kinetic test results have shown tailings would have relatively low reactivity and low potential to form acidic or hazardous metalliferous seepage. Tailings seepage is predicted to be fresh to brackish and circumneutral to slightly alkaline, and to contain low concentrations of metals and metalloids of potential environmental concern, and as such is unlikely to result in any impacts to environmental values. |

#### 7.5.5.4 Erosion of Material from Constructed Landforms Causing Land Contamination

Erosion of material from the surface of constructed landforms can potentially cause contamination of soils and sedimentation within the surrounding area as well as loss of growth medium from the landform. This may also result in the exposure of stored tailings and/or encapsulated mine waste materials within the landforms.

Prevention of erosion during landform construction during operations where mine waste is actively being placed is not feasible. Transport of materials from the active waste landforms into adjacent areas would be prevented by incorporation of a toe bund into the landform design.

Landloch was engaged to undertake an assessment of the long-term erosional stability of materials (soils and the various waste types) at the project in order to guide landform closure designs to reduce the risk of erosion (Appendix F4). Results from these studies indicate that fresh waste lithologies from both deposits are likely to be durable, slow-weathering and not prone to excessive erosion and can be used as rock armouring within the final surface of a rehabilitated landform. When mixed with a soil at the appropriate ratio, a surface that is suitably resistant to erosion and that can support vegetation is achievable.

The oxide/transition/regolith wastes are finer-grained, more prone to weathering and less erosion resistant meaning that the use of these wastes as the surface materials would potentially result in lower stable landform heights, potentially low gradient batter slopes, wider cross-batter benches, and an increased footprint compared to a landform sheeted with fresh waste.

The limitations posed by the oxide and transition wastes are more relevant for the rehabilitation design of the Nebo WRD because it is dominated by oxide and transition wastes, and less relevant for the Babel WRD as it would be dominated by fresh waste. Given the Nebo WRD would be much smaller than the Babel WRD (accounting for only 14.6 percent of total mine waste generated), this risk would be able to be effectively managed. Constructing landforms as per approved site specific WRD designs where competent, benign waste is used for outer slopes and PAF materials are encapsulated would ensure that environmental risks are minimised.

The assessment of inherent (unmitigated) risk of the erosion of material from the surface of constructed landforms causing land contamination is provided in Table 7-58, and was determined to represent a Medium risk. Section 7.5.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-58: Assessment of Potential Impact of Erosion of Material from Constructed Landforms**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Erosion of material from the surface of constructed landforms causing land contamination | Possible | Minor | Medium | Results from physical characterisation studies indicate that fresh waste lithologies from both deposits are likely to be durable, slow-weathering and not prone to excessive erosion, and are suitable for use as rock armouring within the final surface of a rehabilitated landform. The oxide/transition/regolith wastes are finer-grained, more prone to weathering and less erosion resistant, and use of these on external surfaces of the WRDs would be avoided wherever possible.<br>Surface water studies (Section 7.3.5.2) demonstrate that runoff only occurs as a result of high intensity, low frequency rainfall events (<5% AEP) and that any runoff that does occur is likely to be as sheet flow. Velocities are relatively slow, and erosion potential is also therefore low. |

### 7.5.5.5 Accidental Spills and Leaks Causing Land Contamination

Some processing reagents, hydrocarbons and other potentially hazardous materials would be required for construction and operation of the proposed project. Direct contamination of land and soils can occur during construction and operations from the release of environmentally hazardous materials via spills or leaks, the occurrence of which may be higher if these materials are not appropriately stored and managed. Process streams and tailings if spilt also have potential to cause land contamination. Soils which become contaminated from environmentally hazardous materials may have their composition altered making them unsuitable for plant growth.

The assessment of inherent (unmitigated) risk of accidental spills and leaks of hydrocarbons, processing reagents and other hazardous materials causing land contamination is provided in Table 7-59, and was determined to represent a Medium risk. Section 7.5.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-59: Assessment of Potential Impact of Accidental Spillages of Contaminants**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Accidental spills and leaks of hydrocarbons, processing reagents and other hazardous materials causing land contamination | Possible | Minor | Medium | The processing operations use a variety of chemicals that, if spilled, may cause extremely localised and short-term impacts which would be able to be readily remediated. |

#### 7.5.5.6 Discharge of Inadequately Treated Sewage Effluent Causing Land Contamination

During normal operation of the WWTP, treated wastewater would be irrigated to an assigned area to infiltrate or evaporate, limited to no surface ponding or runoff is expected. However, abnormal operation may cause excess nutrients and other contaminants within inadequately treated effluent outflow to enter the wider environment. Raised nutrient levels may favour the growth of introduced invasive weed species, as well as discourage the growth of native species not adapted to high nutrient loads.

The assessment of inherent (unmitigated) risk of the discharge of inadequately treated sewage effluent from wastewater treatment plant(s) (WWTPs) causing land contamination is provided in Table 7-60, and was determined to represent a Low risk. Section 7.5.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-60: Assessment of Potential Impact of Discharge of Inadequately Treated Effluent**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Discharge of inadequately treated sewage effluent from WWTPs causing land contamination | Unlikely | Minor | Low | The WWTPs would be constructed, operated and maintained in accordance with relevant licence and regulatory conditions and guidelines and is subject to approval under Part V of the EP Act. Uncontained, the effluent produced from the WWTP may pond or run-off, causing localised impacts to flora and vegetation.<br><br>Due to the widespread nature of vegetation associations, priority flora, range extensions and significant fauna identified in the Survey Area, and from regionally available records, the localised nature of impact resulting from inadequately treated sewage effluent is highly unlikely to result in significant impact to any species, associations or habitats. |

#### 7.5.5.7 Loss of Topsoil Availability and/or Viability Due to Erosion, Compaction or Inappropriate Handling and Storage

Inappropriate removal and stockpiling methods can result in a reduction in topsoil quality and structure, as well as affecting the viability of the seed bank within the topsoil.

The assessment of inherent (unmitigated) risk of loss of topsoil availability and/or viability due to erosion, compaction or inappropriate handling and storage is provided in Table 7-61, and was determined to represent a Medium risk. Section 7.5.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-61: Assessment of Potential Impact of Loss of Topsoil Availability and/or Viability**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Loss of topsoil availability and/or viability due to erosion, compaction or inappropriate handling and storage | Likely | Minor | Medium | Inappropriate removal and stockpiling methods can result in a reduction in topsoil quality and structure, as well as affecting the viability of the seed bank within the topsoil. |

### 7.5.6 Mitigation Measures

As described in Section 7.5.5, the inherent risk associated with most terrestrial environmental quality impact events were assessed as Low to Medium and would not require any further mitigation to meet EPA's Objective for Terrestrial Environmental Quality. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP, these avoidance and mitigation measures are shown in Table 7-62.

Two potential risk events associated with the discharge of AMD from constructed landforms and stockpiles were assessed as having a High inherent (unmitigated) risk. The mitigation's proposed in Table 7-62 would reduce this risk of these impact events to Low or Medium and would ensure that EPA's Objective for Terrestrial Environment Quality would be achieved. The mitigations measures to control acid and metalliferous drainage associated with PAF waste rock material and common industry practice with high likelihood of reducing the potential for these impact events resulting in significant impacts.

**Table 7-62: Mitigation Measures for the Terrestrial Environmental Quality Environmental Factor**

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| Inappropriate disposal of mine waste rock causing land contamination through acid, saline or neutral mine drainage | **Measures to Avoid**<br>• Landform design has and would continue to take into account geochemical and physical material properties/characterisation to ensure constructed landforms are safe, stable and non-polluting, during operations, closure and post closure<br>• Total sulphur would be determined during grade control process. Resulting data would inform the mine sequencing and the block model so that waste rock material can be selectively handled and directed appropriately<br>• Locate potentially polluting waste landforms up hydrological gradient of mine pit voids (which act as source sinks)<br>**Measures to Minimise**<br>• Kinetic testing is ongoing to further understand material characteristics. Further refinements to the total sulphur cut-off limit (of 0.7% total S) would continue to be refined as more information relating to waste domains is acquired<br>• PAF and AMD waste rock would be encapsulated within specifically designed encapsulation cells within WRDs to reduce water ingress and the potential for oxidation<br>• Protocols for the testing and assigning of NAF and PAF waste will be developed to ensure that PAF is appropriately categorised and handled to ensure appropriate encapsulation. These protocols will form part of the Mining Proposal required by DMIRS<br>• Where required a series of stepped downstream monitoring stations will be monitored to identify any potential elevation of solutes beyond acceptable levels. Where elevated solutes are identified an adaptive management plan would be followed and may include an investigation of the solute source, remediation as appropriate. Should the problem persist interception bores could be considered. These protocols will be further developed, and form part of the Environmental Protection Act Part V process required by DWER<br>**Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low |

<table>
<tr><th rowspan="2">Potential Impact Event</th><th rowspan="2">Mitigation</th><th colspan="3">Residual Risk Assessment</th></tr>
<tr><th>Likelihood</th><th>Consequence</th><th>Residual Risk</th></tr>
<tr><td rowspan="4">Stockpiling of mineralised waste causing land contamination through acid, saline or neutral mine drainage</td><td>Measures to Avoid</td><td rowspan="4">Unlikely</td><td rowspan="4">Minor</td><td rowspan="4">Low</td></tr>
<tr><td>• Stockpile design considers geochemical and physical material properties/characterisation to ensure stockpiles are safe, stable and non-polluting, during operations, closure and post closure<br>• Locate potentially polluting waste landforms up hydrological gradient of mine pit voids (which act as source sinks)</td></tr>
<tr><td>Measures to Minimise</td></tr>
<tr><td>• Kinetic testing ongoing to further understand material characteristics<br>• Stockpiled unprocessed mineralised waste would be stockpiled according to the design criteria in Table 7-63. The objective of the stockpile design features is to minimise percolation of seepage into the soils underlying and surrounding the stockpiles and direct runoff and seepage via a surrounding drain towards a collection sump<br>• Collected seepage would be returned to the process circuit and not allowed to discharge to the environment<br>• Drain and sump design would be undertaken by a suitably qualified professional, accounting for local climate and materials characteristics<br>• With respect to ongoing management, stockpiles would be included in a routine inspection and monitoring programs, including but not limited to the following:<br>o Visual observation of presence of water in drains and sumps, especially following significant rainfall events<br>o Visual observation of sulphide oxidation such as the formation of efflorescent salts and secondary minerals (e.g. jarosite) at the stockpile surfaces and toe<br>• Where required a series of stepped downstream monitoring stations will be monitored to identify any potential elevation of solutes beyond acceptable levels. Where elevated solutes are identified an adaptive management plan would be followed and may include an investigation of the solute source, remediation as appropriate. Should the problem persist interception bores could be considered. These protocols will be further developed, and form part of the Environmental Protection Act Part V process required by DWER</td></tr>
</table>

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| | • Evidence of significant AMD and or NMD seepage formation would result in the implementation of further management measures, which may involve implementing a temporary or permanent cover to prevent/minimise further oxidation and water ingress until such time as the material is processed or determined to be a waste that would need to be included as a permanent feature within the Mine Closure Plan | | | |
| | **Measures to Rehabilitate** | | | |
| | • Unprocessed mineralised waste stockpile design would take into consideration closure of these stockpiles should they not be processed<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Inappropriate disposal of processing wastes (tailings) causing land contamination through acid, saline or neutral mine drainage | **Measures to Minimise** | Unlikely | Minor | Low |
| | • Implementation of seepage and groundwater quality monitoring programs<br>• Consequent to the low environmental risk, the TSF is proposed to contain an underdrainage and/or seepage recovery system to capture seepage for reuse in the processing plant and maximise the consolidation of tailings | | | |
| | **Measures to Rehabilitate** | | | |
| | • Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Erosion of material from the surface of constructed landforms causing land contamination | **Measures to Avoid** | Possible | Minor | Medium |
| | • Design of landforms considers geochemical and physical material properties | | | |
| | **Measures to Minimise** | | | |
| | • Toe bunds to be constructed at the base of landforms to prevent transport of materials from active landforms during operations | | | |
| | **Measures to Rehabilitate** | | | |
| | • Landforms rehabilitated progressively where practicable.<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| Accidental spills and leaks of hydrocarbons, processing reagents and other hazardous materials causing land contamination | **Measures to Avoid**<br>• Chemicals, hydrocarbons and other environmentally hazardous materials would be stored and handled in accordance with the *Dangerous Goods Safety Act, 2004* (WA), associated regulations and relevant Australian Standards<br>• Ore processing would occur in bunded areas minimising the risk of spill or leakage of processes streams during transfer between tanks and other processing infrastructure<br>• Tailings would be transferred to the TSF via a HDPE pressurised pipeline. The tailings pipeline and return water from the TSF would be situated within earthen bunds with appropriately sized catch sumps to contain spillages<br>**Measures to Minimise**<br>• Minimise potential for spills through personnel training and awareness<br>• Infrastructure would be periodically inspected and maintained to prevent failures into the wider environment<br>• All spills would be cleaned up according to spill clean-up procedures using spill kits provided<br>• Pipelines would be located within bunds to ensure liquors are captured and not released to the environment<br>• Pipelines would incorporate isolation valves at appropriate intervals<br>• Educate the workforce on reporting and management of spills<br>**Measures to Rehabilitate**<br>• A bioremediation facility would be operated for treatment of hydrocarbon affected soils | Unlikely | Minor | Low |
| Discharge of inadequately treated sewage effluent from wastewater treatment plant(s) (WWTPs) causing land contamination | **Measures to Avoid**<br>• The WWTPs would be constructed, operated and maintained in accordance with the DWER Works Approval, Environmental Licence and local government and Department of Health regulations and permitting requirements as issued by the Shire of Ngaanyatjarraku<br>**Measures to Minimise**<br>• The WWTP would have contingency storage for up to two days of normal flow if discharge is suspended | Unlikely | Minor | Low |

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| | • WWTP effluent would be monitored in accordance with DWER license requirements<br>• Effluent outflow produced by the WWTPs would be irrigated to the environment and managed to allow effluent to infiltrate or evaporate and prevent surface ponding or runoff from the irrigation area<br>• The WWTPs would be fitted with alarms and able to be shut down remotely should a failure occur<br>• The WWTPs would be regularly inspected | | | |
| Loss of topsoil availability and/or viability due to erosion, compaction or inappropriate handling and storage | **Measures to Avoid**<br>• Topsoil would be stored for use in future rehabilitation<br>**Measures to Minimise**<br>• Topsoil, when requiring storage, would be stored in low stockpiles no higher than 2 m to retain the viability of seeds<br>• Topsoil stockpiles would be signposted to prevent access and incorrect removal<br>• Collection of topsoil would be undertaken as soon as practicable following vegetation clearing<br>• Topsoil stockpiles would be appropriately situated near disturbance areas to limit the handling and potential loss of material<br>• Topsoil would be used in progressive rehabilitation in preference to stockpiling<br>• Topsoil stockpiles would be located away or protected from stormwater flows, minimising potential losses via erosion and sedimentation<br>• Where practicable, topsoil would not be handled when wet to avoid damaging soil structure and composition<br>• Vehicle movements would be restricted to authorised roads and tracks<br>• Project induction would contain information about not driving out of designated areas<br>**Measures to Rehabilitate**<br>• Compacted areas would be ripped as part of rehabilitation of disturbed areas<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low |

**Table 7-63: Indicative Mineralised Waste Rock Stockpile Design Features**

| Design Feature | Pyrite-Violarite | Sulfidic Mineralised | Oxide-Mineralised |
|---|---|---|---|
| Compacted in situ soil base | | | |
| Compacted oxide waste layer with high silt content to nominal 0.5 m thickness | | | |
| Calcrete layer of nominal 0.5 m thickness | | | |
| Stockpile area includes toe drains that capture all drainage and directed it to a sump/s | | | |
| Drains to be compacted in situ soils | | | |
| Calcrete placed in base of sump | | | |
| Waste to be actively compacted as dumped (truck/equipment movement) | | | |

## 7.5.7 Predicted Outcome

The predicted outcome was determined in accordance with the EIA Framework developed for the Proposal (Appendix A3), and was based on the assessment of impacts (Section 7.5.5) and the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e). The results of this assessment are presented in Table 7-64.

Based on this assessment, the Proposal was assessed as having no significant or irreversible impact on terrestrial environmental quality-related environmental values and the EPA Objective for terrestrial environmental quality 'To maintain the quality of land and soils so that environmental values are protected' would be met should the Proposal be implemented.

**Table 7-64: Assessment of Impact Significance – Terrestrial Environmental Quality**

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Values, sensitivity and quality of the impacted environment which is likely to be impacted | The identification and assessment of values has been considered during the commissioning and undertaking of the specialist study program. Three physically and chemically distinct soil types were identified within the study area, specifically:<br>• Red (aeolian) deep sand, including low vegetated dunes (DAFWA Soil Group 445)<br>• Red (aeolian) shallow sand overlying hardpan, typically calcrete (DAFWA Soil Group 423)<br>• Calcareous stony soils (DAFWA Soil Group 202)<br>These soil types are considered common and are widely distributed across the West Musgrave region<br>As described in the EPA Guideline for Terrestrial Environmental Quality, the beneficial uses of good quality soil are primarily agriculture, maintaining drinking water quality, recreation and cultural values. Ecosystem health values that are supported by soils include biodiversity, water quality, and seed banks. The soils in the project area do not support agriculture operations and local surface waters are not used for drinking water supply nor for recreation. Assessment of the receiving environmental values (ecosystem health values) for flora and vegetation, inland waters, landforms and terrestrial fauna (described in their respective sections) in the area of the likely impact were determined to be not significant | Not Significant |
| Extent (intensity, duration, magnitude and footprint) of the likely impacts | A significant body of work to characterise soils, materials that may generate acid and/or metalliferous drainage (AMD) leachate and the geotechnical behaviour of material associated with project activities was undertaken. The characterisation included:<br>• Characterisation of soils across the proposed Development Envelope<br>• Durability and erosivity assessment of waste rock<br>• Both static and 12 months of kinetic geochemical testing and analysis of composite tailings samples<br>• Both static and 12 months of kinetic geochemical testing and analysis of geological lithologies within the mine pits<br>These studies determined that tailings are unlikely to generate AMD, and that <10% of waste rock has the potential to generate AMD | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | Using the results of geochemical characterisation for tailings and waste a hydrochemical model (Section 7.3.5.3) was undertaken to model the movement of solutes to the receiving environment (in the absence of any design controls e.g. waste rock encapsulation). Using conservative input parameters, the hydrochemical model showed that:<br>• All leachate from the Nebo WRD and backfilled Nebo pit is predicted to be below concentrations of concern at the point of entry to the water table<br>• Seepage from the TSF and Babel WRDs is predicted to be above concentrations of concern at the point of entry to the water table, however concentrations decrease significantly due to adsorption within metres, as the solutes move through the soil matrix<br>Resultantly geochemical impacts would be confined to the immediate area of the TSF and WRD structures and the extent of impacts would be highly localised<br>The key pathway for surface contaminants to the receiving environment are through surface water. Surface water studies (Section 7.3.5.2) have demonstrate that runoff only occurs as a result of high intensity, low frequency rainfall events (<5% AEP) and that any runoff that does occur is likely to be as sheet flow. Velocities are relatively slow, and erosion potential is also therefore low. Impacts of contamination as a result of surface flow are therefore expected to be short in duration and highly localised | |
| The consequence of the likely impacts (or change) | The consequences of various terrestrial environment quality impact events have been assessed using a risk-based framework which included specifically designed consequence criteria for the Terrestrial Environment Quality Environmental Factor<br>Precautionarily the inherent risk of potential impacts (Section 7.5.5) resulting from leachate from waste rock dumps and mineralised landforms was considered High (should they not be appropriately encapsulated); however, following the application of mitigation (e.g. using the industry standard encapsulation of AMD waste within a WRD, or toe drains) (Section 7.5.6), these risks were reduced to medium or low and as such were considered not significant | Not Significant |
| The resilience of the environment to cope with the impact or change | No specific environmental values were identified of being at risk of significant impact, or change in conservation status as a result of potential direct, indirect and cumulative project impacts<br>The hydrochemistry modelling has conservatively shown that any generation of solutes can be attenuated by the receiving environment and any potential impacts would be highly localised, in most cases to within metres of the waste structures (TSF and WRDs) themselves | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | Whilst the proposed project would have a localised (direct) impact, this would not be of an extent to affect the resilience of other identified environmental values to cope with that impact | |
| Cumulative impacts with other existing or reasonably foreseeable activities, developments and land uses | There are no other existing or reasonably foreseeable activities, developments or land uses proposed within the areas potentially impacted by the proposed project, which may have a cumulative impact upon Terrestrial Environment Quality and their associated values. The proposed project represents the only significant development for approximately 450 km | Not Significant |
| Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment | Connections and interactions between project (sources) and the receiving environment (environmental factors and their associated values) were considered using a SPR assessment and subsequent risk assessment. This SPR and risk assessment allowed for an assessment of interactions between the various and overlapping elements of the proposed project<br><br>Key connection between Terrestrial Environment Quality relate to subterranean fauna, flora and vegetation, inland waters and social surroundings. All values associated with these interactions have taken into consideration the combined impacts of changes and were considered in the present impact assessment<br><br>Resultantly, no unacceptable residual impacts to Terrestrial Environment Quality and their relevant values were identified due to multiple or overlapping project sources | Not Significant |
| The level of confidence in the predictions of impacts and the success of proposed mitigation | Extensive survey and analytical test work were undertaken to characterise soil, geochemistry and geotechnical behaviour of tailings and waste rock. Test work included extensive test work and representation of all waste lithology units and composite tailings samples. Kinetic test work was undertaken for a duration of 12 months, which is considered to represent sufficient time to determine the leaching behaviour of rock materials. Test work was undertaken by a NATA accredited independent laboratory and included quality assurance and quality control procedures. Based on this survey and test work there is a high degree of confidence in the characterisation of soils and geochemical hazards associated with the proposed project<br><br>Additionally, a conservative sulphur cut-off value was used to inform total potential AMD waste volumes, which is likely to result in an overestimate of potential AMD generating materials, and hence an overestimate of the potential impact | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | The hydrochemistry model used industry accepted modelling techniques and a number of conservative assumptions to predict the fate of solutes that may be generated from project waste structures such as TSF and WRDs. The levels of conservatism included in the model included the use of the maximum concentration of chemical constituents (rather than a median or mean), assumption of high seepage rates in-line with paleochannel estimates (rather than basement rocks) and the presence of minimal attenuation materials such as calcrete and irons which were found to be 20 x higher than those used in the current modelling.<br>Finally, while the impact assessment found no environmental values to be significantly impacted by the potential movement of solutes, the inherent impact rating for contamination resulting from leachate from waste rock dumps and mineralised stockpiles was given a precautionarily high ranking and a number of fundamental design controls proposed e.g. AMD encapsulation and development of toe drains<br>To manage potential AMD risk, a process of materials characterisation during grade control, and materials characterisation has been proposed. These mitigation measures represent common industry practice and have a high probability of success<br>Based on the test work, use of conservative model assumptions and proposed industry proven mitigation measures OZ Minerals has high confidence in the level predictions of impacts and success of proposed mitigation measures (Section 7.5.6) | |
| Public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment | OZ Minerals developed and implemented a detailed and thorough stakeholder engagement program which included relevant Ngaanyatjarra People, the Ngaanyatjarra Council, relevant Shires, government, and some special interest groups. The focus of this engagement program was on high interest and high influence stakeholder groups, particularly land rights holders. Engagement activities included project briefings, attendance by the Ngaanyatjarra Council to regulator meetings, numerous community meetings, a number of large heritage surveys, and a third-party environmental peer review of the Section 38 Referral submission and associated specialist studies on behalf of the Ngaanyatjarra People to ensure their interests and concerns relating had been appropriately considered, and a dedicated on-country consultation with relevant West Musgrave Traditional Owners relating to the outcomes of this EP Act Part IV impact assessment. A summary of consultation is provided within a consultation-specific record (Appendix A4) and project-specific consultation register (Appendix A5) | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | During on-country consultations relevant West Musgrave Traditional Owners were informed of the broad categories of potential chemical hazards associated with the proposed project e.g. chemical reagents (including fossil fuels), tailings, potentially AMD waste rock, copper and nickel concentrate and the formation of pit lakes. The mechanisms for the management of these broad chemical groups was explained to the Traditional Owners and no material concerns were raised<br>All areas identified by Traditional Owner, Ngaanyatjarra Council and other stakeholders relating to potential impacts inherent to terrestrial environment quality values have been considered in this assessment | |

## 7.6 Terrestrial Fauna

### 7.6.1 EPA Objective

The EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) lists the following as their objective for terrestrial fauna.

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained

In the context of this factor and objective, the EPA defines ecological integrity as the composition, structure, function and processes of ecosystems and the natural range of variation of these elements (EPA, 2016h).

For the purposes of this assessment, terrestrial fauna is defined as animals living on land or using land (including aquatic systems) for all or part of their lives. Terrestrial fauna includes vertebrate (birds, mammals including bats, reptiles, amphibians, and freshwater fish) and invertebrate (arachnids, crustaceans, insects, molluscs and worms) groups.

Fauna habitat is defined as the natural environment of an animal or assemblage of animals, including biotic and abiotic elements, that provides a suitable place for them to live (e.g. breed, forage, roost or seek refuge). The scale at which fauna habitat is defined would depend on the ecological requirements of the species considered.

### 7.6.2 Policy and Guidance

Terrestrial fauna is protected under Commonwealth and State legislation, primarily governed by three Acts:

- *Environment Protection and Biodiversity Conservation Act, 1999* (Cth); EPBC Act
- *Environmental Protection Act, 1986* (WA); EP Act
- *Biodiversity Conservation Act, 2016* (WA); BC Act.

In addition to Commonwealth and State legislation, the following policy and guidance statements were considered in the design of fauna surveys and in the impact assessment for terrestrial fauna:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA, 2020e)
- EPA Environmental Factor Guideline – Terrestrial Fauna (EPA, 2016h)
- EPA Technical Guidance – Terrestrial Fauna Surveys (EPA, 2016i)
- EPA Technical Guidance – Sampling methods for Terrestrial vertebrate fauna (EPA, 2016j)
- EPA Technical Guidance – Sampling of short-range endemic invertebrate fauna (EPA, 2016k)

- Interim guideline for preliminary surveys of Night Parrot (*Pezoporus occidentalis*) in Western Australia (DBCA, 2017)
- Guidelines for surveys to detect the presence of Bilbies and assess the importance of habitat in Western Australia (DBCA, 2017)
- Survey and monitoring guidelines for the Sandhill Dunnart in Western Australia (DPAW, 2016)
- Survey guidelines for Australia's threatened bats (DEWHA, 2010a)
- Survey guidelines for Australia's threatened birds (DEWHA, 2010b)
- Survey guidelines for Australia's threatened mammals (DSEWPaC, 2011a)
- Survey guidelines for Australia's threatened reptiles (DSEWPaC, 2011b)
- Conservation advice *Liopholis kintorei* (Great Desert Skink) (TSSC, 2016)
- National recovery plan for the Great Desert Skink (*Liopholis kintorei*) (McAlpin, 2001)
- Wind Farms and Birds Policy (Birdlife Australia, 2012)
- EPBC Act Policy Statement 2.3 Windfarm Industry (DEWHA, 2009)
- Best practice guidelines for implementation of wind energy projects in Australia (CEC, 2018).

### 7.6.3 Receiving Environment

#### 7.6.3.1 Studies and Survey Effort

Several terrestrial fauna surveys have been undertaken for the proposed project, across many years and varied climatic conditions. These surveys provide a comprehensive understanding of the baseline terrestrial fauna and their habitats in the proposed project area and greater region. Table 7-65 provides a list of the surveys and sampling effort that were undertaken to support the Proposal and Figure 7-46 illustrates their spatial extent. Table 7-66 summarises the survey effort per habitat type/mosaic and Figure 7-47 illustrates their spatial extent. The following studies and surveys, related to terrestrial fauna, were undertaken to systematically characterise the proposed project's potential impact to terrestrial fauna:

- Level 2 vertebrate fauna survey, including targeted survey of conservation significant fauna conducted by Western Wildlife (Appendix G1). Two levels of fauna survey were undertaken across the fauna survey area including a Level 2 fauna survey within the Main Development Area and proposed Western Access Road and a targeted survey for conservation significant species across the whole fauna survey area (including areas of proposed linear infrastructure). These surveys were undertaken as part of three survey events in three seasons. The fauna survey area covered a total area of 40,902 ha.
- Targeted Great Desert Skink survey conducted by Western Wildlife (Appendix G2). A targeted field survey over two sampling periods was undertaken to identify habitats that support Great Desert Skink and identify the extent of Great Desert Skink within the fauna survey area.

- Avian fauna and microbat baseline characterisation conducted by Donato Environmental Services (Appendix G3). A detailed assessment of the aerial fauna (birds and bats) within the proposed project area, concentrating on the proposed wind turbine electricity generator site and main infrastructure area. All expected bat species were recorded from these sites, according to Donato Environmental Services these results can be extrapolated over the greater Development Envelope as bat distribution within the arid zones is not limited by vegetative habitat, instead their abundance is influenced by freestanding water and insect activity. The study also made specific effort in identifying the potential presence or absence of the Night Parrot (*Pezoporus occidentalis*). Specifically, this survey collected four months of audio recordings, using remotely deployed song meters and Anabats. Whilst this survey did not occur after significant rainfall Donato Environmental Services (pers comm. 2020) have noted that this species is not known to be a boom/bust strategists but continues to breed and call during extremely dry conditions in Queensland and that the methodology used has detected the species in areas considered to be under dry conditions. This survey was also followed by a risk assessment to confirm the potential for aerial fauna to interact with wind turbines based on the presence of vegetative canopy, animal flight heights and behavior (Appendix G4).
- Targeted survey and habitat assessment for the McDonnell Ranges Black-Footed Rock-Wallaby and the Great Desert Skink conducted by Timbs and Knight (Appendix G5). The Ngaanyatjarra Ranger Team, coordinated by the Ngaanyatjarra Council, undertook a regional study investigating the presence of both Great Desert Skink (*Liopholis kintorei*) and McDonnell Ranges Black-Footed Rock-Wallaby (*Petrogalis lateralis*) within 200 km of the proposed project's fauna survey area. The survey had two study aims, the first to confirm the presence of further populations of Great Desert Skink from a regional perspective, and the second to confirm the presence or absence of Black-Footed Rock-Wallaby, both inside the fauna survey area, and regionally.
- Short Range Endemic (SRE) survey conducted by Alacran (Appendix G6). A targeted survey consisting of three sampling events to identify SRE habitat, identify potential SRE species and determine if the fauna survey area supports a known SRE. Survey effort for SREs at the WMP is shown in Figure 7-48. It should be noted that records from National or State museums other than the West Australian Museum (WAM) were not assessed for SREs as those institutions do not use the WAM morphospecies system.
- An independent peer review of project-related impacts on EPBC listed threatened species and migratory species was undertaken by Jacobs. Jacobs concluded that the proposed project would not have a significant impact on MNES based on the Australian Government's Department of the Environment's (DoE) Significant Impact Guidelines 1.1 (DoE, 2013a).

**Table 7-65: Local and Regional Terrestrial Fauna and Habitat Surveys of the WMP Region**

| Survey | Sampling Effort | Dates |
|---|---|---|
| Level 2 vertebrate fauna survey, including targeted survey of conservation significant fauna over 40,405.9 (Appendix G1) | • Identification of fauna habitats<br>• 1,580 pitfall trap nights<br>• 1,570 Elliot trap nights<br>• 870 funnel trap nights<br>• 314 cage trap nights<br>• 39 hours of active bird surveys<br>• 30 nights of 2 x Anabat Swift call detection<br>• 795 km of walking transects looking for signs of conservation significant species<br>• Deployment of 57 camera traps (of which 30 were left deployed for 3.5 months targeting conservation significant species habitat)<br>• Mist netting<br>• Spotlighting<br>• Marsupial mole trenching | 20 June to 4 July 2018<br>17 to 31 October 2018<br>24 April to 6 May 2019 |
| Targeted Great Desert Skink Survey (Appendix G2) | • 767.3 km of walking transects | 20 June to 4 July 2018<br>17 to 31 October 2018<br>24 April to 5 May 2019 |
| Avian fauna and microbat baseline characterisation (Appendix G3) | • 3,455 hours of recordings using 4 x SM2 and 4 x SM4; comprising 10,366 20-minute recording sessions<br>• 308 hours of microbats recordings using 4 x SD2 Anabat™ | Four-month deployment of SM Song Meters, and Anabats between 7 October 2018 and 24 January 2019 |
| Targeted survey and habitat assessment for the McDonnell ranges Black Footed Rock Wallaby and the Great Desert Skink (Appendix G5) | • Walking transects at six Great Desert Skink Regional Zones<br>• Field inspections of six near mine and regional rocky-outcrops and rangelands<br>• Deployment of six camera traps at near mine rocky outcrops | Multiple field visits between 23 September 2019 and 22 November 2019 |
| Short Range Endemic Survey (Appendix G6) | • 47 foraging sites<br>• 22 dry pitfall trapping sites<br>• 19 wet pitfall trapping sites | 20 June to 4 July 2018<br>17 to 31 October 2018<br>8 to 15 October 2019 |

**Table 7-66: Survey Effort per Habitat Type/Mosaic at the WMP**

| Habitat Type | Pitfall Traps per Habitat Type | Camera Trap Nights per Habitat Type | Location of Habitat Type/Mosaic |
|---|---|---|---|
| Sand dunes | 1 | 586 | Inside and Outside Development Envelope |
| Spinifex sandplain | 1 | 436 | Inside and Outside Development Envelope |
| Calcrete – Spinifex sandplain mosaic | 2 | 192 | Inside and Outside Development Envelope |
| Mallee sandplain | 1 | 567 | Inside and Outside Development Envelope |
| Calcrete – Mallee sandplain mosaic | 1 | 110 | Inside and Outside Development Envelope |
| Mulga sandplain | 1 | 215 | Inside and Outside Development Envelope |
| Calcrete plains | 1 | 215 | Inside and Outside Development Envelope |
| Mulga woodland | 4 | 249 | Inside and Outside Development Envelope |
| Stony hills and plains* | | | Inside and Outside Development Envelope |
| Chenopod shrublands* | | | Inside and Outside Development Envelope |
| Claypans* | | | Inside and Outside Development Envelope |

*The three habitats where no trapping occurred were represented by small habitat areas that were mostly outside of the Development Envelope, where they were located inside the Development Envelope they were located along areas that would be subject to low impact infrastructure

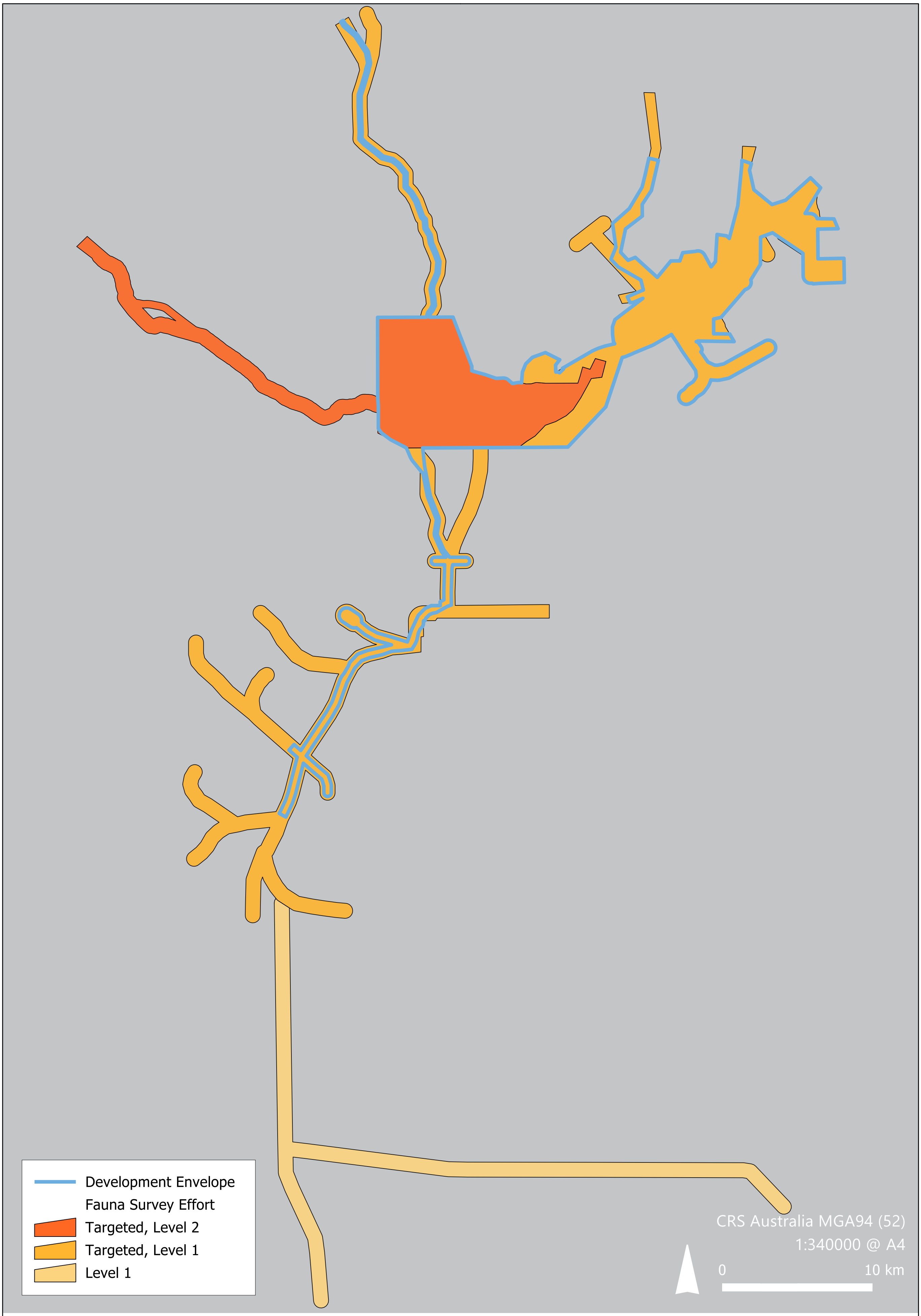


Figure 7-46: Spatial Extent of Terrestrial Fauna and Habitat Surveys Conducted for the WMP

WEST MUSGRAVE COPPER AND NICKEL PROJECT

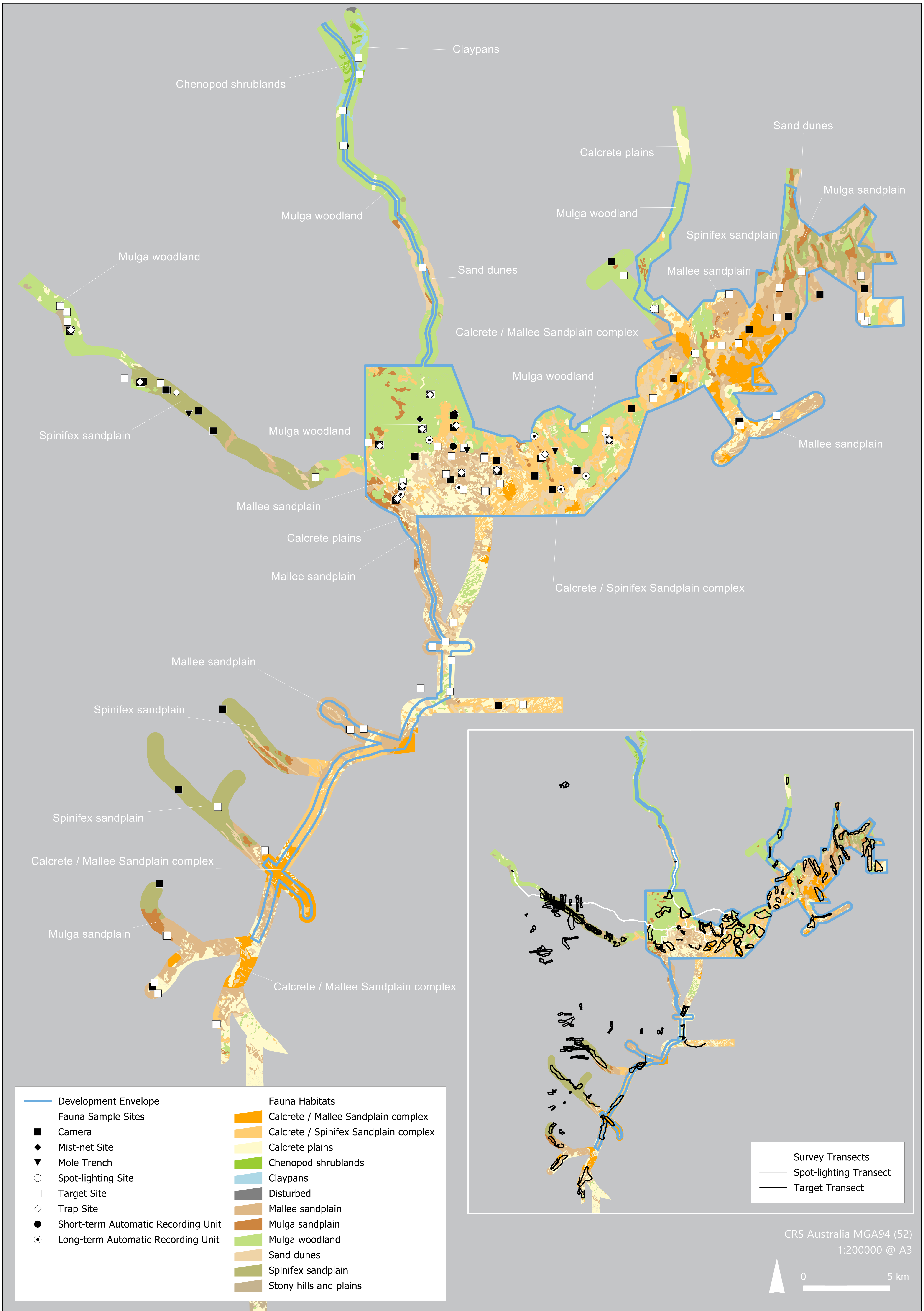


Figure 7-47: Terrestrial Fauna Survey Effort per Habitat Type/Mosaic at the WPM

WEST MUSGRAVE COPPER AND NICKEL PROJECT

OZ MINERALS

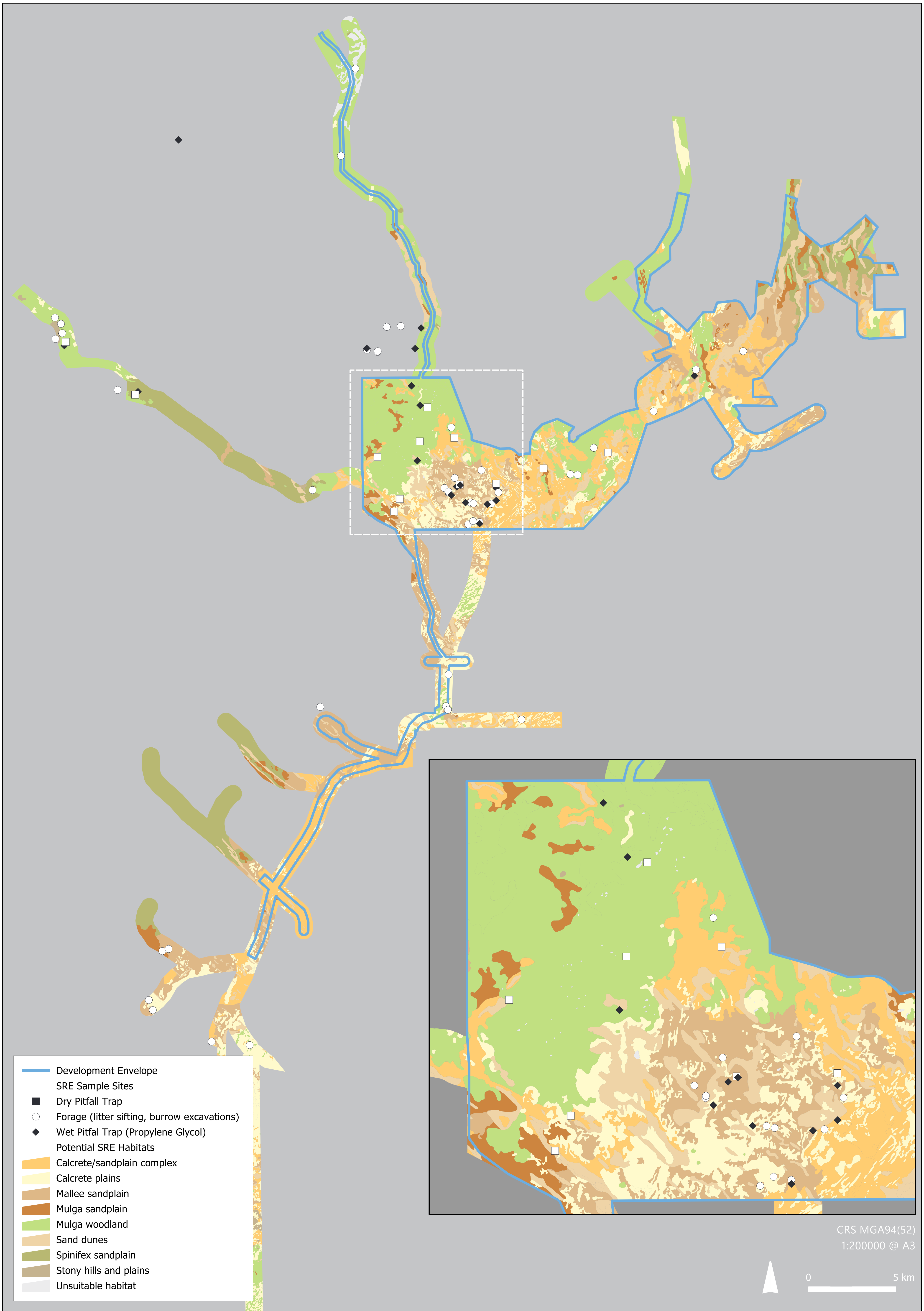


Figure 7-48: Short-Range Endemic Survey Effort per Habitat Type/Mosaic at the WMP

WEST MUSGRAVE COPPER AND NICKEL PROJECT

OZ MINERALS

#### 7.6.3.2 Fauna Habitat

Eleven fauna habitats (Table 7-67) were identified in the fauna survey area (Appendix G1). These fauna habitats were identified based on observations made in the field, vegetation mapping and interpretation of aerial photography. Two of the eleven habitats are 'mosaics', where the Spinifex Sandplain or Mallee Sandplain occur in association with outcropping calcrete, at a scale too fine to be separately mapped (Figure 7-49). All habitats present in the fauna survey area are widely represented in the CR or GVD Bioregions (Appendix G1).

