

Appendix N

**North Kiaka Subterranean Fauna
Desktop Assessment**

Desktop Assessment of Subterranean Fauna for the North Kiaka Quartzite Mine, Moora, Western Australia



Report by Invertebrate Solutions for
Simcoa Contracting Ltd on behalf of
GHD Pty Ltd

June 2019

Dr Timothy Moulds
Director and Principal Ecologist
Invertebrate Solutions
PO Box 14
Victoria Park, WA 6979
Australia
tim@invertebratesolutions.com
www.invertebratesolutions.com

Invertebrate Solutions. (2019). Desktop assessment of subterranean fauna for the North Kiaka
Quartzite Mine, Moora, Western Australia. Unpublished report to GHD, June 2019.

Report Number 2018ISJ1002_F01_20190619

Prepared for: Simcoa Contracting Ltd, on behalf of GHD Pty Ltd

COPYRIGHT: This document has been prepared to the requirements of the client identified above, and no representation is made to any third party. Copyright and any other Intellectual Property associated with the document belongs to Invertebrate Solutions and may not be reproduced without written permission of the Client or Invertebrate Solutions. It may be cited for the purposes of scientific research or other fair use, but it may not be reproduced or distributed to any third party by any physical or electronic means without the express permission of the client for whom it was prepared or Invertebrate Solutions.

Contents

Contents.....	iii
Executive Summary.....	v
1. Introduction	1
1.1. Purpose of this report	1
1.2. Purpose of this report	3
1.3. Study Area.....	3
1.4. Documents examined	3
1.5. Conservation Legislation and Guidance Statements	3
1.6. Classifications of subterranean dependence.....	4
1.7. Report Limitations and Exclusions	5
1.8. Assumptions and Limitations	6
2. Desktop Methods.....	7
2.1 Likelihood of Subterranean fauna occurrence.....	7
2.2 Potential Impacts to Subterranean Fauna	7
3. Desktop Subterranean Fauna Review.....	9
3.1 Subterranean fauna in the Wheatbelt	9
3.2 Conservation Significant Fauna and Habitats	9
3.3 Subterranean Fauna Habitat in the Project Area.....	10
3.4 Likelihood of stygofauna presence	11
3.5 Likelihood of troglafauna presence	14
4. Subterranean Fauna Risk Assessment	15
4.1 Preliminary Risk Assessment for Stygofauna	15
4.2 Preliminary Risk Assessment for Troglafauna.....	15
4.3 Cumulative impacts.....	16
5. Conclusions and Recommendations.....	17
5.1 Recommendations	17
6. References	
Appendix 1	
Department of Parks and Wildlife Conservation Codes (November 2015)	
Appendix 2	
Protected Matters Search Results	

List of Figures

Figure 1	North Kiaka Quartzite Project subterranean fauna desktop study area.	2
Figure 2	Stygofauna sampling location from Knott and Goater 2005 (Figure 1), with the locations of stygal Parabathnellids marked in orange and the approximate boundary of the North Kiaka Project in red.....	13

List of Tables

Table 1	Geological units in the North Kiaka Project and Subterranean fauna habitat potential.....	10
Table 2	Stygofauna recorded by Knott and Goater 2005 from the Simcoa Quartzite Project.	12
Table 3	Risk of impact to stygofauna from resource development.....	15
Table 4	Risk of impact to troglafauna from resource development.....	16

List of Plates

Plate 1	Inset of the geology surrounding the North Kiaka Quartzite Project. The brown units represent the Noondine chert. The red dashed line shows the approximate position of the Proposed development.	11
Plate 2	Images of the Parabathynellid specimens recorded by Knott and Goater 2005 from bore M1099 from the Simcoa Quartzite Mine Area (Images after Knott and Goater 2005)	12

Executive Summary

Simcoa Operations Pty Ltd (Simcoa Operations) is proposing to construct and operate a quartzite quarry at the North Kiaka Project area (the Project), with processing and associated infrastructure at the adjacent existing Simcoa operations to the south. The proposed mine is located approximately 20 kilometres (km) north of Moora in the Wheatbelt region of Western Australia.

Mining of the quartzite will occur above groundwater and will include a simple open cut operation with clearing and topsoil stockpiling, overburden drilling and blasting followed by conventional removal with truck.

Invertebrate Solutions has been requested by GHD Pty Ltd (GHD) on behalf of Simcoa Operations to undertake a desktop assessment for subterranean fauna (stygo fauna and troglo fauna) for the North Kiaka Project area.

The North Kiaka Project is located primarily in Noondine Chert surrounded by lower lying colluvium and alluvium to the west of the Project area and minor outcrops of the Mokadine Formation to the south east. The colluvium and alluvium lithologies to the west of the Project area have a low suitability for both troglo fauna and stygo fauna habitat due to the absence of interconnected voids in these fine grained units. The Noondine Chert is known to contain palaeokarst and subsurface voids that is highly suitable habitat for stygo fauna (Appleyard 2002). The Noondine Chert is the target lithology for the North Kiaka Quartzite Project and previous subterranean fauna surveys for the existing Simcoa operations revealed the existence of a stygal community within the local groundwater. The Noondine Chert formation located within North Kiaka Project is also known to contain at least four species of stygo fauna.

Searches of the Western Australian Museum databases for Crustaceans and Arachnids/Myriapods were undertaken of a rectangle of approximately 50 km sides centred on the North Kiaka quartzite project. The results of these filtered for subterranean species revealed no specimen records of any subterranean fauna held by the Western Australian Museum.

The known stygo fauna previously recorded by Knott and Goater 2005, do not occur within the current North Kiaka Project area with the records being to the north of the proposed development area and within the existing approved operations.

Due to the presence of stygo fauna within a fractured rock aquifer within the Project area, there is a moderate likelihood that habitat exists for troglo fauna within the unsaturated zone of the Noondine Chert. No core photos were available for examination to confirm the presence or absence of suitable fracturing that provides interconnected void space in the upper rock strata that may provide habitat for troglo fauna.

The mining pit excavation is anticipated to have a low to moderate impact upon any local stygo fauna community and a low impact on potential troglo fauna as no dewatering is anticipated to occur thus limiting any potential impacts.

The waste rock storage areas are anticipated to have a low risk of impact to stygo fauna and troglo fauna, dependent upon it not significantly altering subsurface hydrology or clogging

subterranean voids with fine sediment. This risk will be minimised by locating the waste rock dump on the colluvium units within the North Kiaka Project area.

The construction and operation of other associated surface mine infrastructure are expected to pose a Low risk to stygofauna and potential troglafauna.

The following recommendations are made with regard to the potential development of the North Kiaka Project:

- The surface clearing footprint and positioning of infrastructure should be tailored to minimise clearing within and adjacent to any identified subterranean fauna habitat. The impacts to this habitat should be assessed in a detailed manner following finalisation of the surface footprint of the Project.
- The storage of hydrocarbons on site should be limited and all storage areas fully bunded.

1. Introduction

Simcoa Operations Pty Ltd (Simcoa Operations) is proposing to construct and operate a quartzite quarry at the North Kiaka Project area (the Project), with processing and associated infrastructure at the adjacent existing Simcoa operations to the south. The proposed mine is located approximately 20 kilometres (km) north of Moora in the Wheatbelt region of Western Australia.

Mining of the quartzite will occur above groundwater and will include a simple open cut operation with clearing and topsoil stockpiling, overburden drilling and blasting followed by conventional removal with truck.

Invertebrate Solutions has been requested by GHD Pty Ltd (GHD) on behalf of Simcoa Operations to undertake a desktop assessment for subterranean fauna (stygo fauna and troglo fauna) for the North Kiaka Project area.

