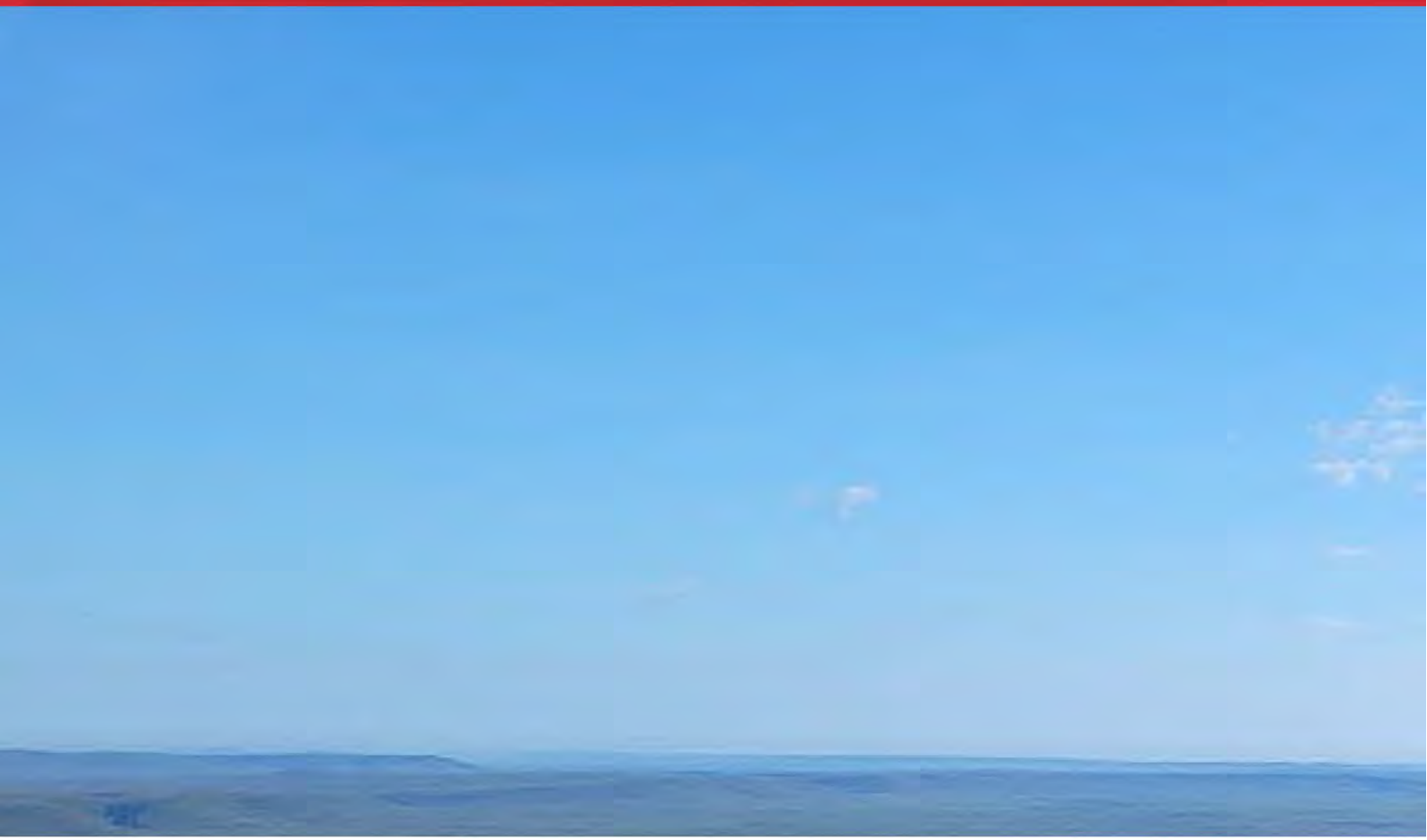
APPENDIX B ECOLOGICAL ASSESSMENT EP154

Note: Ecological Assessments provide an overview of the ecological work conducted as part of this project. Changes to the EMP have been made following this assessment, and this is why different maps and areas are covered within this report.

EP154 Ecological Assessment Seismic and Exploratory Drilling Program

MINERALS AUSTRALIA



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EXECUTIVE SUMMARY

Minerals Australia Pty Ltd. is planning an exploration program within their Exploration Permit area 154 (EP154) on the freehold tenures Alawa 1 and Mangarrayi Aboriginal Land Trusts. The exploration works will be regulated through an Environmental Management Plan (EMP) approved by the Department of Environment, Parks and Water Security (DEPWS). To inform the EMP, an assessment of the ecological values within EP154, particularly the exploration program footprint, is required.

To address the potential impacts associated with the exploration activities a desktop and brief site assessment was undertaken between the 13 and 15 of July 2021 by two ecologists. Helicopter flyovers were undertaken to investigate the presence of significant vegetation, potential habitat for threatened species, erosion and priority weed infestations along proposed seismic line routes, access tracks and the drill pad. The assessments were conducted by flying low to the ground at a slow pace and landing at observed infestations, analogue vegetation sites and random assessment sites. Walkover transects were also performed in a 1 ha area around the proposed drill pad.

The following ecological values were identified in the project area.