**Table 7-67: Fauna Habitat in the Project Area**

| Habitat Type | Fauna Habitat Description | Total Area Mapped (ha) | Representative Photo |
|---|---|---|---|
| Sand dunes | Sand dunes composed of fine red sand and support a shrubland of Grevillea and *Acacia* spp. on the dune crests, over *Aluta maisonneuvei* and Spinifex (*Triodia schinzii* and *Triodia basedowii*). Shrublands on the mid to lower slopes are often dominated by *Aluta maisonneuvei* over sparse Spinifex. | 4,206.5 |  |
| Spinifex sandplain | Deep red sands supporting a grassland of Spinifex (*Triodia schinzii* and/or *Triodia basedowii*). Much of this habitat includes a shrub layer of *Acacia* spp. | 4,114.7 |  |

| Habitat Type | Fauna Habitat Description | Total Area Mapped (ha) | Representative Photo |
|---|---|---|---|
| Calcrete - Spinifex sandplain mosaic | Small calcrete outcrops intermingled with areas of red sandplain. Often occurring as narrow bands between the base of sand dunes and the underlying calcrete. The vegetation of the sandplain patches is often indistinguishable from areas of more extensive sandplain, however, the sands are shallower, often with calcrete pebbles at the surface. | 5,129.8 |  |
| Mallee sandplains | Red sands of varying depth supporting a low mallee woodland of *Eucalyptus oxymitra* and *Eucalyptus gamophylla* over Spinifex (*Triodia basedowii* and *Triodia scariosa*) grassland. | 5,780.7 |  |

| Habitat Type | Fauna Habitat Description | Total Area Mapped (ha) | Representative Photo |
|---|---|---|---|
| Calcrete - Mallee sandplain mosaic | Numerous small calcrete outcrops intermingled with areas of low mallee woodlands on red sandplain. | 1,950.0 |  |
| Mulga sandplain | Vegetation characterised by Mulga woodland over Spinifex (*Triodia basedowii*) grassland, often with a shrub layer of *Eremophila longifolia*, *Hakea lorea* and *Acacia* spp. | 1,907.8 |  |

| Habitat Type | Fauna Habitat Description | Total Area Mapped (ha) | Representative Photo |
|---|---|---|---|
| Calcrete plains | Flat or undulating plains of calcrete occurring as small or large patches, often in a mosaic with sandplain habitats. The calcrete plains support Spinifex (*Triodia scariosa*) grasslands, often with open woodlands of *Hakea lorea* and sometimes with an open shrubland of Mulga, *Melaleuca eleuterostachya, Allocasuarina helmsii* or *Acacia eremophila*. On the southern part of the Southern Monitoring Bores area, the calcrete plains also support open woodlands of Desert Bloodwood (*Corymbia opaca*). | 6,495.0 |  |
| Mulga woodland | Occurring mainly on sandy-loam plains, occasionally with calcrete outcropping. The open woodland canopy is dominated by Mulga species with *Hakea lorea*. The mid-storey is represented by a sparse shrubland and the understorey a sparse chenopod shrubland of *Sclerolaena* spp. or tussock grassland. In drainage areas, the understorey is forbland that includes *Eremophila foliosissima*, chenopods (*Maireana* and *Sclerolaena spp*.) and grasses. Mulga groves occur where internally drained sites support a greater density of vegetation. In the interzone between Mulga woodlands and sandplains, the Mulga woodland occurs over perennial Wanderrie grasses. | 10,319.8 |  |

| Habitat Type | Fauna Habitat Description | Total Area Mapped (ha) | Representative Photo |
|---|---|---|---|
| Stony hills and plains | On the Western Access Road, the lower stony slopes of granitic hills support shrublands of Mulga, *Acacia kempeana*, *Acacia cuthbertsonii* and/or *Senna* spp. On the Northern Access Road, near Jameson (Mantamaru), low ironstone hills support Mulga shrublands, some over chenopod shrubland (*Maireana triptera*). | 212.3 |  |
| Chenopod shrublands | Small areas of chenopod shrublands in association with the gravelly lower slopes and plains below ironstone hills. The shrubland is a low open mix of *Atriplex vesicaria* and *Maireana* spp. with *Eremophila clarkei* and occasional grasses. | 118.6 |  |

| Habitat Type | Fauna Habitat Description | Total Area Mapped (ha) | Representative Photo |
|---|---|---|---|
| Claypans | Small claypans have a sparse grassland in the centre and are fringed by a shrubland of *Eremophila longifolia* and *Acacia* spp. The larger claypans have a perennial grassland with occasional *Eremophila longifolia* and *Acacia* spp. These areas are likely to hold water after significant rainfall events. | 170.7 |  |
| | **Total Area Mapped** | **40,405.9** | |

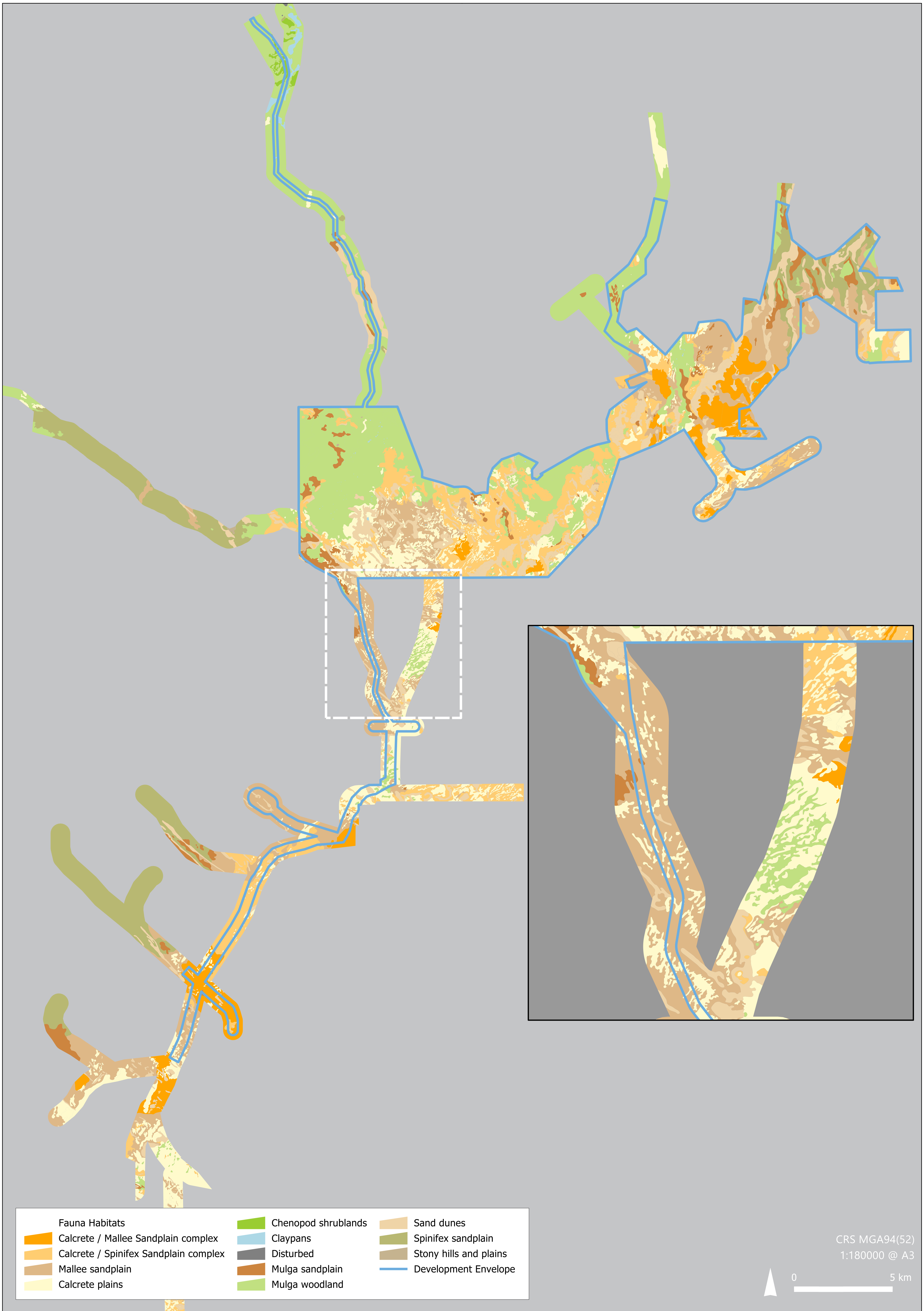


Figure 7-49: Fauna Habitat Distribution in the Proposal Area

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#### 7.6.3.3 Faunal Assemblage

The overall vertebrate faunal assemblage was observed to be largely intact except for species that are extinct or greatly reduced in their distribution in the Bioregions. The faunal assemblage and significant species are discussed in the following sections and detail is provided in Appendix G1.

**Amphibians**

Seven species of frog have potential to occur within the fauna survey area. These species are common and widely distributed in the semi-arid zone. No frogs were trapped during surveys, however two species, the Desert Spadefoot (*Notaden nichollsi)* and Main's Frog (*Cyclorana maini*) were recorded after rain events.

Frogs are likely to occur throughout the fauna survey area, potentially breeding anywhere that holds relatively fresh water after rainfall, including small claypans in the Mulga woodlands, larger claypans near Jameson (Mantamaru) and man-made depressions. Regionally important habitat for frogs, such as permanent rock waterholes, were not recorded.

**Reptiles**

There are 94 species of reptile that have the potential to occur within the fauna survey area, 62 of which were recorded during fauna surveys. The reptile assemblage is likely to be largely intact, with most species having a widespread distribution across arid central Australia.

**Birds**

Based on known species range, 122 species of bird potentially occur in the fauna survey area, 89 of which were recorded during fauna surveys.

The bird assemblage is likely to include:

- A core suite of species that are resident in the area
  - Resident species include many of the small insectivores such as fairywrens, thornbills, whistlers and robins. Resident species are present all year, though their populations may fluctuate in response to rainfall and fire. Particularly common species included the Crested Pigeon (*Ocyphaps lophotes*), Singing Honeyeater (*Gavicallis virescens*) and Zebra Finch (*Taeniopygia gutatta*).
- A group that makes regular or nomadic movements into and through the area
  - Birds that make regular seasonal movements include the Rainbow Bee-eater (*Merops ornatus*), cuckoos and some birds of prey. Honeyeaters are also likely to make seasonal or nomadic movements to take advantage of flowering events. Although not present all year, these species are likely to use the fauna survey area for foraging, breeding or shelter on a seasonal basis or when conditions are suitable.

- A group of vagrants, that may occur in the area on occasion
  - Wetland dependent bird species may occur as occasional visitors in small numbers, however the only surface water in the fauna survey area is likely to be in the small claypans that are within the Mulga woodland and the larger claypans near Jameson (Mantamaru).

### Mammals

Based on known species ranges, 43 species of mammal have the potential to occur in the fauna survey area, of which 35 are native and eight introduced. A total of 26 species of mammal were recorded during surveys, 18 of which were native (including seven microbats) and eight introduced species.

The mammal assemblage is dominated by species that favour sandy desert habitats with most species likely to be widespread across the central arid regions of Australia.

### 7.6.3.4 Significant Fauna

Significant survey effort focussed on identifying presence of significant fauna, as defined by the BC Act and EPBC Act. One Threatened fauna species and no Extinct fauna species as defined under the BC Act or EPBC Act were identified during baseline surveys. Fifteen species of significant fauna were identified (Table 7-68), comprising:

- One Threatened (Vulnerable) species under the BC Act and EPBC Act
- Six species listed under the EPBC Act were listed as Marine of which one is also listed as Migratory under the BC Act and EPBC Act
- Three Specially Protected (Priority 4) species under the BC Act
- One locally significant species not listed under the BC Act or EPBC Act
- Four species that whilst not listed under the EPBC Act or BC Act are considered significant as the observations represent range extensions. Given the fauna of the CR and GVD Bioregions are relatively poorly surveyed, this result is expected. These are shown in Table 7-69.

These are discussed in further detail in the following subsections.

**Table 7-68: Significant Fauna Recorded During Surveys**

| Species | EPBC Act Listing | BC Act Listing | Other |
|---|---|---|---|
| Great Desert Skink (*Liopholis kintorei*) | Vulnerable | Vulnerable | |
| Striated Grasswren (*Amytornis striatus striatus*) | - | Priority 4 | |
| Brush-tailed Mulgara (*Dasycercus blythi*) | - | Priority 4 | |
| Southern Marsupial Mole (*Notoryctes typhlops*) | - | Priority 4 | |
| Pallid Cuckoo (*Cacomantis pallidus*) | Marine | - | |
| Black Eared Cuckoo (*Chalcites osculans*) | Marine | - | |

| Species | EPBC Act Listing | BC Act Listing | Other |
|---|---|---|---|
| Sacred Kingfisher (*Todiramphus sanctus*) | Marine | - | |
| Rainbow Bee-eater (*Merops ornatus*) | Marine | - | |
| Australian Pratincole (*Stiltia isabella*) | Marine | - | |
| Oriental Pratincole (*Glareola maldivarum*) | Migratory, Marine | Migratory | |
| Spiny-tailed Goanna (*Varanus acanthurus*) | | | Range Extension |
| Ribbon Slider Skink *(Lerista taeniata)* | | | Range Extension |
| Ornate Soil-crevice Skink *(Notoscincus ornatus)* | | | Range Extension |
| Beaked Blind Snake (*Anilios grypus*) | | | Range Extension |

Table 7-69 provides a list of significant species listed under the BC Act and/or EPBC Act that were identified through desktop surveys as potentially occurring in the fauna survey area, that were not observed during project specific studies and an assessment of their likely status.

**Table 7-69: Potential Significant Terrestrial Fauna Not Found Within the Survey Area**

| Species | Explanatory Notes | Likely Status in the Survey Area |
|---|---|---|
| Crest-tailed Mulgara (*Dasycercus cristicauda*) | Despite extensive survey effort, this species was not identified in the fauna survey area. This species is not currently known to occur in Western Australia. The habitats of the survey area are dissimilar to the habitats where this species currently occurs. | Locally extinct |
| Bilby (*Macrotis lagotis*) | Through extensive survey effort this species was not identified in the fauna survey area. This species is currently not known to occur as far south as the survey area. | Locally extinct |
| Sandhill Dunnart (*Sminthopsis psammophila*) | Despite extensive survey effort this species was not identified in the fauna survey area. On the basis on the current known distribution of the species and the habitats available in the survey area, it is considered unlikely that the Sandhill Dunnart occurs in the survey area. A recently published Ph.D thesis in which a predictive tool was developed for ascertaining Sandhill Dunnart habitats was also used by Western Wildlife (Appendix G1) that supported these findings. There are no records of this species within 100 km of the survey area. | Locally extinct |
| Black-footed rock-wallaby (*Petrogale lateralis*) | Despite extensive survey effort, this species was not identified in the fauna survey area. Rocky outcrops near to the Development Envelope were considered very poor and unsuitable habitat, with the rock features lacking the level of complexity sufficient to provide adequate protection from predators. | Not present in area |
| Malleefowl (*Leipoa ocellata*) | Despite extensive survey effort, this species was not identified in the fauna survey area. This species is only known from historical records in the region. No mounds or other evidence was detected during the fauna survey. It is likely that its range has contracted south. As a large diurnal bird with distinctive | Locally extinct |

| Species | Explanatory Notes | Likely Status in the Survey Area |
|---|---|---|
| | mounds, it is unlikely that this species would remain unrecorded if still present in the region. | |
| Night Parrot (*Pezoporus occidentalis*) | From 3,455 hours of song meter recordings over a four-month period across the fauna survey area, and 30 hours of active listening at field transects, no records of this species were identified. This significant survey effort provides a high level of confidence that the Night Parrot does not occur in the survey area. Madden-Hallett and Donato also concluded that preferred Night Parrot habitat probably does not occur in the survey area.<br>When taking fauna habitat mapping into account potential breeding/roosting Night Parrot habitat at the WMP includes:<br>• Spinifex sandplains—this habitat may provide Night Parrot habitat, noting that recently burnt areas will most likely not be suitable for breeding/roosting.<br>• Calcrete-spinifex complex—spinifex within the calcrete habitat is typically small except on the edges of the calcrete platforms where water runoff promotes larger spinifex clumps (i.e. the calcrete spinifex sandplain complex). Potential Night Parrot habitat is patchy within this habitat type.<br>• Calcrete-mallee sandplain complex—this habitat may contain patches of larger spinifex but would be less attractive as this habitat complex is more wooded.<br>• Sand dunes may contain spinifex clumps however, these tend to be small and scrappy for the most part, with the shifting dune sands making them less suitable for breeding/roosting.<br>Based on the above potential Night Parrot breeding/roosting habitat was classified as having a high, medium or low probability of supporting the species at the WMP. Project design took this classification into consideration with only the Northern Borefield extending into areas with a high probability as can be seen in Figure 7-50. | Not present in area |

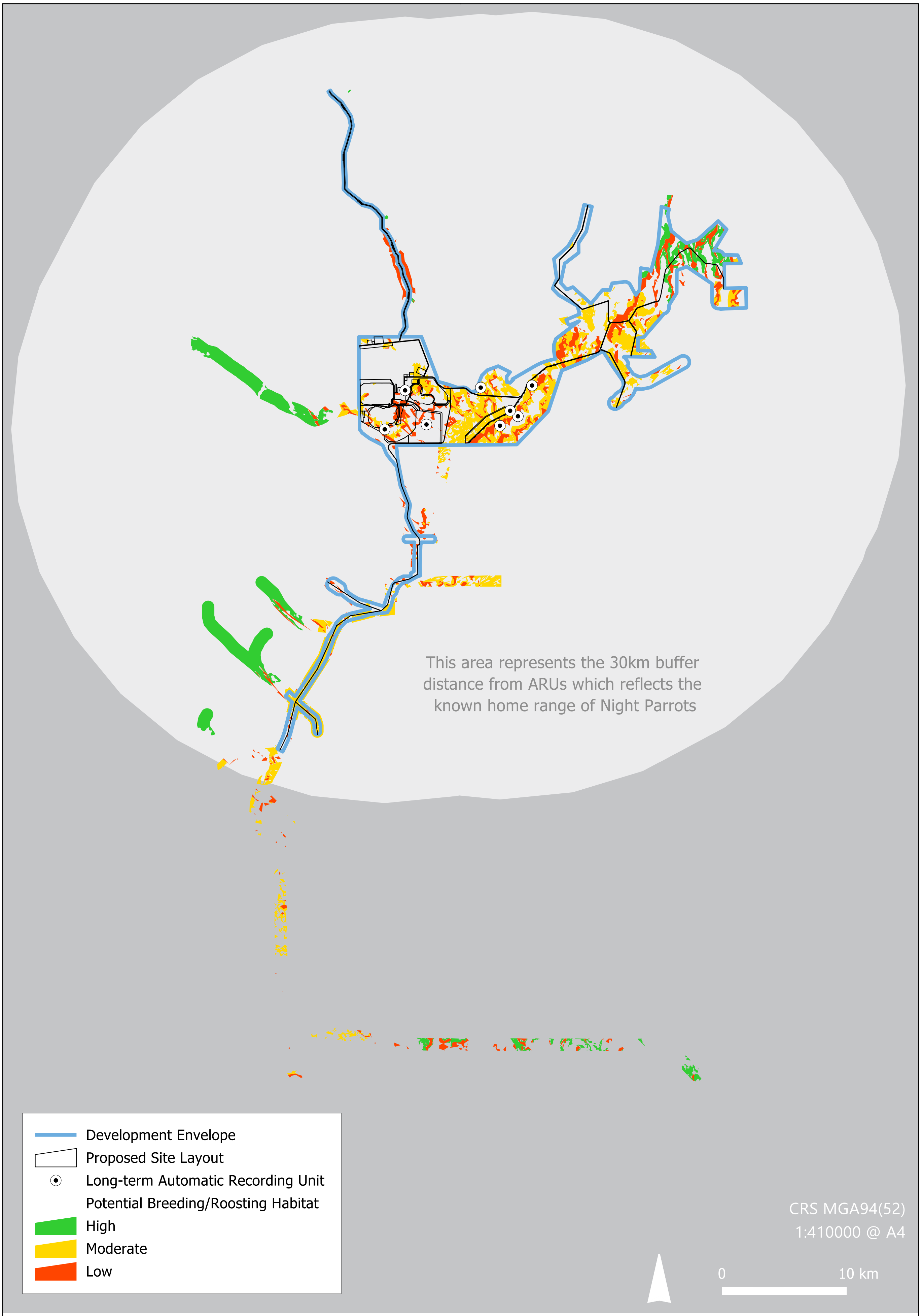


Figure 7-50: Likelihood of Habitat to Support Night Parrot Breeding/Roosting at the WMP

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### Great Desert Skink (*Liopholis kintorei*)

The Great Desert Skink is a large burrowing lizard restricted to sandy and gravelly habitats in the western desert region of Central Australia (Plate 7-5). Listed as Vulnerable under both the EPBC Act and the BC Act, the Great Desert Skink has a scattered distribution across its range, and is known to have disappeared from former habitats, particularly in the Gibson Desert, Great Victoria Desert and Great Sandy Desert Regions.

Threats to the Great Desert Skink include predation after loss of vegetation cover from fire and possibly habitat degradation from feral Camels and Rabbits (TSSC, 2016). With the cessation of traditional land management practices across much of the western desert's region, frequent patch-burning has been replaced by extensive hot fires (McAlpin, 2001). Both cats and foxes are known to prey on the Great Desert Skink.

#### *Ecology and Habitat*

The Great Desert Skink can grow to approximately 440 mm in length and weighs up to 350 g, with juveniles weighing as little as 9 to 13 g and measuring 70 to 80 mm. The species usually occurs on spinifex sandplains, but is also known to inhabit adjacent dune swales. In the Tanami and parts of the Great Sandy Desert it also occurs in the lateritic soils of paleodrainage lines (McAlpin, 2001).

The Great Desert Skink constructs large burrow systems to a depth of one metre and ten centimetres in diameter. New tunnels are progressively added to form a network of connected tunnels up to five or six metres across. The burrow systems can have multiple entrances. On the surface the burrow system is identifiable by at least one large external scat latrine (McAlpin, 2001). Great Desert Skinks are known to sometimes take over, adapt and enlarge burrows of other animals, such as the Mulgara (*Dasycercus cristicauda*), Spinifex Hopping Mouse (*Notomys alexis*), Night Skink (*Liopholis striata*), and Sand Goanna (*Varanus gouldii*) (McAlpin, 2001). Further information relating to this species ecology and habitat can be found in Appendix G2 and Appendix G5.

GREAT DESERT SKINK
(*Liopholis kintorei*)

BURROW

SCAT LATRINE

HABITAT
Spinifex Sandplain

Images courtesy of Western Wildlife

Plate 7-5: Great Desert Skink (*Liopholis kintorei*)

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### *Distribution and Extent*

The Great Desert Skink is endemic to Australian arid areas within the western desert region and occurs across a broad area covering the south-western and western areas of the Northern Territory, the north-western extent of South Australia, and a central expanse of inland Western Australia. Detailed knowledge regarding the species distribution within this broad range is imprecise, due to the extreme remoteness and inaccessibility of much of the potential suitable habitat across the range (McAlpin, 2001, cited in TSSC, 2016; AWE, 2020b). Dennison et al. (2015) note the presence of Great Desert Skink from 'fewer than 100 localities' within its range, but it is noted that recent targeted searches in suitable habitat within the species range have been able to locate new populations (e.g. Appendix G2 and Appendix G5).

Known population extents include seven main populations (McAlpin, 2001 and DoE, 2020), with the greatest concentration of historic records occurring in the Northern Territory (ALA, 2020). Table 7-70 and Figure 7-51 provide known locations of Great Desert Skink (McAlpin, 2001 and TSSC, 2016). Further unpublished records of Great Desert Skink are also known in Western Australia 480 km west of the Proposal (e.g. Lake Wells).

**Table 7-70: Known Populations of the Great Desert Skink**

| Location of Known Population | State | Tenure | Estimated Population | Habitat | Distance from Proposal |
|---|---|---|---|---|---|
| Patjarr (Karilywara) and proposed Gibson Desert IPA | WA | Ngaanyatjarra Council | <2,500 | Gravelly undulating plain with scattered *Acacia pruinocarpa* or *A. aneura* over *Triodia basedowii* and low shrubs | 200 km |
| Kiwirrkura community and surrounds including vicinity of Lake Mackay | WA | Ngaanyatjarra Council | <500 | Sandplain with spinifex and scattered shrubs (*Acacia spp., Eucalyptus spp., Hakea spp., Grevillea spp.*) | 350 km |
| Karlamilyi National Park | WA | DBCA | Unknown | Unknown | 630 km |
| Tanami Desert including Rabbit Flat-Sangster's Bore, The Granites, and near Kintore | NT | Various Aboriginal Lands Trusts | <2,250 | Sandplain with spinifex and scattered shrubs and occasional trees (*Acacia spp., Eucalyptus spp., Hakea spp., Grevillea spp.)* | 700 km |
| Uluru-Kata Tjuta National Park (includes part of the Yulara borefields area) | NT | Uluru-Kata Tjuta Land Trust leased to Parks Australia. | <500 | | 325 km |

| Location of Known Population | State | Tenure | Estimated Population | Habitat | Distance from Proposal |
|---|---|---|---|---|---|
| Yulara lease lands and surrounding Land Trust lands (includes part of the borefields area) | | Ayers Rock Resort Corporation and Katiti Land Trust. | <350 | Sandplain with spinifex (*Triodia basedowii and T. pungens*.) and scattered shrubs and occasional trees (*Acacia spp., Allocasuarina decaisneana., Hakea spp., Grevillea spp*.) | |
| Anangu-Pitjantjatjara Lands | SA | Anangu-Pitjantjatjara Council | <50 | Sandplain with mulga and minyura over woollybutt grass (*Eragrostis eriopoda*) and spinifex | 280 km |

Documented populations of Great Desert Skink which are protected under conservation reserve represent important populations of the species owing to the added protection that this provides, and include those within the Uluru-Kata Tjuta National Park, Watarrka National Park and Newhaven Reserve all situated within the Northern Territory.

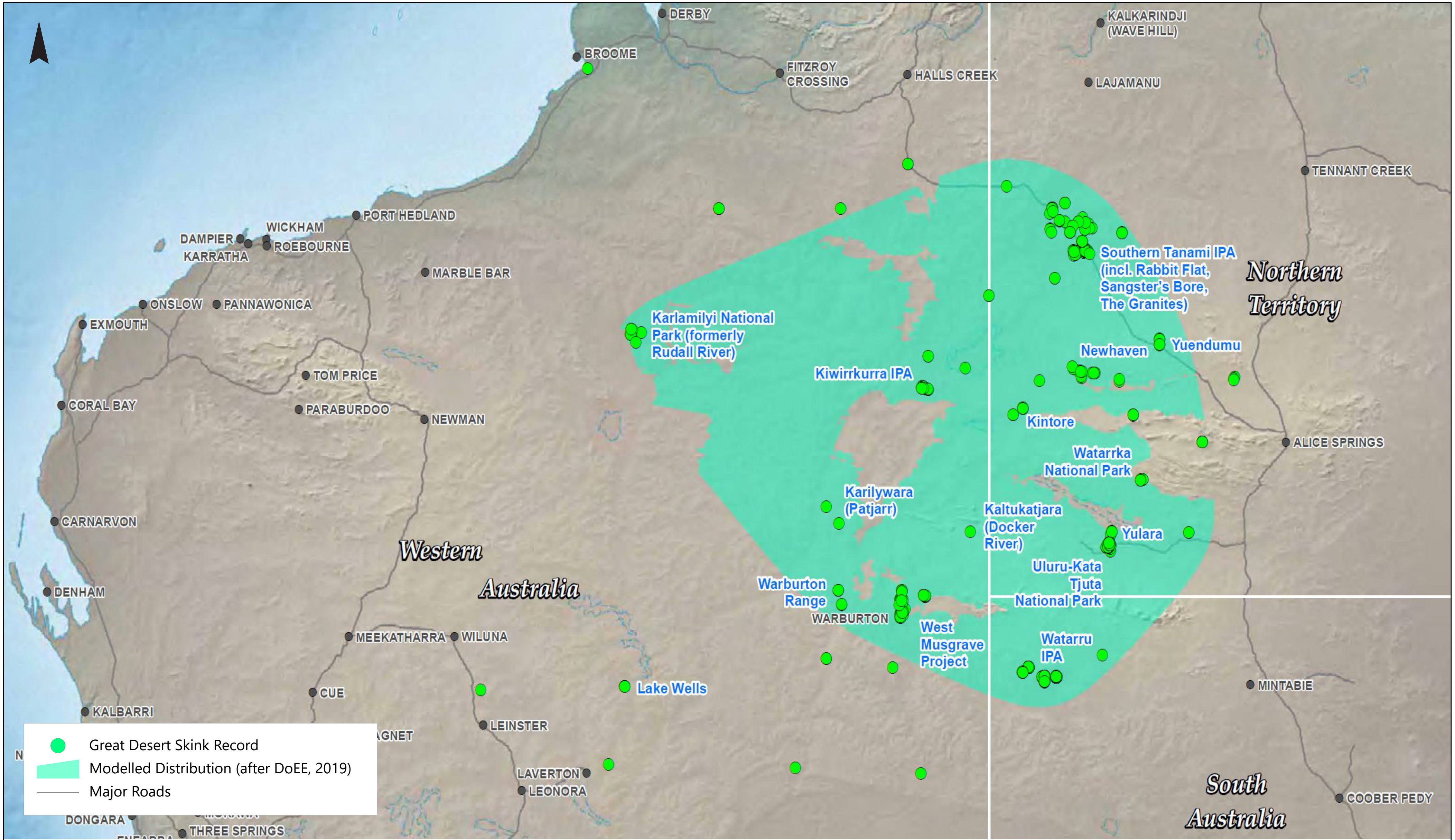


Figure 7-51: Known Populations of the Great Desert Skink

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### *Great Desert Skink and the West Musgrave Project*

Two studies relating to the presence and habitat of Great Desert Skink were undertaken, these included:

- Targeted walking transects, of 767.7 km, within the immediate fauna survey area to identify signs of the Great Desert Skink, primarily burrows in association with a scat latrine (Appendix G2). The total survey effort for each habitat type given is described in Table 7-71 and the extent of surveys illustrated in Figure 7-52. Transects focused on habitats considered most likely to support the species, based on the literature, i.e. sandplains and dune swales. Other habitats, such as Calcrete – Spinifex Sandplain mosaic, were also surveyed, as these presented as superficially similar and it was unknown whether these had the potential to support the species.
- Regional survey for Great Desert Skink within a 200 km radius surrounding the Proposal Area. This regional survey undertaken by the Ngaanyatjarra Ranger team through the Land and Cultural division of the Ngaanyatjarra Council aimed to identify the regional occurrence of Great Desert Skink to contextualise the importance of the findings within the fauna survey area (Appendix G5).

**Table 7-71: Survey Effort for the Great Desert Skink per Habitat Type**

| Habitat Type | Total Transects (km) |
|---|---|
| Sand dunes | 47.5 |
| Spinifex sandplains | 166.3 |
| Calcrete – Spinifex sandplain mosaic | 137.1 |
| Mallee sandplains | 74.8 |
| Calcrete – Mallee sandplain mosaic | 25.7 |
| Mulga sandplains | 24.5 |
| Calcrete plains | 51.0 |
| Mulga woodlands | 72.3 |
| Stony hills and plains | - |
| Chenopod shrublands | - |
| Claypans | 0.4 |
| Outside fauna survey area (primarily Spinifex Sandplain) | 165.1 |
| **Total** | **767.7** |

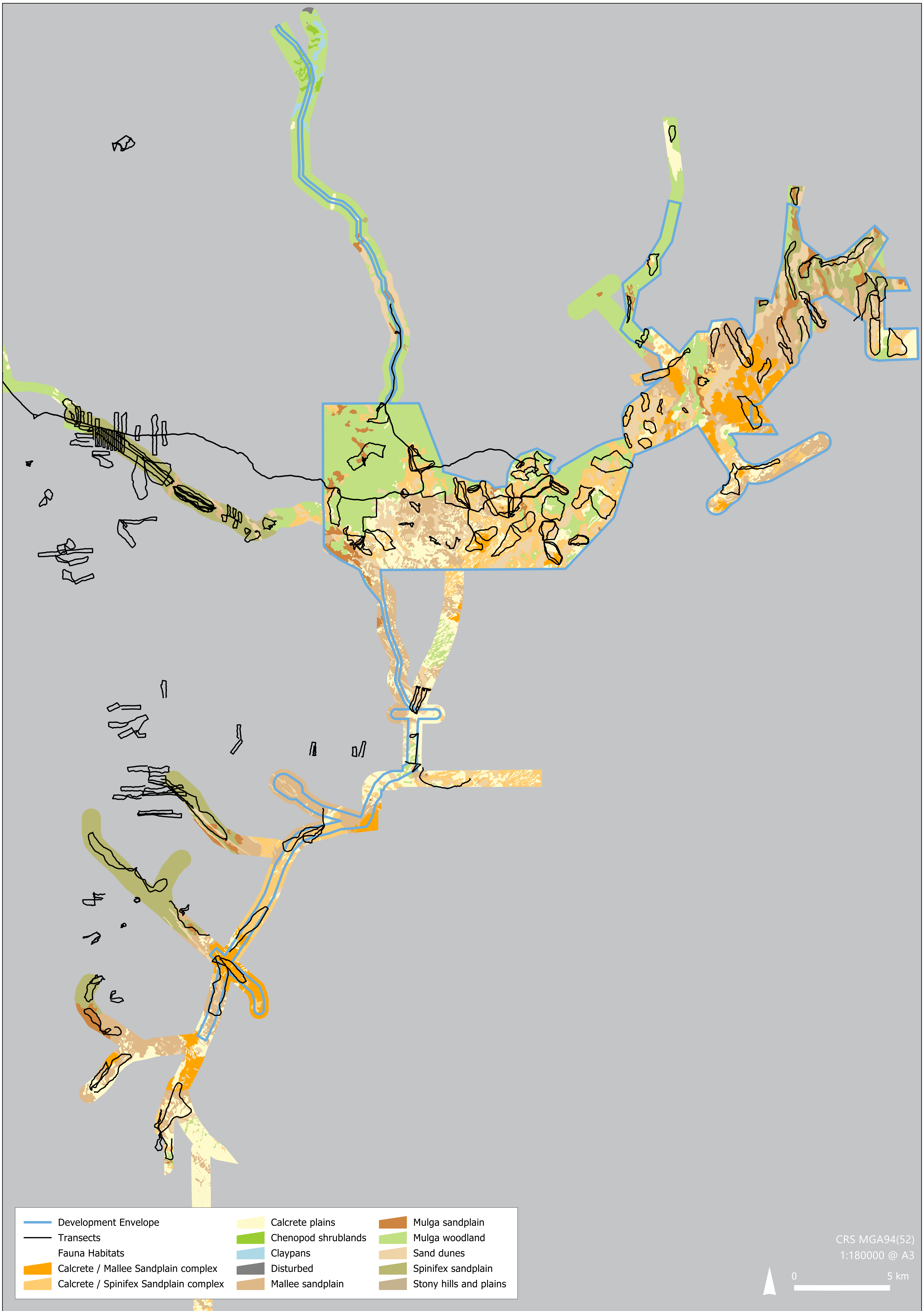


Figure 7-52: Great Desert Skink Survey Effort (Transects)

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A total of 106 Great Desert Skink burrows were recorded in four distinct areas or sub-population (Table 7-72, Figure 7-53 and Plate 7-5). In all cases, it is considered likely that more burrows were present as the purpose of the survey was to investigate the extent of the population rather than document every burrow. The overall number of burrows present is larger than has been documented for other populations.