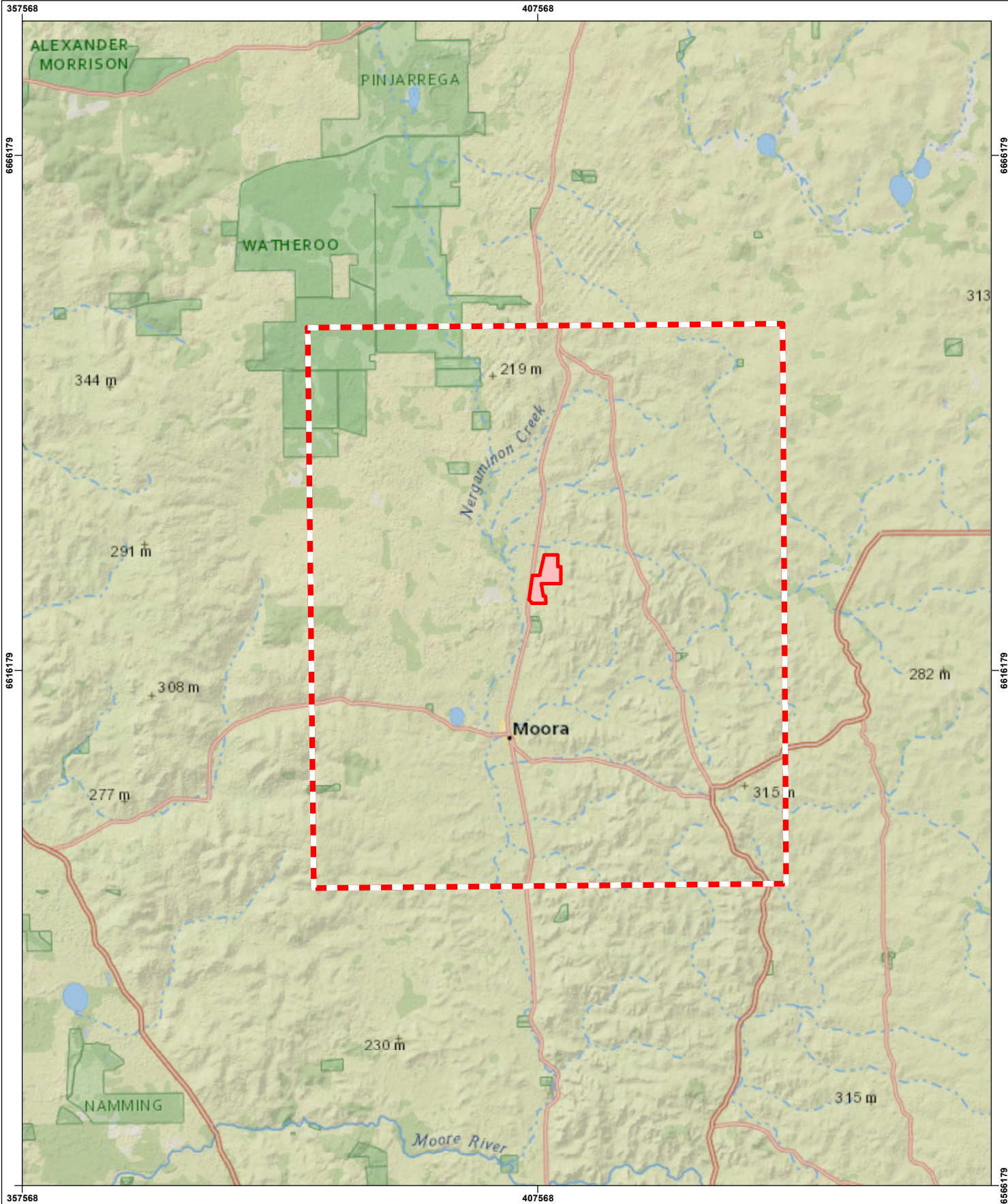
Subterranean fauna are comprised of stygo fauna (aquatic subterranean dependent species) and troglo fauna (air breathing subterranean dependent species) which are known to be relatively diverse on a worldwide scale in Western Australia. Many species of subterranean fauna have highly restricted ranges, due to habitat connectivity issues and evolutionary history. Stygo fauna and troglo fauna are known to occur widely in much of Western Australia with many locally endemic species present.

The high degrees of local endemism and lack of habitat connectivity make subterranean fauna susceptible to impacts from sometimes localised projects, with species' extinction a real possibility if they are not adequately considered during project planning phases.



1.1. Purpose of this report

GHD has requested Invertebrate Solutions to undertake the following scope of works for the North Kiaka Project area, Moora, Western Australia:

- Undertake a desktop review for stygo fauna and troglo fauna presence.
- Undertake a risk assessment for impacts to stygo fauna and troglo fauna from the proposed development.
- Provide recommendations to minimise potential impacts and any suggested requirements for further work to comply with relevant legislation.
- Provide a written report containing the above items.



Legend

-  Desktop Study Area
-  Site Boundary

0 3.75 7.5 15
km
Scale: 1:500,000 @ A4

 **Invertebrate Solutions**
m +61 (0) 429 792 834
s +61 (0) 405 561 978
e tim@invertebratesolutions.com
w www.invertebratesolutions.com

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



PROJECT ID
North Kiaka Quartzite Mine

DATE
24/01/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	TM	TM	0

Client: Simcoa Operations Ltd

Figure 1
Subterranean Fauna Desktop Assessment, North Kiaka Quartzite Mine, Moora, WA

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- NATGEO WORLD MAP FROM OPEN SOURCE

1.2. Purpose of this report

GHD has requested Invertebrate Solutions to undertake the following scope of works for the North Kiaka Project area, Cape Range, Western Australia:

- Undertake a desktop review for stygofauna and troglafauna presence.
- Undertake a risk assessment for impacts to stygofauna and troglafauna from the proposed development.
- Provide recommendations to minimise potential impacts and any suggested requirements for further work to comply with relevant legislation.
- Provide a written report containing the above items.

1.3. Study Area

The proposed mine is located approximately 20 kilometres (km) north of Moora in the Wheatbelt region of Western Australia and is shown in Figure 1. The desktop study area comprised a rectangle of approximately 50 km sides bounded by the north west corner (30.281015°S, 115.807140°E) and the south east corner (30.771696°S, 116.286079°E) centred on the North Kiaka quartzite project.

1.4. Documents examined

The following documents have been examined in the compilation of this report, along with other referenced scientific papers used to provide general background:

- Geological Survey of Western Australia (1982). Moora 1:250,000 Sheet SF 50-10 Geological Map, Geological Survey of Western Australia.
- Knott, B. and Goater, S. (2005). Moora Quartzite Mine Stygofauna Pilot Study.
- Moulds, T.A. (2007a). Subterranean fauna of the Eneabba, Jurien and South Hill River (Nambung) karst areas, Western Australia. Unpublished report to the Department of Environment and Conservation Mid West Region, 27p.
- Moulds, T.A. (2007b). October sampling of subterranean invertebrate fauna of the Eneabba, Jurien and South Hill River (Nambung) karst areas, Western Australia. Unpublished report to the Department of Environment and Conservation Mid West Region, 10p.

This report has been prepared with regard to the Technical Guidance – subterranean fauna survey (EPA2016a), Technical Guidance – sampling methods for subterranean fauna (EPA2016b), and the Environmental Factor Guideline – Subterranean Fauna (EPA 2016c).

1.5. Conservation Legislation and Guidance Statements

Subterranean fauna are protected under state legislation via the newly enacted Biodiversity Conservation (BC) Act (2016) which came into force on 1st January 2019, replacing the outdated Wildlife Conservation (WC) Act (1950). The new BC Act is aligned with the federal Environment Protection and Biodiversity Conservation (EPBC) Act (1999). The assessment of subterranean fauna for environmental impact assessment (EIA) is undertaken in Western Australia with regard to the Technical Guidance – Subterranean Fauna Survey (EPA2016a), Technical Guidance – Sampling

Methods for Subterranean Fauna (EPA2016b) and the Environmental Factor Guideline – Subterranean Fauna (EPA 2016c).