Riparian and drainage line vegetation

Typical riparian and drainage line vegetation in the region consists of *Eucalyptus* and *Melaleuca* communities with tussock grass understoreys. Five of the 14 waterway crossing sites were considered to support significant riparian vegetation due to the presence of River Red Gum *Eucalyptus camaldulensis* along the banks. The riparian vegetation along the banks was in the most part considered narrow, before transitioning into woodland community beyond. Water crossing sites supporting riparian vegetation include: WC1, WC3, WC5, WC6, WC7, WC8, WC10 and WC12. All other waterway crossing sites support drainage line vegetation. Inspected areas of riparian and drainage line vegetation exhibited impacts from cattle and feral animals. Erosion was evident on the banks of eight of the watercourse crossing sites (WC1, WC4, WC6, WC8, WC9, WC10, WC11, and WC13). Declared weed Hyptis* (*Mesosphaerum suaveolens*) was observed in eight sites (WC2, WC5, WC6, WC7, WC8, WC10, WC12, and WC14) and environmental weeds at four of the sites (WC3, WC4, WC8, WC14).

Large trees with hollows

The project footprint supports vegetation communities with large old hollow bearing trees. Remnant vegetation with hollow bearing trees was observed where the drainage line that intersects with Seismic Line 3 (WC7) and the proposed drill pad are located. Hollow bearing trees included, River Red Gum (*Eucalyptus camaldulensis*) along the waterways and Snappy Gums (*Eucalyptus leucophloia*) within the woodland communities. Removal of large trees should be avoided to minimise potential impacts to EPBC-listed Gouldian Finch and other fauna that are reliant on these hollows for breeding.

Watercourses, wetlands and Groundwater Dependent Ecosystems

Eleven creeks and their tributaries associated with the Roper River and Limmen Bight River are included within EP154. The watercourses within EP154 are intermittent – flowing only during the wet season – although there are some permanent spring-fed waterholes. Packsaddle Creek, Deadmans Creek and Blackwater Creek are crossed by the project footprint.

The Limmen Bight (Port Roper) Tidal Wetlands System is an important wetland located 140 km east of the project footprint, encompassing the estuary of the Roper River. The proposed works are located upstream of the Roper River catchment. Implementation of an erosion and sediment control plan must be undertaken to minimise impacts to downstream values.

There are two known terrestrial Groundwater Dependent Ecosystems (GDE's) in the project footprint, namely Blackwater Creek and the floodplain of one of its tributaries, both supporting *Melaleuca* woodlands.

Blackwater Creek is crossed by Seismic Lines 3 and 4 (e.g. WC7), within the eastern and southern sections of the seismic lines respectively. Packsaddle Creek is crossed by the northern access track and Seismic Line 1 (WC12) and has a moderate potential to be a GDE. Works must aim to minimise impacts on GDEs associated with Blackwater and Packsaddle Creeks through the control of erosion, minimisation of vegetation loss and rehabilitation post-works.

Threatened species

The project footprint has the potential to support two threatened species considered to have a high likelihood of occurrence:

- Gouldian Finch (*Erythrura gouldiae*) (listed as Vulnerable under the *TPWC Act* and Endangered under *EPBC Act*)
- Mertens' Water Monitor (*Varanus mertensi*) (listed as Vulnerable under *TPWC Act*)

Mertens' Water Monitor has a broad range and utilises riparian vegetation near permanent watercourses that are abundant north of the project footprint and only cross the project footprint through Seismic Line 1 (Packsaddle Creek, water crossing site WC9). As such, the exploration program is considered unlikely to have a significant impact on this species or its habitat.

The project footprint supports potential Gouldian Finch habitat. These potential areas of habitat are associated with hilled regions supporting Snappy Gums (nesting habitat). Potential habitat for this species is also present within the proposed drill pad location and along access tracks and seismic lines. Avoidance of large hollow bearing trees is recommended through the project footprint. If impacts to large old trees cannot be avoided, a targeted assessment is recommended within areas of suitable habitat to determine the presence and potential impacts to this species.

Weeds

Weed invasion and spread is a key risk to ecological values and pastoral activities. Exploration activities can be a vector for the transport of weed material. Forty sites were assessed for the occurrence of weeds. Weed surveys were undertaken within the water crossing sites, vegetation assessment sites and specific weed survey sites. A number of weeds are present in the region and are listed under the *Katherine Regional Weed Strategy 2021-2026* (DEPWS 2021).

There are at least 25 priority weed species identified for the region that are relevant to the project footprint (Table 5-1). Of these, one declared species was recorded within the project footprint:

- Hyptis (*Mesosphaerum suaveolens*) was widespread along the drainage lines within EP154 including those that are crossed by the proposed seismic lines and access tracks (water crossing sites - WC2, WC5, WC6, WC7, WC8, WC10, WC12, and WC14). These areas of infestation are considered a high risk for spread.
- Three additional environmental weeds were recorded:
    - *Stylosanthes hamata* was observed along Seismic Line 4.
    - Spiny Sida (*Sida spinosa*) was recorded along seismic line 2 (WC4), seismic line 5 and the drill pad.
    - *Stylosanthes scabra* was recorded along seismic line 5.

The risk of spreading these weed species is high since the location of their infestations increases the likelihood of transportation of their reproductive material by machinery to other disturbed areas.