Based on interrogation of aerial imagery, Western Wildlife have indicated it is reasonable to assume that the area of occupancy of the species is far larger than just those locations where Great Desert Skink were identified. An indicative area of occupancy based on habitat mapping has been identified, as shown in Figure 7-57).

**Table 7-72: Number of Great Desert Skink Burrow Records**

| Sub-population | Number of Burrows | Habitat | Notes |
|---|---|---|---|
| Western Access Road | 39 | Spinifex Sandplain | A portion of the Western Access Rd was surveyed at a higher intensity, showing that, in this area at least, the burrow density is quite high |
| Southern Monitoring Bores | 47 | Spinifex Sandplain | The sub-population is restricted to the sandplains on the western edge of the study area. This region includes some very recently burnt areas (burnt in 2017). In some places there are many burrows in close proximity. |
| Blackstone-Warburton Rd | 7 | Spinifex Sandplain | Recently burnt patch near road (burnt in 2017). This area was not extensively sampled. It is highly likely that many more burrows are present as the sandplain is extensive. |
| Northern Borefield | 13 | Spinifex Sandplain, typically in broad flat swales between dunes. Also, the saddles of low stabilised dunes. | The sub-population is restricted to the sandplains on the north-eastern edge of the study area. Although only a few burrows were recorded, sandplain habitat appears to extend outside the study area to the north-east. |

The majority of Great Desert Skink burrows were present in Spinifex Sandplain, with a few burrows on the saddles of low dunes adjacent to sandplain (Plate 7-5). Figure 7-54 shows the distribution of the burrows found within the fauna survey area. Burrows were often located in areas with patches of *Leptosema chambersii*, a widespread low shrub of the arid region. No burrows were found in the Calcrete – Spinifex Sandplain Mosaic. This fauna habitat was generally notable from the presence of calcrete and calcrete pebbles expressed at the surface. The lack of soil depth and the patchy nature of the sandplain within the Calcrete – Spinifex Sandplain Mosaic habitat appear to make this habitat unsuitable for the Great Desert Skink.

It is considered likely that the Western Access Road, Southern Monitoring Bores area and Blackstone-Warburton Road sub-populations are connected by dispersal. The sandplains these sub-populations occur on are less than 10 km apart and the Great Desert Skink is known to disperse at least this far (McAlpin, 2001). The Northern Borefield sub-population is separated from the others by about 35 km, and much of the habitat in between is unsuitable (e.g. Mulga woodlands and calcrete outcrops), though very small patches of sandplain occur as part of the Calcrete – Spinifex Sandplain Mosaic habitat. It is unknown whether the Northern Borefield sub-population would be connected to the others by dispersal.

The targeted regional study undertaken by the Ngaanyatjarra Ranger team identified 80 new warrens (groups of burrows), representing 10 to 12 previously undocumented clusters or sub-populations (e.g. populations separated by 10 km or more). Sixty-nine of these records were classified as active, having latrines with fresh scats, with the remaining 11 having been abandoned with decaying or absent scats (Figure 7-55). It is noted that the newly recorded burrows in the regional study were predominantly in relatively proximity to vehicle access tracks (0.5 – 1 km) and do not represent an exhaustive inventory of the species area of occupancy throughout the landscape.

Based on typical group size within a burrow system (between 2 – 9 individuals), it was estimated that the area could represent an additional recording of between 130 – 600 individuals (Appendix G5). Further survey effort would be required to arrive at a reliable estimate of population size given the limitations of the regional survey (Appendix G5).

The results demonstrate that records obtained within the proposed project's fauna survey area are not isolated in the landscape, but contiguous with a broader local population.

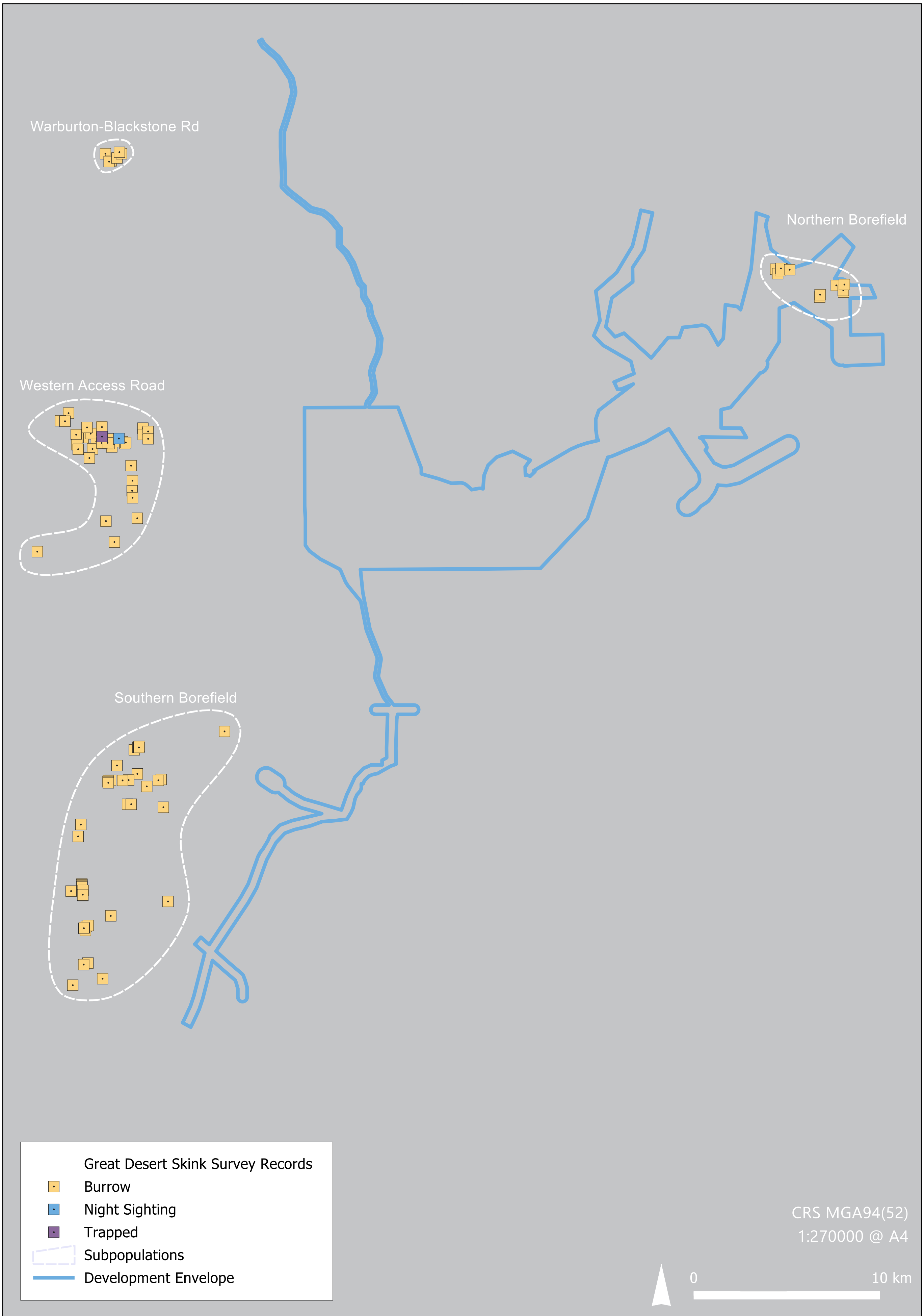


Figure 7-53: Great Desert Skink Survey Records Within the Survey Area

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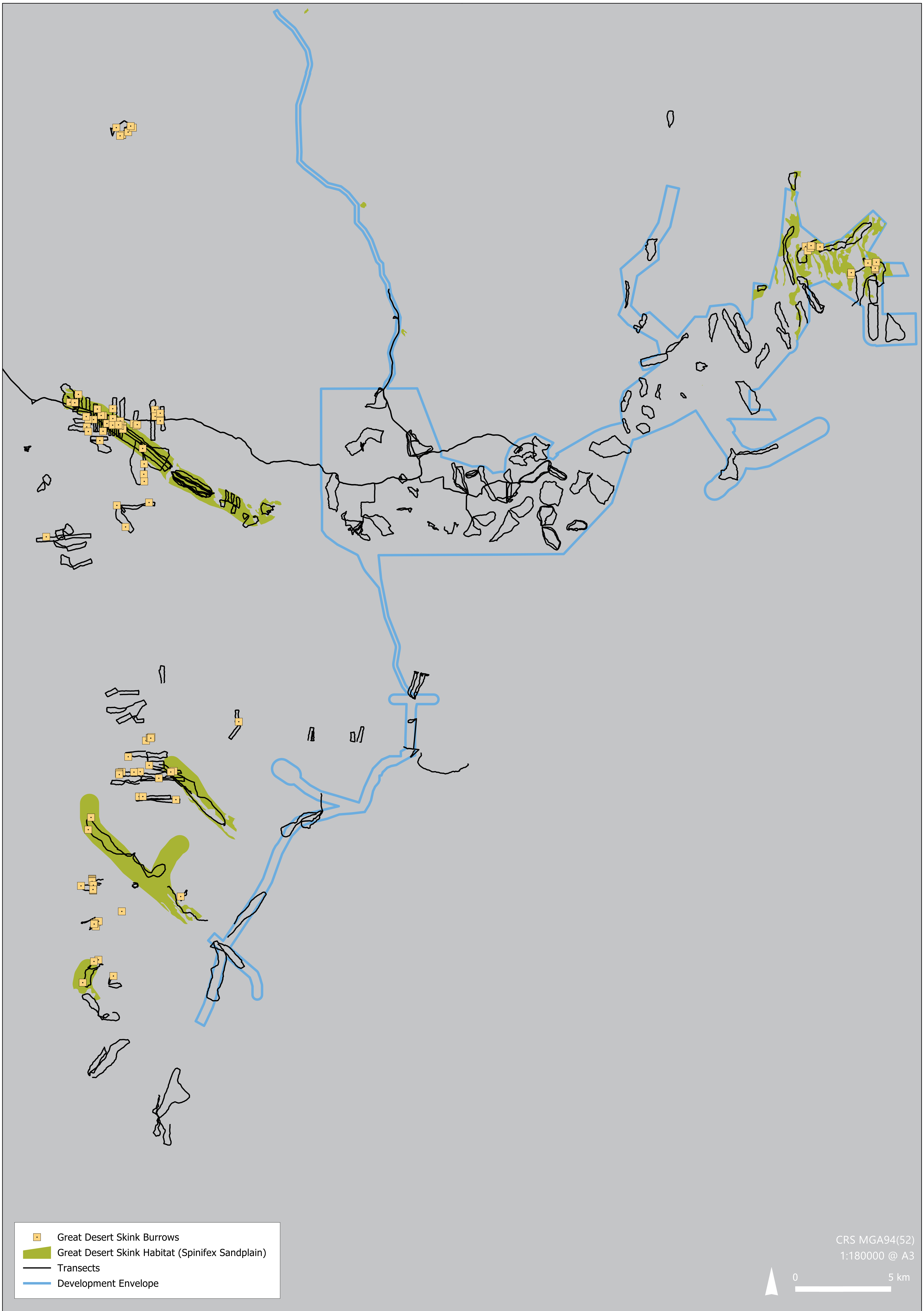


Figure 7-54: Observed Great Desert Skink Burrows in the Project Area

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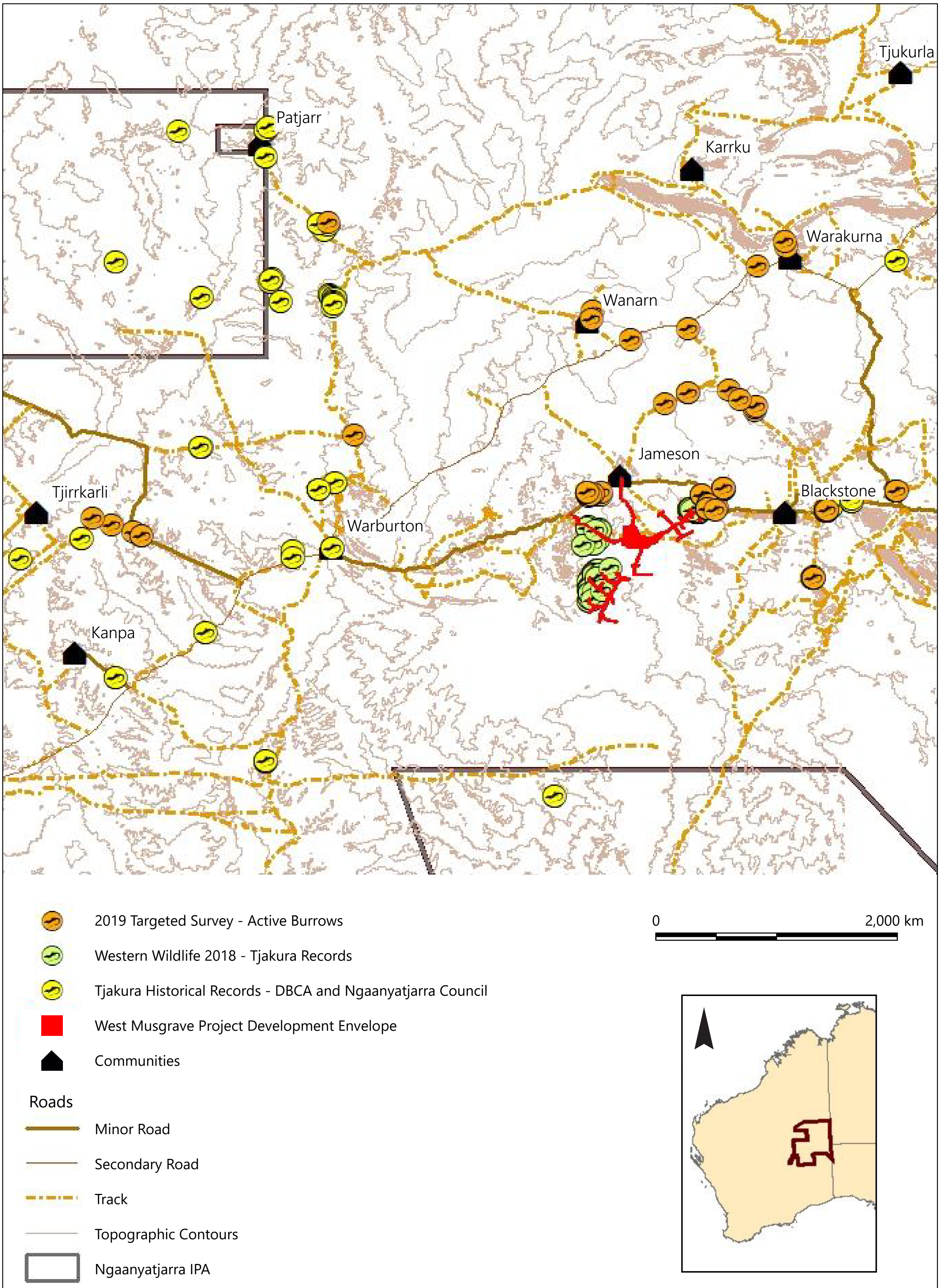


Figure 7-55: Regional Records for the Great Desert Skink Active Burrows

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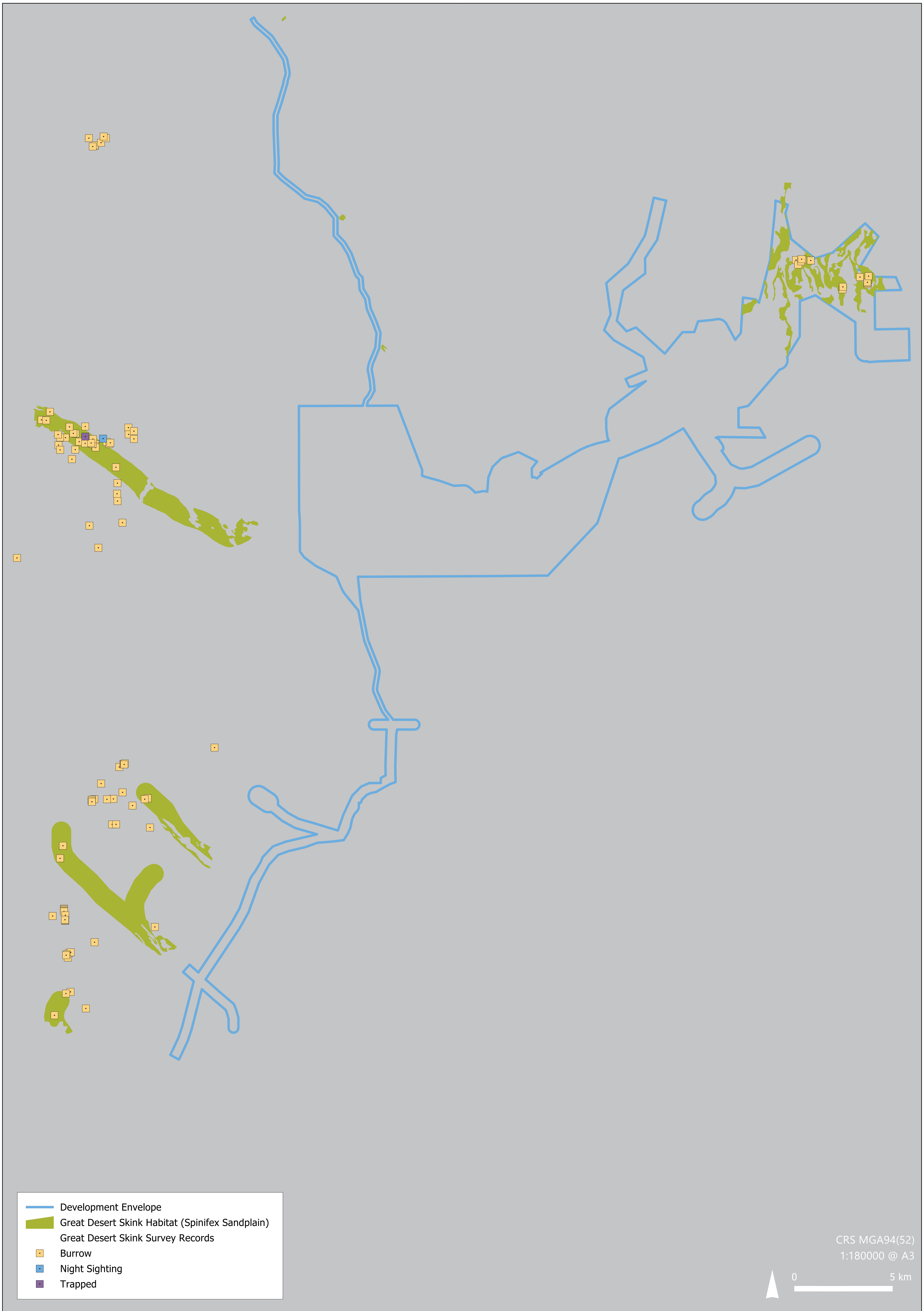


Figure 7-56: Great Desert Skink Habitat Within the Project Area

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Figure 7-57: Assumed Area of GDS Occupancy in and Adjacent to the Development Envelope

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### Striated Grasswren (Amytornis striatus striatus)

The Striated Grasswren (Plate 7-6) is a Specially Protected fauna species listed as a Priority 4 ('Rare, Near Threatened and other species in need of monitoring') under the BC Act. The sandplain subspecies inhabits spinifex sandplains, usually with an overstorey of shrubs or mallee eucalypts (Garnett et al. 2011; Johnstone and Storr, 2004).

The Striated Grasswren is listed as 'Near Threatened' in the Action Plan for Australian Birds due to its decline in the central and south-eastern parts of its range (Garnett et al. 2011). The key threat to the Striated Grasswren is extensive fires that burn mature Spinifex grasslands.

The Striated Grasswren was recorded on the Western Access Road, Northern Borefield, Southern Monitoring Bores area and Main Development Area in a range of habitats. It is likely to occur in suitable habitats throughout the region, but may be absent from areas that have been subject to extensive fires (Figure 7-58).

Image courtesy of Western Wildlife

Plate 7-6: Striated Grasswren (*Amytornis striatus striatus*)

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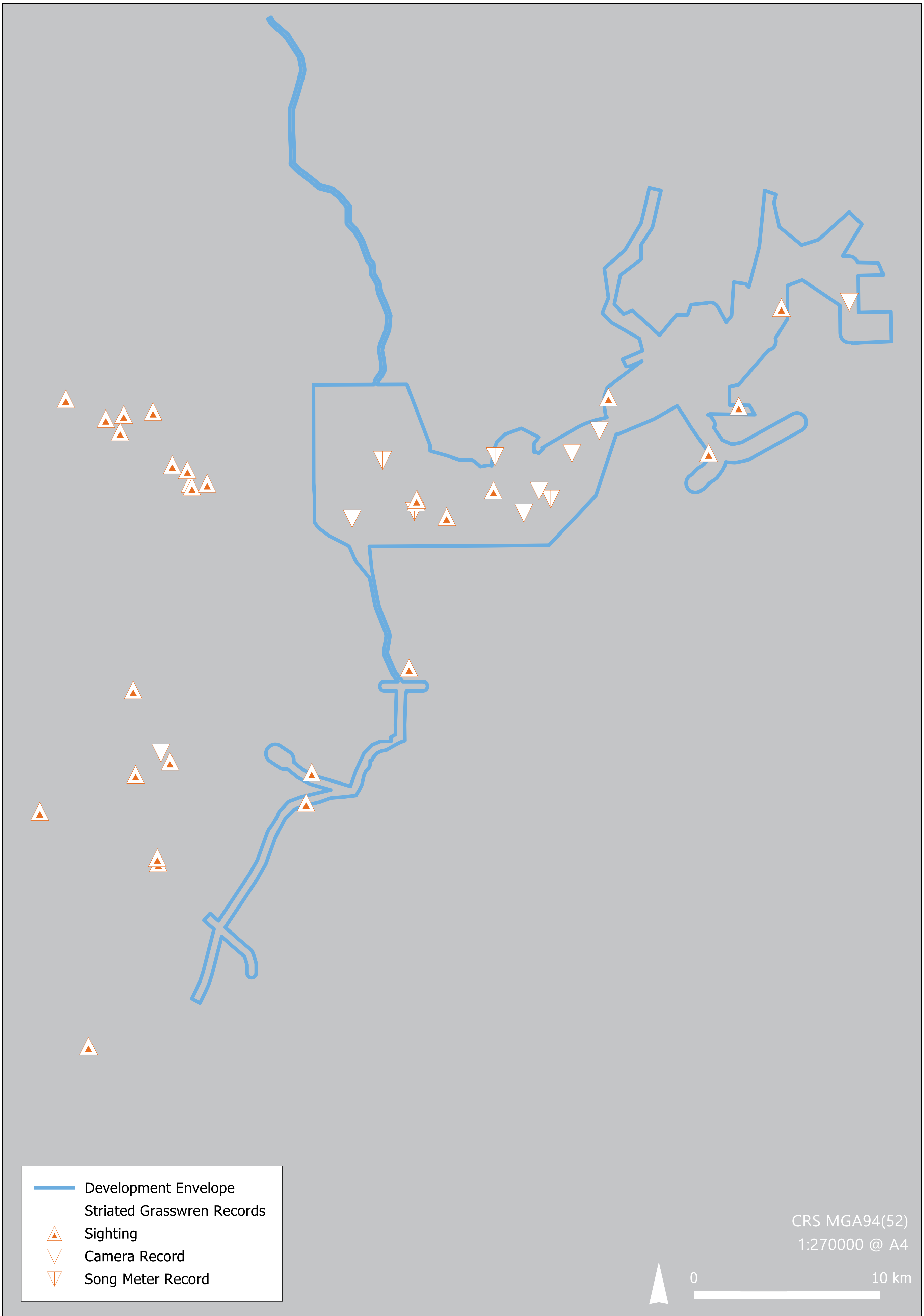


Figure 7-58: Striated Grasswren Records

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### Brush-tailed Mulgara (*Dasycercus blythi*)

The Brush-tailed Mulgara (Plate 7-7) is a Specially Protected fauna species listed as a Priority 4 ('Rare, Near Threatened and other species in need of monitoring') under the BC Act. It is widely distributed across arid Australia, and though its population has declined in the past, it is currently thought to be stable or declining only slowly (Woinarski et al., 2014). It is thought that its ability to use a variety of food resources, tolerate severe declines in bodyweight, enter torpor and dig deep burrows has buffered the species from the impacts of feral predators and a variable climate and resource availability (Masters and Dickman, 2012). It is therefore listed as of 'Least Concern' in the Action Plan for Australian Mammals 2012 (Woinarski et al., 2014).

The Brush-tailed Mulgara occurs mostly on Spinifex grasslands, sheltering during the day in burrows which have been constructed on the flats between sand dunes. Cattle grazing altered fire regimes and predation by cats and foxes are said to have contributed to the population decline of this species (Van Dyck and Strahan, 2008).

Tracks, burrows and diggings of this species were recorded extensively across the fauna survey area, records were obtained on remote cameras within Spinifex Sandplain on the Western Access Road and Southern Monitoring Bores area, with a single individual trapped in each survey period along the Western Access Road (Figure 7-59).

Image courtesy of Western Wildlife

Plate 7-7: Brush-tailed Mulgara (*Dasycercus blythi*)

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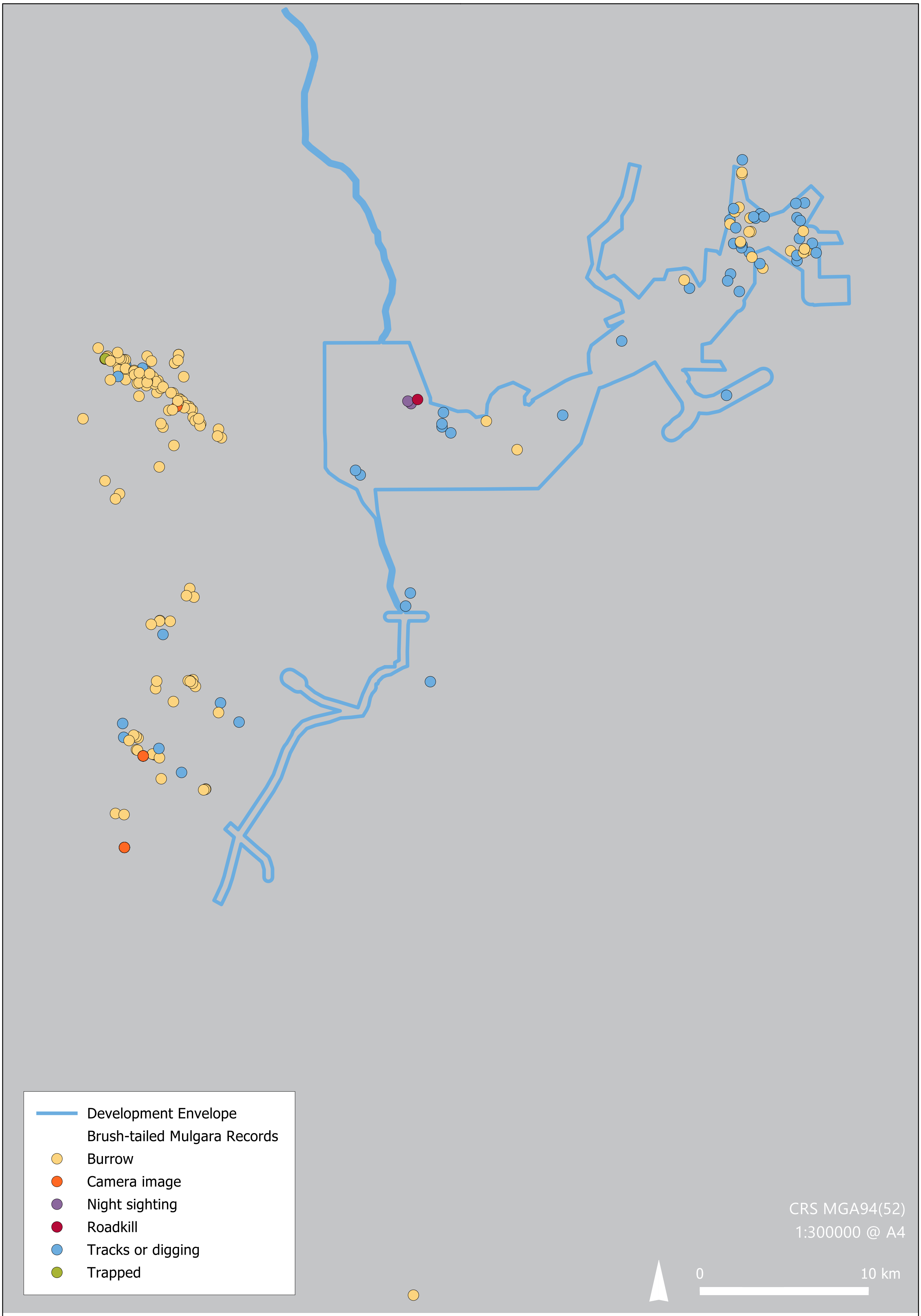


Figure 7-59: Brush-tailed Mulgara Records

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**Southern Marsupial Mole (*Notoryctes typhlops*)**

The Southern Marsupial Mole is a Specially Protected fauna species listed as a Priority 4 ('Rare, Near Threatened and other species in need of monitoring') under the BC Act. It is widespread across the deserts of central Australia, occurring where its sand dune habitat is present (Woinarski et al., 2014). Plate 7-8 shows a backfilled burrow of the Southern Marsupial Mole. Although there are no robust estimates of population size given the inherent challenges of sampling for this species, there is no evidence of on-going population decline and it is listed as of 'Least Concern' in the Action Plan for Australian Mammals 2012 (Woinarski et al., 2014).

The Southern Marsupial Mole spends most of its time underground, where it 'swims' through the sand. Its underground lifestyle means that it may be less vulnerable to predation by feral cats and foxes (Woinarski et al., 2014).

Evidence of its presence was found opportunistically in dune cuttings in the Northern Borefield where numerous back-filled tunnels were observed, as well as in a mole trench dug in the proposed Development Envelope (Figure 7-60; Appendix G1). A number of records were also identified in an extensive area of sand dunes and spinifex sandplain immediately south-west of the proposed Development Envelope. This habitat, near to, but outside of the Development Envelope is extensive and totals over 20,000 ha. The Southern Marsupial Mole is considered likely to occur throughout the dune habitat in the fauna survey area.

Image courtesy of Western Wildlife

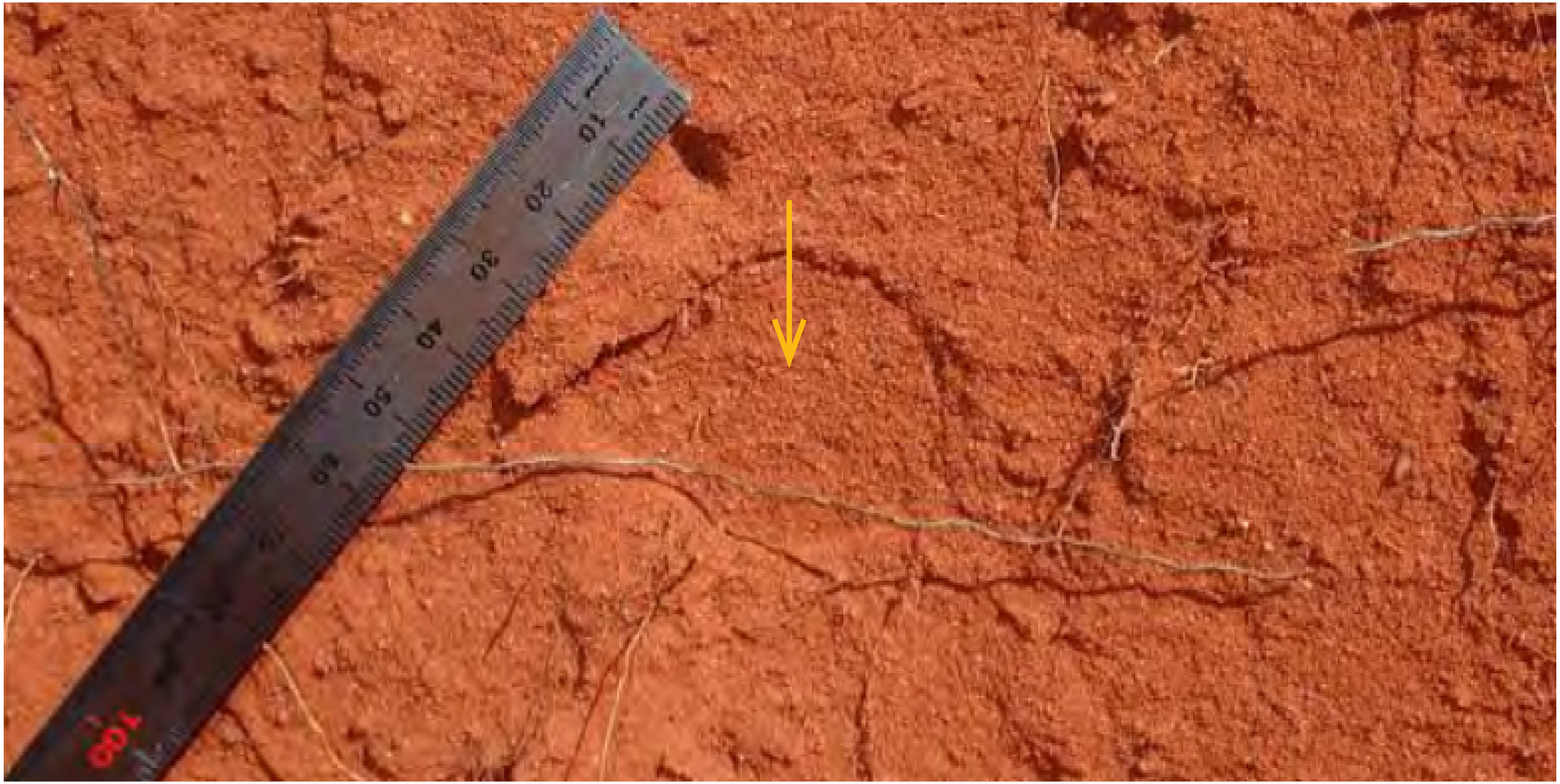

Plate 7-8: Backfilled Burrow of the Southern Marsupial Mole (*Notoryctes typhlops*)

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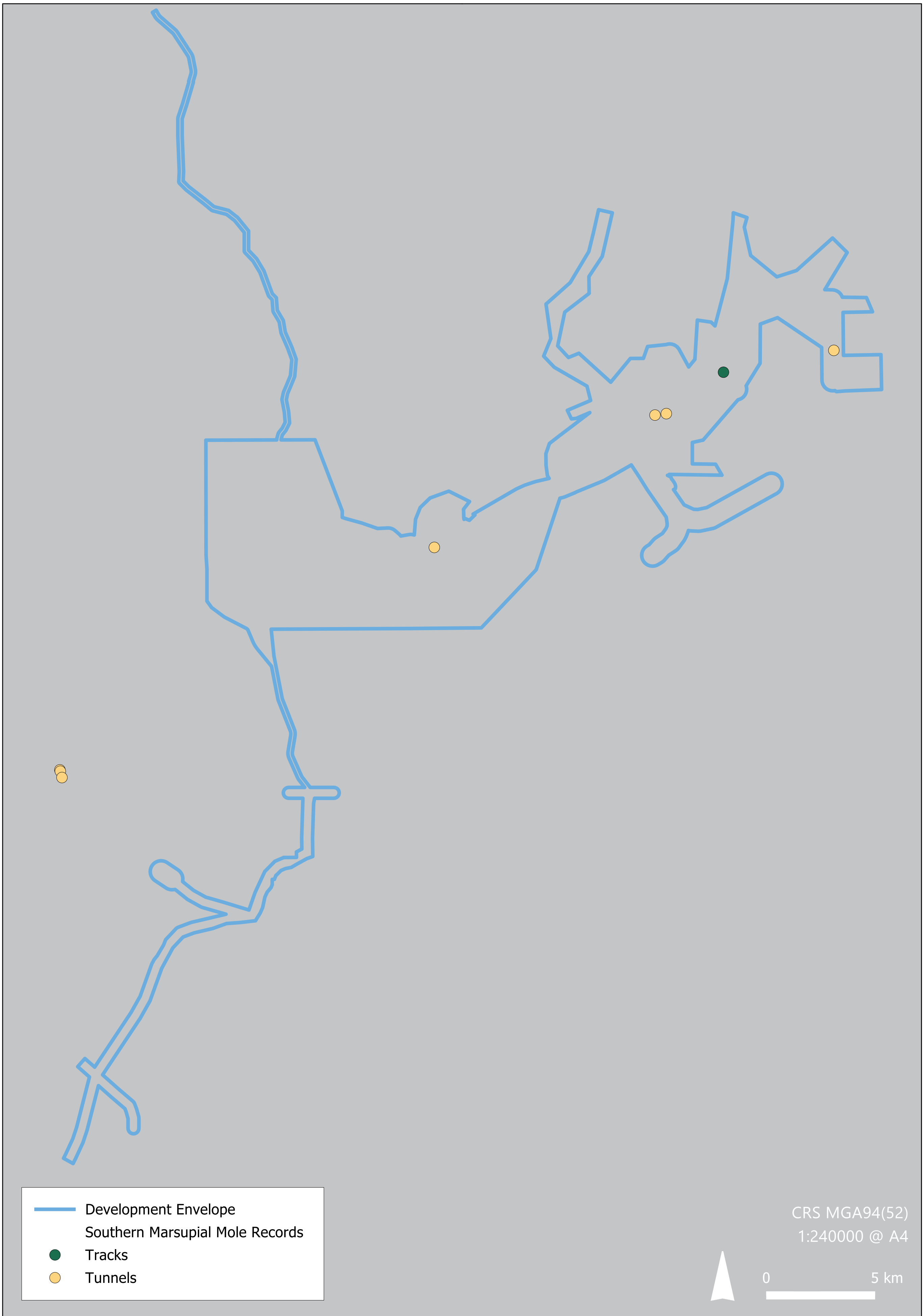


Figure 7-60: Southern Marsupial Mole Records

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### Pallid Cuckoo (*Cacomantis pallidus*) and Black Eared Cuckoo (*Chalcites osculans*)

The Pallid and Black Eared Cuckoos are listed as a Marine species under the EPBC Act. The Pallid Cuckoo is the most widely distributed of the cuckoos and is found throughout Australia, inhabiting open forests and woodlands as well as cultivated lands, whilst the Black Eared Cuckoo is widespread on the mainland of Australia, but avoids the wet, heavily forested areas (Birdlife Australia, 2020a and 2020b).

Both species are listed as 'Least Concern' in the Action Plan for Australian Birds (Garnett *et al.*, 2010) and by the IUCN.

The Pallid Cuckoo's call was recorded at the proposed wind farm and within the proposed project area during the avian fauna and bat baseline survey, whilst the Black Eared Cockatoos call was only recorded within the proposed project area (Appendix G3, Figure 7-61).

### Sacred Kingfisher (*Todiramphus sanctus*)

The Sacred Kingfisher is listed as a Marine species under the EPBC Act. It is common throughout coastal regions of mainland Australia. The species is also found on islands from Australasia to Indonesia and New Zealand (Birdlife Australia, 2020c).

The Sacred Kingfisher is listed as 'Least Concern' in the Action Plan for Australian Birds (Garnett *et al.* 2010) and by the IUCN.

The Sacred Kingfisher's call was recorded from within the Development Envelope (Figure 7-61 and Appendix G3).

### Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as a Marine species under the EPBC Act. It is found throughout mainland Australia, as well as eastern Indonesia and New Guinea. In Australia it is widespread and breeds throughout most of its range (Birdlife Australia, 2020d).

The Rainbow Bee-eater is listed as 'Least Concern' in the Action Plan for Australian Birds (Garnett *et al.*, 2010) and by the IUCN.

The Rainbow Bee-eater's call was recorded from within the proposed wind farm area (Figure 7-61 and Appendix G3).

### Australian Pratincole (*Stiltia isabella*) and Oriental Pratincole (*Glareola maldivarum*)

The Australian Pratincole is listed as Migratory under the EPBC Act whilst the Oriental Pratincole is listed as Marine under the EPBC Act and Migratory under the EPBC Act and BC Act. The Australian Pratincole is mainly found in the north and eastern inland of Australia, as well as Lord Howe Island, Christmas Island and in New Guinea, Borneo and Sulawesi (Birdlife Australia, 2020e). Within Australia, the Oriental

Pratincole is widespread in northern areas, especially along the coast. It is also widespread but scattered inland with occasional records in South Australia (DoEE, 2020).

Both species are listed as 'Least Concern' in the Action Plan for Australian Birds (Garnett *et al.*, 2010) and by the IUCN.

The Australian Pratincole was recorded within the proposed wind farm area whilst the Oriental Pratincole was recorded within the Development Envelope (Figure 7-61 and Appendix G3).