At the State level, the BC Act provides a list of species that have special protection as species listed under Part 2 of Biodiversity Conservation Act, 2016. This notice is updated periodically by the Department of Biodiversity, Conservation and Attractions (DBCA) (formerly the Department of Parks and Wildlife (DPaW) and the current list (November 2018) includes numerous subterranean species mainly from the Cape Range and Pilbara regions. Included in the list are crustaceans, arachnids and myriapods that are considered to be “rare or likely to become extinct, as critically endangered fauna, or are declared to be fauna that is in need of special protection” (DPaW 2015). In addition to the specially protected fauna, DBCA also maintains a list of Priority fauna that are considered to be of conservation significance but do not meet the criteria for formal listing under the BC Act. The Priority fauna list is irregularly updated by DBCA and, although it offers no formal legislative protection, these species are generally considered in the EIA process.

The Biodiversity Conservation Act now provides the ability for the state government of Western Australia to formally list Threatened Ecological Communities (TECs), along with threatening processes. Several subterranean ecological communities are recognised as Threatened including the Bundera Cenote Anchialine community on Cape Range, Cameron’s Cave near the townsite of Exmouth on Cape Range, stygal root mat communities in both the Yanchep and Margaret River regions and stygobionts in the Ethel Gorge aquifer in the Pilbara.

The federal EPBC Act protects both species and ecological communities. The most relevant listings for subterranean fauna include the Bundera Cenote on the western side of the Cape Range which contains a unique anchialine ecosystem including the stygal Cape Range Remipede *Kumonga exleyi* (Yager and Humphreys 1996) that is listed as Vulnerable. The Cape Range gudgeon *Milyeringa veritas* and the Cape Range blind eel *Ophisternon candidum* (Humphreys 2008) are also listed as Vulnerable species from subterranean habitats on the Cape Range.

1.6. Classifications of subterranean dependence

Subterranean fauna is a collective term that refers to both troglofauna (terrestrial subterranean fauna inhabiting air voids) and stygofauna (aquatic subterranean fauna) (Humphreys 2000).

Extensive amounts of jargon has historically been associated with subterranean fauna and multiple forms of classification have been used through time (Sket 2008). The most commonly accepted and used terms divide troglofauna into categories that describe a particular species’ degree of dependence upon the subterranean environment. Due to the reliance upon ecological information to determine if a species is a troglobite, the concept of troglomorphy (Christiansen 1962), specific morphological adaptations to the subterranean environment, is used to define obligate subterranean species. The term troglomorphy, initially confined to morphology has since been used to describe both morphological or behavioural adaptations (Howarth 1973). This combination provides a practical system, easily applied in the field and with minimum of detailed ecological study required (Sket 2008). The level of subterranean dependency for different ecological groupings is described below:

- Troglobiont: animals that are obligate subterranean species, and mostly show morphological adaptation to subterranean habitats (troglomorphisms) including depigmentation, loss or

reduction of eyes, elongation of appendages, flightlessness or wing reduction, and extra sensory hairs.

- Troglaphiles: animals that can complete their entire lifecycle within a cave but possess no specific adaptations to the cave environment. These species are capable of living outside caves in suitably dark and moist epigeal habitats.
- Troglaxenes: animals that use the subterranean environment, but require surface environments to complete part of their lifecycle (generally either feeding or breeding). Common troglaxenes are cave dwelling bats, cave swiftlets and cave crickets that leave subterranean habitats to feed.

The terms above refer to stygofauna when the prefix is altered to stygo (Humphreys 2000).

Species which inhabit the deep soil habitat (Edaphophiles) often exhibit convergent morphological adaptations to those animals found exclusively within caves, such as eyelessness, body flattening, loss of pigmentation etc. Soil dwelling species commonly do not show highly restricted distributions as they are less easily isolated in evolutionary timeframes, thus only true troglotic animals are the focus of surveys for subterranean fauna. Taxa discussed in this study were assessed upon their combination of loss/reduction of eyes, and reduction in pigmentation, wing development, and elongation of appendages to assess if a taxa was an edaphophile or truly reliant upon the subterranean habitat (Troglobiont).

1.7. Report Limitations and Exclusions

This study was limited to the written scope provided to the client by Invertebrate Solutions (30th July 2018) and in Section 1.2. This study was limited to the extent of information made available to Invertebrate Solutions at the time of undertaking the work. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. Invertebrate Solutions has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by Invertebrate Solutions described in this report (this section and throughout this report). Invertebrate Solutions disclaims liability arising from any of the assumptions being incorrect.

Invertebrate Solutions has prepared this report on the basis of information provided by GHD on behalf of Simcoa Operations and others (including Government authorities), which Invertebrate Solutions has not independently verified or checked beyond the agreed scope of work. Invertebrate Solutions does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.8. Assumptions and Limitations

Invertebrate Solutions has made the following assumptions in the writing of this report and its subsequent conclusions:

- The potential impacts identified and assessed in Section 4 are not necessarily exhaustive and may change with additional detail regarding the potential development.
- No core photos were made available to assess the potential for habitat for troglofauna above the saturated zone.
- No dewatering will be required for the mining proposal and operations will not occur below the local watertable.
- No groundwater will be abstracted within the Project area for construction or other purposes.
- The impacts to subterranean fauna may require additional investigation following finalisation of the development plan.

2. Desktop Methods

The subterranean fauna desktop review comprises of two distinct sections:

- An assessment of the likelihood that subterranean species are present in the habitats located within the study area.
- Consideration of the potential impacts to subterranean species that may occur as a result of the proposal.

2.1 Likelihood of Subterranean fauna occurrence

The likelihood of stygofauna and troglafauna species occurring in the study area was assessed using a combination of regional information, geological, hydrogeological and database searches including:

- Analysis of published and unpublished reports concerning subterranean fauna from the region.
- Available geological maps.
- Geological, geotechnical and hydrogeological information available for the Study area.
- Results of a Protected Matters Search from the Federal Government's Department of the Environment and Energy website.
- Records of fauna held by the Western Australian Museum.

Based on the analysis of all available information the study area was assigned a level of likelihood to support subterranean fauna of either 'Low', 'Moderate', 'High', or 'Definite'.

2.2 Potential Impacts to Subterranean Fauna

The potential impacts of the installation of infrastructure and general construction activities on subterranean fauna may be categorised as being either direct or indirect impacts.

Direct impacts are the obvious and unavoidable destruction or degradation of habitat that occurs in excavation for footings and other subsurface excavations, including associated aquifer dewatering. Indirect impacts are generally gradational, and more difficult to predict and manage because they may occur at moderate to large distances from the project footprint. These impacts may be expressed some time after development has been undertaken.

Some examples include changes to hydrology, nutrient and microclimate regimes, contamination, reduced habitat area, water quality, and population viability. The zone of influence for indirect impacts may be considerably larger than the immediate area of the disturbance area. Potential indirect impacts of development include:

- Alteration of surface hydrology that affects groundwater recharge regimes, sedimentation, and water quality (e.g. under and adjacent to infrastructure areas, roads and hard packed surfaces).
- Reduction in organic inputs beneath areas cleared of vegetation and sealed surfaces.
- Vibration disturbance from construction and operational activities.
- Surface and groundwater contamination from plant equipment and infrastructure (e.g. chemical pollutants, hydrocarbons or waste water of lower quality).

- Changes to subterranean microclimate in rock masses surrounding clearing areas (exposure of subterranean habitat to desiccation).
- Risk of species extinction from reduction and/or fragmentation in habitat.
- Cumulative impacts from nearby developments

The Project aspects were reviewed to assess the potential severity of impact to potential subterranean habitats. In evaluating the relevance of these factors to the Project, consideration was given to the magnitude, duration and spatial extent of the impacts, where known. This assessment has taken the approach of considering these broad categories of potential impacts and evaluating their occurrence and relative severity. The impacts were then assigned a level of either 'Low', 'Moderate', or 'High' according to their potential degree to adversely affect the EPA's objective to maintain representation, diversity, viability and ecological function at the species, population and assemblage level for subterranean fauna.

Where an impact is designated as 'Low' no further consideration to this factor is required if all assumptions made throughout this report are correct.