Land Condition Assessment

A land condition assessment using multiple criteria (vegetation, erosion, weeds and impacts of pastoral activities) was undertaken for 18 vegetation assessment sites and 14 waterway crossing sites in the project footprint. All 18 analogue vegetation sites were considered to be in good condition. Ten waterways crossing sites were considered to be in good condition (WC2, WC3, WC5, WC6, WC7, WC9, WC11, WC12, WC13,

WC14) and four were considered to be in average condition due to the presence of weeds and some erosion (e.g. WC1, WC4 WC8, & WC10).

Conclusions and Recommendations

The proposed works will include the removal of native vegetation and fauna habitat along the seismic lines, access tracks and drill pad. These works will include areas supporting significant vegetation as per the NT Land Clearing Guidelines (DNRE 2020): riparian vegetation, areas supporting large hollow bearing trees and known and potential ground water dependent ecosystems. Works also have the potential to spread weeds and promote erosion along the waterways. Further, there is potential for the works to impact on nesting habitat for EPBC-listed Gouldian Finch, particularly within areas supporting Snappy Gum. The potential impacts to biodiversity values, however, can be minimised if appropriate control measures are undertaken. As such, the following recommendations are made:

- Travel between project area sites using existing tracks, roads, and trails only.
- Where possible, minimise impacts to riparian vegetation through avoidance and or minimisation of native vegetation removal and protection of large old trees.
- Avoid the removal of any large trees with DBH > 40 cm, especially the Snappy Gums (located primarily in the sandstone plains and rises) to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, further assessment will be required. This would include targeted field surveys, evaluation of impacts and potential referral under the EPBC Act.
- Prior to exploration works, a weed management plan must be prepared and implemented.
- During exploration activities, all vehicles, plant, and equipment should be certified weed-free prior to entry into the project area. Weed hygiene protocols must be implemented to ensure that weeds are not introduced or spread through the site.
- Control infestations and avoid the spread of Hyptis, *Spiny sida* and *Stylosanthes* species, with weed control focused on drainage crossings where infestations are established.
- An erosion and sediment control plan must be developed as per the NT Land Clearing Guidelines (DENR 2020). This plan must outline measures to minimise impacts associated with waterway crossings, other erosion prone landforms and minimise downstream impacts outside the project footprint.
- Produce a rehabilitation plan for all the disturbed areas, aiming to replicate the environmental conditions of the sites prior to the disturbances.

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ACRONYMS

BOM	Bureau of Meteorology
DBH	Diameter at Breast Height
DEPWS	Department of the Environment, Parks and Water Security (Northern Territory) – formally DENR
DENR	Department of Environment and Natural Resources (Northern Territory) – now DEPaWS
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP	Exploration Permit
EPBC Act	*Environment Protection and Biodiversity Conservation Act (1999)* (Commonwealth)
GDE	Groundwater Dependent Ecosystem
IUCN	International Union for Conservation of Nature
NT	Northern Territory
TPWC Act	*Territory Parks and Wildlife Conservation Act* (Northern Territory)
WoNS	Weeds of National Significance