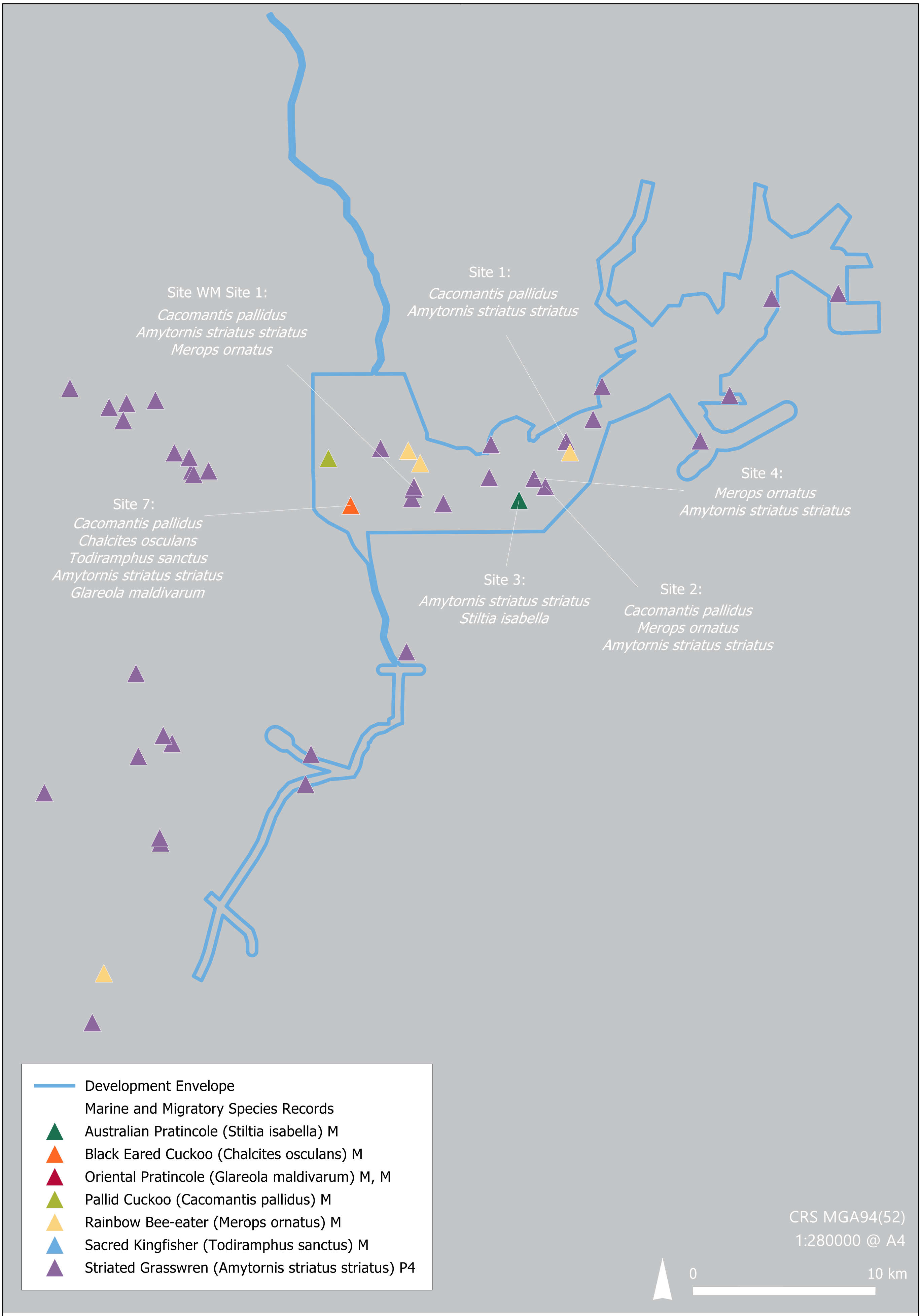


Figure 7-61: Records of Marine and Migratory Birds Within the Development Envelope

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#### 7.6.3.5 Range Extensions

The fauna of the CR and GVD Bioregions are relatively poorly surveyed, as such, many of the species identified within the fauna survey area occur as range extensions for WA.

Range extensions were recorded for four reptiles as shown on Figure 7-62, including:

- Spiny-tailed Goanna (*Varanus acanthurus)*
- Ribbon Slider Skink (*Lerista taeniata*)
- Ornate Soil-crevice Skink (*Notoscincus ornatus*)
- Beaked Blind Snake (*Anilios grypus*).

#### 7.6.3.6 Species of Cultural Interest

Through consultation with Ngaanyatjarra People, a number of fauna species of cultural importance were identified, these included totem species representative of story lines or dreamtime stories or those used as food resources. These animals included:

- Bardi grubs (witchetty grub) which are generally associated with *Acacia kempeana* and are widely eaten by Ngaanyatjarra People.
- Australian Bustard (*Ardeotis australis*) known locally as Nganurti which is actively hunted and also the subject of dreamtime stories.
- Goanna (all the Varanus genus) which are commonly hunted and the subject of dreamtime stories.
- Emus (*Dromaius novaehollandiae*) known locally as Karlaya which are both actively hunted, and form part of a nearby dreaming story.
- Macropods including Western Grey Kangaroo (*Macropus fuliginosus*), Euro (*Osphranter robustus*) and Red Kangaroo (*Osphranter rufus*). The kangaroo, known as Marlu to the Ngaanyatjarra People is a preferred food source, however is also representative of one of the most important dreamtime stories within the vicinity of the proposed project area.

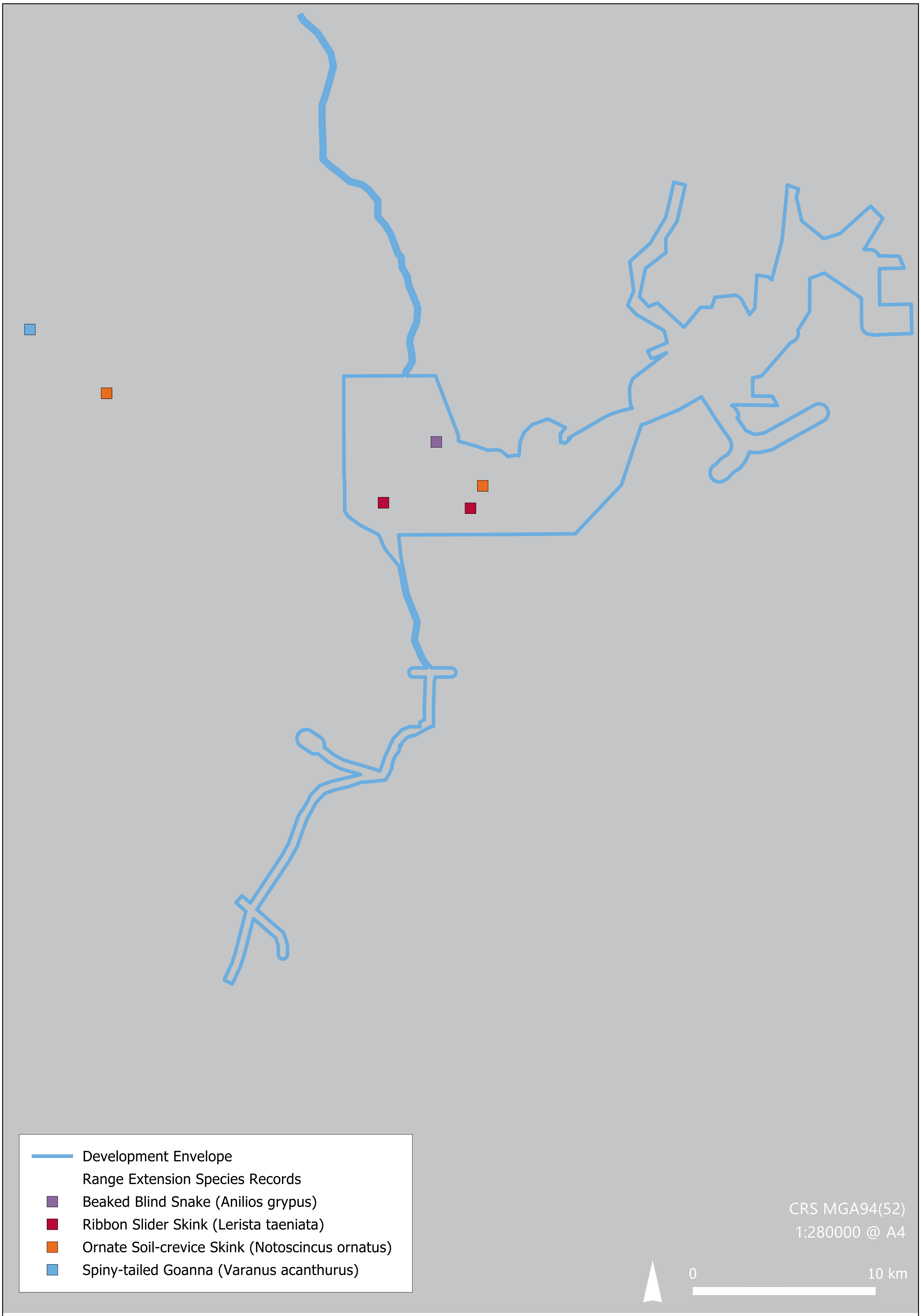


Figure 7-62: Fauna Range Extensions

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### 7.6.3.7 Feral Mammals

Eight species of feral mammals were recorded (Table 7-73) with several groups of Camels (*Camelus dromedarius*) sighted and evidence, such as tracks, scats and trampling of vegetation, almost ubiquitous across the fauna survey area. The cat (*Felis catus*), fox (*Vulpes vulpes*) and wild dog (*Canis familiaris*) were also commonly recorded on camera traps.

**Table 7-73: Feral Animals Observed in the Project Area**

| Species | Common Name |
|---|---|
| *Mus musculus* | house mouse |
| *Oryctolagus cuniculus* | rabbit |
| *Canis familiaris* | dog/dingo |
| *Vulpes vulpes* | fox |
| *Felis catus* | feral cat |
| *Equus caballus* | horse |
| *Camelus dromedarius* | camel |
| *Bos taurus* | cow |

### 7.6.3.8 Potential Short-Range Endemics

#### Habitat

Habitat mapping undertaken by Western Wildlife (Appendix G1) identified 11 different habitats. SRE sample sites corresponded with nine of these habitats and constitute the most likely of those habitats to support SREs within the fauna survey area (Appendix G6). All of these habitat types are considered widely represented in the CR or GVD Bioregions (Appendix G1).

Of the nine habitats surveyed, eight yielded invertebrates belonging to SRE groups. Of those eight, Mulga woodland supported the greatest species richness of taxa from SRE groups (28).

According to Alacran (Appendix G6) only one location within the fauna survey area that supported SRE groups of invertebrates represented unique habitat; a small granite boulder outcrop as shown in Figure 7-63. This outcrop falls within the Stony Hills and Plains habitat and is likely to represent an extension of the nearby granite hills approximately 0.5 km south-west of this sampling location.

The eastern and central parts of the fauna survey area and the south-eastern section of the Southern Monitoring Bores area cross a large spinifex sandplain habitat. This was the only geographical feature that could potentially represent a barrier to dispersal for species not suited to this habitat (Appendix G6).

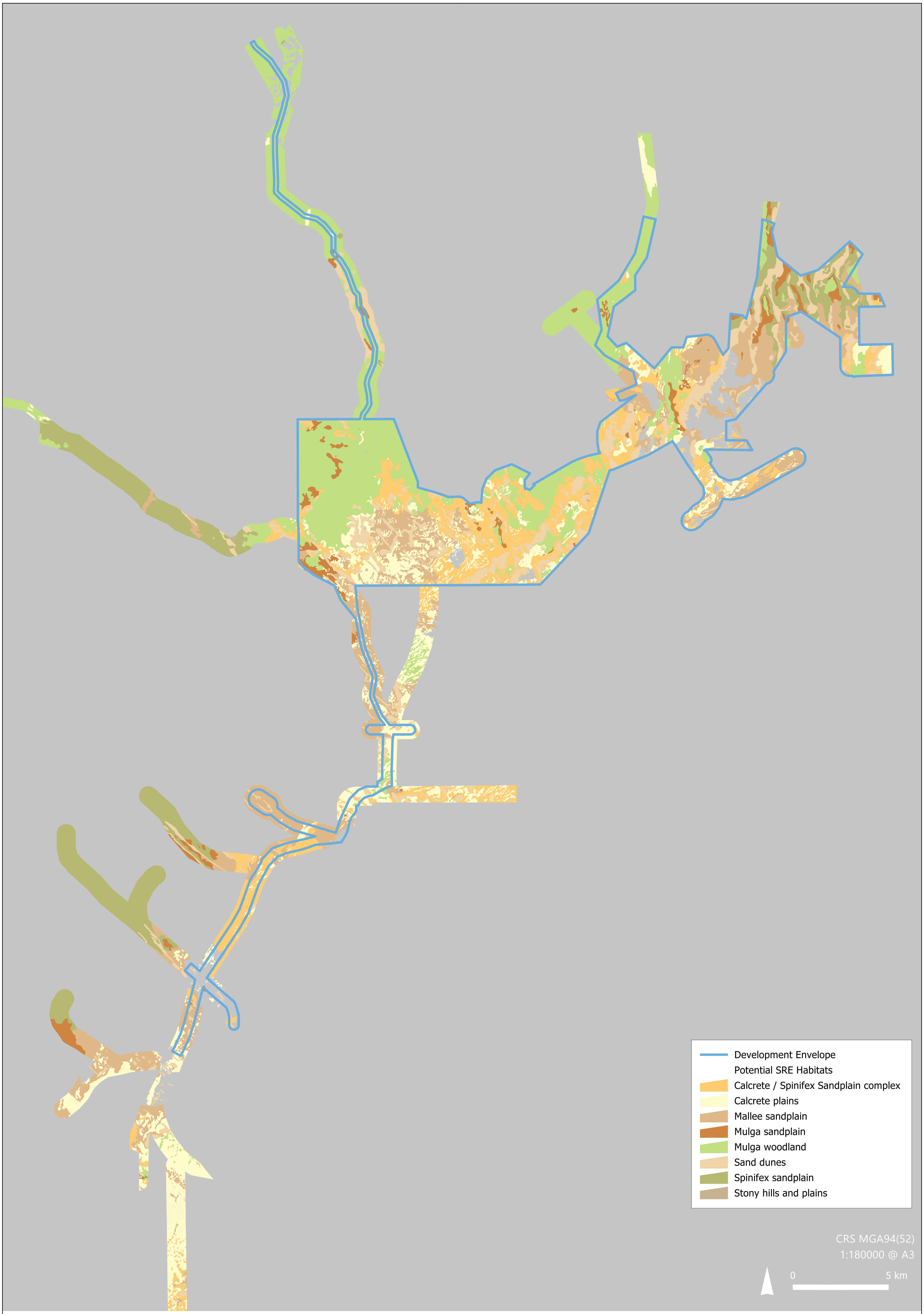


Figure 7-63: Potential Short-Range Endemic Habitat in the Project Area

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### Short Range Endemic Assemblage

SRE surveys yielded a total of 3,209 invertebrate specimens from SRE groups, with a total of six orders, 15 families and 55 different taxa (Table 7-74). The poor state of knowledge about invertebrate fauna in and around the fauna survey area resulted in the majority of species being interpreted as new species after comparisons with WAM reference specimens and publicly available DNA sequences failed to find species matches.

Identification of species and morphospecies involved the use of both morphological and DNA sequence data, Cytochrome C Oxidase subunit I (COI). Of the 55 different taxa, 50 were identified as being potential SREs owing to data deficiency (DD) regarding their known distribution or taxa belonging to unresolved species complexes with the remaining five species being widespread. The distribution of potential SRE species within the fauna survey area is shown in Figure 7-63. All of these species were recorded from habitat types that were also observed outside of, but in close proximity to the fauna survey area, suggesting they may not be restricted to the fauna survey area (Appendix G6).

**Table 7-74: Potential SREs Identified from the Proposal Area**

| Class | Order | Family | Species | SRE Status |
|---|---|---|---|---|
| Arachnida | Araneae | Actinopodidae | *Missulena* 'WM1' | Potential SRE: DD |
| | | Barychelidae | *Synothele* 'WM1' | Potential SRE: DD |
| | | | *Synothele* 'WM2' | Potential SRE: DD |
| | | | *Barychelidae* 'WM1' | Potential SRE: DD |
| | | Halonoproctidae | *Conothele* sp. | Potential SRE: DD |
| | | Idiopidae | *Blakistonia* 'WM1' | Potential SRE: DD |
| | | | *Idiosoma 'manstridgei* mosaic' | Widespread |
| | | | *Idiopidae* sp. | Potential SRE: DD |
| | | | *Idiosoma* 'WM1' | Potential SRE: DD |
| | | | *Idiosoma* 'WM2' | Potential SRE: DD |
| | | | *Idiosoma* 'WM3' | Potential SRE: DD |
| | | Nemesiidae | *Aname* 'MYG514' | Potential SRE: DD |
| | | | *Aname* 'WM1' | Potential SRE: DD |
| | | | *Aname* 'WM4' | Potential SRE: DD |
| | | | *Aname* 'WM5' | Potential SRE: DD |
| | | | *Aname* 'WM6' | Potential SRE: DD |
| | | | *Aname* 'WM7' | Potential SRE: DD |
| | | | *Kwonkan* 'WM3' | Potential SRE: DD |
| | | | *Kwonkan* 'WM8' | Potential SRE: DD |
| | | | *Kwonkan* 'WM9' | Potential SRE: DD |
| | | | *Nemesiidae* 'WM2' | Potential SRE: DD |
| | | | *Nemesiidae* sp. | Potential SRE: DD |

| Class | Order | Family | Species | SRE Status |
|---|---|---|---|---|
| | | Theraphosidae | *Theraphosidae* sp. | Widespread |
| | Pseudoscorpiones | Atemnidae | *Oratemnus* 'WM1' | Potential SRE: DD |
| | | Chernetidae | *Chernetidae* sp. | Potential SRE: DD |
| | | | *Sundochernes* 'WM1' | Potential SRE: DD |
| | | Olpiidae | *Austrohorus* 'WM1' | Potential SRE: DD |
| | | | *Austrohorus* 'WM2' | Potential SRE: DD |
| | | | *Austrohorus* 'WM3' | Potential SRE: DD |
| | | | *Beierolpium* 'WM-8/2' | Potential SRE: DD |
| | | | *Beierolpium* 'WM-8/3' | Potential SRE: DD |
| | | | *Indolpium* sp. | Potential SRE: DD |
| | | | *Indolpium* 'WM1' | Potential SRE: DD |
| | | | *Indolpium* 'WM2' | Potential SRE: DD |
| | | | *Indolpium* 'WM3' | Potential SRE: DD |
| | Scorpiones | Buthidae | *Lychas 'adonis'* | Widespread |
| | | | *Lychas* sp. | Potential SRE: DD |
| | | | *Lychas 'annulatus* complex' | Potential SRE: DD |
| | | | *Lychas 'multipunctatus* complex' | Potential SRE: DD |
| | | Urodacidae | *Urodacus hoplurus* | Widespread |
| | | | *Urodacus* 'WM1' | Potential SRE: DD |
| | | | *Urodacus* 'WM2' | Potential SRE: DD |
| | | | *Urodacus 'yaschenkoi* mosaic' | Potential SRE: DD |
| Chilopoda | Geophilomorpha | Oryidae | *Orphnaeus* 'WM1' | Potential SRE: DD |
| Malacostraca | Isopoda | Paraplatyarthridae | *Paraplatyarthrus* 'WM1' | Potential SRE: DD |
| | | Armadillidae | *Acanthodillo* 'WM1' | Potential SRE: DD |
| | | | *Acanthodillo* 'WM2' | Potential SRE: DD |
| | | | *Acanthodillo* 'WM3' | Potential SRE: DD |
| | | | *Buddelundia* '100' | Potential SRE: DD |
| | | | *Buddelundia* '101' | Potential SRE: DD |
| | | | *Buddelundia* '27JM' | Potential SRE: DD |
| | | | *Buddelundia* sp. | Potential SRE: DD |
| | | | *Buddelundiinae* 'WM1' | Potential SRE: DD |
| | | | *Pseudodiploexochus* 'WM1' | Potential SRE: DD |
| Gastropoda | Eupulmonata | Pupillidae | *Pupoides adelaidae* | Widespread |

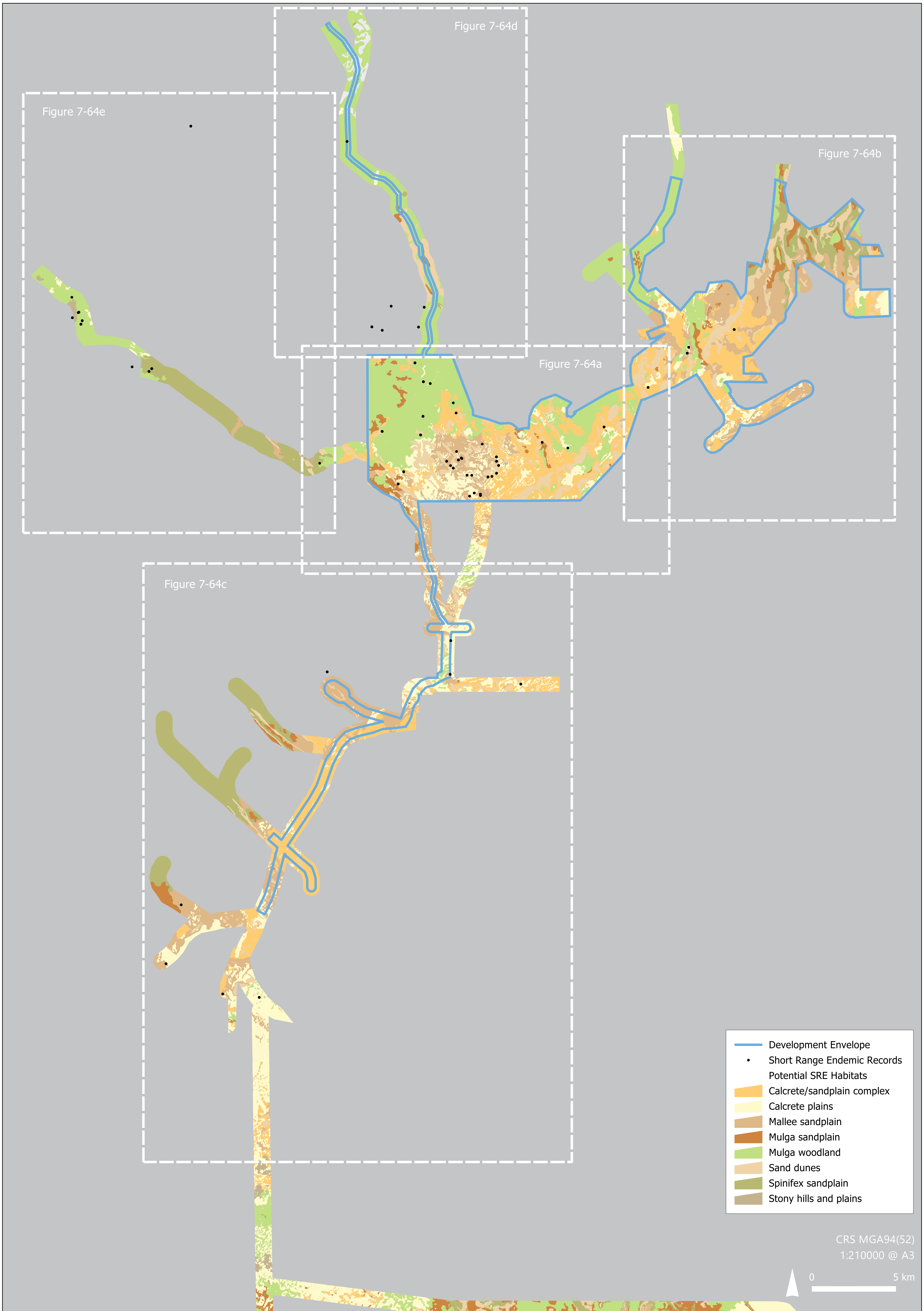


Figure 7-64: Locations of Potential Short-Range Endemics from the Project Area

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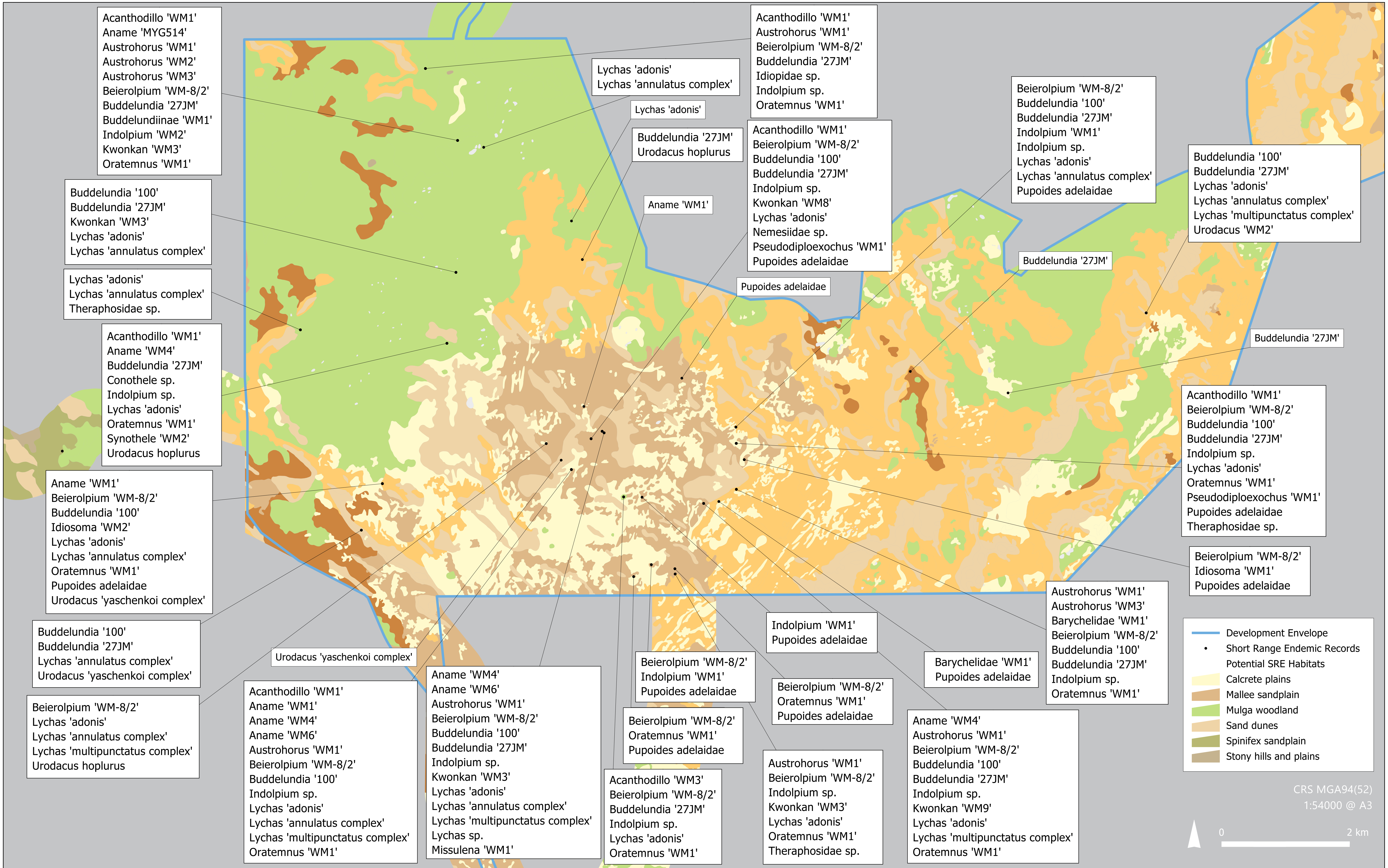


Figure 7-64a: Locations of Potential Short-Range Endemics from the Project Area

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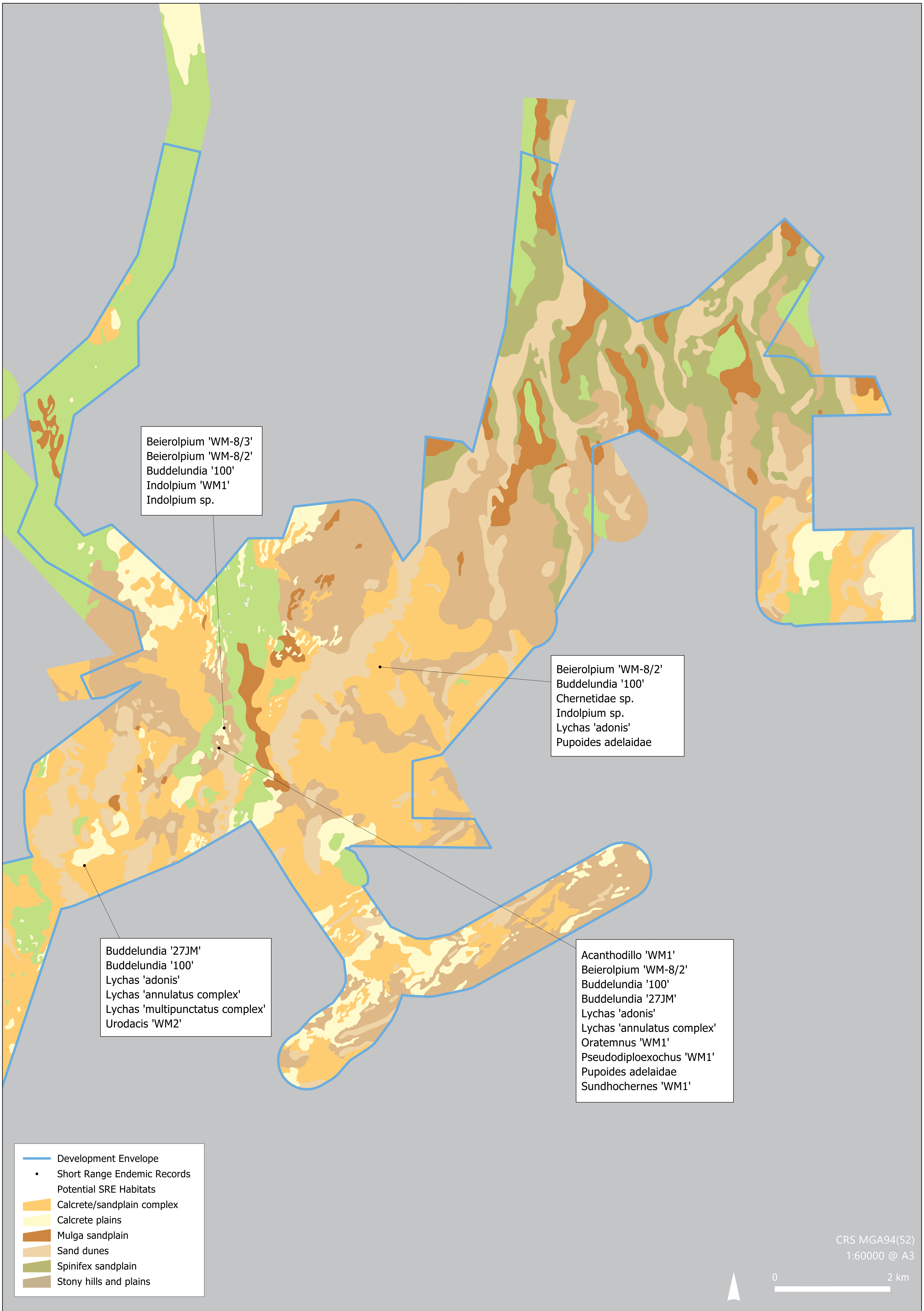


Figure 7-64b: Locations of Potential Short-Range Endemics from the Project Area

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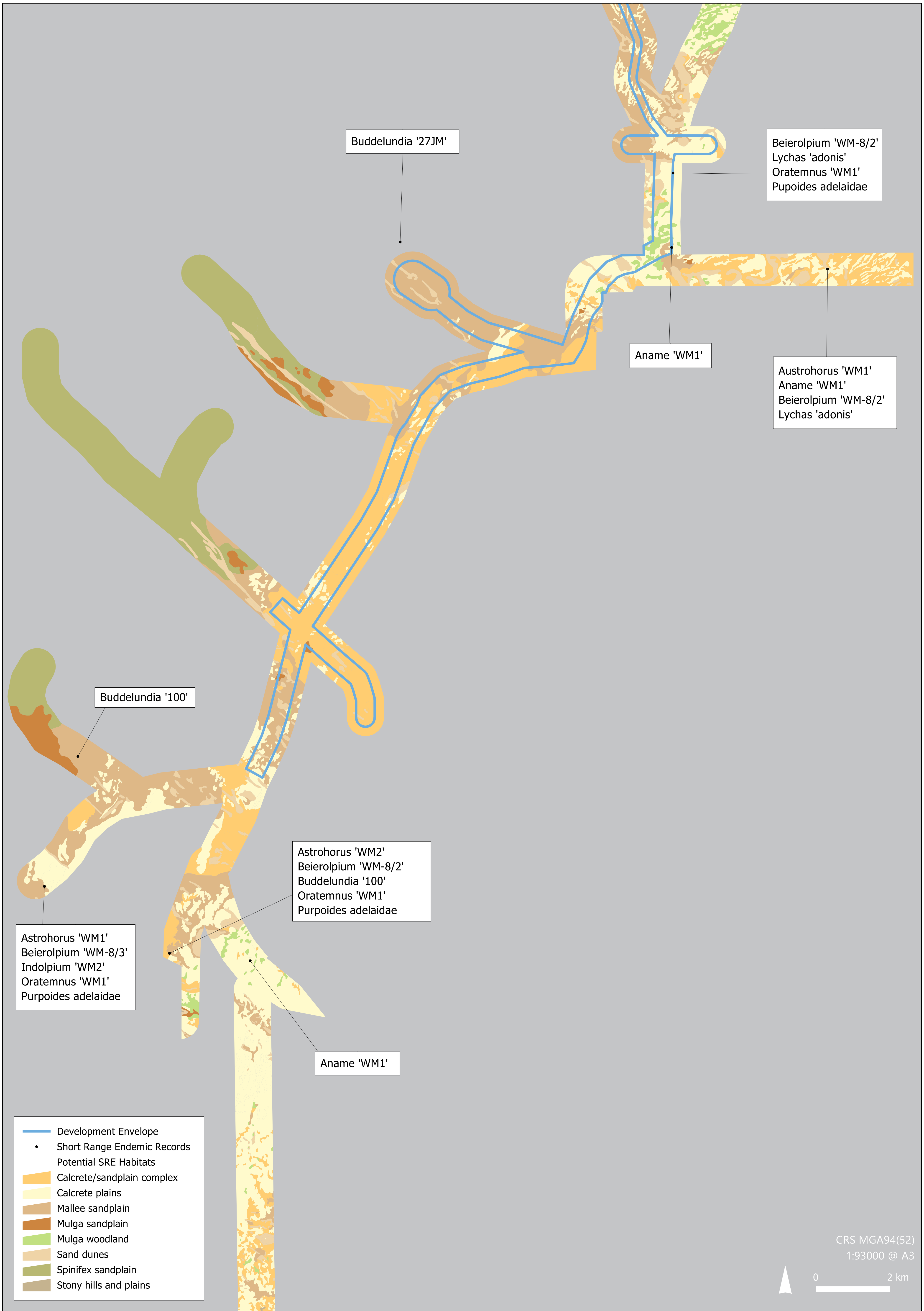


Figure 7-64c: Locations of Potential Short-Range Endemics from the Project Area

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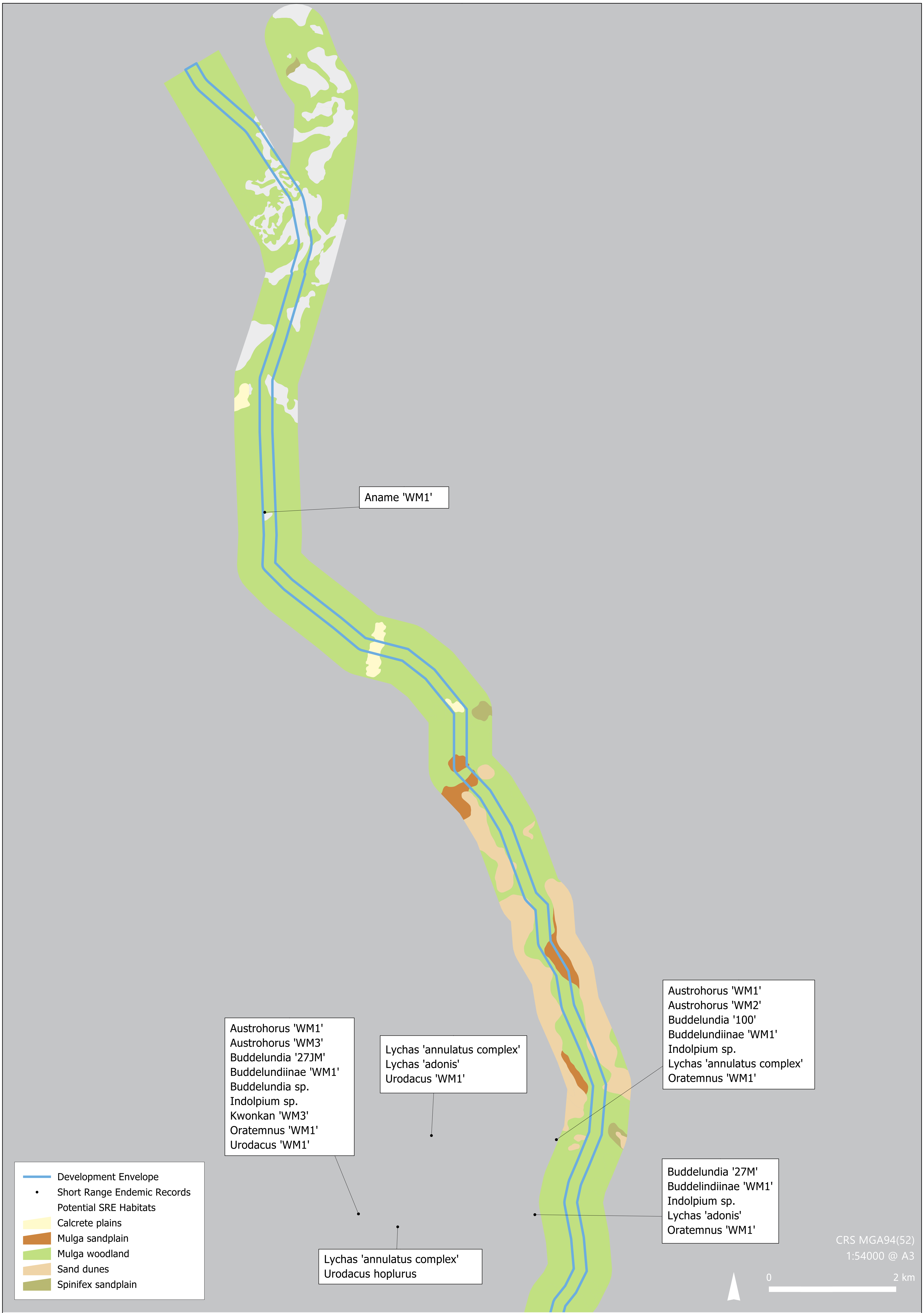


Figure 7-64d: Locations of Potential Short-Range Endemics from the Project Area

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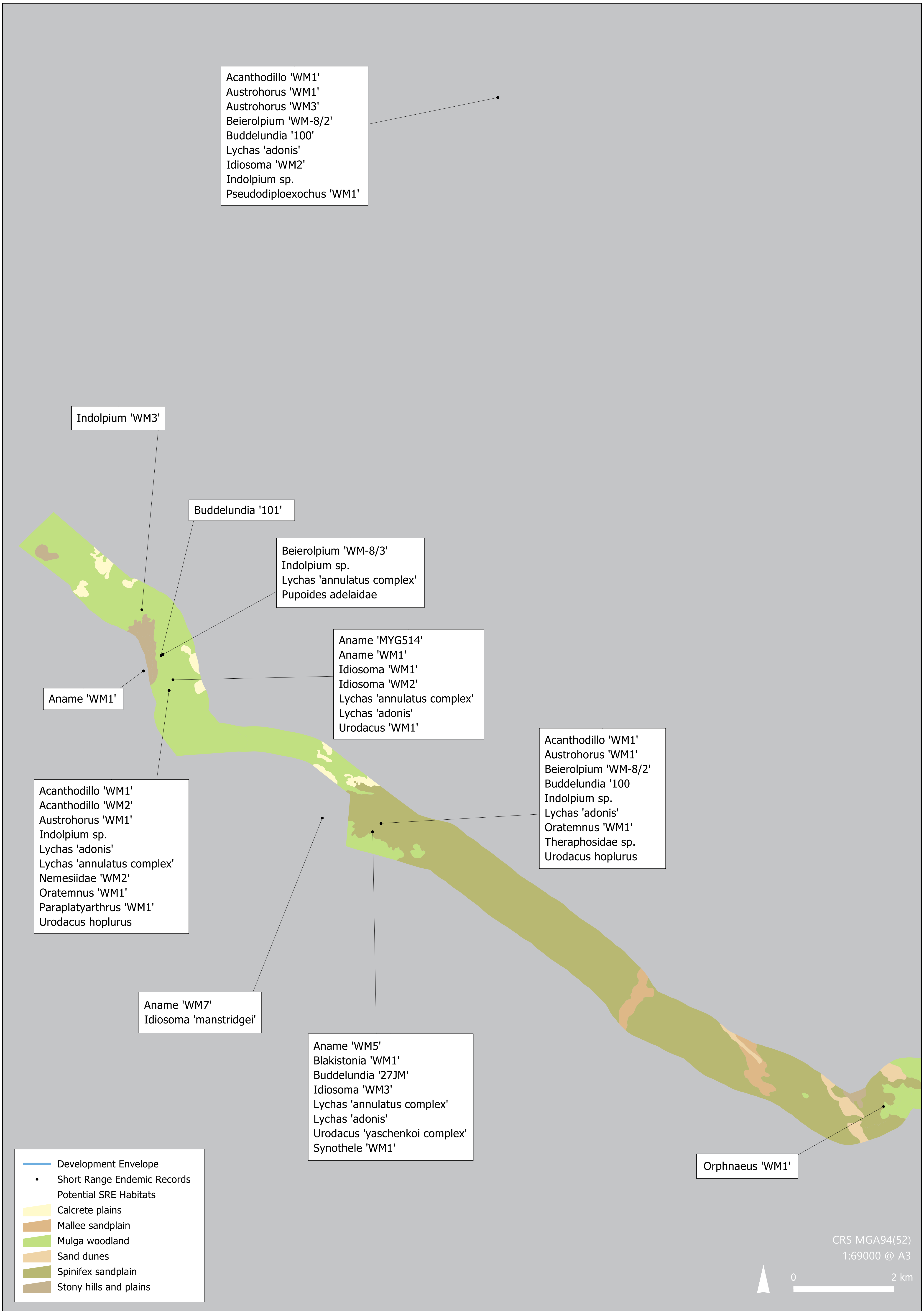


Figure 7-64e: Locations of Potential Short-Range Endemics from the Project Area

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### 7.6.4 Potential Impacts

The EPA Guidance for terrestrial fauna provides several mechanisms ('issues') for consideration during the EIA process, specifically:

- Habitat loss, degradation and fragmentation – affects the health and survival of individual populations as well as entire species
- Fire regimes – interruption of natural ecological processes
- Invasive species – compete with local species for food and habitat, or directly predate them
- Short range endemism – vulnerable through their limited ability to move
- Changing climate – cumulative impacts of the Proposal and a changing climate
- State of knowledge – scientific gaps that may influence the assessment.