3. Desktop Subterranean Fauna Review

3.1 Subterranean fauna in the Wheatbelt

Knowledge of subterranean fauna within the Wheatbelt is less than the more comprehensively surveyed areas of the Pilbara and Yilgarn. Sporadic surveys for troglofauna have been undertaken from the limestone caves near the coast from the 1970s to recent years (Moulds 2007a, 2007b, WASG 2016). To the east of the karstic calcarenite coastal band, on the eastern side of the Darling fault some pilot surveys for stygofauna have been undertaken in other lithologies including quartzite north of Moora at the Kiaka Quartzite mine (Knott and Goater 2005).

On the western side of the Darling Fault to the North Kiaka Project, troglofauna are known to occur throughout the karstic areas of the coastal Tamala limestones (Moulds 2007a, 2007b). These are moderately diverse although the diversity of troglobionts is low. Several species of troglofauna do appear to be restricted in range to this limestone band although sampling at a regional scale has been ad hoc and research is required.

The Yarragadee aquifer, occurring to the west of the Darling Fault, is a confined aquifer and the deepest of the three aquifers (Gnangara Mound and Leederville Aquifer) that combine to form the Yarragadee formation. The Yarragadee formation is comprised of poorly sorted sandstones that are highly porous and can therefore store large amounts of water also making it prospective habitat for stygofauna. No published results for any stygofauna sampling is available for the deeper Yarragadee aquifer, however, stygofauna has been sampled within the superficial Gnangara Mound as part of regional stygofauna sampling (Bennelongia 2008). This sampling has shown that stygofauna do occur within the unconfined aquifer, but with low species richness. A moderately extensive regional sampling program recorded only 11 from within the Gnangara Mound between Guilderton in the north, east to the Darling fault and south to the Swan River (Bennelongia 2008). This aquifer does not occur within the North Kiaka Project area.

When stygofauna is present it does, however, show high levels of endemism with 98% of the stygobites and 83% of the other groundwater species occur only within the Pilbara (Halse et al. 2014). Recent analysis by Halse et al. (2014) has shown that there is little correlation between water quality and geology for predicting the presence of stygofauna, however, the non-random siting of groundwater wells in highly transmissive locations within various geologies has undoubtedly created a bias in the data. The use of predictive modelling has shown that some of the highest diversity areas in the Pilbara for stygofauna are within Quaternary alluvial aquifers (Halse et al. 2014).

3.2 Conservation Significant Fauna and Habitats

A search was undertaken for conservation significant subterranean fauna for the Study Area using both the DPaW Wildlife Conservation (Specially Protected Fauna) Notice 2018 (DPaW 2018) and the Protected Matters Search Tool (PMST) of the Australian Government's Department of the Environment and Energy (DEE). No subterranean species were found to be listed under either of these resources. A full description of the DPaW conservation codes are shown in Appendix 1.

3.3 Subterranean Fauna Habitat in the Project Area

The North Kiaka Project is located primarily in Noondine Chert surrounded by lower lying colluvium and alluvium to the west of the Project area and minor outcrops of the Mokadine Formation to the south east (Table 1, Plate 1). The colluvium and alluvium lithologies to the west of the Project area have a low suitability for both troglofauna and stygofauna habitat due to the absence of interconnected voids in these fine grained units. The lateritic unit may provide some limited habitat for stygofauna in the saturated zone depending upon the degree of weathering present.

The Yarragadee sandstones and conglomerates that provide highly suitable habitat for stygofauna, with known occurrences of stygofauna from the Yarragadee formation near Lancelin (Bennelongia 2008) are located on the western side of the Darling Fault which separates the Noondine Chert within the Project area from this stygofauna habitat.

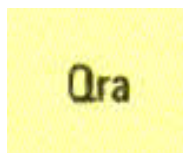
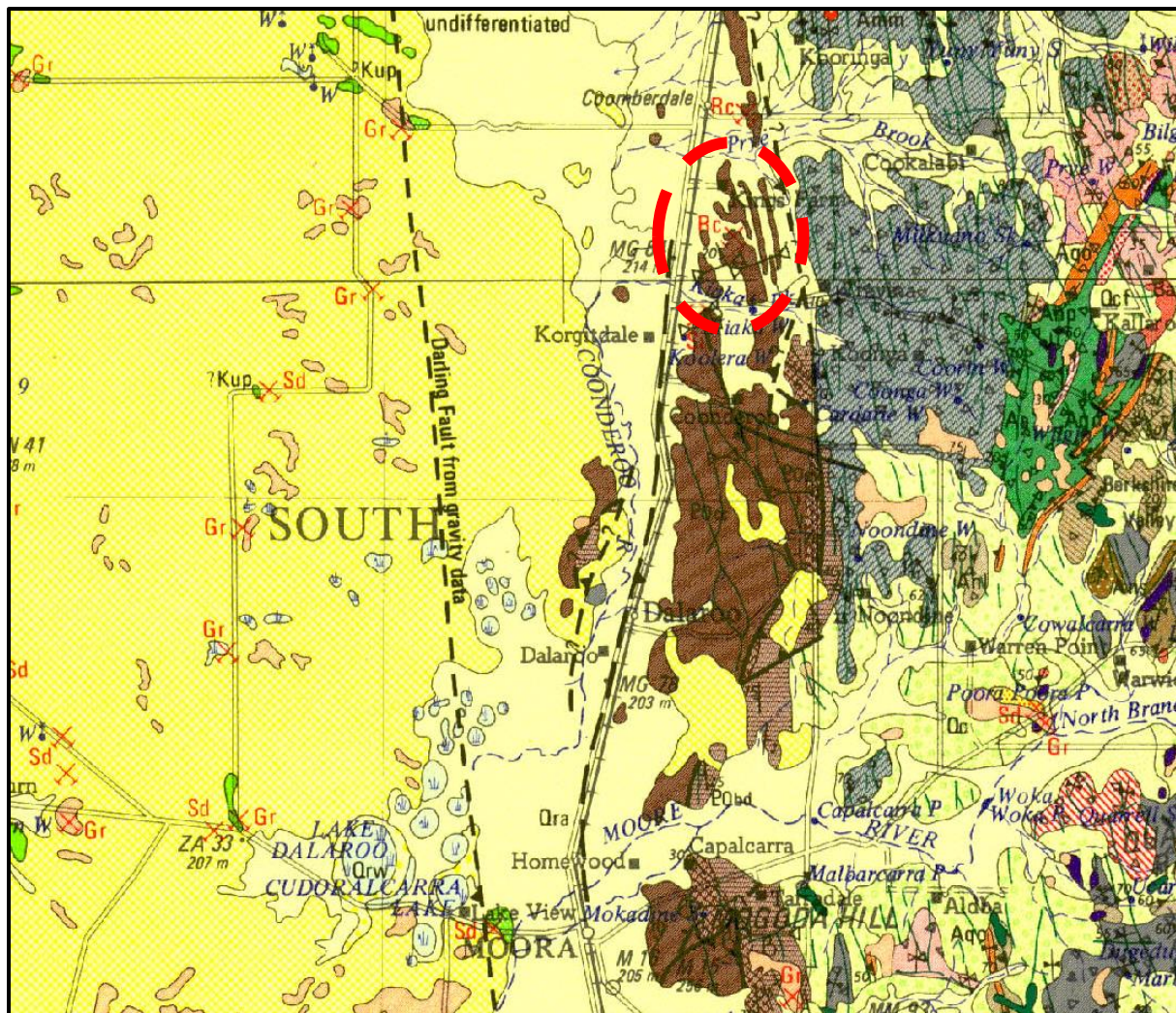
The Noondine Chert is known to contain palaeokarst and subsurface voids that is highly suitable habitat for stygofauna (Appleyard 2002). The Noondine Chert is the target lithology for the North Kiaka Quartzite Project and previous subterranean fauna surveys for the existing Simcoa operations (Knott and Goater, 2005) revealed the existence of a stygal community within the local groundwater. The Noondine Chert formation located within North Kiaka Project is also known to contain at least four species of stygofauna (Knott and Goater 2005).