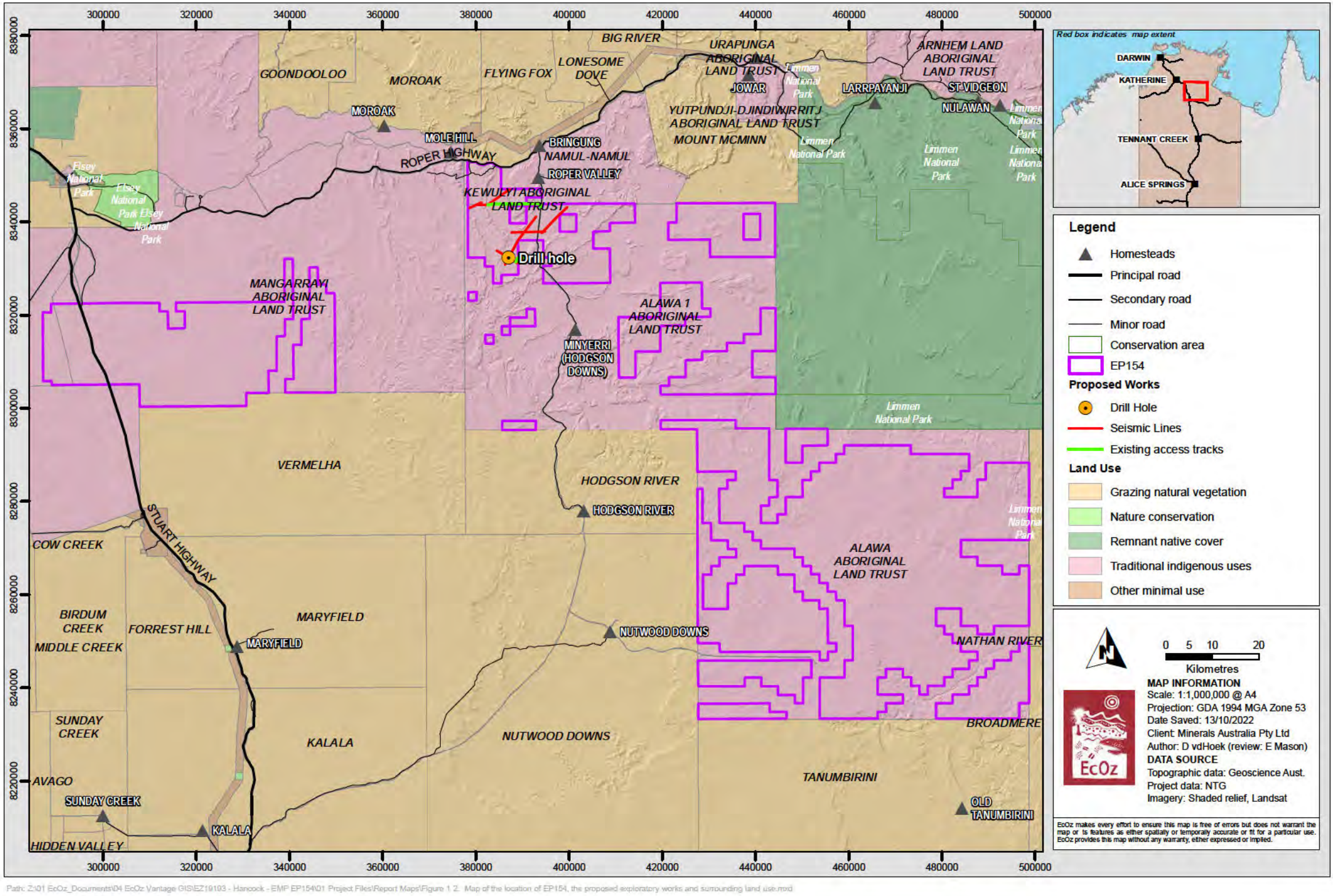
1 INTRODUCTION

Minerals Australia Pty. Ltd. is planning an exploration program within the northern portion of their Exploration Permit area 154 (EP154) in the Gulf lands approximately 100 km east of Mataranka, and south of the Roper River – see Figure 1-1. The program involves undertaking approximately 44 km of seismic survey and the drilling of one core hole to approximately 1000 m depth. In this report, the *project footprint* is considered to be the area directly disturbed by works, surrounding areas (to the degree that there could be a significant impact by noise and/or dust – i.e., a few hundred metres), and downstream of any significant watercourse (to the extent that changes to drainage and water quality, or quantity could have a noticeable effect – i.e., a few kilometres).

The exploration works will be regulated through an Environmental Management Plan (EMP) approved by the Department of the Environment, Parks and Water Security (DEPWS). To inform the EMP, an assessment of the ecological values within EP154, and particularly the exploration program footprint, is required. Consequently, this report presents:

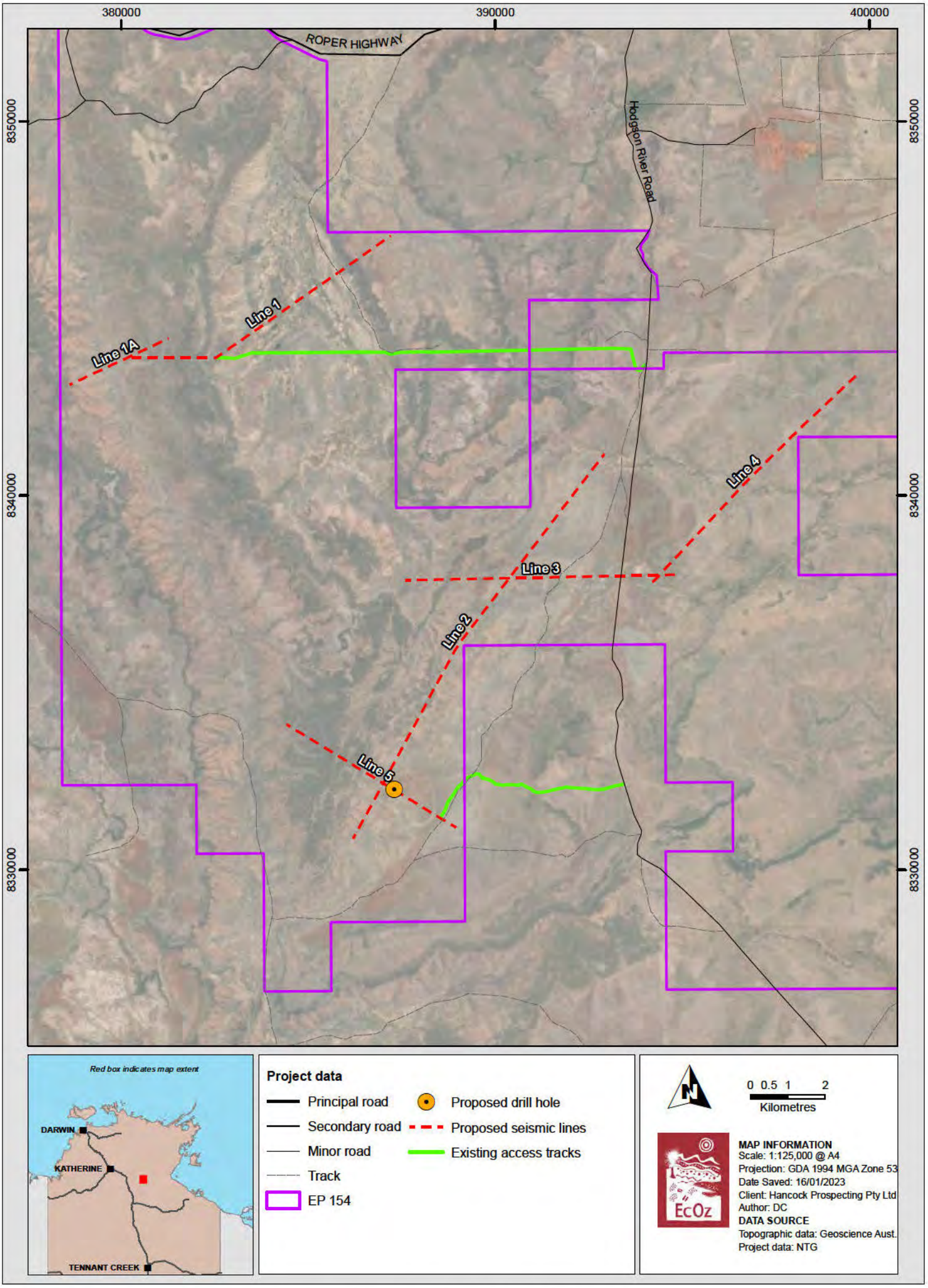
- A desktop review of the existing environment (climate, bioregions, surface water, significant areas, land systems, land use, threatened species and weeds).
- The results of the on-ground field survey examining:
    - Land condition, assessment of analogue sites and waterway crossings, potential for threatened species and the presence of significant vegetation communities.
    - Threatening processes, including weeds to inform the weed management plan for the proposed works.
- A 'likelihood of occurrence' assessment for threatened species based on desktop information and field survey.
- Identification of the potential impacts associated with the exploratory activities and recommendations for avoidance and minimisation of impacts to environmental values.