A systematic assessment of how the Proposal interacts with the environment through terrestrial fauna was undertaken, with consideration to the identified EPA issues (Appendix A2). In particular, the assessment aimed to confirm the potential for the Proposal's activities to interact with the environment that may result in direct, indirect or cumulative impacts to terrestrial fauna and their related ecosystem processes. Based on this assessment the following potential impact events were identified:

- Loss of poorly represented fauna habitat as a result of land clearing
- Habitat fragmentation resulting in the loss of significant fauna or adverse change to ecosystem services
- Loss or reduction in health and abundance of significant fauna
- Loss of access to, or reduction in abundance of culturally important fauna
- Loss of SRE species and SRE habitat as a result of land clearing
- Significant reduction in richness and abundance of fauna resulting from interactions with vehicles and machinery, ingestion of chemicals and/or, entanglement or entrapment, including significant fauna
- Reduction in significant fauna due to interaction with electricity generating wind turbine blades
- Significant reduction in fauna richness and abundance due to creation of a localised heat island associated with operation of the photovoltaic electricity generation panels
- Increased richness and or abundance of pest fauna species as result of increased attractants (water and food sources) which may result in increased competition for resources with an increased predation of native fauna
- Significant reduction in species richness and abundance of fauna as a result of noise, light, dust and vibration emissions
- Changes to existing fire regimes result in a decrease in the richness and abundance of poorly represented fauna habitat and significant fauna.

### 7.6.5 Assessment of Impacts

Each potential impact event identified in Section 7.6.4 was assessed to understand the mechanism by which impacts may occur, and to determine the inherent (unmitigated) risk of each potential impact.

Using the consequence and likelihood tables in the EIA Framework (Appendix A3), it was determined that the inherent risk of any of the identified potential impact events not meeting the EPA Objective for Terrestrial Fauna as a result of the proposed project were Low or Medium (Table 7-76 to Table 7-86), thereby not considered to require any specific avoidance and mitigations to meet the EPA's Objective for Terrestrial Fauna. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP (Section 7.6.6).

#### 7.6.5.1 Loss of Habitat due to Clearing

Habitat loss can lead to the direct mortality of individuals, forced relocation of fauna and a reduction of foraging and breeding habitat. All habitat types identified in the fauna survey area are widely represented in the CER and GVD Bioregions and are not restricted to the Development Envelope (Appendix G1). Total areas and relative percentages of clearing for each habitat type are presented in Table 7-75, whilst Figure 7-65 shows the indicative Project layout over habitat types, which shows that:

- Of the nine fauna habitats and two habitat complexes mapped, no single habitat would experience more than 30 percent removal of the mapped area through direct clearing.
- Development of the proposed project would result in clearing of approximately 3,830 ha of native fauna habitat within a 20,852 ha Development Envelope. The proposed clearing represents approximately 9.5 percent of the total area surveyed and 18.4 percent of the Development Envelope.
- No habitat type identified in the fauna survey area, except for Spinifex sandplain, was found to exclusively support significant species. Design of the proposed project has focused on avoidance of clearing of this habitat type, with 0.8 percent of the area within the Development Envelope and 0.2 percent of the mapped area proposed to be removed as a result of project implementation.
- Project design has minimised potential loss of habitats that were identified as being less well represented within the mapped area i.e. Chenopod shrublands, Claypans and Stony hills and plains. The Development Envelope specifically excludes the majority of these habitat types.

**Table 7-75: Indicative Disturbance by Habitat Type from the Proposal**

| Habitat Type | Total Mapped (ha) | Total Within Development Envelope (ha) | Proposed Land Clearing (ha) | Percentage Impacted Within Mapped Area (%) | Percentage Impacted Within Development Envelope (%) |
|---|---|---|---|---|---|
| Sand dunes | 4,206.5 | 2,852.1 | 477.4 | 11.3 | 16.7 |
| Spinifex sandplain | 4,114.7 | 881.7 | 6.7 | 0.2 | 0.8 |
| Calcrete – Spinifex sandplain mosaic | 5,129.8 | 3,884.6 | 639.7 | 12.5 | 16.5 |
| Mallee sandplain | 5,780.7 | 3,445.7 | 524.7 | 9.1 | 15.2 |
| Calcrete – Mallee sandplain mosaic | 1,950.0 | 1,328.2 | 46.3 | 2.4 | 3.5 |
| Mulga sandplain | 1,907.8 | 797.3 | 120.9 | 6.3 | 15.2 |
| Calcrete plains | 6,495.0 | 2,330.0 | 732.2 | 11.3 | 31.4 |
| Mulga woodland | 10,319.8 | 5,274.6 | 1,264.8 | 12.3 | 24.0 |
| Stony hills and plains | 212.3 | 1.7 | 0.0 | 0.0 | 0.0 |
| Chenopod shrublands | 118.6 | 28.7 | 11.1 | 9.4 | 38.7 |
| Claypans | 170.7 | 27.6 | 6.5 | 3.8 | 23.6 |
| **Total** | **40,405.9** | **20,851.8** | **3,830.4** | **9.4** | 18.4 |

As all habitat types recorded in the Development Envelope are regionally widespread, and do not represent habitat that supports significant terrestrial fauna, the Proposal is considered to have minimal impact to terrestrial fauna as a result of vegetation clearing.

The assessment of inherent (unmitigated) risk loss of fauna habitat as a result of clearing for project-related infrastructure resulting in the EPA Objective for Terrestrial Fauna not being met is provided in Table 7-76 and was determined to represent a Low risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-76: Assessment of Inherent Risk – Loss of Habitat due to Clearing**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Loss of fauna habitat as a result of clearing for Project-related infrastructure. | Unlikely | Minor | Low | All fauna habitats identified in the study area are well represented and widespread throughout the region. No individual habitat type would experience more than 30% removal of what was mapped in the proposed project's fauna survey area. |

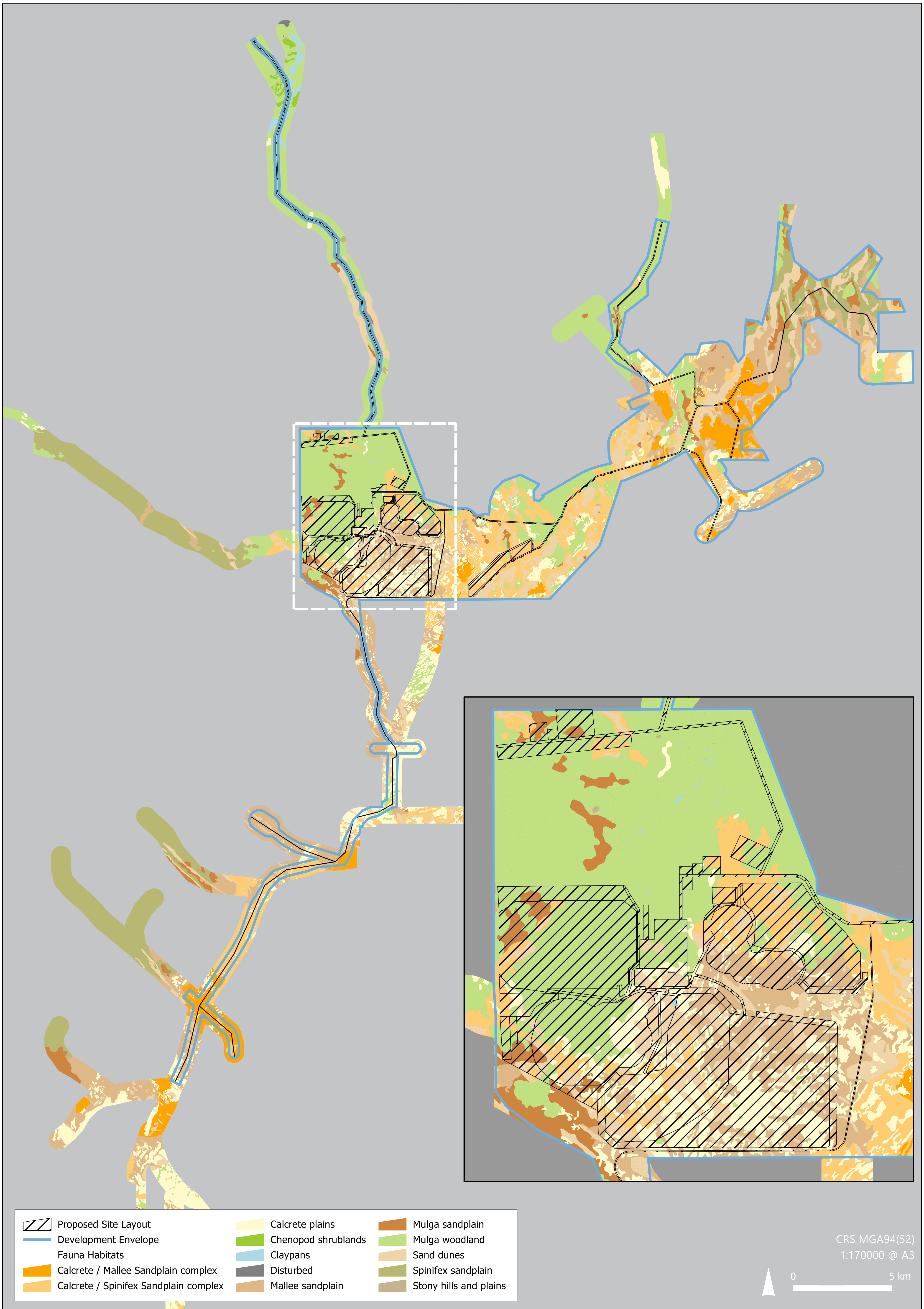


Figure 7-65: Project Disturbance Footprint in the Context of Mapped Fauna Habitat

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#### 7.6.5.2 Fragmentation of Habitat

Fragmentation occurs when a large expanse of habitat is transformed into several smaller patches of smaller total area due to clearing, isolating these smaller fragments from each other by cleared areas (Wilcove et al., 1986). Where the landscape surrounding the fragments is inhospitable to species of the original habitat and when dispersal is low, remnant patches can be considered true habitat islands and local communities would be isolated. Small habitat fragments are likely to be low in heterogeneity, that is, the habitat may not present the range of habitat variety required by some species (e.g. both foraging and breeding habitat) (Wilcove, et al., 1986).

This fragmentation and isolation may result in species residing within these fragments, in particular those species with lower mobility, to become isolated from the population in surrounding uncleared areas. Individuals may no longer be able to access breeding habitat or alternatively may lose access to areas where they may forage. Ultimately, if connectivity with surrounding habitat is permanently lost, or is not re-established within a reasonable timeframe, individual species with poor mobility living in these habitat fragments may not persist.

As described in Section 7.6.3.4, the habitats expected to be impacted by the proposed project are widely represented in the CR and GVD Bioregions and are not restricted to the Development Envelope.

Of the components of the proposed project, the Northern Access Road, Northern Borefield and Southern Monitoring Bores area have the greatest potential to potentially fragment fauna habitat due to their linear nature and length. Given the width of these corridors would be less than tens of metres, it is considered unlikely to restrict fauna movement or dispersal across the corridor.

Given the widespread nature of fauna habitats found within and adjacent to the Development Envelope, land clearance associated with the proposed project is unlikely to create small and/or disconnected islands or fragments within or across habitats (Figure 7-65) and as such connectivity throughout the mapped fauna habitats would largely remain during and after the proposed project.

Potential impacts that may occur as a result of habitat fragmentation can be mitigated through progressive rehabilitation to re-establish ecological linkages.

The assessment of inherent (unmitigated) risk of habitat fragmentation resulting in the loss of significant fauna species or adverse changes to ecosystem services is provided in Table 7-77 and was determined to represent a Low risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-77: Assessment of Inherent Risk – Habitat Fragmentation**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Habitat fragmentation resulting in the loss of significant fauna species or adverse change to ecosystem services | Unlikely | Minor | Low | Given the large and widespread nature of fauna habitats found within and adjacent to the Development Envelope, land clearance associated with the proposed project is unlikely to create small and/or disconnected islands or fragments within or across habitats. Linear infrastructure such as borefields and access roads may bisect habitats, however the distances e.g. less than tens of metres are unlikely to result in impacts to species or ecosystem functions. |

### 7.6.5.3 Loss or Reduction in Abundance of Significant or Culturally Important Fauna

#### Great Desert Skink

Targeted surveys of Great Desert Skink in the fauna survey area identified four clusters of burrow complexes, all of which. were recorded well outside of the Main Development Area (e.g. greater than 15 km from the proposed mine pits, WRDs and TSF) on the periphery of the fauna survey area (Figure 7-56). Clusters of Great Desert Skink burrows were found at the following locations within the fauna survey area:

- Western access road
- Southern Monitoring Bores area
- Warburton to Blackstone Road
- Northern extent of the Northern Borefield.

Much of the habitat between Great Desert Skink records and the Main Development Area represents inhospitable habitat.

Detailed studies of preferred habitat of Great Desert Skink in the fauna survey area, found that their occurrence was exclusive to Spinifex sandplains (Section 7.6.3.4). Subsequently, over 78 percent of the Spinifex sandplain habitat that had been mapped in the fauna survey area was excluded from the Development Envelope to minimise potential impacts to the species. Three of the four identified clusters of burrows or sub-populations are thus excluded from the Development Envelope (Figure 7-66).

The remaining single cluster of burrows within the Development Envelope occurs in the northern extent of the Northern Borefield. This remaining cluster of burrows was interpreted by Western Wildlife

(Appendix G2) to extend a further 30 km to the north-east beyond the extent of the Development Envelope (Figure 7-66). Timbs and Knight (Appendix G5) supported this assumption by identifying further Great Desert Skink burrows east of the Blackstone (Papulankutja) to Warburton Road in this same area (Figure 7-67).

In the Northern Borefield, up to 6.7 ha of Spinifex sandplain habitat may be subject to minor and temporary impacts associated with the construction of the borefield pipeline and associated infrastructure (e.g. service tracks, pipeline and bore infrastructure). This direct impact would represent a clearing of up to 0.2 percent of the total mapped area of Spinifex sandplain habitat and 0.8 percent of the area of this habitat within the Development Envelope. To further reduce impacts to the Great Desert Skink's habitat, micro-siting of infrastructure to avoid burrows would occur in Spinifex sandplain during construction.

Regional surveys undertaken by the Ngaanyatjarra Ranger team as part of this proposal provided further context to the importance of the populations identified near to, and inside of the Development Envelope (Appendix G5). The Ngaanyatjarra Ranger team identified a further 10 to 12 regional sub-populations within 200 km of the proposed project, indicating that those present in the proposed project's fauna survey area don't constitute critical populations for the persistence of this species in the region. These studies also confirmed that Great Desert Skink are far more prevalent within the region than previously available data indicated. Contemporary, local traditional ecological knowledge attests to this finding, with local perceptions of Great Desert Skink suggesting that they are abundant throughout the Ngaanyatjarra Native Title Area (pers. comm., Winston Mitchell, 2019; Anawari Mitchell, 2019; Jennifer Mitchell, 2019).

The combined records obtained during local targeted surveys (Appendix G2), and those of the regional targeted survey (Appendix G5) represent between 180 and 650 individuals and demonstrates a significant contribution to the known population numbers formerly available. This data indicates that the populations observed in the proposed project area are not isolated in the landscape, but contiguous with a broader local population. The presence of Great Desert Skink sightings within the Ngaanyatjarra IPA affords this species additional protections, as these areas are less subject to the impacts of intensive land use without due impact assessment considerations. Great Desert Skink habitats within the IPA are subject to more frequent and less intense fire regimes as implemented as part of Traditional Owner land management practices. The more frequent and less intense fire regime resulting from Traditional Owner land management practices means that a good mosaic of different age spinifex for Great Desert Skink to assume refuge exists. These smaller patches are also less vulnerable to a single fire destroying all available habitat.

With consideration to the avoidance measures proposed (i.e. exclusion of 78% of mapped Spinifex Sandplain habitat from the proposed Development Envelope, the restriction of direct impacts of Spinifex Sandplain habitat to 0.2 percent of the mapped survey area) and the additional understanding of the regional populations derived from the extensive survey efforts associated with the Proposal, that implementation of the proposed project would not have a significant effect on the abundance, distribution or conservation status of the species.

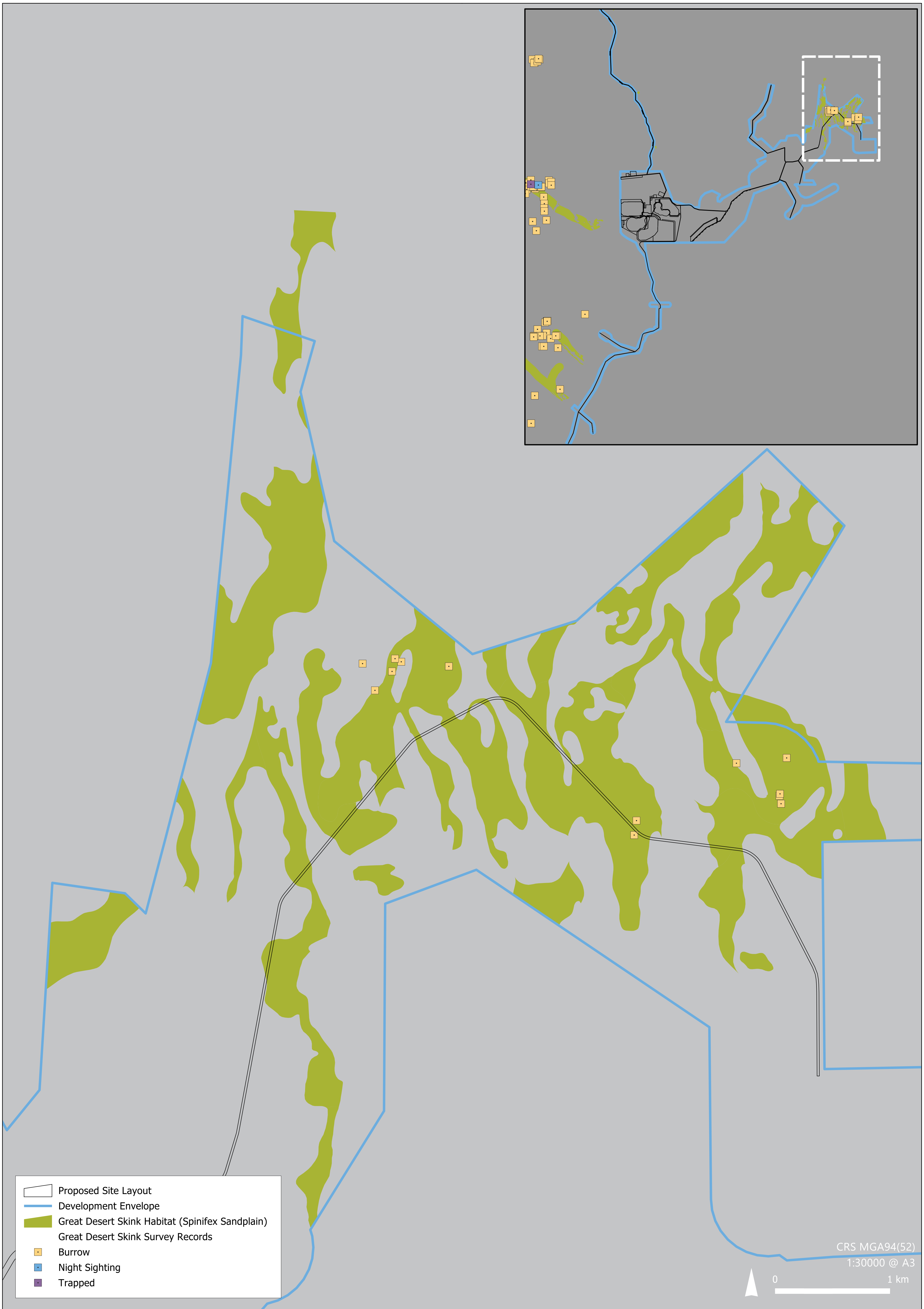


Figure 7-66: Indicative Disturbance of Preferred Great Desert Skink Habitat

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OZ MINERALS

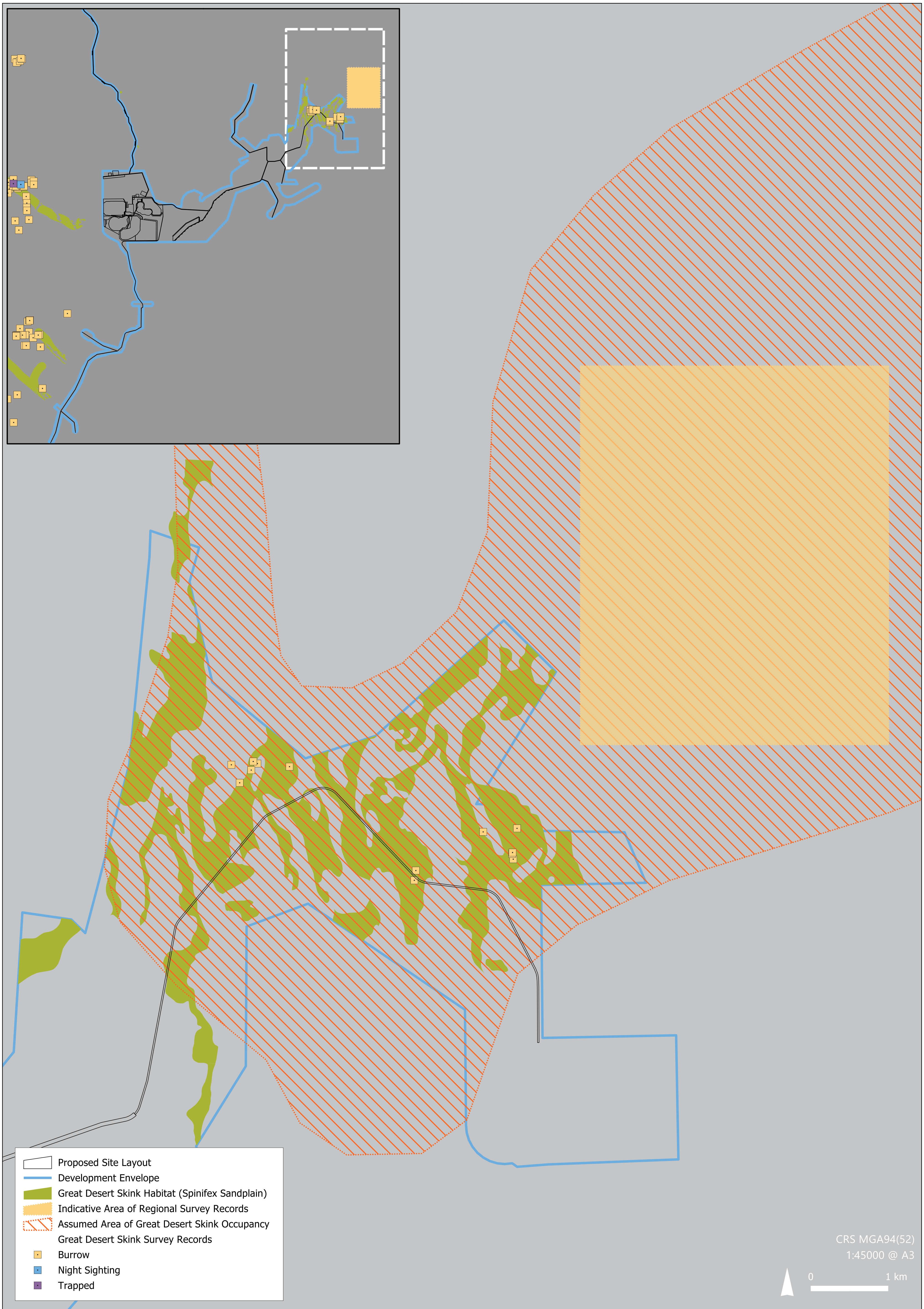


Figure 7-67: Northern Borefield Local and Regional Great Desert Skink Records and Assumed Area of Occupancy

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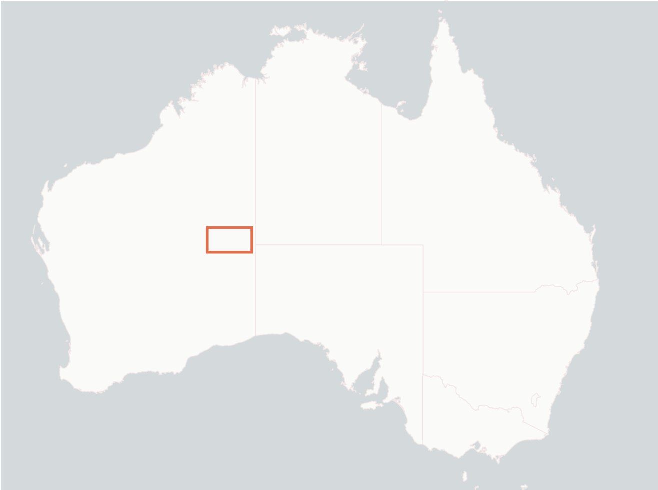
### Striated Grasswren and Brush-tailed Mulgara

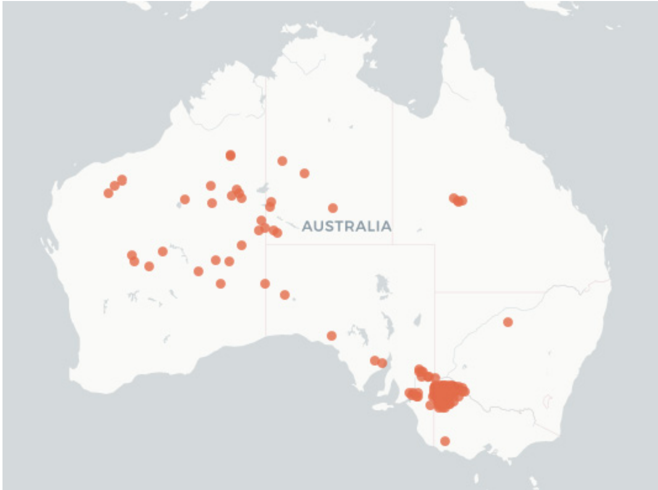
The Striated Grasswren and Brush-tailed Mulgara inhabit spinifex, mulga and mallee sandplains within the Development Envelope (Appendix G1). Field surveys indicated that both of these species were particularly abundant within the Spinifex sandplains to the south and west of the proposed project, similar to the Great Desert Skink. As discussed previously, the proportion of disturbance to Spinifex sandplain habitat as a result of the proposed project is low (approximately 0.2 percent of mapped area) and thus it is not expected that habitat loss would result in a significant impact to either species.

A search of the Atlas of Living Australia (ALA) shows a total of 601 records for the Striated Grasswren Nationally (Figure 7-68) and 1,444 records for the Brush-tailed Mulgara within Western Australia, the Northern Territory, South Australia and Queensland, including multiple sightings in all directions around the project area (Figure 7-68). Many of these records are located in Aboriginal Lands and Reserves, and as such affords these species additional protection.

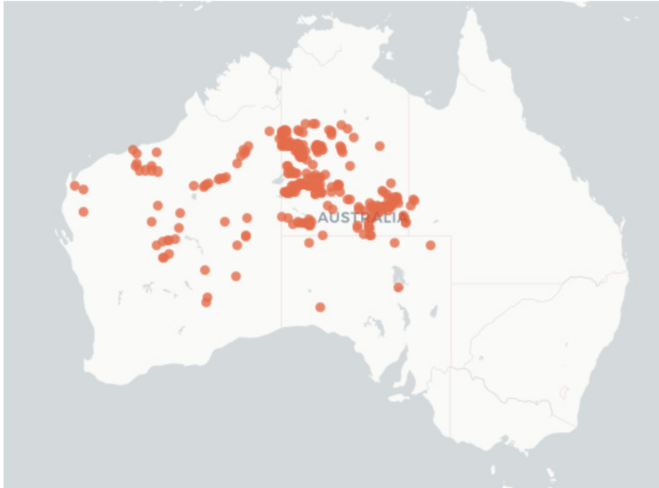
Based on the avoidance measures detailed previously (e.g. exclusion of 78 percent of mapped Spinifex sandplain habitat from the Development Envelope, and restricting clearance of this habitat to approximately 0.2 percent of the mapped area), and the extent of regional occurrence of these species, the proposed project is unlikely to have a significant effect on the abundance, distribution or conservation status of these species.



WEST MUSGRAVE PROJECT LOCATION

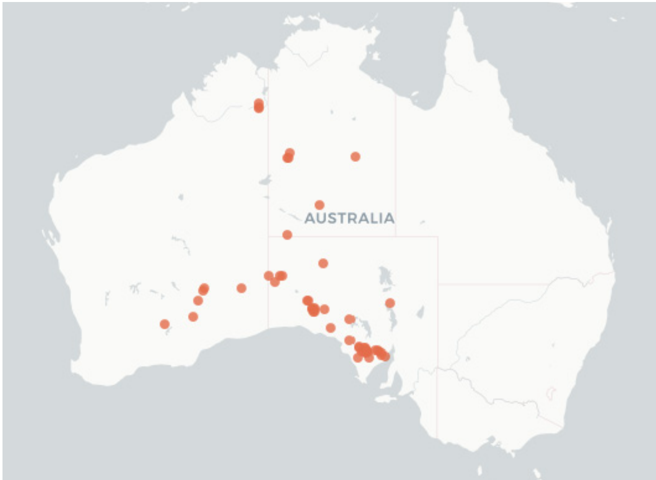



STRIATED GRASSWREN SUBSPECIES




BRUSHED-TAILED MULGARA


SOUTHERN MARSUPIAL MOLE




*Lerista taenita*


*Anilios grypus*

Figure 7-68: Known Distribution of Striated Grasswren Subspecies, Brushed-tailed Mulgara, Southern Marsupial Mole, *Lerista taeniata* and *Anilios grypus*

### Southern Marsupial Mole

The Southern Marsupial Mole is likely to occur throughout the Sand dune habitat within the fauna survey area, and more regionally (Appendix G1). Up to 11.3 percent of the mapped extent and 16.7 percent of the Sand dune habitat within the Development Envelope is proposed to be cleared (Table 7-75 and Figure 7-65). Immediately south-west of the Development Envelope is an area of over 20,000 ha of Sand dune habitat where numerous signs of Southern Marsupial Moles were identified (Figure 7-68). This expanse of Sand dune habitat which would be unimpacted by the proposed project represents nearly 400 percent more Sand dune habitat than the 2,852.0 ha of sand dune habitat mapped inside the Development Envelope.

A search of the ALA shows a total of 384 records for this species found within Western Australia, and immediately over the border in the Northern Territory and South Australia (Figure 7-68). Many of these records occur within Aboriginal Lands, and Reserve Areas which affords them additional protection from more intensive and widespread land uses.

Based on the small relative area of Sand Dune habitat proposed to be disturbed by the Proposal, the expanse of Sand Dune habitat immediately adjacent the Development Envelope (representing an area 400% larger than sand dune habitat mapped in the Development Envelope), and the more widespread regional occurrence of these species, the proposed project is unlikely to have a significant effect on the abundance, distribution or conservation status of these species.

### Marine and Migratory Species

The Pallid and Black Eared Cuckoo, Sacred Kingfisher, Rainbow Bee-eater and Australian Pratincole are listed as marine species, they do not rely on the habitats within the Development Envelope for breeding, and are most likely, transient fly over species which may use the habitats within the area for foraging. All these marine species are recognised to have broad distributions across Australia and/or internationally where they occur in large numbers when present.

The Oriental Pratincole is listed as a marine, migratory shorebird. Habitat within the Development Envelope is not considered important habit for migratory shorebirds as per *EPBC Act Policy Statement 3.21 – Industry Guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE, 2017) as it does not regularly support:

- 0.1 percent of the fly away population of a single species of migratory shorebirds
- 2,000 migratory shorebirds
- 15 migratory shorebird species.

All of these species are listed as 'Least Concern' in the Action Plan for Australian Birds (Garnett *et al.*, 2011) and by the IUCN. Due to the low inherent risk to these species, they have not been considered further in the assessment of impacts.

### Range Extensions

Of the four known fauna species with recorded range extensions two species (*Varanus acanthurus* and *Notoscincus ornatus)* were either recorded only outside of the Development Envelope or both inside and outside of the Development Envelope and have thus not been considered further.

Due to the proximity of the fauna survey area to the Northern Territory and South Australian Borders, a broader Australia wide perspective for each range extension has been presented using data from the AVH website to fully assess the potential impacts to the two remaining species.

The skink (*Lerista taeniata)* was recorded in the fauna survey area, representing a range extension of about 270 km west of the nearest record near Sangsters Bore in the Northern Territory. A search of the ALA shows a total of 221 records in Western Australia, Northern Territory and South Australia (Figure 7-68). Given the number of records of this species immediately surrounding the fauna survey area, it is logical to assume that the current siting reflects the lack of survey effort in the area rather than the inherent rarity of the species.

The Beaked Blind Snake (*Anilios grypus*) was recorded in the Main Development Area, representing a range extension of 350 km south-west of the nearest record at Yulara in the Northern Territory and 525 km south of the nearest Western Australian record on the Canning Stock Route. A search of the ALA shows a total of 466 records found within WA, the Northern Territory, South Australia and Queensland forming a relatively uniform occurrence from east to west across arid Australia (Figure 7-68).

Accordingly, the incidence of range extensions reflects the under-studied nature of the region, rather than the inherent rarity of these species (Appendix G1). Whilst some habitat for these species would be lost and the proposed project may have direct impacts on some individuals of these species should the Proposal be implemented, it is anticipated this would not affect their ability to persist either regionally or on a National scale.

### Species of Cultural Importance

Through consultation with Ngaanyatjarra People, a number of fauna species of cultural importance were identified, these included totem species representative of story lines or dreamtime stories or those used as food resources. These animals included bardi grubs (witchetty grub) which are generally associated with *Acacia kempeana*, Australian Bustard (*Ardeotis australis*), goanna (all the Varanus genus), Emus (*Dromaius novaehollandiae*) and macropods including the Western Grey Kangaroo (*Macropus fuliginosus*), Euro (*Osphranter robustus*) and Red Kangaroo (*Osphranter rufus*).

### *Bardi Grubs and Acacia kemeana*

Bardi grubs are commonly found in the roots of *Acacia kempeana* which commonly occur within the fauna survey area and region (see FloraBase).

*Acacia kempeana* is a spreading shrub or tree of between 1 and 6 m in height. The species is common throughout inland Australia and has no conservation status.

The proposed project is unlikely to impact these species on either a local or regional scale, and as such is unlikely to result in any change of access or abundance of Bardi grubs to Aboriginal People.

### *Goanna (Varanus species)*

Seven goanna species comprising 67 individuals were identified in the fauna survey area. Of these, the majority were represented by the sand goanna, *Varanus gouldii* (45 records). This species represented one of the most numerous reptile species identified in the fauna survey area. Varanus species are particularly widespread in inland arid Australia and have no conservation status. Varanus species are found in a wide variety of habitats including open woodland and sand plains which are particularly prevalent in the region.

While there may be a very localised decline in the abundance of this species near to the Main Development Area, the large range of habitats occupied by this species and the abundance of available regional habitat makes it unlikely that the proposed project would have an impact on the abundance or ability of Ngaanyatjarra People to access this species.

### *Australian Bustard*

The Australian bustard is a large ground dwelling bird up to 1.2 m tall, which is common in grasslands and open woodlands throughout mainland Australia. This species remains relatively common and widespread across most of northern Australia; however, its range appears to have contracted in the south-east of Australia over the past century. While the Australian Bustard has no Commonwealth or WA State conservation listing, the assessment of IUCN in 2016 noted a declining population trajectory. The total population is thought to exceed 10,000 and be no greater than 100,000 individuals.

Forty-nine records of the Australian Bustard were made during field surveys from throughout the fauna survey area in a range of habitats types. Given the range of habitats this species occupies and the abundance of available regional habitat, it is considered unlikely that the proposed project would have an impact on this species. Targeted hunting of this species is likely to present a greater pressure to this species than the proposed project activities.

### *Macropods*

Macropods are a relatively rare visitor to the project area. Traditional Owners have anecdotally noted that macropods are more plentiful in the area during sustained wet periods, and during dry periods are more prevalent in specific areas such as nearby to some of the larger rocky ranges such as Jameson Range.

Six records of Grey Kangaroo were identified from a single camera trap in the southern most extent of the fauna survey area. No other macropod species were identified in the fauna survey area. Macropods are uncommon in the area likely due to the limited number of water points and hunting pressure. Implementation of the proposed project is considered unlikely to change the already uncommon occurrence of macropods in the Development Envelope. If anything, the increasing number of water points may result in some increased incidence of macropods into the project area.

### *Emus*

Emus are known to occupy most of mainland Australia and are known from a range of habitats including woodlands and open plains. Emus do not have any Commonwealth or WA state conservation listing.

Two sightings of Emus and four indications of their presence were identified during field surveys of the West Musgrave area indicating that they are relatively uncommon to the project area. Similarly, to macropods, Emus are said to be more common during sustained periods of good conditions and are more commonly known from areas with available surface water. The proposed project is considered unlikely to change the already uncommon occurrence of Emus in the Development Envelope. If anything, the increasing number of water points may result in some increased incidence of Emus into the project area.

### Assessment of Inherent Risk

While it is accepted that there may be a very localised reduction in the numbers of those species listed above as a result of the proposed project, and that to a degree, some loss of access to hunting grounds within the Main Development Area would occur. These species represent common species that are widespread in the region in multiple habitats, as such the proposed project is considered unlikely to impact the availability or abundance of these species for the purpose of hunting.

The assessment of inherent (unmitigated) risk of loss or reduction in health and abundance of significant or culturally important fauna is provided in Table 7-78 and was determined to represent a Medium risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-78: Assessment of Inherent Risk – Significant or Culturally Important Fauna**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Loss or reduction in health and abundance of significant fauna | Rare | Moderate | Medium | 15 fauna species of significance were identified from the area including one Threatened species, (Great Desert Skink), and three Priority 4 species. All these species have been shown to have significant areas of occupancy in the study area and region and as such would not result in a change in conservation status as a result of the proposed project.<br>Project design has considered known locations of significant species and habitat known to support them with such areas excluded from the Development Envelope and project footprint wherever practicable.<br>About 0.2% of Great Desert Skink habitat mapped in the fauna survey area is expected to be impacted by the proposed project.<br>Regional studies have shown a far wider and more numerous occurrences of Great Desert Skink than was previously known.<br>The Proposal is unlikely to change the conservation status of any of the significant fauna species. |
| Loss of access to, or reduction in abundance of culturally important fauna. | Unlikely | Minor | Low | Through consultation with Traditional Owners species of cultural interest were determined.<br>It is acknowledged that the proposed project may reduce access to some hunting grounds to protect community safety, and that the project may have a localised impact on the availability of some species. |

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| | | | | Species determined to be of cultural interest were found to be common species that are widespread across regionally available habitats. |

### 7.6.5.4 Loss of SRE Species and SRE Habitat

The status of SRE invertebrate fauna recorded at the proposed project and surrounding area was based on categories developed by WAM in order to describe the status of taxa using current knowledge of distribution and biology of each species.

Of the 50 known potential SREs collected from the fauna survey area, 37 were recorded from both inside and outside of the Development Envelope and have thus not been considered further in this assessment.