The Mokadine Formation that has minor outcrops to the south east of the North Kiaka Project area would provide a low to moderate likelihood of containing stygofauna habitat, unless it is highly fractured within the saturated zone. The likelihood of troglofauna habitat being present within this formation is low due to a general absence of interconnected void space in sandstone units.

The basement Archean migmatites also has a low likelihood of stygofauna or troglofauna habitat unless it is highly fractured which is generally uncommon in such lithologies.

Table 1 Geological units in the North Kiaka Project and Subterranean fauna habitat potential.

Unit	Description / Remarks	Subterranean Fauna Suitability
Colluvium and alluvium	Quartz sand and soil	Low for stygofauna and troglofauna.
Yarragadee Formation	Sandstone and conglomerate (situated across the Darling Fault to the Project area)	Moderate/High for stygofauna. Low/Moderate for troglofauna.
Noondine Chert	Chert and orthoquartzite with minor sandstone and dolomite	Stygofauna known to occur in the Noondine Chert Moderate for troglofauna
Mokadine Formation	Arkose with sandstone siltstone, claystone and chert	Low/Moderate for stygofauna (unless highly fractured) Low for troglofauna
Archean basement migmatite	Partially remelted Archean metamorphic rock	Low for stygofauna and troglofauna unless highly fractured.



Ora – Colluvium and alluvium



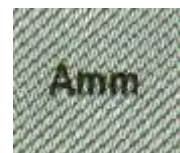
JKY – Yarragadee Formation



POcc – Noondine Chert



POc – Mokadine formation



Amm – Migmatite basement

Plate 1 Inset of the geology surrounding the North Kiaka Quartzite Project. The brown units represent the Noondine chert. The red dashed line shows the approximate position of the Proposed development.

3.4 Likelihood of stygofauna presence

A search was undertaken of the Western Australian Museum databases for Crustaceans (WAM 2018a) and Arachnids/Myriapods (WAM 2018b). The desktop study area comprised a rectangle of approximately 50 km sides bounded by the north west corner (30.281015°S, 115.807140°E) and the south east corner (30.771696°S, 116.286079°E) centred on the North Kiaka quartzite project. The results of these filtered for subterranean stygofauna species. No stygofauna has previously been recorded from the Project area from Western Australian Museum database records (WAM 2018a and 2018b), however, records of stygofauna recorded by Knott and Goater (2005) are summarised in Table 2 and locations are shown in Figure 2.

Table 2 Stygofauna recorded by Knott and Goater 2005 from the Simcoa Quartzite Project.

Higher Classification	Family	Genus and Species	Notes
Nematoda		<i>Undetermined genus and species</i>	Bore MT35
Oligochaeta	Naidae	<i>Undetermined genus and species</i>	Bore M1455
Bathynellaceae	Parabathynellidae	<i>Undetermined genus sp1</i>	identified by Knott and Goater 2005 to family only, Site M1099
	Bathynellid	<i>Undetermined genus sp2</i>	identified by Knott and Goater 2005 to family only Site MT36

The known stygofauna previously recorded by Knott and Goater 2005, do not occur within the current North Kiaka development area (Figure 2), with the records being to the north of the proposed development area and within the existing approved operations. Images of the Parabathynellid species 1 from bore M1099 are shown in Plate 2.

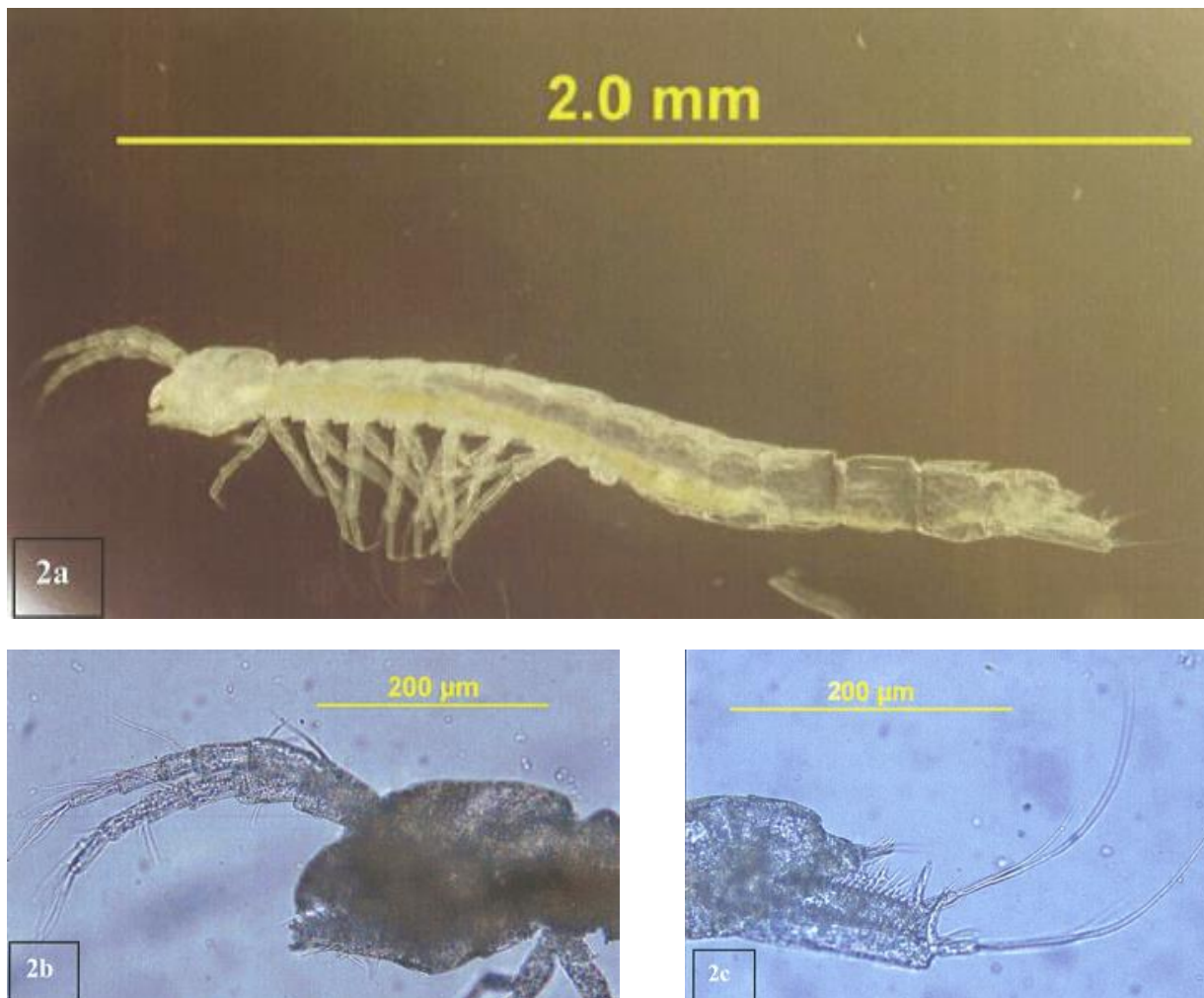


Plate 2 Images of the Parabathynellid specimens recorded by Knott and Goater 2005 from bore M1099 from the Simcoa Quartzite Mine Area (Images after Knott and Goater 2005)

3.5 Likelihood of troglofauna presence

A search was undertaken of the Western Australian Museum databases for Crustaceans (WAM 2018a) and Arachnids/Myriapods (WAM 2018b). The desktop study area comprised a rectangle of approximately 50 km sides bounded by the north west corner (30.281015°S, 115.807140°E) and the south east corner (30.771696°S, 116.286079°E) centred on the North Kiaka quartzite project. The results of these filtered for subterranean troglofauna species. No troglofauna has previously been recorded from the Project area from Western Australian Museum database records (WAM 2018a and 2018b), however, no sampling within the immediate Project area has occurred.

The overlaying colluvium, known as the Mesovoid Shallow Substratum (MSS) is virtually un-sampled within the Wheatbelt, but is increasingly known worldwide to contain significant troglobiont communities (Ortuño 2013), however, the sand and soil dominated nature of this colluvium makes the likelihood low that it will contain troglofauna in this particular area.