The scope of the report is to assess the risks and potential impacts of exploratory activities only. This report does not assess ecological impacts and risks related to any development activities that may follow the exploratory phase of this project.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure 1 2. Map of the location of EP154, the proposed exploratory works and surrounding land use.mxd

Figure 1-1. Map of the location of EP154 and surrounding land use



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Map of key works and exploration activity sites within EP154.mxd

Figure 1-2. Map of key works and exploration activity sites within EP154

2 ENVIRONMENTAL CONTEXT

This section presents an overview of the existing environment within and surrounding the project footprint.

2.1 Land Use

Traditional indigenous uses predominate within the northern section of EP154 with the project footprint occurring within two Aboriginal Land Trusts – Kewulyi and Alawa. The project footprint is also bounded to the west by Mangarrayi Aboriginal Land Trust and to the north and northeast by, Flying Fox and Namul-Namul cattle stations, respectively. Cattle stations in the area rely on grazing of native vegetation. The north and southeast are also bound by marsh/wetlands associated with the Roper and Hodgson Rivers floodplains, respectively (Figure 1-1).

2.2 Climate

The project footprint is located in the transition between the hot arid steppe and tropical climates of the Northern Territory – respectively *BSh* and *Aw* – according to the Köppen–Geiger classification (Beker et al. 2018). The area is characterised by hot dry summers and cool dry winters, with a low average annual rainfall restricted between December and March. The closest long-term Bureau of Meteorology weather station is located in Ngukurr Airport (station number 014299), approximately 90 km northeast of the project footprint. Mean annual maximum temperature recorded at that station is 35.6 °C, while, the mean annual minimum is 21.2 °C. Extremes averages oscillate between 14.3 °C in July and 40.1 °C in November. Median annual rainfall is 717.3 mm with extremes in the past ten years reaching 1068.4 mm of rain in 2014, and 443.4 mm of rain in 2019. If heavy rainfall occurs, it is generally in January, coinciding with the monsoon storms in the north that can result in flash flooding in the waterways (BoM 2021). Figure 2-1 presents the average monthly rainfall and temperatures extremes for Ngukurr Airport weather station.