Based on EPA Technical Guidance for Sampling of SREs (EPA, 2016k), if vegetation units are restricted to the potential impact area, and are especially different from adjoining units, then there is potential for some SREs to be similarly confined (an example might be a granite outcrop in an otherwise sandy environment). In contrast, if similar vegetation units are contiguous and broadly distributed outside of the proposed impact area, then the likelihood of SREs being confined to the impact area is reduced.

Additionally, the guidance states that a risk-based approach may be adopted for situations where surveys have been completed, but potential SREs are only recorded from within the Development Envelope. In this situation a risk-based approach would be considered in cases where:

- A potential SRE taxon is represented by one or few specimens from only within proposed development areas
- Contextual data on the wider distribution and status of the taxon is unavailable from WAM or DBCA
- Additional targeted surveys appear unlikely to yield results in a reasonable timeframe.

For potentially restricted taxa that meet the above criteria, the use of habitat as a surrogate for inferring distributional boundaries can be considered. While there are limitations to the use of such surrogates, this provides the only practicable method of undertaking an informed assessment as to the likelihood of small-scale SRE distributional restrictions. Consideration can also be given to the known distribution patterns and ecology of other species belonging to the same genus, to inform assessment of potential restriction.

A vulnerability rating has been included in Table 7-80 for the 13 potential SRE species in order to inform the assessment of the likelihood of SRE species being lost as a result of clearing from the proposed project. This vulnerability rating is based on the number of locations where specimens were collected and the prevalence near to, but outside the Development Envelope of the habitat types at these locations. Prevalence of habitat types available to potential SREs is depicted in Figure 7-64. The following describes the three classes of vulnerability assignment:

- Low Vulnerability: species collected from within a common habitat type at either multiple locations or a potential species surrogate has been observed at the proposed project
- Medium Vulnerability: species collected from either a common habitat type or multiple locations (but not both)
- High Vulnerability: species which were collected in only one location in a rare habitat type.

No potential SRE species recorded as part of the proposed project assessment are considered to have a high vulnerability rating, whilst three have a medium vulnerability rating and ten a low vulnerability rating (Table 7-80).

Of the species which have a medium vulnerability rating, two (*Missulena* 'WM1' and *Sundochernes* 'WM1') occur within the Mallee sandplain habitat whilst one (*Conothele* sp.) occurs in the Mulga woodland habitat, all of which are common habitats within the fauna survey area and region, and all of which represent continuous habitats.

As shown in Table 7-75, 5,780.7 ha of Mallee sandplain has been mapped, with 3,445.7 ha occurring within the Development Envelope. Of this, 524.7 ha (or 9.1 percent within the mapped area) of this habitat type is expected to be impacted by the proposed project.

Similarly, 10,319.8 ha of Mulga woodland has been mapped, with 5,274.6 ha occurring within the Development Envelope. Of this 1,264.8 ha (or 12.3 percent within the mapped area) of this habitat type is expected to be impacted by the proposed project. The potential SRE identified to be potentially restricted (*Conothele* sp.) was a juvenile species and therefore could not be compared with any species based on its morphology. Two attempts to amplify COI sequences from the specimen also failed. Due to it being the only representative of this genus and family from the fauna survey area, it was treated as an undiagnosable morphospecies rather than an ambiguous species by Alacran (Appendix G6).

Based on only three species receiving a vulnerability rating of medium, and each of these species occurring in habitats that are both common in the fauna survey area and region, and are continuous between the Development Envelope and beyond, these potential SREs are considered likely to be widely occurring, and as such unlikely to be materially impacted by the proposed project.

The assessment of inherent (unmitigated) risk loss of SRE species and SRE habitat as a result of clearance for project-related infrastructure is provided in Table 7-79 and was determined to represent a Medium risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-79: Assessment of Inherent Risk – Loss of SRE species and SRE habitat**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Loss of SRE species and SRE habitat as a result of clearance for Project-related infrastructure | Possible | Minor | Medium | 13 of the 50 potential SRE species collected were considered potential SREs. Of these only three were assessed as having a medium vulnerability rating based on only a single individual being found, however these individuals were found in habitats that are both common in the fauna survey area and region, and are continuous between the Development Envelope and beyond. None of these species were found within the project footprint and would not be directly impacted by land clearing. As such, these potential SREs are considered likely to be widely occurring, and unlikely to be materially impacted by the Proposal. |

**Table 7-80: Relative Vulnerability of the Proposal on Potential SREs**

| Order | Family | Species | No. of Collection Locations | Habitat | Species Surrogate | Vulnerability Assessment |
|---|---|---|---|---|---|---|
| Araneae | Actinopodidae | *Missulena* 'WM1' | 1 | Mallee Sandplain | | Medium |
| | Barychelidae | *Synothele* 'WM2' | 1 | Mulga Woodland | *Synothele* 'WM1' | Low |
| | | *Barychelidae* 'WM1' | 2 | Calcrete/Spinifex Complex | | Low |
| | Halonoproctidae | *Conothele* sp. | 1 | Mulga Woodland | | Medium |
| | Nemesiidae | *Aname* 'WM4' | 4 | Mulga Woodland<br>Calcrete Plains<br>Mallee Sandplain | *Aname* 'MYG514'<br>*Aname* 'WM1'<br>*Aname* 'WM5'<br>*Aname* 'WM7' | Low |
| | | *Aname* 'WM6' | 2 | Calcrete Plains<br>Mallee Sandplain | | |
| | | *Kwonkan* 'WM8' | 1 | Mallee Sandplain | *Kwonkan* 'WM3' | Low |
| | | *Kwonkan* 'WM9' | 1 | Mallee Sandplain | | |
| | | *Sundochernes* 'WM1' | 1 | Mallee Sandplain | | Medium |
| | Olpiidae | *Indolpium* 'WM1' | 4 | Calcrete/Spinifex Complex<br>Mallee Sandplain | *Indolpium* 'WM2'<br>*Indolpium* 'WM3' | Low |
| Scorpiones | Buthidae | *Lychas 'multipunctatus* mosaic' | 5 | Mallee Sandplain<br>Calcrete/Spinifex Complex | *Lychas adonis'*<br>*Lychas 'annulatuss* mosaic' | Low |
| | Urodacidae | *Urodacus* 'WM2' | 1 | Calcrete/Spinifex Complex | *Urodacus* 'WM1'<br>*Urodacus* 'yaschenkoi' complex<br>*Urodacus holplurus* | Low |
| | Armadillidae | *Acanthodillo* 'WM3' | 1 | Mulga Woodland | *Acanthodillo* 'WM1'<br>*Acanthodillo* 'WM2' | Low |

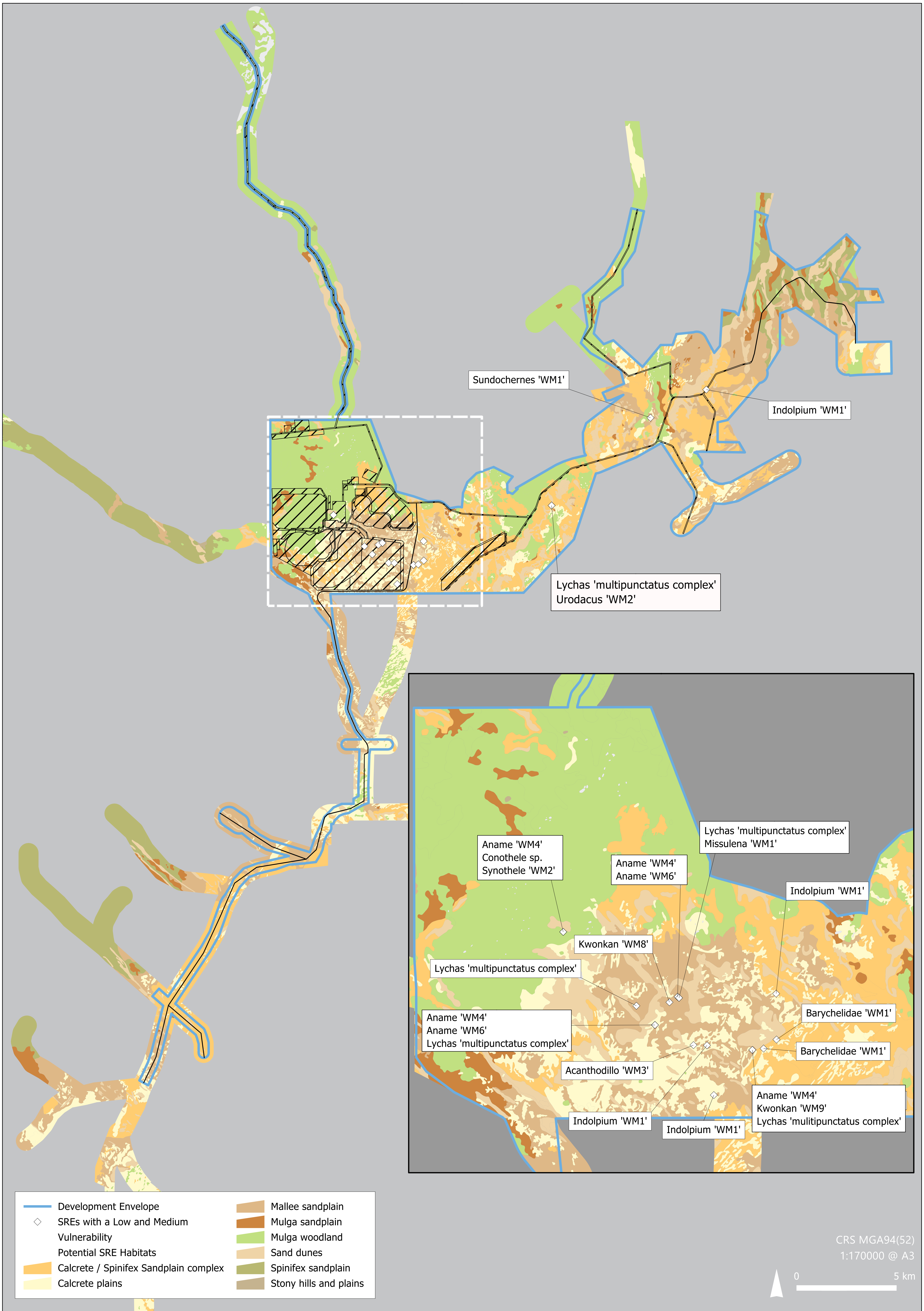



Figure 7-69: Indicative Site Layout Depicting Potential Short Range Endemics over Habitat Type Restricted to the Proposal Area

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#### 7.6.5.5 Death or Injury of Fauna Due to Interactions with Project Activities

Fauna within the Development Envelope may be at risk of death, injury or displacement due to:

- Interactions with vehicles and machinery
- Entrapment in excavations or tailings
- Entanglement in powerlines or guides
- Acutely toxified by chemical ingestion.

Fauna would be most at risk of death or injury during clearing activities due to the direct interface between vehicle movement and fauna habitats. The proposed project, and in particular the Northern Access Road would result in an increase in the number of vehicles in the local area. Species particularly at risk of vehicle strike include slow-moving animals, species that are easily startled and nocturnal animals. Vehicles travelling at night are more likely to strike native fauna when visibility is reduced, and more animals are moving through the landscape. Species such as birds of prey are also likely to feed off dead carcases on roads and may also become victim to vehicle strike. The implementation of lower traveling speeds (particularly at night) would reduce this likelihood of vehicle strikes. Additionally, the width of the Site Access Road corridor (up to 60 m including other services) would allow drivers to identify fauna well in advance allowing them to slow down or stop.

Trenches, excavations, and water storage structures often have steep, slippery sides which prevent fauna that fall into them from escaping, however also prevent wading birds from landing and attempting to feed. Fauna may also be attracted to waste storage bins or domestic waste facilities and become trapped. Entrapment may lead to fauna injury or death from starvation, dehydration, drowning, bogging or injury. Artificial water sources would have fauna egress points so that fauna would be able to escape. Open holes, trenches (if applicable) and the landfill would be fenced, and visual inspections would be implemented to reduce potential impact to fauna.

Entrapment of fauna in tailings is known to occur based on experiences at other operations. As progressive lifts are added to the TSF the slope angles become steep and less hospitable to land-based terrestrial fauna. In addition, the high evaporation and water management (e.g. centralised decant and free draining foundations) would mean that tailings would be well consolidated and present less risk for entrapment.

Results of tailings characterisation show that acute toxication of fauna is unlikely to occur, particularly those that feed and drink 'on the wing' e.g. some bird and bat species. In addition, the landscape within the tailings impoundment would be made to be inhospitable to animals, e.g. the removal of roosting sites and vegetative debris to minimise fauna visitors and interaction.

The chemistry of the long-term pit lake has been evaluated. The lake is likely to progressively increase in salinity making it a natural deterrent as a drinking resource (see inland waters Section 7.3.5.5).

The use of guides and/or stays to stabilise tall infrastructure such as wind turbines would be avoided where possible to minimise the possibility of entanglement. Wind turbines are unlikely to have any guides for structural support.

Given that the Main Development Area (considered to represent that area with the highest potential for interactions) is 10 to 15 km from habitats that supports significant fauna species (e.g. Spinifex sandplain), the potential for interactions with significant fauna resulting in death or injury are greatly reduced.

The assessment of inherent (unmitigated) risk significant reduction in richness and abundance of fauna due to interactions with vehicles and machinery, ingestion of chemicals and/or, entanglement or entrapment, including significant fauna is provided in Table 7-81 and was determined to represent a Medium risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-81: Assessment of Inherent Risk – Death or Injury of Fauna**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Significant reduction in richness and abundance of fauna resulting from interactions with vehicles and machinery, ingestion of chemicals and/or, entanglement or entrapment, including significant fauna | Unlikely | Minor | Medium | Project design has considered known locations of significant species and habitat known to support them with such areas excluded from the Development Envelope and project footprint wherever practicable<br>15 fauna species of significance were identified from the area including one Threatened species, (Great Desert Skink), and three Priority 4 species. All these species have been shown to have significant areas of occupancy in the study area and region and as such would not result in a change in conservation status as a result of the proposed project |

### 7.6.5.6 Death or Injury of Aerial Fauna Resulting from Interaction with Wind Turbines

The location selected for a wind farm relative to sites of importance to avian fauna or bats is a critical consideration to minimise fauna death and injury. The proposed wind farm is not located near a coastal area and there are no wetlands of importance located within close proximity. The closest Ramsar wetland is Eighty Mile Beach located 1,000 km north-west of the proposed project. The wind farm is also not located along any recognised migratory corridors.

A total of 89 bird species and seven bat species were recorded during surveys (Section 7.6.3.4). Appendix G3 provides a consolidated list of bird and bat species. Brief ecologies and flight behaviours have been assessed for each species by Donato Environmental Services (Appendix G3).

Of the species identified during surveys, only the Oriental Pratincole (listed under the EPBC Act as a migratory species and protected under international treaties, and listed under the BC Act as IA representing its international protection and migratory status) was identified from the fauna survey area. In addition, the Pallid and Black Eared Cuckoo, Sacred Kingfisher, and Australian Pratincole (listed as marine species) were also noted. These species do not rely on the habitats within the Development Envelope for breeding and are most likely transient, fly over species which may use the habitats within the area for foraging. Based on a risk assessment that considered the potential for bird strikes based on animal flight height above the vegetation canopy and their likely abundance in the area, these species were considered to be low risk of wind turbine strikes, and as such impacts to these species would not result in any change of their abundance, distribution or conservation status.

The principal risk to resident avian fauna and bats in the local area from the proposed project is believed to be posed by wind turbines swept path which have the potential for local resident bird and bats to be killed or injured as a result of collision with moving rotor blades.

The studies undertaken to inform the Proposal determined that the following species returned a moderate risk of bird strikes associated with the proposed wind farm:

- Fork-tailed Swift (*Apus pacificus*)
- Wedge-tailed Eagle (*Aquila audax*)
- Rainbow Bee-eater (*Merops ornatus*)
- Nankeen Kestrel (*Falco cenchroides*)
- Australian Hobby (*Falco longipennis*)
- Brown Falcon (*Falco berigora*).

It is expected that the frequency of mortalities is likely to be stochastic, with randomness derived from numerous variables, with few mortalities expected during long dry periods, due to inherently low abundances of animals, and higher mortality rates during brief or successive favourable seasons. None of the species identified as moderate risk of turbine strike are listed as species of conservation significance, and it is unlikely that the proposal would result in the change of abundance, distribution or conservation status of any fauna species.

A number of studies have shown that turbines located at the edge of a cluster are also more likely to result in aerial fauna mortality, as such mitigations employed would consider both maximising the height of swept path depth, and minimising the number of edges within a cluster of turbines (e.g. bunching all turbines into a single cluster rather than multiple small clusters across the landscape).

The assessment of inherent (unmitigated) risk reduction in significant fauna due to interaction with electricity generating wind turbine blades which results in a reduction in the richness and abundance of significant fauna is provided in Table 7-82 and was determined to represent a Low risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-82: Assessment of Inherent Risk – Death or Injury of Aerial Fauna**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Reduction in significant fauna due to interaction with electricity generating wind turbine blades. | Unlikely | Minor | Low | A risk assessment was undertaken that considered flight height above the canopy and aerial animal abundance. Six fauna species returned a risk ranking of moderate. All of these species are common species in the arid land environment. None of these species represent significant species. As such, the Proposal is unlikely to result in a change to the conservation status of any significant species. |

#### 7.6.5.7 Photovoltaic Solar Panel 'Heat Island' Impacts on Fauna

With the emergence of more photovoltaic (PV) solar farms, the concept of the heat island effect and its impacts is receiving increased consideration. The PV "heat island" (PVHI) effect results from PV solar panels altering the way that incoming energy is reflected to the atmosphere or absorbed, stored, and reradiated (Barron-Gafford *et al,* 2016). This effect occurs as a result of how PV plants change the albedo, vegetation, and structure of the terrain. While the results of existing studies vary in their findings, it is generally agreed that large PV solar farms can increase the temperature in the immediate vicinity of the array by anywhere between 1.8 and 4 degrees Celsius, and that this temperature diminishes with distance from the array, one study noting that temperatures within 300 m of a solar array were 0.3 degrees Celsius higher compared with control sites (Barron-Gafford *et al,* 2016; Fthenakis and Yu, 2013).

The area where the PV solar farm is proposed to be located would require clearing of vegetation, or be significantly pruned to allow for construction, including an associated fire break, to allow for the placement and operation of the PV panels, as such the area would already experience direct impacts. The proposed solar array would be sited in vegetation associations and fauna habitat that is commonplace within the fauna survey area, and region. As such it is unlikely that the PVHI effect would result in any impacts to significant fauna species or habitat.

The assessment of inherent (unmitigated) risk significant reduction in richness and abundance of fauna due to creation of a localised heat island associated with operation of the photovoltaic electricity generation panels is provided in Table 7-83 and was determined to represent a Low risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-83: Assessment of Inherent Risk – Heat Island Impacts on Fauna**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Significant reduction in fauna richness and abundance due to creation of a localised heat island associated with operation of the photovoltaic electricity generation panels | Unlikely | Insignificant | Low | The siting of PV solar panels would be away from habitats known to support significant species (e.g. Spinifex Sandplain), and in habitats that are widespread in the fauna survey area and region. As such it is unlikely that the heat island effect from the operation of a PV solar farm would result in a significant effect on fauna, or result in the change of conservation status for any significant fauna. |

### 7.6.5.8 Increase in the Abundance and Diversity of Pest Species

A large number of introduced fauna species have already been recorded in the fauna survey area and Development Envelope including camels (*Camelus dromedaries*), cats (*Felis catus*), foxes (*Vulpes Vulpes*) and wild dogs (*Canis familiaris*), rabbits (*Oryctolagus cuniculus*) and mice (*mus masculatus*). The development of new tracks, increased water points and production of domestic waste has the potential to attract and increase the abundance and diversity of introduced species. The result of which may increase competition with and predation of native species.

Fencing of attractant areas (waste disposal/landfill) would limit the increase of these species within the Development Envelope through decreasing access and attraction. Additional management measures such as the regular covering of wastes as well as trapping of pest species would further reduce the impact to native fauna.

Whilst there is the possibility that the proposed project could result in an increased number of feral animals, it is more likely that the implementation of management measures in an area with limited feral animal control programs in place, would result in a decrease in feral animal populations in the local area.

The assessment of inherent (unmitigated) risk increased richness and or abundance of pest fauna species as result of increased attractants (water and food sources) which may result in increased competition for resources with and increased predation of native fauna is provided below in Table 7-84 and was determined to represent a Medium risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-84: Assessment of Inherent Risk – Increase in Pest Species**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Increased richness and or abundance of pest fauna species as result of increased attractants (water and food sources). This may result in increased competition for resources with and increased predation of native fauna | Possible | Minor | Medium | The local and regional abundance and species richness of pest animals is already high. The Proposal could result in an increased number and diversity of pest animals in the project area due to increased attractants (water and food resources and importation of materials during construction and operations<br>Given that most pest fauna attractants would be located near to the Main Development Area and away from habitats known to support significant species, the threat of pest species on significant species is likely to be reduced<br>Should active programs for pest management be put in place at the site, it is likely to result in a net benefit compared with current conditions |

### 7.6.5.9 Disruption or Disturbance to Fauna Populations as a Result of Noise, Light, Dust and Vibration Emissions

Elevated noise, light, dust and vibration emissions associated with mining activity can impact on fauna. The direct impacts are typically non-lethal and generally take the form of changes to behaviour, resulting in avoidance of or attraction to an area. Noise and vibrations associated with blasting, drilling and operation of machinery may cause animals to move from the area. Lighting required for continuous operations has the potential to attract fauna that forage nocturnally on species that are attracted to the light and to force other species to move away from the area. All these outcomes may alter the local fauna assemblages.

The amount of natural habitat surrounding the project means that impacts are likely to be minimal and confined to the immediate area of the proposed project, and susceptible affected fauna are likely to move away from these sources. Management measures to limit the impact of noise and light on fauna would be considered during the detailed design, construction and operational phases of the proposed project and engineering controls implemented where possible.

The assessment of inherent (unmitigated) risk for significant reduction in species richness and abundance of fauna as a result of noise, light, dust and vibration emissions is provided in Table 7-85 and was determined to represent a Low risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-85: Assessment of Inherent Risk – Increase in Pest Species**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Significant reduction in species richness and abundance of fauna as a result of noise, light, dust and vibration emissions. | Unlikely | Insignificant | Low | The amount of natural habitat surrounding the Proposal means that impacts are likely to be minimal and confined to the immediate area of the Proposal, and susceptible affected fauna are likely to move away from these sources. The Main Development Area is also located over 15 km from the core habitat supporting significant species (Spinifex Sandplain), as such the effect of these anthropogenic disturbances on this habitat is likely to be low. |

### 7.6.5.10 Degradation of Habitat due to Altered Fire Regime

Changes to fire regimes has a significant impact on vegetation structure. Too-frequent fires reduces vegetation cover, potentially exposing fauna species to a higher risk of predation and may reduce abundance of food or increase the prevalence of weed species.

The highest risk of bushfire ignition occurs during construction activities while undertaking hot works activities. Effective management of construction activities would prevent the incidence of bushfire. The increased road network resulting from the proposed project, and maintenance of firebreaks would also help to control the extent and size of potential bushfires. Appropriate work procedures would be employed to reduce the risk of fires starting from activities associated with the proposed project.

Because of the nature of the vegetation throughout the Development Envelope and traditional land management practices in the broader region, it is impossible to exclude fire from the area. With construction of the proposed project's access track and internal road network there is, however, the opportunity to develop and implement a Fire Management Plan which can dramatically reduce risks to personnel and infrastructure, as well as achieving good environmental outcomes. A prescribed burning program can also enable a dramatic reduction in risk from unplanned bushfires and offers strong possibilities in facilitating development of collaborative partnerships with Traditional Owners and interested government agencies. This option would be considered in consultation with the relevant stakeholders.

The assessment of inherent (unmitigated) risk of changes to existing fire regimes that result in a decrease in the richness, abundance and diversity of fauna habitat and significant fauna is provided in Table 7-86 and was determined to represent a Medium risk. Section 7.6.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-86: Assessment of Inherent Risk – Degradation of Habitat due to Altered Fire Regime**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Changes to existing fire regimes that result in a decrease in the richness, abundance and diversity of fauna habitat and significant fauna | Possible | Minor | Medium | Traditional Owners actively use fire as a land management tool within the local area and region. Implementation of the Proposal would require changes in traditional use of fire to ensure protection of people and project assets. While the increased occurrence of tracks, road networks, and cleared areas associated with the proposed project provide natural fire breaks likely to reduce the intensity and extent of fires, further management measures would be required to minimise the likelihood of fire starting from project activities<br>In addition, due to the widespread nature of habitats, and significant fauna mapped in the survey area, fire events generated from the proposed project are highly unlikely to result in a change in conservation status to any of fauna species |

## 7.6.6 Mitigation Measures

As described in Section 7.6.5, the inherent (unmitigated) risk of any of the identified potential impact events not meeting the EPA Objective for Terrestrial Fauna as a result of the Proposal were Medium or Low, and were therefore not considered to require any specific avoidance and mitigation to meet the EPA's Objectives relating to Terrestrial Fauna. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP, these avoidance and mitigation measures are shown in Table 7-87.

**Table 7-87: Mitigation Measures for the Terrestrial Fauna Environmental Factor**

<table>
<tr><th rowspan="2">Potential Impact Event</th><th rowspan="2">Mitigation</th><th colspan="3">Residual Risk</th></tr>
<tr><th>Likelihood</th><th>Consequence</th><th>Risk</th></tr>
<tr><td rowspan="6">Loss of poorly representative habitats due to land clearing<br><br>and<br><br>Habitat fragmentation resulting in the loss of significant fauna or adverse change to ecosystem services.</td><td>Measures to Avoid</td><td rowspan="6">Unlikely</td><td rowspan="6">Minor</td><td rowspan="6">Low</td></tr>
<tr><td>• Adjustment of the Development Envelope to remove habitat known to support significant species (removed 78% of Spinifex Sandplain habitat)<br>• Avoidance through informed design by minimising clearing to the smallest area possible and placing waste in-pit where practicable<br>• Avoidance or minimisation through informed design by avoiding clearing of habitat for conservation-significant species and, where practicable, micro-sighting infrastructure during construction to avoid significant habitats</td></tr>
<tr><td>Measures to Minimise</td></tr>
<tr><td>• Development and implementation of a site-specific internal clearing/disturbance procedure and associated permit to prevent clearing outside approved boundaries, and to minimise disturbance to only that required<br>• The site induction program would provide information on protection of significant fauna habitats and ground disturbance authorisation procedures<br>• A pre-clearance survey would be undertaken in Spinifex Sandplain to ensure that proposed clearing aligned away from any signs of Great Desert Skink</td></tr>
<tr><td>Measures to Rehabilitate</td></tr>
<tr><td>• Progressive rehabilitation would be undertaken on disturbed areas as they become available<br>• Monitoring of analogue and rehabilitated areas would be undertaken to ensure short, medium and long-term rehabilitation objectives are achieved<br>• Ongoing development of monitoring methodology and rehabilitation techniques would occur during the life of the project. Further assessments over time would plot the development of rehabilitated areas against analogue sites and progression towards completion targets<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b)</td></tr>
</table>

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Risk |
| Loss or reduction in health and abundance of significant fauna species | As per above measures | Rare | Moderate | Medium |
| Loss of access to, or reduction in abundance of culturally important fauna species | As per above measures | Unlikely | Minor | Low |
| Loss of SRE species | As per above measures | Possible | Minor | Medium |
| Significant reduction in richness and abundance of fauna resulting from interactions with vehicles and machinery, ingestion of chemicals and/or, entanglement or entrapment, including significant fauna. | **Measures to Avoid**<br>• Pre-clearance surveys for conservation significant fauna would occur in spinifex sandplain habitat. If any such fauna, or signs of fauna are identified and where practicable, project infrastructure would be offset, or individuals would be relocated to similar habitats outside the Development Envelope within the region<br>**Measures to Minimise**<br>• Speed limits would be implemented for operational areas and the Site Access Road in order to minimise the risk of fauna injury or mortality from vehicle strike<br>• Personnel would be required to adhere to speed limits and drive to road/weather conditions to minimise risks of fauna injuries or death due to vehicle traffic<br>• Vehicle traffic would be confined to defined roads and tracks<br>• The site induction program would provide information on fauna of conservation significance including their appearance and habitats. Training would also discuss standard operating procedures in the event of fauna interactions<br>• Steep excavations and holes will either be capped or ramps will be put in place to allow egress<br>• TSF will minimise vegetative debris or other material that would provide roosts or feeding locations (e.g. facility will be made to be inhospitable for habituation of animals) | Possible | Minor | Medium |

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Risk |
| | • The use of significant length guides on towers and windfarms will be reduced where possible<br>• Borrow pits would be designed, constructed and rehabilitated to minimise surface water ponding after rehabilitation<br>• Artificial water sources would have egress points installed<br>• Open holes, trenches, the landfill, and any water holding facilities would be inspected regularly for fauna<br>• The landfill would be fenced and putrescible wastes would be regularly covered | | | |
| | **Measures to Rehabilitate** | | | |
| | • Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b)<br>• Borrow pits would be rehabilitated to minimise surface water inflows and to prevent water ponding | | | |
| Reduction in significant fauna due to interaction with electricity generating wind turbine blades. | **Measures to Avoid** | Unlikely | Minor | Medium |
| | • Siting of turbines outside of habitats known to support significant fauna species<br>• The swept height of wind turbine blades above the vegetation canopy would be a design consideration for wind farm design and development | | | |
| | **Measures to Minimise** | | | |
| | • Various aspects of the conceptual and detailed design of the wind farm and individual turbines would take into account the following design features to reduce the risk of avian fauna and bat mortalities:<br>o Design of turbine towers with solid structure turbines. as opposed to lattice style structures to prevent birds, particularly raptors, using the turbines as perching and/or nesting locations, increasing the likelihood of rotor collision<br>o Size of turbines would be as large as practicable to allow the turbines to be more visible to avian fauna species and have lower blade rotational speeds than smaller turbines<br>o Turbines would be designed and constructed within clusters to create less edges<br>o Provision of visibility enhancement devices | | | |

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Risk |
| | **Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Significant reduction in fauna richness and abundance due to creation of a localised heat island associated with operation of the photovoltaic electricity generation panels | **Measures to Avoid**<br>• Siting of PV cells outside of habitats known to support significant fauna species<br>**Measures to Minimise**<br>• Land disturbance process to ensure that the cleared area is as small as reasonably required<br>**Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Insignificant | Low |
| Increased richness and or abundance of pest fauna species as result of increased attractants (water and food sources). This may result in increased competition for resources with and increased predation of native fauna | **Measures to Minimise**<br>• Landfill would be fenced and putrescible wastes would be regularly covered<br>• Borrow pits would be designed and constructed to minimise surface water ponding after rehabilitation<br>• Tailings and other water bodies would minimise vegetative debris or other material that would provide roosts or feeding locations (e.g. facility would be made to be inhospitable for habituation of animals)<br>• Feral animal control would be undertaken as required, in co-operation with regional control programs and the Traditional Owners<br>**Measures to Rehabilitate**<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | Unlikely | Minor | Low |
| | **Measures to Avoid**<br>• Lights would be strategically placed and designed to shine towards plant operations and minimise light spill to the environment<br>• Equipment design would be specified to be within Australian standard noise limits | Unlikely | Insignificant | Low |

| Potential Impact Event | Mitigation | Residual Risk | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Risk |
| Significant reduction in species richness and abundance of fauna as a result of noise, light, dust and vibration emissions | • Dust would be managed by watering unsealed roads with a water cart or with fixed sprays as required<br>• Vehicle traffic would be confined to defined roads and tracks<br>• During high winds, topsoil and overburden stripping and other high dust generating activities would be restricted if risk-based assessment measures determine that dust cannot be adequately controlled<br>• Vehicles would be required to travel at safe operating speeds on unsealed roads and would be restricted from accessing rehabilitated surfaces except for management purposes<br>• Spilt ore and materials outside of the ore processing areas would be regularly cleaned up<br>• Bulk products would be transported in covered containers | | | |
| | **Measures to Rehabilitate** | | | |
| | • Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Changes to existing fire regimes result in a decrease in the richness and abundance of poorly represented fauna habitat and significant fauna | **Measures to Minimise** | Unlikely | Minor | Low |
| | • Fire breaks would be maintained around fixed plant areas<br>• Fire management infrastructure would be maintained on site and in vehicles, along with competent persons for the management of bushfires<br>• A Hot Works procedure would be put in place to ensure adequate controls are put in place for activities that have the potential to result in bush fire<br>• Fire management protocols and land management would be consulted with the Ngaanyatjarra Council to ensure that aligned fire management outcomes are achieved | | | |

### 7.6.7 Predicted Outcome

The predicted outcome was determined in accordance with the EIA Framework developed for the Proposal (Appendix A3), and was based on the assessment of impacts (Section 7.6.4) and the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e). The results of this assessment are presented in Table 7-88.

Based on this assessment, the Proposal was assessed as having no significant or irreversible impact on terrestrial fauna-related environmental values and the EPA Objective for terrestrial fauna 'To protect terrestrial fauna so that biological diversity and ecological integrity are maintained' would be met should the Proposal be implemented.

**Table 7-88: Assessment of Impact Significance – Terrestrial Fauna**

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Values, sensitivity and quality of the impacted environment which is likely to be impacted | The identification and assessment of values has been considered during the commissioning and undertaking of the specialist study program. The following was noted in relation to key values:<br>• Fauna habitats are considered to be widespread and well represented in the regions (Appendix G1)<br>• A single Threatened (vulnerable) species listed under EPBC Act, and BC Act was identified, the Great Desert Skink. Project design has resulted in exclusion of three of the four identified populations and 78% of its habitat from the Development Envelope. Further, the Proposal would result in a minor impact of 6.7 ha or 0.2% of its preferred spinifex sandplain habitat mapped within the fauna survey area. Regional studies of this species have confirmed a further 10 to 12 populations of this species within 200 km, and a far larger potential area of occupancy. The Proposal is unlikely to result in a negative change to the conservation status of this species<br>• Three Priority 4 species were identified. Potential loss of Priority fauna is considered to present a low risk to the conservation status of these species as the species are known to occur outside the Development Envelope with many of them occurring in Aboriginal Lands and areas in other States or Territories<br>• Three potential SREs were identified in the Development Envelope as having medium vulnerability, all of which occur in locally and regionally widespread habitats that are continuous between the impacted area, and outside of the Development Envelope<br><br>Several species of totem or hunting importance to relevant West Musgrave Traditional Owners were identified. All such species held no level of conservation significance and were represented by common and widespread species that are not uncommon to the area and region. Based on the above, OZ Minerals believes that should the Proposal be implemented it would not significantly impact the value, sensitivity and quality of the environment | Not Significant |
| Extent (intensity, duration, magnitude and footprint) of the likely impacts | Numerous terrestrial fauna surveys occurred over 40,742.1 ha including the entire Development Envelope. Further regional surveys were undertaken for the Commonwealth and State listed Great Desert Skink and Black-footed Rock Wallaby at a regional scale (within 200 km of the proposed project). No inherently restricted habitats were identified in this area, and impacts to identified significant species have a low likelihood of changing the conservation status of any species | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | The proposed project would result in the clearing of up to 3,830 ha within a Development Envelope of 20,852 ha. Upon cessation of activity-related pressures (circa 26 years mine life), the environment in the areas of non-permanent infrastructure is expected to recover to their pre-mining condition | |
| The consequence of the likely impacts (or change) | The consequences of various Terrestrial fauna related impact events have been assessed using a risk-based framework which included specifically designed consequence criteria for the terrestrial fauna Environmental Factor. A summary of the risk assessment is provided in Section 7.6.5. The results of the risk assessment determined any need for further mitigation measures<br>Both the inherent and residual risks to Terrestrial fauna as a result of the proposed project were assessed as being Low and Medium and as such were considered not significant | Not Significant |
| The resilience of the environment to cope with the impact or change | The proposed project is located within an arid, desert environment and the terrestrial fauna have evolved to tolerate changing availability in resources including low water, and bushfires<br>No individual species were identified of being at risk of a change in conservation status as a result of the proposed project<br>Whilst the Proposal would have a localised (direct) impact on terrestrial fauna, this would not be of a magnitude to affect the resilience of the environment to cope with that impact, and upon cessation of activity-related pressures, much of the environment would recover to, or near to their pre-mining condition. No impact events identified as part of the Proposal are considered to result in significant or irreversible impacts to species with inherent vulnerability (e.g. significant species) or on ecosystem services | Not Significant |
| Cumulative impacts with other existing or reasonably foreseeable activities, developments and land uses | There are no other existing or reasonably foreseeable activities, developments or land uses proposed within the areas potentially impacted by the proposed project, which may have a cumulative impact upon Terrestrial fauna and their associated values<br>The proposed project represents the only significant development for approximately 450 km | Not Significant |
| Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment | Connections and interactions between project (sources) and the receiving environment (environmental factors and their associated values) were considered using a SPR assessment and subsequent risk assessment. This SPR and risk assessment allowed for an assessment of interactions between the various and overlapping elements of the proposed project. Connections from all relevant Project-related sources were considered in the impact assessment presented in Section 7.6.5 particularly in the SPR assessment (Appendix A2) | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | Key connection between Terrestrial fauna relate to clearing, potential introduction of pests, and changes to ecosystem functions through hydrogeology or hydrology. The present assessment has taken into consideration the combined impacts of changes to these combined impacts<br>Resultantly, no unacceptable impacts to terrestrial fauna and their relevant values due to multiple or overlapping project sources were identified | |
| The level of confidence in the predictions of impacts and the success of proposed mitigation | Detailed terrestrial fauna surveys have been undertaken for the Proposal over multiple seasons by accredited zoological and ecological consultants and Traditional Owners with customary knowledge of the project area (Section 7.6.5), with results being subject to third-party peer review. Results from these surveys have informed the assessment process as well as project design<br>A third-party review on MNES was undertaken to confirm whether the Proposal would result in significant impacts to species listed under the EPBC Act. The peer review found that the Proposal, if implemented, would not result in a significant impact to MNES including, migratory species and the Great Desert Skink<br>OZ Minerals has a high level of confidence in the predictions of potential impacts to terrestrial fauna and the success of proposed mitigation measures | Not Significant |
| Public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment | OZ Minerals developed and implemented a detailed and thorough stakeholder engagement program which included relevant Ngaanyatjarra People, the Ngaanyatjarra Council, relevant Shires, government, and some special interest groups. The focus of this engagement program was on high interest and high influence stakeholder groups, particularly land rights holders. Engagement activities included project briefings, attendance by the Ngaanyatjarra Council to regulator meetings, numerous community meetings, a number of large heritage surveys, and a third-party environmental peer review of the Section 38 Referral submission and associated specialist studies on behalf of the Ngaanyatjarra People to ensure their interests and concerns relating had been appropriately considered, and a dedicated on-country consultation with relevant West Musgrave Traditional Owners relating to the outcomes of this EP Act Part IV impact assessment. No material concerns relating to any of the information shared with Traditional Owners relating to impacts to fauna as a result of the project were raised. A summary of consultation is provided within a consultation-specific record (Appendix A4) and project-specific consultation register (Appendix A5)<br>All areas identified by Traditional Owner, Ngaanyatjarra Council and other stakeholders relating to potential impacts inherent to terrestrial fauna values have been considered in this assessment | Not Significant |

## 7.7 Air Quality

### 7.7.1 EPA Objective

The EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) lists the following as their objective for air quality.

To maintain air quality and minimise emissions so that environmental values are protected

In the context of this factor and objective, the EPA's primary focus is maintaining air quality and minimising emissions for human health and amenity, where air quality is defined as the chemical, physical, biological and aesthetic characteristics of air, and refers to all the air above the ground up to and including the stratosphere.

The objective recognises the fundamental link between air quality and the environmental values supported by good air quality. It also recognises the principle of waste minimisation as set out in the EP Act.

'Environmental values' is defined under the EP Act as a beneficial use, or an ecosystem health condition. The ecosystem health values related to air quality as applied in this Environmental Factor are human health and amenity. Changes in air quality can also impact other Environmental Factors, for example, dust may smother flora and vegetation. In these circumstances, the assessment of the potential impacts has been undertaken against the relevant Environmental Factor, in this example the Environmental Factor Flora and Vegetation (Section 7.1).

### 7.7.2 Policy and Guidance

Air quality is protected under State legislation, primarily governed by the *Environmental Protection Act, 1986* (WA).

In addition to State legislation, the following policy and guidance statements were considered in impact assessment for air quality:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA, 2020e)
- EPA Environmental Factor Guideline – Air Quality (EPA, 2020a).

### 7.7.3 Receiving Environment

#### 7.7.3.1 Studies and Survey Effort

The following assessment was undertaken to systematically characterised the proposed project's potential impacts to air quality:

- Air Quality characterisation and effects assessment (Appendix H1). This assessment detailed the regional baseline air quality and predicted effects to air quality resulting from proposed project's activities.

#### 7.7.3.2 Regional Context

The proposed project is situated in remote Western Australia within the Shire of Ngaanyatjarraku. The nearest towns/settlements that have the potential to be impacted by air quality related impacts from the proposed project are Jameson (Mantamaru, approximate population of 160 people), Blackstone (Papulankutja, approximate population of 153 people) and Warburton (approximate population of 580 people) located approximately 26 km north, 50 km east and 110 km west of the Proposal respectively.

The meteorological conditions that influence air quality in the project area are detailed in Section 2.6.2.