Due to the presence of stygofauna within a fractured rock aquifer within the Project area, there is a moderate likelihood that habitat exists for troglofauna within the unsaturated zone of the Noondine Chert. No core photos were available for examination to confirm the presence or absence of suitable fracturing that provides interconnected void space in the upper rock strata that may provide habitat for troglofauna.

4. Subterranean Fauna Risk Assessment

This preliminary risk assessment is based primarily upon the proposed open cut mining operations for the North Kiaka Project. The anticipated activities at the North Kiaka Project area include land clearing, construction of buildings and surface access roads, storage of hydrocarbons and minor excavation for the purposes of building footings. The anticipated mining activities include no mining below the local watertable and this assessment of impact is based no dewatering occurring during the life of the project.

4.1 Preliminary Risk Assessment for Stygofauna

The mining pit excavation is anticipated to have a low to moderate impact upon any local stygofauna community (Table 3) as no dewatering is anticipated to occur thus limiting any potential impacts to stygofauna in the local area.

The waste rock storage areas are anticipated to have a low risk of impact to stygofauna, dependent upon it not significantly altering subsurface hydrology or clogging subterranean voids with fine sediment. This risk will be minimised by locating the waste rock dump on the colluvium units within the North Kiaka Project area.

The construction and operation of other associated surface mine infrastructure are expected to pose a Low risk to stygofauna.

Table 3 Risk of impact to stygofauna from resource development

Disturbance mechanism	Likelihood of disturbance occurring	Subterranean fauna presence	Risk of Impact to Stygofauna Community if present
Pit excavation	Definite	Stygofauna Confirmed	Low/Moderate
Dewatering	Nil	Confirmed	Very High
Waste rock storage facility altering subsurface hydrology and nutrient inputs	Moderate	Low (if not positioned on Noondine Chert Formation)	Low
Surface infrastructure including roads, buildings and laydown areas	Definite	Low	Very Low

4.2 Preliminary Risk Assessment for Troglofauna

The mining pit excavation is anticipated to have a low impact upon any local troglofauna community (Table 4) as the pits are relatively small and habitat for troglofauna is anticipated to remain outside of the proposed mining areas.

The waste rock storage areas are anticipated to have a low risk of impact to troglofauna, dependent upon it not significantly altering subsurface hydrology or clogging subterranean voids with fine sediment. This risk will be minimised by locating the waste rock dump on the colluvium units within

the North Kiaka Project area and away from the Noondine Chert that would provide potential troglofauna habitat.

The construction and operation of other associated surface mine infrastructure are expected to pose a Low risk to troglofauna.

Table 4 Risk of impact to troglofauna from resource development

Disturbance mechanism	Likelihood of disturbance occurring	Subterranean fauna presence	Risk of Impact to Stygofauna Community if present
Pit excavation	Definite	Troglofauna Moderate	Low
Dewatering	Nil	Confirmed	Moderate
Waste rock storage facility altering subsurface hydrology and nutrient inputs	Moderate	Low (if not positioned on Noondine Chert Formation)	Low
Surface infrastructure including roads, buildings and laydown areas	Definite	Low	Very Low

4.3 Cumulative impacts

Cumulative impacts in the local region are expected to be minimal with the only other major impacts being the existing quarry operation to the south of the proposed North Kiaka Quartzite Project. The primary cumulative impacts from the developments is land clearance and excavation of small mining pits and potentially altered hydrology, however, these are relatively small in the scale of the Central Wheatbelt with minimal clearing of native vegetation to occur. It is anticipated that the North Kiaka Project will not add significantly to the cumulative impacts to subterranean fauna in the local area.

5. Conclusions and Recommendations

The North Kiaka Project is located primarily in Noondine Chert surrounded by lower lying colluvium and alluvium to the west of the Project area and minor outcrops of the Mokadine Formation to the south east. The colluvium and alluvium lithologies to the west of the Project area have a low suitability for both troglifauna and stygofauna habitat due to the absence of interconnected voids in these fine grained units. The Noondine Chert is known to contain palaeokarst and subsurface voids that is highly suitable habitat for stygofauna (Appleyard 2002). The Noondine Chert is the target lithology for the North Kiaka Quartzite Project and previous subterranean fauna surveys for the existing Simcoa operations revealed the existence of a stygal community within the local groundwater. The Noondine Chert formation located within North Kiaka Project is also known to contain at least four species of stygofauna.

Searches of the Western Australian Museum databases for Crustaceans and Arachnids/Myriapods were undertaken of a rectangle of approximately 50 km sides centred on the North Kiaka quartzite project. The results of these filtered for subterranean species revealed no specimen records of any subterranean fauna held by the Western Australian Museum.

The known stygofauna previously recorded by Knott and Goater 2005, do not occur within the current North Kiaka development area with the records being to the north of the proposed development area and within the existing approved operations.

Due to the presence of stygofauna within a fractured rock aquifer within the Project area, there is a moderate likelihood that habitat exists for troglifauna within the unsaturated zone of the Noondine Chert. No core photos were available for examination to confirm the presence or absence of suitable fracturing that provides interconnected void space in the upper rock strata that may provide habitat for troglifauna.

The mining pit excavation is anticipated to have a low to moderate impact upon any local stygofauna community and a low impact on potential troglifauna as no dewatering is anticipated to occur thus limiting any potential impacts.

The waste rock storage areas are anticipated to have a low risk of impact to stygofauna and troglifauna, dependent upon it not significantly altering subsurface hydrology or clogging subterranean voids with fine sediment. This risk will be minimised by locating the waste rock dump on the colluvium units within the North Kiaka Project area.

The construction and operation of other associated surface mine infrastructure are expected to pose a Low risk to stygofauna and potential troglifauna.

5.1 Recommendations

The following recommendations are made with regard to the potential development of the North Kiaka Project:

- The storage of hydrocarbons on site should be limited and all storage areas fully bunded.

6. References

- Appleyard, S. (2002). Palaeokarst in the Noondine Chert in Southwestern Australia: Implications for Water Supply and the Protection of Biodiversity. *Helictite* **38**(1): p 17-19.
- Bennelongia (2008). Literature review and monitoring program for stygofauna in the Gngangara Groundwater System. Unpublished report to Department of Environment and Conservation, 19p.
- Christiansen, K. A. (1962). Proposition pour la classification des animaux cavernicoles. *Spelunca Mem.* 2: 76-78.
- Department of Parks and Wildlife (DPAW). (2018). Wildlife Conservation (Specially Protected Fauna) Notice 2018. Accessed November 2018
- EPA (2016a). Technical guidance subterranean fauna survey. Environmental Protection Authority: Perth. 24 pp.
- EPA (2016b). Technical guidance Sampling methods for subterranean fauna. Environmental Protection Authority: Perth. 37 pp.
- EPA (2016c). Environmental factor guideline. Subterranean Fauna. Environmental Protection Authority: Perth. 5 pp.
- Geological Survey of Western Australia (1982). Moora 1:250,000 Sheet SF 50-10 Geological Map, Geological Survey of Western Australia.
- Halse S.A., Scanlon M.D., Cocking J.S., Barron H.J., Richardson J.B. and Eberhard S.M. (2014). Pilbara stygofauna: deep groundwater of an arid landscape contains globally significant radiation of biodiversity. *Records of the Western Australian Museum, Supplement* 78: 443–483
- Howarth, F. G. (1973). The cavernicolous fauna of Hawaiian lava tubes, 1. Introduction. *Pacific Insects* 15: 139-151.
- Humphreys, W. F. (2000). Background and glossary. *Ecosystems of the world. Subterranean ecosystems*. Wilkens, H., Culver, D. C. and Humphreys, W. F. Amsterdam, Elsevier. 30: 3-14.
- Humphreys, W.F. (2008). Rising from Down Under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective. *Invertebrate Systematics* 22:85-101.
- Moulds, T.A. (2007a). Subterranean fauna of the Eneabba, Jurien and South Hill River (Nambung) karst areas, Western Australia. Unpublished report to the Department of Environment and Conservation Mid West Region, 27p.
- Moulds, T.A. (2007b). October sampling of subterranean invertebrate fauna of the Eneabba, Jurien and South Hill River (Nambung) karst areas, Western Australia. Unpublished report to the Department of Environment and Conservation Mid West Region, 10p.
- Ortuño VM, Gilgado JD, Jiménez-Valverde A, Sendra A, Pérez-Suárez G, Herrero-Borgoñón JJ. (2013). The “Alluvial Mesovoid Shallow Substratum”, a New Subterranean Habitat. *PLoS ONE* 8(10): e76311. doi:10.1371/journal.pone.0076311
- Pesce, G.L., De Laurentiis, P. and Humphreys, W.F. (1996). Copepods from ground waters of Western Australia. I. The genera *Metacyclops*, *Mesocyclops*, *Microcyclops* and *Apocyclops* (Crustacea: Copepoda: Cyclopidae). *Records of the Western Australian Museum.* 18:77-85.