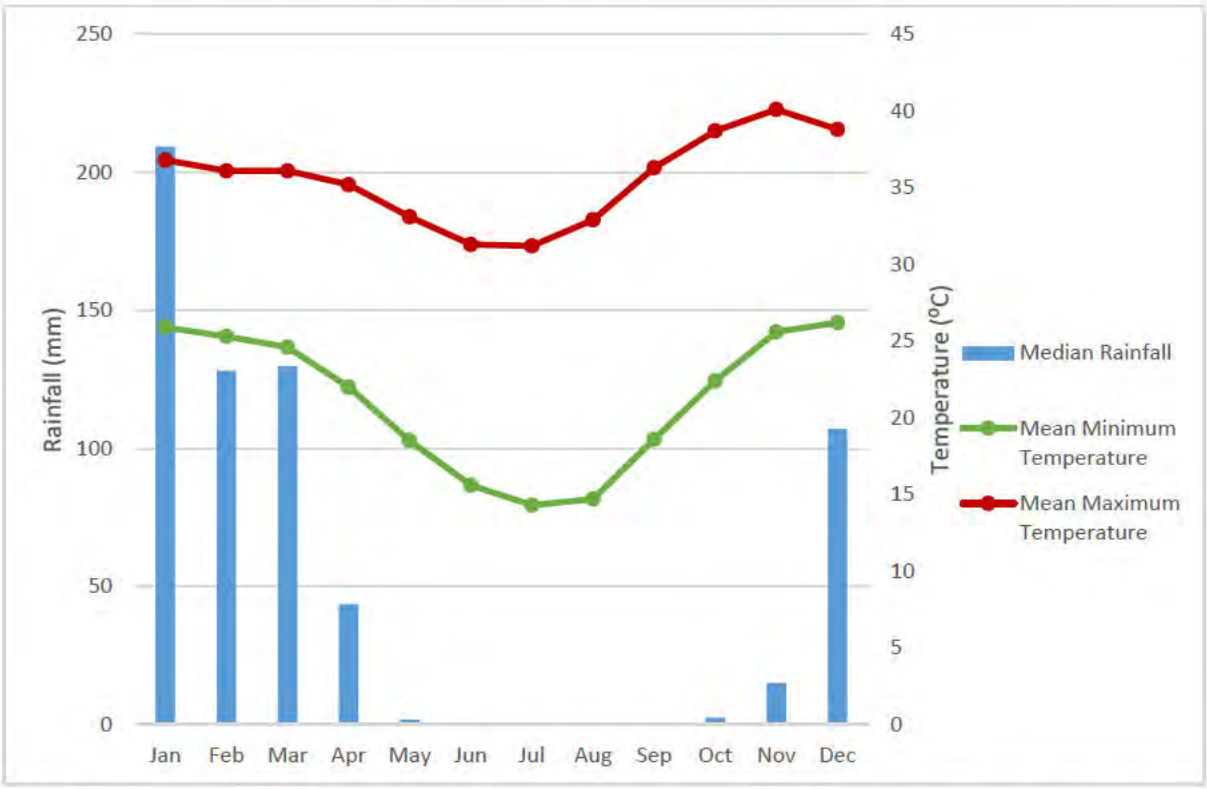


Figure 2-1. Average monthly rainfall and temperature at Ngukurr Airport (014299) from 2012 to 2021 (source: BoM, 2021).

2.3 Bioregion

Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. They capture the large-scale geophysical patterns across Australia. These patterns in the landscape are linked to fauna and flora assemblages and processes at the ecosystem scale, thus providing a useful means for simplifying and reporting on more complex patterns of biodiversity (NSW 2003). NT bioregions are described in Baker et al. (2005).

EP154 occurs within two bioregions – the Sturt Plateau (western side of EP154), and the Gulf Uplands and Falls (eastern side of EP154). Sturt Plateau comprises flat to gently undulating plains of predominant Eucalypt woodlands or tall shrublands and woodlands of Bullwaddy and Lancewood. In more open areas, perennial grasses predominate. Soils are mainly lateritic, but deep sands occur in the south and cracking clays in the south-east. Gulf Falls and Uplands is characterised by undulating terrain with scattered low, steep hills. Soils are mostly skeletal or shallow sands. The most extensive vegetation is dominated by Darwin Stringybark and variable Barked Bloodwood over a spinifex understory and woodland dominated by Northern Box over tussock grasslands.