As there are few anthropogenic influences in the area, the natural contributors to background dust (particulate) concentration include bush fires and wind erosion.

#### 7.7.3.3 Environmental Values

Environmental values are defined under Part I S3 of the EP Act as a beneficial use, or an ecosystem health condition. The ecosystem health values as they related to EPA's Air Quality Guideline (EPA, 2020a) are human health and amenity.

For the purposes of this assessment, human health and amenity values have been considered in the context of impacts to sensitive receptors. Sensitive receptors are defined as living things that can be adversely impacted by exposure to pollution or contamination. In relation to air quality and the EPA Air Quality Guideline, these are typically those humans who are at heightened risk of negative health impacts due to exposure to air pollution e.g. children, elderly, asthmatics. Sensitive receptor locations are where these people congregate e.g. schools, hospitals, elderly housing areas and where populations reside (in accordance with the National Environment Protection (Ambient Air Quality) Measure).

The nearest potential sensitive receptor locations to the proposed project are those in Jameson (Mantamaru), located 26 km north of the project.

#### 7.7.3.4 Regional Ambient Air Quality

Project-specific air quality monitoring was not undertaken due to the remoteness of the proposed project from potential receptors and the lack of anthropogenic emission sources.

The closest location where air quality monitoring has been undertaken is Wingellina, 120 km east of the proposed project (Figure 7-70). Wingellina, like the project, is located in the Ngaanyatjarra IPA and the Yarnangu Ngaanyatjarraku Parna Native Tittle Determination Area. The Wingellina site is considered highly analogous to the proposed project as it is in a climatically and geologically similar area to the West Musgrave Province and experiences the same land uses (e.g. traditional land management by Traditional Owners). Estimated baseline air quality at the proposed project is considered analogous to the results collected for Wingellina (Table 7-89). Air quality monitoring undertaken as part of the Wingellina Nickel Project baseline (Hinckley Range, 2015) included:

- Eight depositional dust gauges (August 2008 to April 2011)
- Particulate monitoring using Tapered Elemental Oscillating Microbalance (TEOM) monitoring equipment (October 2010 to November 2011).

**Table 7-89: Estimated Baseline Air Quality at West Musgrave**

| Parameter | Value and Unit |
|---|---|
| Maximum 24-hour average $PM_{10}$ | 19.7 µg/m$^3$ |
| Maximum 24-hour average $PM_{2.5}$ | 8.7 µg/m$^3$ |
| Annual average $PM_{10}$ | 11.3 µg/m$^3$ |
| Annual average $PM_{2.5}$ (estimated, not measured) | 7.7 µg/m$^3$ |
| Background average dust deposition rate (all seasons) | 0.9 g/m$^2$/month |

To provide context to the estimated baseline air quality, the results of monitoring at other similar (arid and semi-arid) sites within Western Australia and South Australia are presented in Table 7-90. These data represent the most recent externally reported annual averages, however the OZ Minerals Carrapateena operation represents a long-term average from 2013–2017 inclusive. This data indicates that the assumed baseline air quality for the proposed project is broadly equivalent, although slightly better, to that measured at other arid and semi-arid locations within central Australia. This likely reflects the lack of anthropogenic emission sources, such as pastoral operations.

**Table 7-90: Air Quality in Arid and Semi-Arid Areas of Australia**

| Project Site | Distance from Project (km) | $PM_{10}$ (µg/m$^3$) | | $PM_{2.5}$ (µg/m$^3$) | | Dust Deposition (g/m$^2$/month) |
|---|---|---|---|---|---|---|
| | | 24-hr | Annual | 24-hr | Annual | |
| Carrapateena (OZ Minerals) | 1,110 | 3.0–23.0 | 13.0 | 1.0–7.7 | 3.9 | 1.6 |
| Olympic Dam (BHP) | 1,010 | N/A | N/A | N/A | N/A | 1.9 |
| Tarcoola Gold (WPG Resources) | 840 | 25 | 15 | 12.5 | 2.5 | 2 |
| Kalgoorlie (DWER 2018 NEPM monitoring) | 810 | 29.7 | 12.8 | 15.9 | 5.1 | N/A |
| Kintyre (Cameco) | 700 | N/A | N/A | N/A | N/A | 2.0 |
| Mulga Rock (Vimy Resources) | 590 | N/A | 13.5 | N/A | N/A | 0.6 |
| Wiluna Uranium Project (Toro Energy) | 760 | N/A | 16 | N/A | N/A | N/A |


Figure 7-70: Location of Regional Air Quality Monitoring in Relation to the Proposed Project

WEST MUSGRAVE COPPER AND NICKEL PROJECT

### 7.7.4 Potential Impacts

The EPA Guidance for air quality provides several mechanisms ('issues') for consideration during the EIA process, specifically:

- Maintaining ambient air quality to protect human health
- Air sheds and cumulative impacts
- Particulates.

A systematic assessment of how the proposed project interacts with the environment through air quality and greenhouse gas was undertaken (Appendix H1). In particular, the assessment aimed to confirm the potential for the proposed project's activities to interact with sensitive receptors that may result in direct, indirect or cumulative impacts to air quality-related environmental values. Based on this assessment the following potential impact events were identified:

- Emissions of particulates from the proposed project's activities (including ore and waste rock material handling, crushing and wheel-generated dusts) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community)
- Emissions of gaseous pollutants from the proposed project's activities (including operation of mobile fleet and diesel electricity generation) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community)
- Emissions of dust from the proposed project's activities negatively impact amenity values (such as increases in dust deposition and changes in visual amenity) in the region (Section 6.1, not addressed in this section).
- Emissions of dust from the proposed project's activities (including ore and waste rock material handling, crushing and wheel-generated dusts) contribute to a decrease in the richness, abundance and diversity of native vegetation and, indirectly, fauna habitat (Section 7.1 and Section 7.6, not assessed in this section).

### 7.7.5 Assessment of Impacts

Each potential impact event identified in Section 7.7.4 was assessed to understand the mechanism by which impacts may occur, and to determine the inherent (unmitigated) risk of each potential impact.

Using the consequence and likelihood tables in the EIA Framework (Appendix A3), it was determined that the inherent risk of any of the potential impact events not meeting the EPA Objective for Air Quality as a result of the proposed project were 'Low' (Table 7-91 and Table 7-92), thereby not considered to require any specific avoidance and mitigations to meet the EPA's Objective for Air Quality.

#### 7.7.5.1 Determination of Impact

The three most significant air pollutants expected to be emitted by the proposed project include:

- Particulates (dust) generated by mining and ore and waste rock material handling
- Combustion product emissions associated with the use of diesel electricity generation and the use of diesel-powered mining and earth moving vehicles that emit gaseous pollutants (NOx, SOx, VOCs)
- Particulates (dust) generated from road transport on unpaved roads to and from the proposed project.

These are each described in more detail in Appendix H1.

**Emission of Particulates (Dusts) from Project Activities**

The EPA (2005) provides advice on the use of generic separation distances (buffers) between industrial and sensitive land uses to avoid conflicts between incompatible land uses. The distances outlined in the guideline are not intended to be absolute separation distances, rather they are a default distance for the purposes of identifying the need for specific separation distance or buffer definition studies and for providing general guidance on separation distances in the absence of site specific technical studies. The specified minimum separation distance between large open cut mining operations and residences is 1,500 – 3,000 m. This range is more conservative than similar guidelines in other states (e.g. Queensland 1,000 m (Queensland Government, 2016), ACT 500 m (ACT Government, 2018), Northern Territory 600 m (NT EPA, 2017), Victoria 1,000 m (EPA Victoria, 2013)).

Benchmarking of air quality modelling and monitoring data at the OZ Minerals Prominent Hill operation, being of similar scale (12 Mtpa throughput) and in a similar arid location, together with benchmarking of emissions concentrations (modelling and monitoring) at other mine sites, demonstrate that concentrations of $PM_{10}$ dust generated from the operation is indistinguishable from background within less than 20 km of the mining operation, and the National Environment Protection (Ambient Air Quality) Measure criterion for $PM_{10}$ met approximately 4 km from the operations, which is reasonably consistent with the EPA (2005) separation distance guideline value.

Due to the remoteness of the site from the nearest sensitive (human) receptor and the lack of cumulative emissions sources, air quality (dispersion) modelling was not considered necessary.

OZ Minerals recognises that dust from unpaved roads may result in a change in air quality at Jameson (Mantamaru) and that off-site wheel-generated dust from product transport is expected to be generated by heavy vehicles travelling on the unpaved site access road and the bypass road near to Jameson (Mantamaru). However, the location of the bypass road in relation to the township (being 1.5 km) is considered to be sufficient to account for uncertainties in the nature of dust emission from this road based on previous studies, benchmarking and operational experience, which suggest that effects associated with wheel-generated dusts are typically limited to an extent of tens to hundreds of metres (e.g. Bluett et al, 2017, Cuscino et al, 2006 and SA EPA, 2016). In addition to the location of the bypass road, other mitigations will include regular maintenance and reduced speeds to reduce the potential for wheel-generated dust. No further dust mitigation measures have been specifically proposed, however if dust becomes a matter of community concern, then additional mitigation in the form of a further reduction in vehicle speed, the use of water carts and/or the addition of road surface treatments (e.g. polymer or bitumen applications) may be considered.

The assessment of inherent (unmitigated) risk of emissions of particulates from the proposed project's activities (including ore and waste rock material handling, crushing and wheel-generated dusts) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community) is provided in Table 7-91, and was determined to represent a Low risk. Section 7.7.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-91: Assessment of Inherent Risk – Emissions of Particulate Dust Impacts Human Health Values at Receptor Locations**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Emissions of particulates from the Proposal's activities (including ore and waste rock material handling, crushing and wheel-generated dusts) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community) | Rare | Minor | Low | The nearest sensitive receptor (Jameson (Mantamaru) Community) is approximately 26 km from the proposed project.<br>The distance between the product transport road and the nearest receptor (1.5 km) is significant in the context of wheel-generated dust emissions, which are typically limited to an extent of tens to hundreds of metres.<br>As such there is predicted to be no significant or irreversible impact to sensitive receptors and environmental values. |

### Emission of Gaseous Pollutants from Project Activities

The combustion of up to 1 ML/annum of diesel in on-site mobile fleet (e.g. haul trucks and excavators/shovels) and in the generation of back-up electricity to support the base case renewable options would release combustion gases such as carbon monoxide, fluoride compounds, formaldehyde (methyl aldehyde), oxides of nitrogen, fine particulate matter, polycyclic aromatic hydrocarbons, sulphur dioxide and volatile organic compounds (DEWHA, 2008). By contrast, vehicles registered for use on public roads consumed 2,167 ML of diesel in the 12 months ending 30 June 2018 (ABS, 2019) within Western Australia, with unregistered vehicles associated with mining operations also using significant volumes of diesel (e.g. Shastri et al, 2012)

Given the relatively small volume of annual diesel consumption and the limited sources of gaseous emissions in the local area, impacts are expected to be highly localised and would not affect significant receptors due to the large separation distances.

The assessment of inherent (unmitigated) risk of emissions of gaseous pollutants from the proposed project's activities (including from the operation of mobile fleet and diesel electricity generation) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community) is provided in Table 7-92, and was determined to represent a Low risk. Section 7.7.6 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-92: Assessment of Inherent Risk – Emissions of Gaseous Pollutants Impact Human Health Values at Receptor Locations**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Emissions of gaseous pollutants from the Proposal's activities (including from the operation of mobile fleet and diesel electricity generation) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community) | Rare | Minor | Low | The nearest sensitive receptor (Jameson (Mantamaru) Community) is approximately 26 km from the Proposal. Given these separation distances, there is predicted to be no significant or irreversible impact to sensitive receptors and environmental values (including those at Jameson (Mantamaru)) |

## 7.7.6 Mitigation Measures

As described in Section 7.7.5, the inherent risk associated with impacts to air quality were assessed as Low, and thus would require no further mitigation in order to meet the EPA's Objectives relating to air quality and greenhouse gas. Never-the-less, and in keeping with OZ Minerals' commitment to reduce the severity of potential impacts to ALARP, mitigation measures are proposed as described in Table 7-93.

**Table 7-93: Mitigation Measures for Air Quality and Greenhouse Gas Environmental Factor**

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| Emissions of particulates from the Proposal's activities (including ore and waste rock material handling, crushing and wheel-generated dusts) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community) | **Measures to Avoid**<br>• The proposed project's activities are located 26 km from the nearest community receptors<br>• The new bypass road has been constructed 1.5 km from the nearest community receptors<br>• The bypass road intersection has been staggered to reduce vehicle speeds and therefore the potential for dust generation<br>• Agreement has been made with the Traditional Owners that some sections of road will be improved as agreed in the Mining Agreement, these areas may include the bypass road 1.5 km west of Jameson (Mantamaru) and a small 1 km section of road along the main access road between Jameson (Mantamaru) and the proposed project area<br>**Measures to Minimise**<br>• Land disturbance process to ensure that the cleared area is as small as reasonably required thereby reducing the amount of exposed dust producing surfaces<br>• The VRM operates under negative pressure (vacuum) and as such, does not expel dust. Air is emitted to the atmosphere via a baghouse to collect any entrained dusts. The dust extraction system is fitted with a two-stage dust detection system. The bag filter is equipped with broken bag detectors and there is a dust monitoring system installed in the stack outlet.<br>• External VRM belts (rejects and products) are covered with the exception of the VRM feed (75 mm nominal size) out of the crushing circuit for which dust will be mitigated by spray misters as per a standard comminution circuit. Fine ground product is kept in sealed silos<br>• Where practical, machinery movements would be confined to defined roads and tracks<br>• Vehicle hygiene measures to be adopted for the concentrate storage shed (including covered)<br>• Imposition of speed limits for vehicle traffic<br>• On-site dust minimisation measures would be implemented using water carts and fixed sprays where necessary<br>• Off-site dust minimisation measures would be implemented on the bypass road, including consideration of the use of polymer or bitumen road surface applications as necessary<br>**Measures to Rehabilitate** | Rare | Minor | Low |

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| | • Progressive rehabilitation would be undertaken on disturbed areas as they become available<br>• Preparation and regular update of a Mine Closure Plan consistent with DMIRS and EPA Guidelines for Preparing Mine Closure Plans (DMIRS, 2020b) | | | |
| Emissions of gaseous pollutants from the Proposal's activities (including from the operation of mobile fleet and diesel electricity generation) contribute to impacts to human health values at receptor locations (i.e. Jameson (Mantamaru) community) | **Measures to Avoid**<br>• The proposed project's activities are located 26 km from the nearest community receptors<br>**Measures to Minimise**<br>• Appropriate emission control mechanisms would be selected to ensure that emissions comply with statutory requirements and acceptable standards<br>• Diesel engines would be regularly serviced to maintain efficiency and minimise harmful combustion products | Rare | Minor | Low |

### 7.7.7 Predicted Outcome

The predicted outcome was determined in accordance with the EIA Framework developed for the Proposal (Appendix A3), and was based on the assessment of impacts (Section 7.7.5) and the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e). The results of this assessment are presented in Table 7-94.

Based on this assessment, the Proposal was assessed as having no significant or irreversible impact on air quality-related environmental values (specifically human health and amenity) and the EPA Objective for air quality 'To maintain air quality and minimise emissions so that environmental values are protected' would be met should the Proposal be implemented.

**Table 7-94: Assessment of Impact Significance – Air Quality**

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Values, sensitivity and quality of the impacted environment which is likely to be impacted | Baseline air quality for the proposed project is broadly equivalent, although slightly better to that measured at other arid and semi-arid locations within central Australia. This likely reflects the lack of anthropogenic emission sources such as pastoral operations and other mines<br>Sensitive receptors to dust and emissions related potential impacts have been identified these include Jameson (Mantamaru) community 26 km from the Main Development Area. A bypass road around Jameson (Mantamaru) community has in-part been completed which is offsets from the product transport alignment by 1.5 km<br>All uninhabited receptors to dust and air emissions such as ethnographic sites have been addressed in the Social Surroundings Section 6.1 | Not Significant |
| Extent (intensity, duration, magnitude and footprint) of the likely impacts | Based on a program of literature review and project benchmarking for other similar projects, changes to air quality would be indistinguishable from background with approximately 20 km from the project sources, and compliant with relevant air quality criteria within 3 to 4 km of the main dust generating activities in the Development Envelope (Appendix H1)<br>Changes to air quality within this extent would be limited to the duration of the operation, with air quality returning to baseline conditions upon project closure | Not Significant |
| The consequence of the likely impacts (or change) | The consequences of various greenhouse gas related impact events have been assessed using a risk-based framework which included specifically designed consequence criteria for the air quality Environmental Factor. The results of the risk assessment determined any need for further mitigation measures. A summary of the risk assessment is provided in Section 7.7.5. Both the inherent and residual risks to air quality as a result of the proposed project were assessed as being Low and as such were considered not significant | Not Significant |
| The resilience of the environment to cope with the impact or change | Particulate and gaseous emissions from the proposed project would result in change in local air quality, however this would not affect human health or amenity due to the significant separation distances between the proposed project and the nearest receptors. Dispersion of localised emissions would readily occur in an area with low anthropogenic emissions<br>Changes to air quality within this extent would be limited to the duration of the operation, with air quality returning to baseline conditions upon project closure | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Cumulative impacts with other existing or reasonably foreseeable activities, developments and land uses | There are no other existing or reasonably foreseeable activities, developments or land uses proposed within the areas potentially impacted by the proposed project, which may have a cumulative impact upon air quality and their associated values<br>The proposed project represents the only significant development for approximately 450 km | Not Significant |
| Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment | Connections and interactions between environmental components were considered by the SPR assessment and indirect impact assessment to social surroundings. Impacts from air emissions have been considered for other aspects and are addressed in other sections of the document. Impacts considering connections and interactions inherent to Air Quality are not considered to be significant | Not Significant |
| The level of confidence in the predictions of impacts and the success of proposed mitigation | Although air quality modelling and monitoring was not undertaken, there is a significant body of knowledge regarding air emissions from mining operations and air quality in arid environments. In particular, baseline air quality data was attained from the Wingellina Nickel project. The Wingellina site is considered highly analogous to the proposed project as it is in a climatically and geologically similar area to the West Musgrave Province and experiences the same land uses (e.g. traditional land management by Traditional Owners). There is no uncertainty in relation to the proposed project and receptor locations, which is the primary mitigating factor for this assessment | Not Significant |
| Public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment | OZ Minerals developed and implemented a detailed and thorough stakeholder engagement program which included relevant Ngaanyatjarra People, the Ngaanyatjarra Council, relevant Shires, government, and some special interest groups. The focus of this engagement program was on high interest and high influence stakeholder groups, particularly land rights holders. Engagement activities included project briefings, attendance by the Ngaanyatjarra Council to regulator meetings, numerous community meetings, a number of large heritage surveys, a third-party environmental peer review of the Section 38 Referral submission and associated specialist studies on behalf of the Ngaanyatjarra People to ensure their interests and concerns had been appropriately considered, and a dedicated on-country consultation with relevant West Musgrave Traditional Owners relating to the outcomes of this EP Act Part IV impact assessment. A summary of consultation is provided within a consultation-specific record (Appendix A4) and project-specific consultation register (Appendix A5) | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| | During on-country consultations Traditional Owners were taken to a number of sites around the proposed project including the proposed bypass road near Jameson (Mantamaru), a number of ethnographic sites near to the Development Envelope and to the proposed Main Development Area. The potential impacts of dust and air quality as experienced at these sites was explained to Traditional Owners. No material concerns relating to any of the information shared with Traditional Owners relating to air quality impacts were raised, however the community expressed a preference for sealing sections of road both at the Jameson (Mantamaru) bypass and a 1 km section along the main access road between Jameson (Mantamaru) and the proposed project site. This control measure has been agreed and has been highlighted Section 7.7.6<br>All areas identified by Traditional Owner, Ngaanyatjarra Council and other stakeholders relating to potential impacts inherent to air quality values have been considered in this assessment | |

## 7.8 Greenhouse Gas Emissions

### 7.8.1 EPA Objective

The EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) lists the following as their objective for greenhouse gas emissions.

To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change

The objective recognises the fundamental link between greenhouse gas (GHG) emissions and other Environmental Factors through effects on climate. For example, climate change has already caused a significant drying of the State's south-west, which in turn places significant additional pressures on water resources, flora and fauna, marine environmental quality, and social surroundings.

This section addresses one of the major causes of a changing climate, however the potential impacts of changes in the climate have been considered under each relevant Environmental Factor. EPA guidance with respect to maintaining air quality and minimising emissions for human health and amenity are dealt with in Section 7.7 Air Quality.

### 7.8.2 Policy and Guidance

GHG emissions are addressed under State legislation, primarily governed by the *Environmental Protection Act, 1986* (WA).

In addition to State legislation, the following policy and guidance statements were considered in the impact assessment for greenhouse gas emissions:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA, 2020e)
- EPA Environmental Factor Guideline – Greenhouse Gas Emissions (EPA, 2020f)
- State Greenhouse Gas Emissions Policy for Major Projects (Government of Western Australia, 2019a).

The EPA Guidance for GHG Emissions provides several items for consideration during the EIA process, specifically:

- Application of the mitigation hierarchy to avoid, reduce and offset emissions
- The interim and long-term emissions reduction targets the proponent proposes to achieve
- Adoption of best practice design, technology and management appropriate to mitigate GHG emissions
- Whether proposed mitigation is plausible, timely, achievable and is all that is reasonable and practicable.

### 7.8.3 Receiving Environment

#### 7.8.3.1 Studies and Survey Effort

Two assessments relating to GHG emissions were undertaken to inform the Proposal. These studies were used to systematically characterise the proposed project's potential GHG emissions and to inform considerations that the proposed project may need to make for various climate change projections. These assessments included:

- Greenhouse Gas Emissions scenario modelling conducted by Greenbase (Appendix I1). This assessment quantified the volume of emissions associated with various project alternatives across all project phases.
- Assessment of Climate Change Projections (Appendix I2). This assessment used recognised climate models to predict various climate change scenarios for the proposed project site over the life of the project and post-closure. These climate projections have and would continue to inform project design and ensure preparedness for any potential risks that may result from worst-case climate change projections.

#### 7.8.3.2 OZ Minerals' Approach to Climate Change

OZ Minerals accept the international scientific consensus of the Intergovernmental Panel on Climate Change (IPCC), recognise the 2015 Paris Agreement and support its commitment to limit global average temperature rise to below 2 degrees Celsius and pursue 1.5 degrees Celsius. To this end, the proposed project would be managed in accordance with the OZ Minerals Climate Change Statement, described in the following section.

#### Climate Change Statement

OZ Minerals is committed to building our business sustainably — operating ethically, safely, minimising our environmental footprint, ensuring we are well-governed and are socially responsible. We deliver our sustainability aspirations by focusing on value creation for our stakeholders and we report on our value creation achievements under the sustainability elements of Safety, Environment, Community, Health and Wellbeing (www.ozminerals.com/media/reports/annual).

A key focus of our commitment to sustainability relate to the threat of climate change. OZ Minerals recognises that climate change is a shared global challenge that requires business, government and society to work together. We are committed to playing our part in reducing greenhouse gas emissions and preparing for the physical impacts of climate change and the transition to a net-zero emissions by 2050.

OZ Minerals recognises there is a need for large reductions in global greenhouse gas emissions to reduce the scale of climate change and avoid the most severe impacts. This, coupled with the world's increasing requirement for secure, affordable energy, creates significant challenges which are best met by companies, governments and society working together. This climate challenge statement has been integral to the thinking when designing the WMP.

### Climate Change Risk Management

OZ Minerals recognises that the physical and non-physical impacts of climate change may affect its assets, productivity, the markets in which it sells its products, and the communities in which we operate. Risks related to the physical impacts of climate change include acute risks resulting from increased severity of extreme weather events and chronic risks resulting from longer-term changes in climate patterns. Non-physical risks arise from a variety of policy, regulatory, legal, technology, financial and market responses to the challenges posed by climate change and the transition to a lower-carbon economy. Table 7-95 describes the proponent approach to climate change risk management.

**Table 7-95: Climate Change Risk Management**

| Aspect | Description |
|---|---|
| Risk Trend Analysis | Increasing risk as community, investor and regulatory standards and expectations in relation to climate change continued to increase during 2019 and are expected to continue through 2020 and beyond |
| Threat | Climate change can cause disruption to mine production, logistics, and water supply as a result of extreme weather events. As regulatory agencies respond to climate change over the medium term, costs of inputs may rise and restrictions may be placed on how certain resources are provided, transported, and used. This may adversely impact the execution of the strategy and the ability of assets to operate efficiently |
| Opportunity | Climate change, combined with regulatory change, also has the potential to be a catalyst for growth in industries that require copper and could result in upward pressure on copper prices. Ability to proactively use lower-emission sources of energy, efficient production and distribution processes, new technologies, water and energy efficiency, and proactive participation in the carbon market can result in reduced operating costs, increased production capacity, an improved revenue and liquidity position. This can also increase reputational benefits and create value for our key stakeholders |
| Mitigation | OZ Minerals is committed to reducing the energy and water intensity of its operations, developing innovative practices in relation to chemical processing, and being more efficient in its transportation and processing activities. OZ Minerals' power strategy is focussed on the four key elements for all its operations: distribution, generation, procurement and demand management. Initiatives are underway across operations to reduce OZ Minerals' environmental footprint, including energy intensity, water use, waste management, and transport and logistics. We are focused on reducing carbon emissions, investing in low emissions technologies, managing climate-related threats and opportunities, and working collaboratively with others to contribute to identify improvements and transformational change. OZ Minerals has published a Climate Change Statement on its website which commits to playing its part in achieving net-zero carbon emissions by 2050 |

### Taskforce on Climate-Related Financial Disclosure

OZ Minerals has prepared a roadmap for reporting its integrated climate change risks and climate-related financial disclosures in-line with the Task Force on Climate-related Financial Disclosure (TCFD) framework. The TCFD framework would also provide a process to gain a better understanding of physical and financial climate-related threats and opportunities, which can then be further integrated into our Company standards and policies.

OZ Minerals' TCFD Roadmap has been developed in alignment with our OZWay (Section 2.2) of working to support integration into our business. Integration through our strategy, governance framework, including risk and other process standards, policies and performance standards, ensures climate change risk management can be implemented across the Company and our devolved operating assets. As the Roadmap outlines, we aim to leverage and modify our Risk Management Specifications to comprehensively accommodate opportunities and threats arising from climate-related risk. Identifying both opportunities and threats for our business is key to delivering our strategy, in which creating value for all stakeholders is central. We would continue to assure our responses to our identified climate risks are occurring and we would disclose progress in our annual reporting.

### 7.8.3.3 Climate Change Context

Since the start of the industrial revolution 260 years ago, the Earth's land surface has warmed by about 1.5°C. This global warming is attributed to increased radiative forcing (i.e. increases in the difference between insolation (sunlight) absorbed by the Earth and energy radiated back to space) resulting from human-generated GHGs. These increases in anthropogenic GHGs include $CO_2$, methane, nitrous oxide, ozone and halocarbons (Sudmeyer *et al*, 2016).

As a result of increased GHGs in the atmosphere and increases in radiative forcing, Western Australia's climate has changed over the last century, particularly over the last 50 years. These changes can be summarised as follows:

- Average temperatures have risen approximately 1°C
- Rainfall has increased over the north and interior, declined along the west coast, and declined by about 20 percent over the lower south-west of the Western Australia
- Frost risk has increased in central and eastern areas of the grainbelt
- Fire risk has increased across Western Australia (Department of Primary Industries and Regional Development 2018).

The BoM trend maps indicate general rises in temperature and rainfall across central Australia. The following summarises the general trends observed in the area where the proposed project is located (Department of Primary Industries and Regional Development, 2018):

- Temperature: Between 1910 and 2013, average annual temperature increased by 1.0°C.

- Hot spells: the intensity of hot spells increased by 1°C to about 41°C, during the period 1958–2010 and the frequency and duration of hot spells has generally increased.
- Rainfall: Over the last 60 years, annual rainfall has increased. A recent study of tree growth in the Pilbara found that 5 of the 10 wettest years in the last 210 years occurred in the last two decades.
- Tropical cyclones: Over the last 40 years, the frequency of tropical cyclones has not changed significantly in WA, but there is some evidence that the frequency of the most intense cyclones has increased.
- Fire risk: Fire danger has increased across Australia over the last 40 years in response to drier and hotter conditions. Between 1973 and 2010 annualised fire weather danger showed a statistically significant increase ($P<0.05$) at Perth, Kalgoorlie and Broome. On a seasonal basis, fire weather danger increased more in winter and spring, compared to summer and autumn. The frequency of extreme fires has also increased, with significant increases at Perth, Kalgoorlie and Broome.
- Water supplies: Where surface water has been monitored, there has been a trend over the last ten years for streamflow to increase in the Kimberley and decrease in the south-west. Where aquifers have been measured, levels are generally stable or seasonal in the Kimberley, Pilbara and Gascoyne regions; increasing, stable or seasonal in the mid-west; and stable or decreasing in the south-west Western Australia.

### 7.8.3.4 Greenhouse Gas Context

#### Greenhouse Gas Emissions

This GHG assessment relates to the six categories of greenhouse gases covered by the United Nations Framework Convention on Climate Change (UNFCCC) Reporting Guidelines on Annual Inventories. These gases are carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), sulphur hexafluoride ($SF_6$), hydro fluorocarbons (HFCs) and perfluorocarbons (PFCs).

Australia is currently contributing around 1.3 percent of global GHG emissions. Australia's emissions for the year to March 2019 were approximately 540 million tonnes carbon dioxide equivalent ($CO_2$-e), up 0.6 percent on the previous year, primarily due to increased liquefied natural gas (LNG) exports. This is 11.7 percent below emissions in 2005, and the National Inventory Reports 2014 to 2017 indicate that Australia's GHG emissions have risen each year since 2014 (EPA, 2020f).

In 2017, Western Australia (WA) contributed 88.5 million tonnes $CO_2$-e, which is a 23 percent increase from 2005 levels. The State Greenhouse Gas Inventory show a steady increase in GHG emissions in WA from the early 1990s. Generally, emissions growth in WA is expected to continue in the short to medium term.

## Regulatory Approach to Greenhouse Gas Emissions

The UNFCCC provides the framework for international co-operation to reduce global GHG emissions and limit temperature increases. The UNFCCC Paris Agreement entered into force on 4 November 2016 and Australia is currently committed to reducing GHG emissions by 26 to 28 percent below 2005 levels by 2030. The Paris Agreement states that net zero emissions will be required in the second half of the century to achieve its goals of limiting warming to well below two degrees Celsius above pre-industrial levels (EPA, 2020f).

More recently, the IPCC's 1.5 report indicated that global emissions need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050, to limit global warming to 1.5 degrees Celsius.

Locally, the Government of Western Australia released the State Greenhouse Gas Emissions Policy for Major Projects (State Emissions Policy) in August 2019 (Government of Western Australia, 2019a). The State Emissions Policy commits the State Government to working with all sectors of the Western Australian economy to achieve net zero GHG emissions by 2050 and commits to working with the Australian Government's interim target of emission reductions of 26 to 28 percent by 2030. The State Emissions Policy contemplates that proponents of projects with significant emissions may develop GHG management plans that detail their contribution towards achieving net zero emissions by 2050. The State Emissions Policy declares that local innovation and local benefits are encouraged, particularly in the development of carbon offsets, and indicates a willingness to consider credible international offsets to limit abatement costs.

In further recognition of the role that climate change is having on Western Australia's environment, and reflecting the growing public interest in this matter, the Government of Western Australia released its Climate change in Western Australia – Issues Paper in September 2019. The State Government has also committed to developing a State Climate Policy based on this issues paper in 2020.

National and international greenhouse gas reporting standards define a set of distinct classes (scopes) of GHG emissions that delineate sources and associated responsibilities. Scope 1 GHG emissions are the emissions released to the atmosphere as a direct result of an activity, or a series of activities at a facility level. Scope 2 GHG emissions are the emissions from the consumption of an energy product. Scope 3 emissions are indirect GHG emissions other than scope 2 emissions that are generated in the wider community. Scope 3 emissions occur because of the activities of a facility, but from sources not owned or controlled by that facility's business.

In line with this, the EPA will have regard to this guideline when assessing new proposals resulting in an increase in GHG emissions, which may involve the EPA in the reconsideration of GHG conditions. Generally, GHG emissions from a proposal will be assessed where they exceed 100,000 tonnes of scope 1 emissions each year measured in CO2-e. This is currently the same as the threshold criteria for designation of a large facility under the Australian Government's Safeguard Mechanism.

### 7.8.4 Potential Impacts

The EPA Guidance for GHG emissions provides several mechanisms ('issues') for consideration during the EIA process, specifically:

- Consideration of all reasonable and practicable measures to mitigate harmful emissions
- Considerations regarding the application of GHG offsets, and specifically the mechanisms under which these are collected and assigned.

A systematic assessment of how the proposed project interacts with the environment through GHG emissions was undertaken (Appendix A2). In particular, the assessment aimed to confirm the potential for the proposed project's activities to interact with sensitive receptors that may result in direct, indirect or cumulative impacts to GHG-related environmental values. Based on this assessment the following potential impact event was identified:

- Emissions of GHGs from the proposed project's activities contribute to climate change and increase the State's GHG emissions.

### 7.8.5 Assessment of Impacts

The potential impact event identified Section 7.8.3.4 was assessed to understand the mechanism by which it may occur and, using the consequence and likelihood tables in the EIA Framework (Appendix A3), determine its inherent (unmitigated) risk.

Using the consequence and likelihood tables in the EIA Framework (Appendix A3), it was determined that the inherent risk of the potential impact event not meeting the EPA Objective for Greenhouse Gas as a result of the proposed project were Medium (Table 7-98), thereby not considered to require any specific avoidance and mitigations to meet the EPA's Objective for Greenhouse Gas. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP (Section 7.8.5.2).

Assessment of greenhouse gas emissions and climate change impacts is presented in the following sections.

#### 7.8.5.1 Greenhouse Gas Emissions

The three most significant sources of GHG emissions expected to be emitted by the proposed project include:

- Combustion product emissions associated with the use of diesel electricity generation
- Combustion product emissions associated with use of diesel-powered mining and earth moving vehicles
- Emissions from road transport to and from the proposed project.

Estimates of GHG emissions from the proposed project have been prepared using methods and emissions factors from the NGER (Measurement) Determination 2008 for four operational scenarios. For each scenario the diesel combusted for the mining fleet and LPG combusted over the life of the mine remain the same at 997,139 kL (223,381 kL transport and 773,758 kL non-transport) and 214 kL, respectively. The key difference between each scenario was the fuel combustion for power generation:

- Scenario 1: 100 percent diesel / 0 percent renewable (i.e. a typical 'business as usual' case)
- Scenario 2: 20 percent diesel / 80 percent renewable
- Scenario 3: 40 percent diesel / 60 percent renewable
- Scenario 4: 100 percent pipeline natural gas.

These are each described in more detail in Appendix I1.

Scenario 2 represents the current proposed project target, and current base case against which other scenarios were compared, however OZ Minerals recognises that some uncertainty exists relating to the availability and consistency of renewable energy sources such as wind and sun, and as such greenhouse gas emissions have been considered for a range between Scenario 3 and Scenario 2. A summary of these projected emissions is presented in Table 7-96 and the lifetime emissions profile for Scenario 2 is shown in Figure 7-71.

**Table 7-96: Projected Greenhouse Gas Emissions under Scenario 2 and Scenario 3**

| Scenario | Greenhouse Gas Emissions by Scope (average t $CO_2$-e/annum) | | Life-of-Mine Emissions (t $CO_2$-e) |
|---|---|---|---|
| | Scope 1 | Scope 2[1] | |
| Scenario 3 (60% renewable penetration) | 77,670 – 115,570 | 100,400 | 5,415,555 |
| Scenario 2 (80% renewable penetration) | 77,670 – 115,570 | 50,200 | 4,060,221 |

[1] Assumes that electricity is generated and purchased via an 'over-the-fence' contractual arrangement. Contractual arrangements for electricity supply are yet to be finalised.

The total predicted emissions generation over the life of the mine is 4,060,221 t $CO_2$-e with an emission intensity of 0.01560 t $CO_2$-e/tonne ore mined for Scenario 2, and 5,415,555 t $CO_2$-e and 0.02091 t $CO_2$-e/tonne ore mined for Scenario 3, respectively (Appendix I1 for more detail). Even under Scenario 3, this emissions intensity represents a significant improvement over business-as-usual emissions. A comparison of emissions intensity against other similar projects is presented in Table 7-97.

**Table 7-97: Benchmarking of Emissions Intensity**

| Operation | Emissions Intensity ($t\ CO_2$-e / t Ore Mined) |
|---|---|
| Prominent Hill (OZ Minerals) | 0.02863 |
| Tropicana (Independence Group)[1] | 0.02665 |
| Jaguar (Independence Group) | 0.07710 |
| Nova (Independence Group) | 0.10399 |
| **West Musgrave Project (OZ Minerals) – Scenario 2** | **0.01560** |
| **West Musgrave Project (OZ Minerals) – Scenario 3** | **0.02091** |

[1] Source: www.igo.com.au/sustainabilityreport/2017/86/#zoom=z

The assessment of inherent (unmitigated) risk of emissions of GHGs from the proposed project's activities contribute to climate change and increase the State's GHG emissions is provided in Table 7-98, and was determined to represent a Medium risk. Section 7.8.5.2 presents mitigation measures to further reduce the risk to ALARP.

**Table 7-98: Assessment of Inherent Risk – Emissions of Greenhouse Gases Contribute to Climate Change and Significantly Increases the States Emissions**

| Potential Impact Event | Likelihood | Consequence | Inherent Risk | Justification |
|---|---|---|---|---|
| Emissions of GHGs from the Proposal's activities contribute to climate change and significantly increase the State's GHG emissions | Almost certain | Minor | Medium | As a result of the high penetration of renewable electricity for the proposed project Scope 1 and Scope 2 GHG emissions have been modelled to a total of between 76,100 t $CO_2$-e per year (construction phase) to an operations phase average of between approximately 128,000 – 216,000 t $CO_2$-e per annum. Depending on the scenario, this represents up to a 136% (or up to 5.42 Mt $CO_2$-e over the life of mine) reduction over a standard 'business-as-usual' approach to electricity supply.<br>At the peak, this value represents approximately 0.2% of WA's total GHG emissions, and 0.03% of Australia's total annual GHG emissions. Therefore, impacts to air quality, as a result of GHG emissions, are considered to be minor |

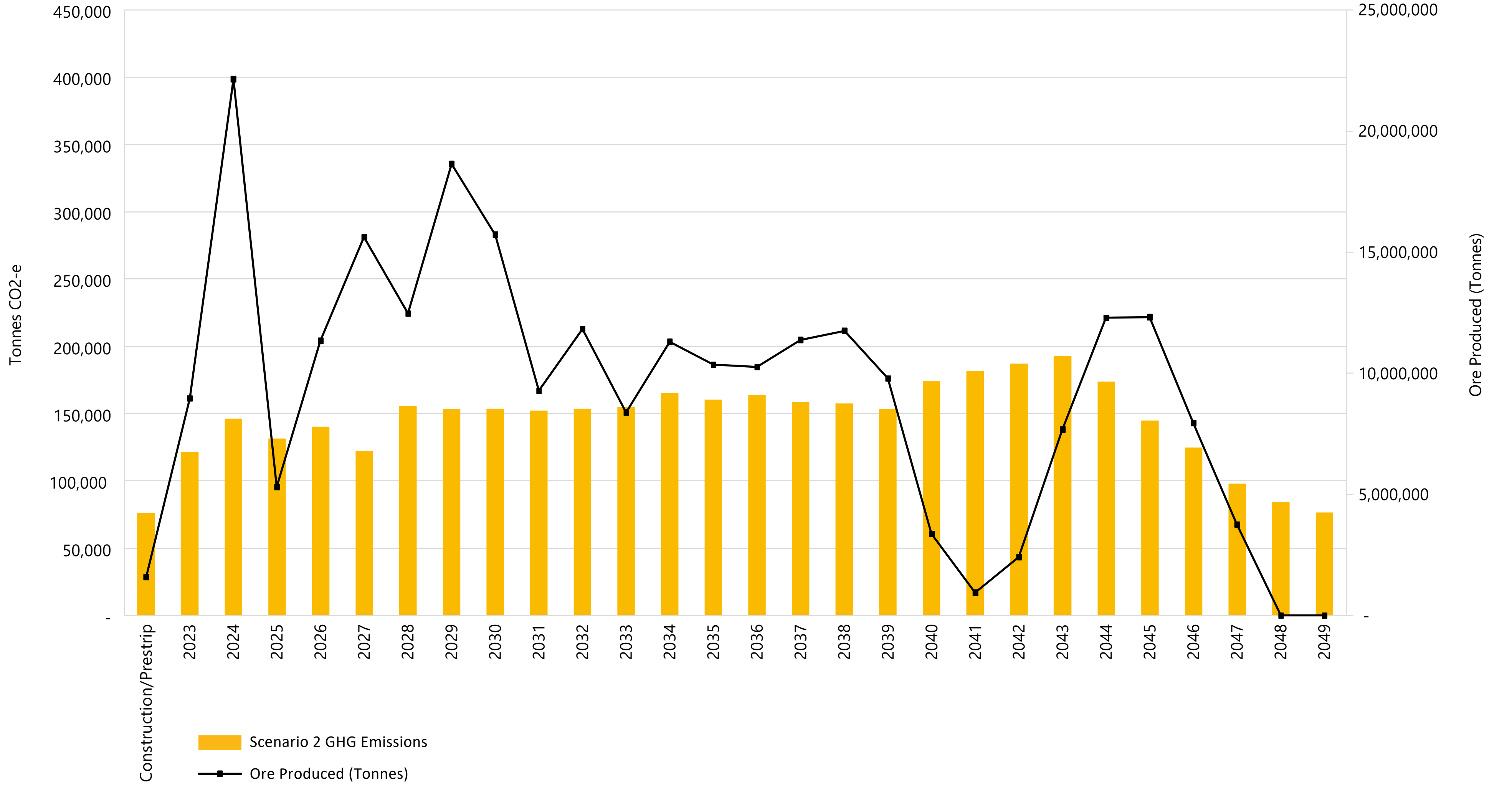


Figure 7-71: Projected Annual Emissions for the West Musgrave Project

#### 7.8.5.2 Climate Change

The potential impacts of a changing climate on both engineering design and the magnitude of potential impacts have been, and will continue to be, considered during project development. To facilitate this, the following climate data (and ranges, where relevant) would be considered during the design of site infrastructure. Complicating this is an understanding of the climate change projection ranges, and that different infrastructure may be sensitive to different values for the same climatic variable. For example, designing for worst-case surface water capture (i.e. water supply) may mean consideration of the climate change projection with the least rainfall, whereas for the management of surface water runoff, consideration must be given to the highest rainfall projection. Similarly, for potential evapotranspiration (PET), water supply storages may need to consider the greatest rate of PET to ensure an adequate water supply is maintained, whereas management of water on the TSF may need to consider the lesser PET rate to ensure that sufficient freeboard is maintained to account for lower evaporation.