- Sket, B. (2008). Can we agree on an ecological classification of subterranean animals? *Journal of Natural History* 42: 1549-1563.
- Western Australian Museum (WAM). (2018a). Crustacean database search, November 2018.
- Western Australian Museum (WAM). (2018b). Arachnida and Myriapoda database search, November 2018.
- Yager, J. and Humphreys, W.F. (1996). *Lasionectes exleyi* sp. nov., the first remipede crustacean recorded from the Australia and the Indian Ocean, with a key to the world species. *Invertebrate Taxonomy* 10:171-187.

Appendix 1

Department of Parks and Wildlife Conservation Codes (November 2015)



CONSERVATION CODES

For Western Australian Flora and Fauna

Specially protected fauna or flora are species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

T Threatened species

Published as Specially Protected under the *Wildlife Conservation Act 1950*, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN Endangered species

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU Vulnerable species

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX Presumed extinct species

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA Migratory birds protected under an international agreement

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Appendix 2

Protected Matters Search Results



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/01/19 11:04:31

[Summary](#)

[Details](#)

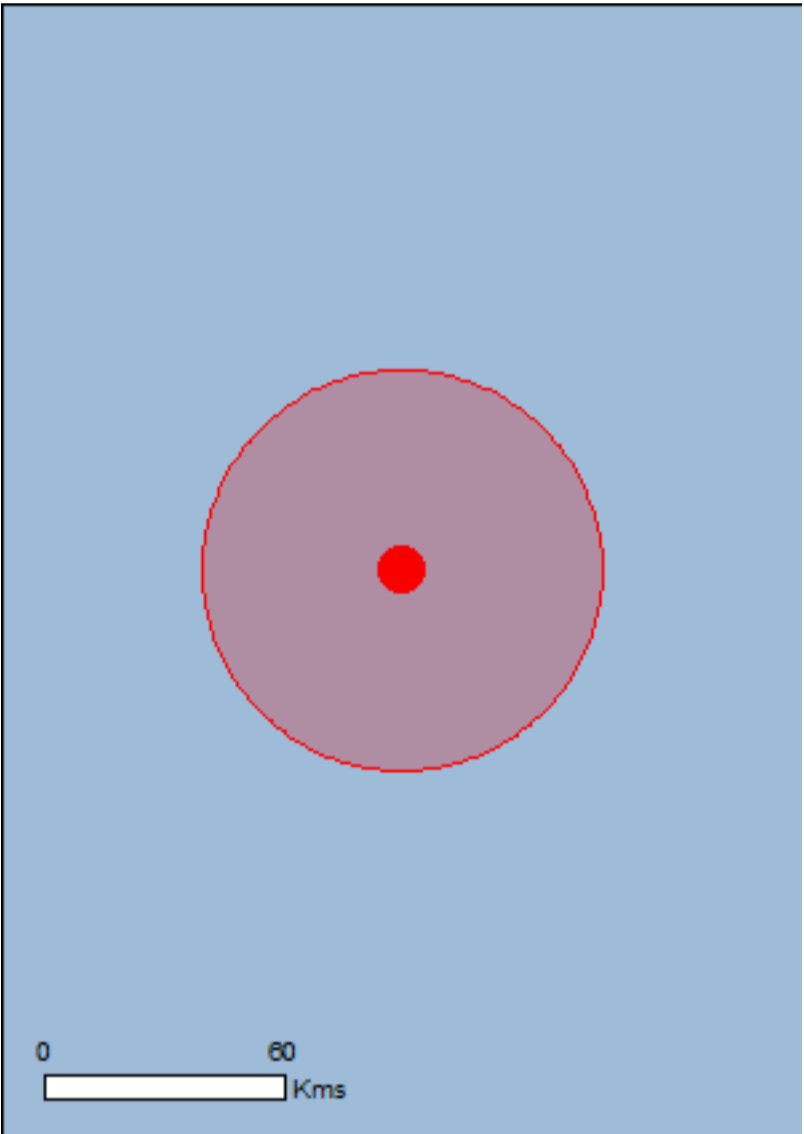
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are
©Commonwealth of Australia
(Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 50.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	78
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	26
Regional Forest Agreements:	None
Invasive Species:	19
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities

[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Eucalypt Woodlands of the Western Australian Wheatbelt	Critically Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat may occur within area
Phascogale calura Red-tailed Phascogale, Red-tailed Wambenger,	Vulnerable	Species or species