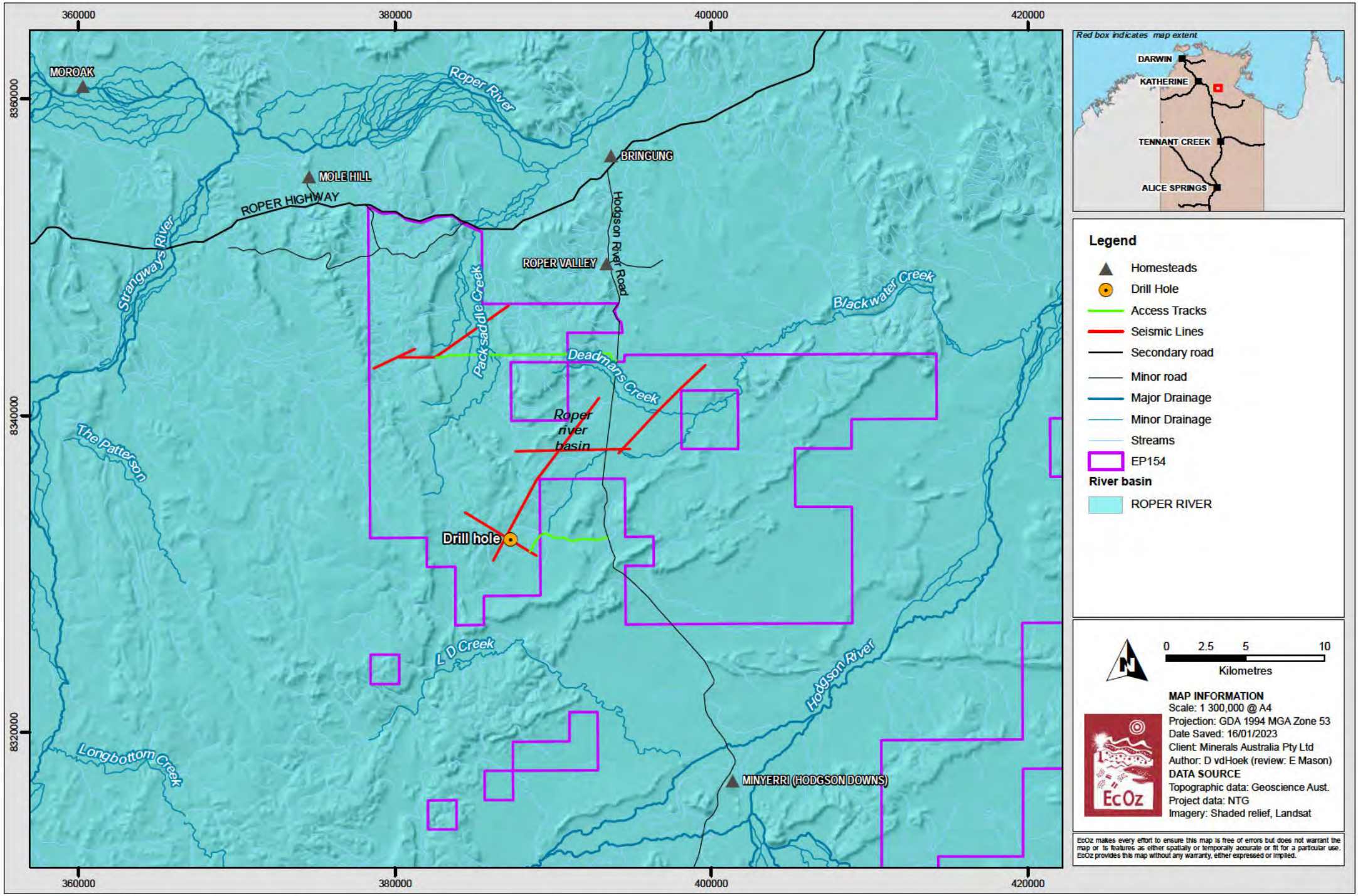
2.4 Significant areas

The Northern Territory lists important sites for biodiversity conservation. These include 'Sites of Botanical Significance' (SoBS) and 'Sites of Conservation Significance' (SoCS). These sites are may be of national and international significance. There are no SoBS or SoCS within or surrounding EP154. The Limmen Bight and associated coastal floodplains, a SoCs of international significance is located approximately 100 km to the East.

2.5 Surface water

The major watercourses, lakes, dams and wetlands within the survey area were identified using NR Maps and aerial imagery. The *Directory of Important Wetlands in Australia* was queried to identify wetlands within survey area. The project footprint sits within the Roper River (west), Towns River (north-east) and Limmen Bight River (east) catchments – see Figure 2-2. The Roper River (stream order 6) is the dominant watercourse in the region, draining east into the Gulf of Carpentaria. Eleven creeks and their tributaries associated with the Roper River and Limmen Bight River are included within EP154. The watercourses within EP154 are intermittent – flowing only during the wet season – although there are some permanent spring-fed waterholes. Packsaddle Creek, Deadmans Creek and Blackwater Creek are crossed by the project footprint (i.e., seismic lines or access tracks).

There are no wetlands of international or national significance within EP154. However, the Limmen River (Port Roper) Tidal Wetlands System is located downstream in the Limmen Bight River catchment.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure 2 2. Map of river basins within and surrounding EP154.mxd

Figure 2-2. Map of river basins and waterways within and surrounding EP154

2.6 Land systems

Christian and Stewart (1968) define a land system as 'an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation'. These have been mapped by across the NT by the government and are at a significantly smaller scale than a bioregion (i.e. bioregions constitute many different land systems). Within each land system, a set of component land units is defined. In some areas of the NT, mapping has been undertaken to the level of detail of land units. However, there is no land unit mapping for EP154.