**Temperature**

The following requirements would be taken into consideration regarding changes to temperature:

- For the proposed project's operational phase, design of project infrastructure would consider projections of mean daily temperatures between 0.8 and 1.7°C greater than those currently experienced.
- For the proposed project's post-closure phase, design of project infrastructure would consider projections of mean daily temperatures between 0.8 and 4.1°C greater than those currently experienced.

**Rainfall**

The following requirements would be taken into consideration regarding changes to rainfall:

- For the proposed project's operational phase, design of project infrastructure would consider that projections of current mean annual rainfall may reduce by up to 7 percent or increase by up to 8 percent.
- For the proposed project's post-closure phase, design of project infrastructure would consider that projections of mean annual rainfall may reduce by up to 17 percent or may increase by up to 15 percent over current ranges.

Climate analogues were used to understand the potential changes to rainfall intensity, frequency and duration (IFD) at the project site. During operations, the most common climate analogue is Windorah (Queensland, see Appendix I2) with rainfall intensities generally around 10–15 percent greater than current predicted for the project site. Post closure, the worst-case IFD data for the nominated climate analogues occurs at Onslow, with predictions of rainfall intensities up to approximately 100 percent greater than currently experienced at the project site.

**Potential Evapotranspiration**

Estimated annual pan evaporation and potential evapotranspiration for the proposed project area are currently 3,254 mm and 2,650 mm, respectively. For the purposes of understanding the future environment, it is considered that for infrastructure assessments relevant during the operations phase only, current mean annual potential evapotranspiration is predicted to increase by between two and six percent. Post-closure mean annual potential evapotranspiration is predicted to increase by between two and twelve percent.

### 7.8.6 Mitigation Measures

OZ Minerals has developed an approach to climate change management that was discussed in Section 7.8.3.2. Further to this, and as described in Section 7.8.5, the inherent (unmitigated) risk of the potential impact event not meeting the EPA Objective for Greenhouse Gas as a result of the proposed project is Medium, and therefore considered not to require any specific avoidance and mitigation measures to meet EPA's Objective for Greenhouse Gas. OZ Minerals has however identified a number of further avoidance and mitigation measures to reduce the risk of potential impacts to ALARP, mitigation measures are proposed as described in Table 7-99.

**Table 7-99: Mitigation Measures for Air Quality and Greenhouse Gas Environmental Factor**

| Potential Impact Event | Mitigation | Residual Risk Assessment | | |
|---|---|---|---|---|
| | | Likelihood | Consequence | Residual Risk |
| Emissions of GHGs from the Proposal's activities contribute to climate change and significantly increase the State's GHG emissions | **Measures to Avoid**<br>• The proposed project is targeting 70–90% of its power supply from renewable sources that would offset significant GHG generation. To this end, the following actions have been undertaken to date:<br>○ Collection of solar and wind data from 100 m tower on site, 24 months+ of data<br>○ Expression of Interested (EOI) process conducted to obtain proposals from invited parties, based on 60 MW load. EOI respondents are Australian and international, and include proposals for a wide range of technologies (renewable and non-renewable) to achieve low cost and high reliability — includes, wind, solar, battery, hydrogen, gas, diesel, trucked LNG<br>• Implementation of an Energy Strategy, the focus area of which is to increase load flexibility and energy efficiency to align with variable renewable energy, focused on four areas:<br>○ Energy Reduction and Efficiency (Energy demand reductions via innovative comminution and flotation solutions)<br>○ Energy Management and Load Flexibility (Active energy management via load scheduling matched to renewable energy generation forecasting)<br>○ Fuel substitution (Substitution of fossil fuel energy with renewable energy and long-term energy storage)<br>• The proposed project would continue to pursue lower energy generation machinery such as vertical roller mills to minimise the overall project electricity requirements as part of ongoing value optimisation<br>• The proposed project would continue to investigate mechanisms to decarbonise the project, particularly the mobile fleet<br>**Measures to Minimise**<br>• Energy efficiency and GHG emissions would be considered as part of equipment selection and purchase<br>• The project would integrate and disclose the vulnerability of the project to climate change risks as per the requirements for the TCFD<br>• Appropriate emission control mechanisms would be selected to ensure that emissions comply with statutory requirements and acceptable standards<br>• Develop a roadmap to net zero emissions by 2050 in-line with OZ Minerals' climate change statement and Western Australia's Greenhouse Gas Emissions Policy for Major Projects (DER, 2019a) | Almost certain | Minor | Medium |

### 7.8.7 Predicted Outcome

The predicted outcome was determined in accordance with the EIA Framework developed for the Proposal (Appendix A3), and was based on the assessment of impacts (Section 7.8.5) and the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e). The results of this assessment are presented in Table 7-100.

OZ Minerals has applied significant efforts to reduce the GHG emissions associated with the proposed project. As a result of these investigations and commitments, the GHG intensity of the proposed project (i.e. the amount of GHG emissions per unit of metal production) has been dramatically reduced over a 'business-as-usual' scenario, due largely to the proposed project's significant commitment to generate electricity via renewable technologies. This would result in a forecast GHG intensity between 1.5 and 10 times lower than other similar operations. In the context of State and National emissions, the additional GHG emissions associated with the proposed project are negligible (contributing up to 0.2 percent and 0.03 percent, respectively), and thus the EPA Objective for GHG Emissions 'To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change' would be met should the Proposal be implemented.

**Table 7-100: Assessment of Impact Significance – GHG Emissions**

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Values, sensitivity and quality of the impacted environment which is likely to be impacted | Western Australia's climate is currently changing in response to global (including national and state) anthropogenic GHG emissions. Emissions from the Proposal are considered minor in the context of state and national emissions and are unlikely to materially change the severity or timelines associated with existing climate change. For this assessment key values relating to greenhouse gas relate to percentage contributions to State and National total emissions | Not Significant |
| Extent (intensity, duration, magnitude and footprint) of the likely impacts | GHG emissions from the proposed project would only occur during the construction, operations and closure phases of the project. Post-closure, no further emissions would occur<br>A range of GHG scenarios have been modelled reflecting both a likely range of the proposed project, and or alternate scenarios. This proposal has considered both Scope 1 and Scope 2 GHG emissions. The impact assessment has considered both State and National impacts | Not Significant |
| The consequence of the likely impacts (or change) | The consequences of various greenhouse gas related impact events have been assessed using a risk-based framework which included specifically designed consequence criteria for the greenhouse gas Environmental Factor. The results of the risk assessment determined any need for further mitigation measures. A summary of the risk assessment is provided in Section 7.8.5. Both the inherent and residual risks to greenhouse gas as a result of the proposed project were assessed as being Medium | Not Significant |
| The resilience of the environment to cope with the impact or change | Western Australia's climate is currently changing in response to global (including national and state) anthropogenic GHG emissions. Emissions from the proposed project are considered minor in the context of state and national emissions and are unlikely to materially change the severity or timelines associated with existing climate change<br>Greenhouse gas emissions would be limited to the duration of the operation and return to baseline conditions upon project closure | Not Significant |
| Cumulative impacts with other existing or reasonably foreseeable activities, developments and land uses | There are no other existing or reasonably foreseeable activities, developments or land uses proposed within the areas potentially impacted by the proposed project, which may have a cumulative impact upon greenhouse gas and their associated values<br>The proposed project represents the only significant development for approximately 450 km | Not Significant |

| EPA Considerations for Significance | Summary of Assessment Outcomes | Impact Outcome (Significant/Not Significant) |
|---|---|---|
| Connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment | Connections and interactions between environmental components were considered in a site-specific climate change assessment. This assessment makes predictions about future climate scenarios which relate to adherence to the Paris agreement. These climate scenarios will be considered in the engineering design of the proposed project and addressed in greater detail during the Mining Proposal. Such considerations may include the sizing of bunding or dam freeboard in consideration to climate change projections | Not Significant |
| The level of confidence in the predictions of impacts and the success of proposed mitigation. | Significant uncertainty exists within the science of prediction of impacts of anthropogenic GHG emissions on the prevailing climate, and subsequent impacts on environmental values, reflected in the range of climate change scenarios modelled at an IPCC level, and the range of predicted variation of climate physicals (e.g. temperature and rainfall) when models are used to predict impacts at a regional scale<br>GHG emissions were calculated based on pre-feasibility study (+/- 25%) estimates of diesel consumption and electricity requirements. Variation of these values within these boundaries is not considered to materially alter the conclusions of this assessment in the context of the greater climate-change related uncertainties, especially so given the relatively small (0.2% State and 0.03% National) contribution of the proposed project to existing emissions | Not Significant |
| Public interest about the likely effect of the proposal or scheme, if implemented, on the environment and public information that informs the EPA's assessment. | OZ Minerals developed and implemented a detailed and thorough stakeholder engagement program which included relevant Ngaanyatjarra People, the Ngaanyatjarra Council, relevant Shires, government, and some special interest groups. The focus of this engagement program was on high interest and high influence stakeholder groups, particularly land rights holders. Engagement activities included project briefings, attendance by the Ngaanyatjarra Council to regulator meetings, numerous community meetings, a number of large heritage surveys, and a third-party environmental peer review of the Section 38 Referral submission and associated specialist studies on behalf of the Ngaanyatjarra People to ensure their interests and concerns relating had been appropriately considered, and a dedicated on-country consultation with relevant west Musgrave Traditional Owners relating to the outcomes of this EP Act Part IV impact assessment. A summary of consultation is provided within a consultation-specific record (Appendix A4) and project-specific consultation register (Appendix A5)<br>All areas identified by Traditional Owner, Ngaanyatjarra Council and other stakeholders relating to potential impacts inherent to greenhouse gas values have been considered in this assessment | Not Significant |

## 7.9 Human Health

### 7.9.1 EPA Objective

The EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) lists the following as their objective for human health.

To protect human health from significant harm

In the context of this factor and objective, the EPA's primary focus is the consideration of possible impacts to human health arising from the emissions of radiation. Other factors such as emissions to air and discharges to soil and inland waters are dealt with in Air Quality (Section 7.7), Terrestrial Environmental Quality (Section 7.5) and Inland Waters (Section 7.3) assessments.

### 7.9.2 Policy and Guidance

Human Health is protected under Commonwealth and State legislation, primarily governed by three Acts:

- *Environment Protection and Biodiversity Conservation Act, 1999* (Cth)
- *Environmental Protection Act, 1986* (WA)
- *Radiation Safety Act, 1975* (WA).

In addition to Commonwealth and State legislation, the following policy and guidance statements were considered in the assessment for human health:

- EPA Statement of Environmental Principles, Factors and Objectives (EPA, 2020e)
- EPA Environmental Factor Guideline – Human Health (EPA, 2016m)
- Code of Practice and Safety Guide: Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing, RPS9 (ARPANSA, 2005).

### 7.9.3 Receiving Environment

#### 7.9.3.1 Studies and Survey Effort

In support of the assessment of this Environmental Factor, studies were used to systematically characterise the proposed project's potential impacts to human health and to inform considerations that the proposed project may need to make to mitigate potential impacts. These assessments included:

- Static Waste Rock and Low-Grade Ore Geochemistry Assessment (Appendix F2). This study investigated the potential for radioactive material to be generated by the proposed project, and its potential to interact with the receiving environment
- Air Quality characterisation and effects assessment (Appendix H1). This assessment detailed the regional baseline air quality and predicted effects to air quality (including human health) resulting from proposed project's activities.

#### 7.9.3.2 Radiation Environment

Radioactive materials exist naturally in soils, water and the air, and are responsible for the naturally occurring radiation known as 'background radiation'. Naturally occurring background radiation is variable, depending largely on the environment, the underlying geology and the meteorological conditions. Naturally occurring background radiation results in radiation exposure to people everywhere. The range of radiation exposure is highly variable, however on average Australians are exposed to 1.5 mSv each year from natural sources. This is about the same amount of radiation received from 75 chest X-rays (ARPANSA, 2015).

Sampling of rock materials associated with the proposed project was undertaken, indicating uranium and thorium concentrations in the range of 0.05 – 3.6 mg/kg and 0.04 – 26 mg/kg respectively across all materials (waste rock, ore and low-grade ore).

Total uranium and thorium concentrations were used to calculate head-of-chain activity concentrations of naturally occurring uranium and thorium series radionuclides in material associated with the project (Appendix F2). Based on maximum total uranium and thorium concentrations, maximum head-of-chain activity concentrations are 0.05 Bq/g and 0.11 Bq/g for 238U and 232Th series radionuclides, respectively. ARPANSA (2005) describes activities of less than 1 Bq/g as 'inherently safe'.

### 7.9.4 Potential Impacts

A systematic assessment of how the proposed project interacts with the environment through radiation was undertaken (Appendix A2). In particular, the assessment aimed to confirm the potential for the proposed project's activities to interact with sensitive receptors that may result in direct, indirect or cumulative impacts to human health-related environmental values as a result of radiation exposures.

As the measured activity concentrations of the materials associated with the proposed project are significantly below 1 Bq/g, the level below which materials are considered inherently safe, there are no potential impact events, and thus no further impact assessment was undertaken.

### 7.9.5 Predicted Outcome

Based on this assessment, the Proposal was assessed as having no significant or irreversible impact on human health-related environmental values and the EPA Objective for human health 'To protect human health from significant harm' would be met should the Proposal be implemented.

# 8 OFFSETS

An environmental offset is an off-site action (or actions) to address significant residual environmental impacts of a development or activity. These provide environmental benefits which counterbalance the significant residual environmental impacts or risks of a project or activity. Unlike mitigation actions which occur on-site as part of the project and reduce the direct impact of that project, offsets are generally undertaken outside of the project area and counterbalance significant residual impacts.

This section summarises the predicted residual environmental impacts associated with the proposed project (as detailed in Section 6 and Section 7 of this document) and discusses the need for environmental offsets in the context of the prevailing regulatory environment.

## 8.1 Policy and Guidance

The WA EPA Environmental Impact Assessment (Part IV Divisions 1 and 2) Procedures Manual (EPA, 2020b) outlines the requirements for environmental impact assessments under the EP Act. Under these procedures, proponents are required, amongst other things, to:

- Consider offsets as early as possible in the assessment process, where a proposal is likely to have a significant residual impact that will remain after application of the mitigation hierarchy
- Follow the WA Environmental Offsets Policy (Government of Western Australia, 2011) and the WA Environmental Offsets Guidelines (Government of Western Australia, 2014) and complete the WA Environmental Offsets template.

### 8.1.1 Western Australia Environmental Offsets Policy

The Government of Western Australia's Environmental Offsets Policy (2011) (the Policy) seeks to protect and conserve environmental and biodiversity values for present and future generations. The Policy ensures that economic and social development may occur while supporting long-term environmental and conservation values. The Policy seeks to ensure that environmental offsets are applied in specified circumstances in a transparent manner to engender certainty and predictability, while acknowledging that there are some environmental values that are not readily replaceable. It serves as an overarching framework to underpin environmental offset assessment and decision-making in Western Australia.

The Policy defines the two categories of environmental offsets, direct and indirect, and establishes the six principles for the use of environmental offsets, specifically:

- Environmental offsets will only be considered after avoidance and mitigation options have been pursued
- Environmental offsets are not appropriate for all projects
- Environmental offsets will be cost effective, as well as relevant and proportionate to the significance of the environmental value being impacted
- Environmental offsets will be based on sound environmental information and knowledge
- Environmental offsets will be applied within a framework of adaptive management
- Environmental offsets will be focused on longer-term strategic outcomes.

### 8.1.2 Western Australia Environmental Offset Guidelines

The Government of Western Australia's Environmental Offset Guidelines (2014) (the Guidelines) complement the Policy by clarifying the determination and application of environmental offsets in Western Australia. Application of the Guidelines is designed to ensure that decisions made on environmental offsets are consistent and accountable under the EP Act.

The Guidelines expand on the Policy to:

- Ensure that the basis for decision-making on environmental offsets is understood by decision makers, government officers, industry and the community and consistently applied by decision-makers
- Ensure transparency in the determination and application of offsets
- Provide a basis for auditing, compliance and enforcement.

Importantly, the Guidelines establish that environmental offsets are designed to address significant environmental impacts that remain, after on-site avoidance and mitigation measures have been undertaken, and specifically 'Environmental offsets will only be applied where the residual impacts of a project are determined to be significant, after avoidance, minimisation and rehabilitation have been pursued' (Government of Western Australia, 2014).

## 8.2 Residual Impact Significance

In accordance with the Guidelines, significant residual impacts include those that affect rare and endangered plants and animals (such as declared rare flora and threatened species that are protected by statute), areas within the formal conservation reserve system, important environmental systems and species that are protected under international agreements (such as Ramsar listed wetlands) and areas that are already defined as being critically impacted in a cumulative context. Impacts may also be significant if, for example, they could cause plants or animals to become rare or endangered, or they affect vegetation which provides important ecological functions.

### 8.2.1 Summary of Impact Assessment Outcomes

Section 6 and Section 7 of this Proposal provided a detailed assessment of the potential environmental impacts of the proposed project on each of the Environmental Factors undertaken in accordance with the project's EIA Framework (Section 5 and Appendix A3). This included identification and consolidation of credible potential impact events, quantification of both the inherent risk (prior to application of avoidance, minimisation and rehabilitation measures) and the residual risk (post application of these measures), and a determination of impact significance undertaken in accordance with the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e).

The outcomes of these assessments are summarised in Table 8-1, indicating that the proposed project is considered unlikely to result in a significant impact across all of the Environmental Factors with the exception of social surroundings. The description of the measures to avoid, minimise and rehabilitate and the justification for the predicted outcome for each Environmental Factor are cross-referenced to the relevant section of the assessment in order to avoid repetition.

**Table 8-1: Summary of Impact Assessment Outcomes**

| Theme | Environmental Factor | Mitigation Measures | Impact Significance |
|---|---|---|---|
| People | Social surroundings | See Section 6.1.6 | Potentially Significant (see Section 6.1.7) |
| | Human health | N/A | N/A |
| Land | Flora and vegetation | See Section 7.1.6 | Not significant (see Section 7.1.7) |
| | Landforms | See Section 7.2.6 | Not significant (see Section 7.2.7) |
| | Subterranean fauna | See Section 7.4.6 | Not significant (see Section 7.4.7) |
| | Terrestrial environmental quality | See Section 7.5.6 | Not significant (see Section 7.5.7) |
| | Terrestrial fauna | See Section 7.6.6 | Not significant (see Section 7.6.7) |
| Water | Inland waters | See Section 7.3.6 | Not significant (see Section 7.3.7) |
| Air | Air quality | See Section 7.7.6 | Not significant (see Section 7.7.7) |
| | Greenhouse gas | See Section 7.8.6 | Not significant (see Section 7.8.7) |

### 8.2.2 Residual Impact Significance Model

In addition to the determination of impact significance undertaken in accordance with the EPA's Considerations of Significance, as described in the EPA's Statement of Environmental Principles, Factors and Objectives (EPA, 2020e) described in Section 8.2.1, the EPA have also developed a 'Residual Impact Significance Model' (RISM) that is based on the categorisation of residual impacts across the EPA Clearing Principles (detailed in Schedule 5 of the EP Act) in order to determine whether a residual impact is significant specifically for the purpose of understanding a project's potential offset requirements. The RISM places impacts into one of the following four categories:

- Unacceptable impacts: those impacts which are environmentally unacceptable or where no offset can be applied to reduce the impact. Offsets are not appropriate in all circumstances, as some environmental values cannot be offset.
- Significant impacts requiring an offset: any significant residual impact of this nature will require an offset. These generally relate to any impacts to species, ecosystems, or reserve areas protected by statute or where the cumulative impact is already determined to be at a critical level.
- Potentially significant impact which may require an offset: the residual impact may be significant depending on the context and extent of the impact. These relate to impacts that are likely to result in a species or ecosystem requiring protection under statute or increasing the cumulative impact to a critical level. Whether these impacts require an offset will be determined by the decision-maker based on information provided by the proponent or applicant and expert judgement.
- Impacts which are not significant: impacts which do not trigger the above categories are not expected to have a significant impact on the environment and therefore do not require an offset.

The RISM template provided in the Guidelines has been adapted for the Proposal and is presented in Table 8-2, demonstrating that the proposed project is not predicted to have a significant residual impact on the environment with respect to the EPA Clearing Principles.

**Table 8-2: Residual Impact Significance Model Assessment**

| **Environmental Factors** | **Flora and Vegetation** | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Terrestrial Fauna** | | | |
| | | | | | | **Subterranean Fauna** | |
| **Residual Impact** | **Threatened flora** | **Threatened ecological communities** | **Remnant vegetation** | **Wetlands and waterways** | **Conservation areas** | **High biological diversity** | **Habitat for fauna** |
| Unacceptable residual impacts | No | No | No | No | No | No | No |
| Significant residual impacts requiring an offset | No | No | No | No | No | No | No |
| Potentially significant residual impacts which may require an offset | No | No | No | No | No | No | No |
| Residual impacts which are not significant | The direct loss of significant flora based on the indicative site footprint was assessed, demonstrating that the clearance of some of these individuals presents little risk to the conservation status of these species as the species are known to occur outside the Development Envelope with many of them occurring within Aboriginal Lands in other States or Territories.<br>Additionally, an evaluation of the spread of known distribution of Priority flora and range extensions demonstrate that these species occur more extensively in multiple direction around the proposed project area. This spread indicates that their presence in the Survey Area is likely to reflect limited regional survey effort rather than inherent rarity, as such the proposed project would not result in a negative change in the conservation status of any Priority listed species | All vegetation communities proposed to be cleared are common in the wider region and present outside of the Development Envelope. There are no TECs or PECs within or adjacent to the Development Envelope | Development of the proposed project would result in the clearing of approximately 3,830 ha of native vegetation, representing 9.5% of the total area surveyed. The assessment demonstrates that, of the 28 vegetation associations and 10 mosaics mapped, no single vegetation association or mosaic would experience more than 30% clearing of the total area mapped | There are no known wetlands or waterways in proximity to the Development Envelope.<br>Studies demonstrate that runoff only occurs as a result of high intensity, low frequency rainfall events (<5% AEP) and that any runoff that does occur is likely to be as sheet flow. Velocities are relatively slow, and erosion potential is also low. Changes to velocities as a result of the proposed project infrastructure are unlikely to have an impact on environmental values. Similarly, although increases to flood depths are likely to occur as a result of proposed project infrastructure, flooding would not persist in the landscape for any extended time and increases in depth is unlikely to have an impact on environmental values | The nearest conservation area to the proposed project is the Gibson Desert Nature Reserve, located 155 km to the north-west of the proposed project.<br>The proposed project is located within the 98,000 $km^2$ Ngaanyatjarra IPA. No legislative requirements for a Proposal are required under the IPA assignment, however OZ Minerals has, and continues to, engage the Ngaanyatjarra Council Ranger teams in work that aligns with the IUCN management requirements for this area | Fifteen fauna species of significance were identified from the area including one Threatened species, (Great Desert Skink), and three Priority 4 species. All these species have been shown to have significant areas of occupancy in the study area and region and as such would not result in a change in conservation status as a result of the proposed project.<br>About 0.2% of Great Desert Skink habitat mapped in the fauna survey area is expected to be impacted by the proposed project. Regional studies have shown a far wider and more numerous occurrences of Great Desert Skink than was previously known. The Proposal is unlikely to change the conservation status of this significant fauna species<br>Of the 27 known stygofauna and 10 troglofauna species collected from the WMP, 21 stygofauna and 3 troglofauna species were recorded from both inside and outside or only outside of the impact area (i.e. 5 m drawdown contour and mining voids). While individuals of these species would be impacted by the proposed project, no | All terrestrial fauna habitats identified in the study area are well represented and widespread throughout the region. No individual habitat type would experience more than 30% removal of what was mapped in the proposed project's fauna survey area<br>Stygofauna and troglofauna habitat assessments have shown that connectivity across the landscape is probable, due to the statistically homogenous water quality, depth to water table, and high degree and frequency of fracturing in the top 40 mbgl across most geological profiles.<br>As such, stygofauna and troglofauna habitat can be considered well represented and widespread throughout the region. No individual habitat type would experience more that 30% removal. |

| Environmental Factors | Flora and Vegetation | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Terrestrial Fauna | | | |
| | | | | | | Subterranean Fauna | |
| | | | | | | changes to their conservation status are predicted given the wide distributions. | |
| | | | | | | Utilising biological (morphological and genetic) and physical habitat as surrogates, it can be concluded that there is continuity of habitats for stygofauna and troglofauna species and it can be reasonably assumed that they will also occur and persist outside of the impact area. | |

## 8.3 Requirement for Environmental Offsets

Both the Environmental Impact Assessments presented in Section 6 and Section 7, and summarised in Section 8.2.1, and the outcomes of the RISM assessment (Section 8.2.2) have demonstrated that the proposed project is not predicted to have a significant residual impact on the environment[5].

In accordance with the Guidelines, environmental offsets need only be applied where the residual impacts of a project are determined to be significant, after avoidance, minimisation and rehabilitation have been pursued. As the proposed project is predicted to have no significant residual environmental impacts, no environmental offsets are proposed.

[5] While Social Surroundings was assessed as having the potential residual impacts to holistic cultural amenity, the Ngaanyatjarra Council has agreed that related compensation and offset provisions to manage holistic cultural amenity impacts will be further developed as part of a Cultural Heritage Management Strategy and Plan that will form part of the Mining Agreement between the Traditional Owners, the Ngaanyatjarra Council and OZ Minerals, and as such has not been included in this Section.

# 9 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The EPBC Act is a legislative tool administered by the Commonwealth Department of Agriculture, Water and the Environment (AWE) on behalf of the Australian Government's Minister for the Environment (the Minister). Under the EPBC Act, proposed actions that would have, or are likely to have a significant impact on an MNES must be referred. Based on the information provided, the Minister would determine whether the proposed action should be assessed, and the level of assessment required. MNES include:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- Commonwealth marine areas
- World heritage properties
- National heritage places
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

Considerations for MNES formed a key component of the study program for the Proposal. Specific studies that considered MNES include:

- Detailed Flora and Vegetation Survey (Appendix B1)
- Assessment of Potential Groundwater Dependent Ecosystems (Appendix B2)
- Static Waste Rock and Low-Grade Ore Geochemistry Assessment (Appendix F2)
- Level 2 Vertebrate Fauna Survey (Appendix G1), which included targeted survey of conservation significant fauna
- Targeted Great Desert Skink Survey (Appendix G2)
- Avian Fauna and Microbat Baseline Characterisation (Appendix G3)
- Regional Habitat and Targeted Survey for Great Desert Skink and Targeted Survey for *Petrogale Lateralis* (Warru) (Appendix G5)
- EPBC Significant Impact Review.

Key results of these studies relating to MNES are provided in Section 7.1 Flora and Vegetation, Section 7.3 Inland Waters, Section 7.6 Terrestrial Fauna and Section 7.9 Human Health. In summary, these studies concluded the following with respect to MNES:

- No listed threatened ecological communities, listed threatened flora, Ramsar wetlands of international importance, world heritage properties, national heritage places or relevant water resources occur in proximity to the proposed project.
- No impacts to Commonwealth marine areas or the Great Barrier Reef Marine Park would occur.
- The Proposal does not involve a nuclear action.
- Listed threatened species and migratory species recorded within or adjacent to the Development Envelope were limited to the Great Desert Skink (*Liopholis kintorei*) listed as vulnerable, and the Oriental Pratincole (*Glareola maldivarun*) listed as a marine, migratory species.
    - The Oriental Pratincole is listed as a marine, migratory shorebird. Habitat within the Development Envelope is not considered important habit for migratory shorebirds as per EPBC Act Policy Statement 3.21 – Industry Guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE, 2017) as it does not regularly support:
        - 0.1 percent of the fly away population of a single species of migratory shorebirds
        - 2,000 migratory shorebirds
        - 15 migratory shorebird species.
    - The Great Desert Skink is listed as vulnerable, Spinifex sandplain habitat was identified within the Development Envelope. Through avoidance measures (i.e. exclusion of 78 percent of mapped Spinifex sandplain habitat from the proposed Development Envelope) and the additional understanding of the regional populations derived from the extensive survey efforts associated with the Proposal, that implementation of the proposed project would not have a significant effect on the abundance, distribution or conservation status of Great Desert Skink. In addition, the proposed project would only impact up to 0.2 percent of the Spinifex Sandplain habitat that was mapped within the project survey area.
- An independent peer review of project-related impacts on EPBC listed threatened species and migratory species was undertaken by Jacobs. Jacobs concluded that the proposed project would not have a significant impact on MNES based on the Australian Government's Significant Impact Guidelines 1.1 (DoE, 2013a).

This body of work represents a comprehensive assessment of MNES and provides a high degree of confidence in assertions made herein with respect to MNES. In conclusion to these study results, should the Proposal be implemented the proposed project would not have a significant impact on MNES.

# 10 HOLISTIC IMPACT ASSESSMENT

The WMP represents the first mine within the West Musgrave Geological Province. No other mines or significant industrial activities are located within 450 km of the proposed project. As such, the environment within the Development Area and nearby region are subject to no other mining or industrial scale environmental impacts and meaningful cumulative impacts as a result of mining and/or multiple industrial projects is not applicable to this Proposal.

OZ Minerals developed an EIA Framework as a core component of the Proposal to inform and consistently apply decisions around risks and impacts associated with the Proposal. The EIA Framework used a number of systematic tools to identify linkages between the proposed project and the receiving environmental values, including connections and interactions between Environmental Factors. The key parts of the EIA Framework that considered connections and interactions between Environmental Factors, thus ensuring a holistic approach was followed. These tools included:

- Source–Pathway–Receptor (SPR) analysis. This analysis systematically identifies all possible permutations of linkages between the proposed project's activities and the receiving environmental values (e.g. receptors). Where credible interactions were identified these were determined to be 'potential risk events', which were further analysed using a risk-based framework. Intrinsic to this process is an understanding that a single source may affect multiple pathways and lead to potential impacts across a range of environmental receptors. Similarly, the SPR analysis highlights that a single receptor may be impacted by multiple sources and/or changes to multiple pathways. The SPR analysis is presented in Appendix A2.
- A risk-based assessment of impact significance was undertaken that considers impacts across the range of relevant Environmental Factors is presented in Section 6 and Section 7.
- The overall predicted outcome for each Environmental Factor was assessed against the EPA's Considerations for Significance, including an assessment of the significance of the connections and interactions between Environmental Factors.

For all environmental values (receptors) potentially impacted by proposed project activities and infrastructure (sources) as part of the Proposal, the severity of any identified impacts resulting from multiple overlapping sources were generally no greater than the larger of a single project source (e.g. groundwater drawdown extent was larger than vegetation clearing extent). The extent overlap and connections of multiple risk events are reflected in the inherent and residual risk ratings for the Proposal and as such are consistent with a holistic approach to impact assessment.

The holistic potential impact of the proposed project on each Environmental Factor has been determined to not be significant on the basis that:

- The EP Act principles and relevant EPA guidance documents have been considered in identifying (via the SPR process) and assessing (via the EIA Framework) the potential impacts of the Proposal on the EPA's Environmental Factors and objectives, which has, in turn, allowed for the identification of potential impact events for which mitigation measures are required to ensure that EPA objectives can be achieved.
- A thorough and considered suite of mitigation measures have been identified for each Environmental Factor which have been demonstrated to reduce the risks associated with the identified potential impact events to as low as reasonably practicable.

Extensive stakeholder consultation and participation in the assessment of potential impacts on the whole of the environment has been undertaken, and all community concerns have been considered in the design of the project (Section 3, Appendix A4 and Appendix A5).

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# 12 DEFINITIONS AND ABBREVIATIONS

## 12.1 Definition of Terms

| Term | Definition |
|---|---|
| Development Envelope | The boundary of the proposed project, within which all mining and infrastructure would be constructed, and comprising an area of 20,852 ha. Shown on Figure 2-5 |
| Main Development Area | The area within the Development Envelope where the majority of the proposed project infrastructure would be located. Shown on Figure 2-5 |
| Disturbance Footprint | A total area of 3,830 ha where the ground would be cleared of vegetation, or otherwise disturbed, for the proposed project |
| Footprint or impact footprint | The spatial extent of a direct and/or indirect impact, or collection of impacts, associated with specific sources and/or activities |
| Direct impact | An impact that occurs through direct interaction of an activity or source with an environmental, social, or economic receptor, most commonly associated with vegetation clearance but more broadly relating to a reduction in the availability of resources as a result of the proposed project (e.g. groundwater and surface water volumes) |
| Indirect impact | An impact to a receptor that is not due to a direct impact from the proposed project but occurs as a result of a project-related activity or source. For example, an indirect impact may be a measurable or visible effect or change to a receptor due to a change in the existing environment that is caused by the project such as a reduction in air quality, an increase in noise and light, a reduction in the abundance and diversity of fauna and/or a change in the existing visual amenity |
| Cumulative impact | The total impact on a specific receptor that is created as a result of the combination of all of the sources and/or activities associated with the proposed project assessed in this document, together with other past, present and reasonably foreseeable future projects or activities in proximity to this project that may cause related impacts |
| Mining Agreement | Mining Agreement refers to an agreement to the terms of land access for mining between the project proponent, the relevant Traditional Owners, and their Agent, the Ngaanyatjarra Council. A Mining Agreement is required under both the *Native Title Act, 1993* (Cth), and the *Aboriginal Affairs Planning Authority Act, 1972* (WA). The reference to Mining Agreement within this document refers to a Mining Agreement that would meet the requirements under both of these Acts. Mining at West Musgrave cannot commence until a Mining Agreement between the above-mentioned parties has been reached. |

## 12.2 Definition of Acronyms

| Acronym | Expansion |
|---|---|
| ABS | Australian Bureau of Statistics |
| ACMC | Aboriginal Cultural Material Committee |
| AEP | Annual Exceedance Probability |
| ALA | Atlas of Living Australia |
| ALARP | as low as reasonably practicable |
| ALT | Aboriginal Lands Trust |
| AMD | acid and/or metalliferous drainage |
| ANC | acid neutralisation capacity |
| ARENA | Australian Renewable Energy Agency |
| ARI | Assessment on Referral Information |
| ASX | Australian Stock Exchange |
| AWE | Australian Government's Department of Agriculture, Water and the Environment (formerly DoE) |
| BGN | barren gabbronorite |
| BoM | Bureau of Meteorology |
| CDFM | cumulative deviation from mean |
| CEC | Clean Energy Council |
| CER | Central Ranges Bioregion |
| CER01 | Mann-Musgrave Block Subregion |
| COI | Cytochrome C Oxidase subunit I |
| CSRM | University of Queensland Centre for Social Responsibility in Mining |
| DBCA | Department of Biodiversity, Conservation and Attractions |
| DD | data deficiency |
| DEM | Digital Elevation Model |
| DFES | Department of Fire and Emergency Services |
| DGV | default guideline value |
| DMA | decision-making authority |
| DMIRS | Government of Western Australia's Department of Mines, Industry Regulation and Safety |
| DoE | Australian Government's Department of the Environment (now AWE) |
| DoH | Government of Western Australia's Department of Health |
| DPIRD | Government of Western Australia's Department of Primary Industries and Regional Development |
| DPLH | Government of Western Australia's Department of Planning Lands and Heritage |

| Acronym | Expansion |
|---|---|
| DWER | Government of Western Australia's Department of Water and Environmental Regulation |
| EIA Framework | Environmental Impact Assessment Framework |
| EMS | Environmental Management System |
| EOI | Expression of Interested |
| EPA | Government of Western Australia's Environmental Protection Authority |
| ERD | Environmental Review Document |
| ESG | Environment and Social Governance |
| EWR | environmental water requirement |
| FIFO | fly-in, fly-out |
| FPIC | free, prior and informed consent |
| GDE | Groundwater Dependent Ecosystem |
| GHG | Greenhouse Gas |
| GVD | Great Victoria Desert Bioregion |
| GVD02 | Great Victoria Desert Central Subregion |
| HDPE | high-density polyethylene |
| HoV | Hill of Value |
| HSU | hydrostratigraphic unit |
| IBRA | Interim Biogeographic Regionalisation for Australia |
| IFD | Intensity Frequency Duration |
| ILUA | Indigenous Land Use Agreement |
| IPA | Indigenous Protected Area |
| IPCC | Intergovernmental Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| IWL | Integrated Waste Landform |
| JTSI | Government of Western Australia's Department of Jobs, Tourism, Science and Innovation |
| Kh | horizontal hydraulic conductivity |
| Kv | vertical hydraulic conductivity |
| LAU | local assessment unit |
| LNG | liquified natural gas |
| LOM | Life of Mine |
| MGN | mineralised gabbronorite |
| MHP | Nickel mixed hydroxide |
| MIBC | methyl isobutyl carbinol |

| Acronym | Expansion |
|---|---|
| MNES | matters of national environmental significance |
| MRWA | Mainroads Western Australia |
| NAF | non-acid-forming |
| NIAA | Australian Government's National Indigenous Australians Agency |
| NMD | Neutral Metalliferous Discharge |
| OAGN | oxide-apatite gabbronorite |
| PAF | potentially-acid-forming |
| PAX | potassium amyl xanthate |
| PBS | Performance Based Standards |
| PEC | Priority Ecological Community |
| PET | potential evapotranspiration |
| PFS | Pre-Feasibility Study |
| PM&C | Australian Government's Department of the Prime Minister and Cabinet |
| PV | photovoltaic |
| PVHI | PV 'heat island' |
| RF | Revenue Factor |
| RISM | Residual Impact Significance Model |
| ROM | run-of-mine |
| SAG | semi-autogenous grinding |
| SD | saline discharge |
| SDG | Sustainable Development Goal |
| SEIFA | socio-economic indexes for areas |
| SIBX | sodium Isobutyl xanthate |
| SILO | Scientific Information for Landowners |
| SIOA | Social Impact and Opportunities Assessment |
| SPR | Source Pathway Receptor |
| SRE | Short Range Endemic |
| Ss | specific storativity |
| SWOT | strengths, weaknesses, opportunities and threats |
| SWWB | site wide water balance |
| Sy | specific yield |
| TCFD | Taskforce on Climate-related Financial Disclosure |
| TDS | total dissolved solids |
| TEC | Threatened Ecological Community |
| TEQ | Terrestrial Environmental Quality |

| Acronym | Expansion |
|---|---|
| TETA | triethylene tetramine |
| TSF | tailings storage facility |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VLGN | variably textured leucogabbronorite |
| VRM | vertical roller mill |
| WAM | West Australian Museum |
| WMP | West Musgrave Project |
| WoNS | Weeds of National Significance |
| WRD | waste rock dump |
| WWTP | wastewater treatment plant |

## 12.3 Units of Measure

| Abbreviation | Expansion of Unit |
|---|---|
| a | year (annum) |
| dB | decibel |
| g | gram |
| GL | gigalitre |
| h | hour |
| ha | hectare |
| km | kilometre |
| $km^2$ | square kilometre |
| kV | kilovolt |
| L | litre |
| µm | micrometre |
| m | metre |
| mAHD | metres relative to Australian Height Datum |
| mbgl | metres below ground level |
| mbrp | metres below reference point |
| mg | milligram |
| ML | Megalitre |
| mm | millimetre |
| $Mm^3$ | cubic megametre |
| mS | millisieverts |

| Abbreviation | Expansion of Unit |
|---|---|
| µS | microsiemen |
| Mt | million tonnes |
| Mtpa | million tonnes per annum |
| MW | megawatt |
| $m^2$ | square metre |
| $m^3$ | cubic metre |
| s | second |
| t | tonne |
| tonnes per annum | tpa |
| y | year |
| % | percent |

OZ MINERALS