Name	Status	Type of Presence
Kenngoor [316]		habitat likely to occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat known to occur within area
Plants		
Acacia aprica Blunt Wattle [64821]	Endangered	Species or species habitat likely to occur within area
Acacia aristulata Watheroo Wattle [64822]	Endangered	Species or species habitat known to occur within area
Acacia ataxiphylla subsp. magna Large-fruited Tammin Wattle [64823]	Endangered	Species or species habitat may occur within area
Acacia cochlocarpa subsp. cochlocarpa Spiral-fruited Wattle [23877]	Endangered	Species or species habitat known to occur within area
Acacia cochlocarpa subsp. velutinos Velvety Spiral Pod Wattle [65112]	Critically Endangered	Species or species habitat likely to occur within area
Acacia forrestiana Forest's Wattle [17235]	Vulnerable	Species or species habitat known to occur within area
Acacia recurvata Recurved Wattle [64825]	Endangered	Species or species habitat known to occur within area
Acacia splendens Splendid Wattle, Dandaragan Wattle [81510]	Endangered	Species or species habitat known to occur within area
Acacia vassalii Vassal's Wattle [6144]	Endangered	Species or species habitat known to occur within area
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area
Banksia fuscobractea Dark-bract Banksia [83059]	Critically Endangered	Species or species habitat known to occur within area
Banksia serratuloides subsp. perissa Northern Serrate Dryandra [82767]	Critically Endangered	Species or species habitat likely to occur within area
Banksia serratuloides subsp. serratuloides Southern Serrate Dryandra [82768]	Vulnerable	Species or species habitat known to occur within area
Caladenia drakeoides Hinged Dragon Orchid [68687]	Endangered	Species or species habitat known to occur within area
Calectasia pignattiana Stilted Tinsel Lily [82018]	Vulnerable	Species or species habitat likely to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Chorizema humile Prostrate Flame Pea [32573]	Endangered	Species or species habitat known to occur within area
Conospermum densiflorum subsp. unicephalum One-headed Smokebush [64871]	Endangered	Species or species habitat known to occur within area
Darwinia acerosa Fine-leaved Darwinia [9004]	Endangered	Species or species habitat known to occur within area
Darwinia carnea Mogumber Bell, Narrogin Bell [9736]	Endangered	Species or species habitat likely to occur within area
Darwinia chapmaniana Chapman's Bell [64877]	Endangered	Species or species habitat likely to occur within area
Dasymalla axillaris Native Foxglove [38829]	Critically Endangered	Species or species habitat likely to occur within area
Daviesia dielsii Diels' Daviesia [19617]	Endangered	Species or species habitat known to occur within area
Daviesia euphorbioides Wongan Cactus [3477]	Endangered	Species or species habitat may occur within area
Drakaea concolor Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eremophila pinnatifida Pinnate-leaf Eremophila [64894]	Endangered	Species or species habitat likely to occur within area
Eremophila scaberula Rough Emu Bush [16729]	Endangered	Species or species habitat known to occur within area
Eremophila vernicosa Resinous Poverty Bush [64596]	Vulnerable	Species or species habitat likely to occur within area
Eremophila viscida Varnish Bush [2394]	Endangered	Species or species habitat may occur within area
Eucalyptus absita Badgingarra Box [24260]	Endangered	Species or species habitat known to occur within area
Eucalyptus crispata Yandanooka Mallee [24268]	Vulnerable	Species or species habitat may occur within area
Eucalyptus dolorosa Dandaragan Mallee, Mount Misery Mallee [56709]	Endangered	Species or species habitat likely to occur within area
Eucalyptus impensa Eneabba Mallee [56711]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Eucalyptus leprophloia Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat likely to occur within area
Eucalyptus pruiniramis Midlands Gum, Jingymia Gum [56403]	Endangered	Species or species habitat known to occur within area
Eucalyptus recta Silver Mallet [56430]	Endangered	Species or species habitat known to occur within area
Eucalyptus rhodantha Rose Mallee [9362]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
Frankenia conferta Silky Frankenia [6074]	Endangered	Species or species habitat may occur within area
Gastrolobium appressum Scale-leaf Poison [7358]	Vulnerable	Species or species habitat known to occur within area
Gastrolobium hamulosum Hook-point Poison [9212]	Endangered	Species or species habitat known to occur within area
Glyceria drummondii Nangetty Grass [14008]	Endangered	Species or species habitat known to occur within area
Goodenia arthrotricha [12448]	Endangered	Species or species habitat known to occur within area
Grevillea calliantha Foote's Grevillea, Cataby Grevillea, Black Magic Grevillea [56339]	Endangered	Species or species habitat may occur within area
Grevillea christineae Christine's Grevillea [64520]	Endangered	Species or species habitat known to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat may occur within area
Grevillea dryandroides subsp. hirsuta Hairy Phalanx Grevillea [64577]	Endangered	Species or species habitat likely to occur within area
Grevillea pythara Pythara Grevillea [64525]	Endangered	Species or species habitat likely to occur within area
Grevillea sp. Gillingarra (R.J.Cranfield 4087) [86383]	Critically Endangered	Species or species habitat known to occur within area
Gyrostemon reticulatus Net-veined Gyrostemon [8491]	Critically Endangered	Species or species habitat likely to occur within area
Hakea megalosperma Lesueur Hakea [10505]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Haloragis platycarpa Broad-fruited Haloragis [15371]	Critically Endangered	Species or species habitat likely to occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat known to occur within area
Hemiandra rutilans Sargents Snakebush, Colourful Snakebush [17932]	Endangered	Species or species habitat likely to occur within area
Jacksonia pungens Pungent Jacksonia [64920]	Endangered	Species or species habitat known to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Paracaleana dixonii Sandplain Duck Orchid [86882]	Endangered	Species or species habitat likely to occur within area
Ptychosema pusillum Dwarf Pea [11268]	Vulnerable	Species or species habitat may occur within area
Rhagodia acicularis Wongan Rhagodia [11145]	Vulnerable	Species or species habitat likely to occur within area
Roycea pycnophylloides Saltmat [21161]	Endangered	Species or species habitat likely to occur within area
Spirogardnera rubescens Spiral Bush [15667]	Endangered	Species or species habitat likely to occur within area
Synaphea quartzitica Quartz-loving Synaphea [64978]	Endangered	Species or species habitat known to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat may occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Verticordia staminosa subsp. staminosa Wongan Featherflower [55825]	Endangered	Species or species habitat may occur within area

Reptiles		
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Migratory Terrestrial Species

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land

[Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name	Threatened	Type of Presence
Commonwealth Land -		
Listed Marine Species		
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
[Resource Information]		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]		Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Boothendarra	WA
Dandarangan	WA
Gillingarra	WA
Gunyidi	WA
Jam Hill	WA
Jocks Well	WA
Karamarra	WA
Koodjee	WA
Long Pool	WA
Manaling	WA
Martinjinni	WA
Merewana	WA
NTWA Bushland covenant (0066)	WA
NTWA Bushland covenant (0115)	WA

Name	State
Namban	WA
Pinjarrega	WA
Unnamed WA23179	WA
Unnamed WA26575	WA
Unnamed WA28710	WA
Unnamed WA39322	WA
Unnamed WA42209	WA
Unnamed WA43811	WA
Unnamed WA44081	WA
Unnamed WA45337	WA
Unnamed WA47694	WA
Watheroo	WA

Invasive Species

[[Resource Information](#)]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-30.49626 116.04327

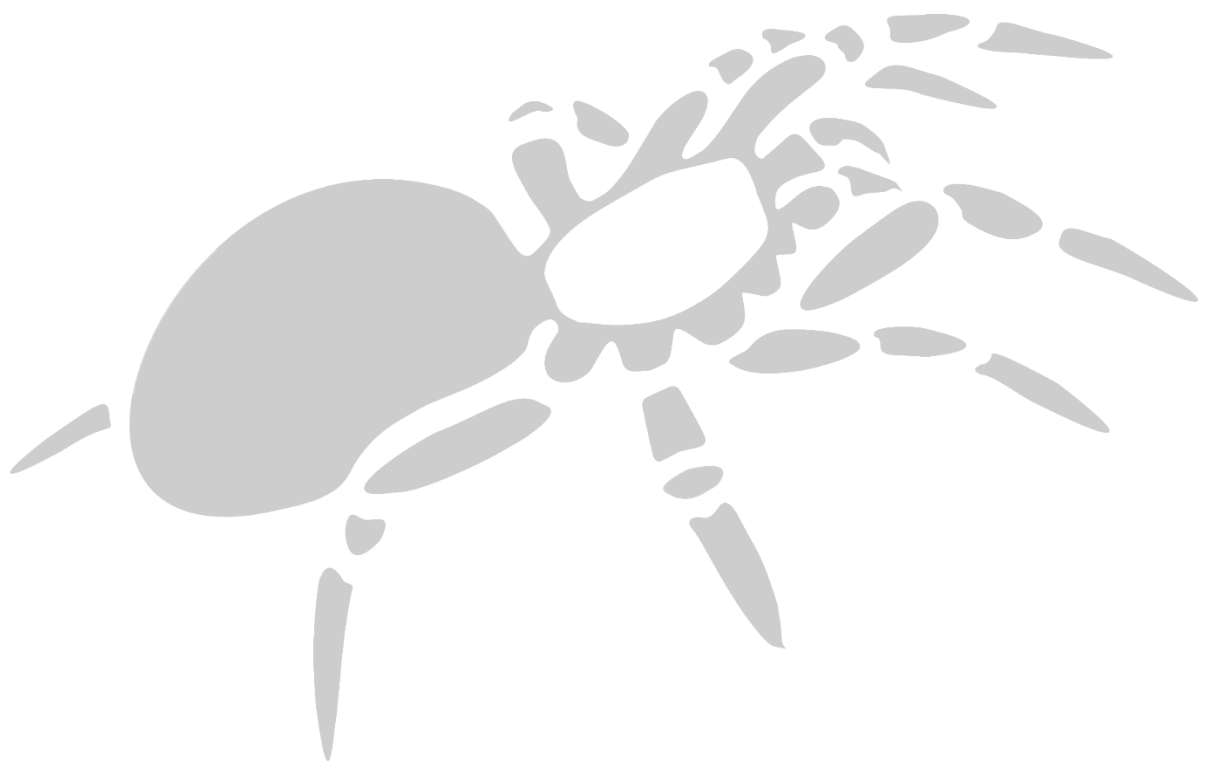
Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.



www.invertebratesolutions.com