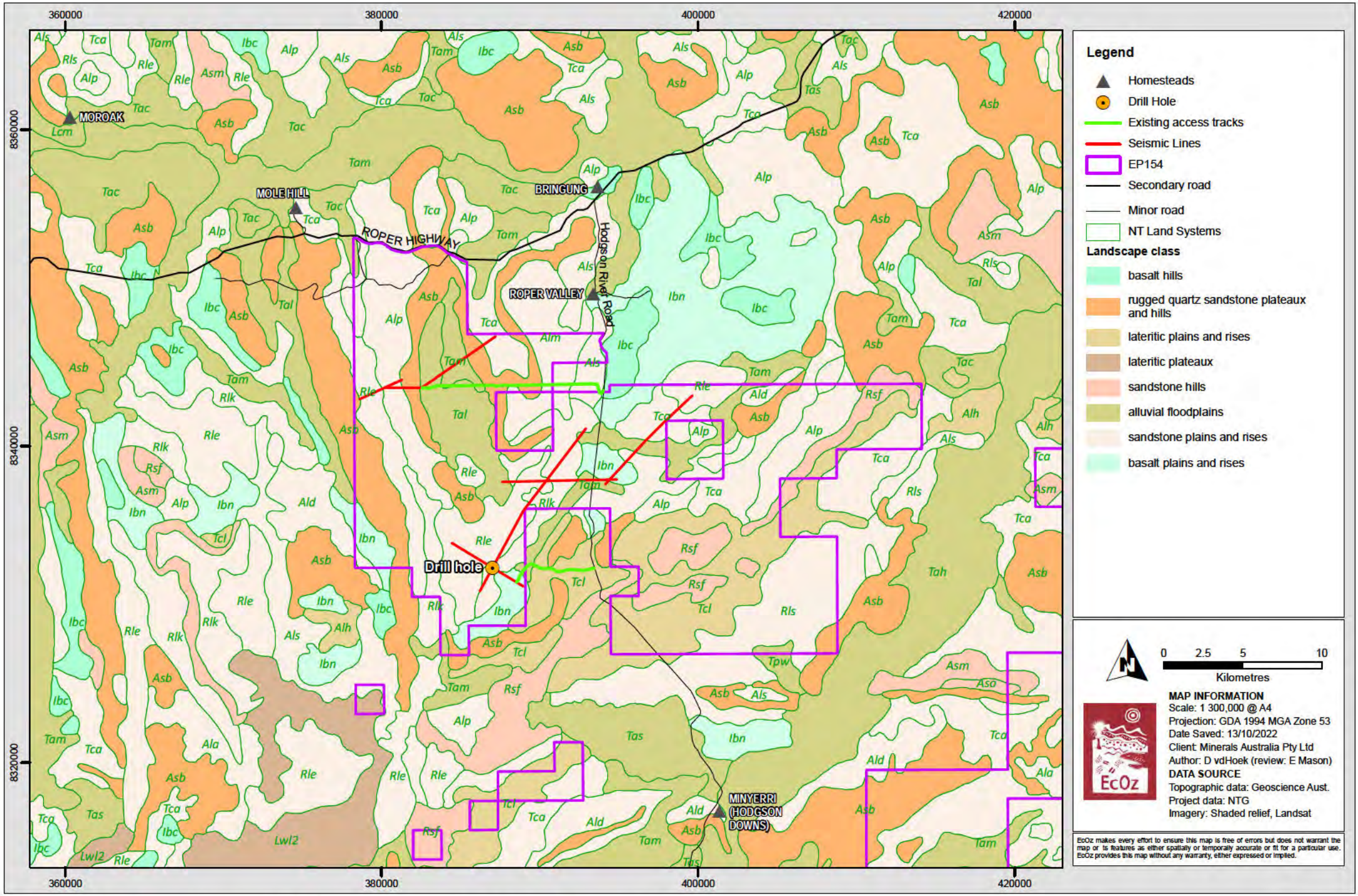
Land system mapping of the region at a scale of 1:250,000 shows that EP154 intersects 48 land systems. These are described in Appendix A and mapped in Figure 2-3. Land systems are grouped into landscape classes. EP154 is dominated by eight landscape classes described as lateritic plains (243,174 ha), sandstone plains and rises (173,165 ha), rugged quartz sandstone plateaux and hills (51,090 ha), alluvial floodplains (32,904 ha) associated with several river systems, sandstone hills (31,842 ha), lateritic plateaux (9,859 ha), small areas of basalt plains and rise (2,549 ha) and basalt hills (132 ha). The project footprint intersects twelve land systems within six landscape classes (see Table 2-1 below).

The dominant land systems and their landscape classes to occur along all seismic lines are: Sandstone plains and rises (landscape classes: Arnold, Emmerugga, Kangaroo, McLeod, Patterson and Siegel), with occasional alluvial floodplain (landscape classes: Lindsay and McArthur) associated with Packsaddle, Blackwater and Deadmans Creeks. The seismic access track intersects Basalt hills and rises (landscape class: Nutwood), Lateritic plains and rises (landscape class: Langdon) and, Rugged quartz sandstone plateaux and hills (landscape class: Bukalara) - see Figure 2-3. This is further described in Section 8.

Table 2-1. Summary of the land systems relevant to the project footprint

Land System	Landform	Soil	Vegetation
Sandstone plain and rises			
Arnold	Very gently sloping pediplains, pediments, colluvial slopes and some alluvium, rarely sedentary.	Yellow earths, yellow podzolics, and other soils with hard, mottled B horizons.	Low open woodland of *Melaleuca citrolens* with some *E. pruinosa*.
Emmerugga	Undulating to rolling low hills on mainly argillaceous sediments	Lithosols and shallow yellow earths	Mid-high open woodland of *C. latifolia, C. grandifolia, E. tectifica, C. confertiflora, Erythrophleum chlorostachys* over *Chrysopogon fallax, Themeda triandra, Sorghum plumosum.*
Kangaroo	Gently undulating to undulating rises on mainly argillaceous sediments	Shallow yellow earths and yellow podsolics	Mid-high open woodland of *E. tectifica, C. terminalis, Erythrophleum chlorostachys, Terminalia platyphylla, Brachychiton diversifolius* over *Chrysopogon fallax, Sorghum plumosum, Heteropogon triticeus.*
McLeod	Gently undulating plains and low plateaux with frequent steeply incised valleys on sub-horizontally bedded massive sandstones and siltstones	Leptic Tenosols and Rudosols	Mid-high open woodlands *of E. tetrodonta, Callitris intratropica, C. ferruginea, Erythrophleum chlorostachys, E. miniata* over *Plectrachne pungens, Eriachne obtusa, Aristida hygrometrical.*
Patterson	Low hills, rises and undulating area on reddish platy sandstones and siltstones, often micaceous	Leptic Rudusols and Leptic Tenosols, shallow red and brown Kandosols	Mid-high open woodland of *E. leucophloia, Acacia shirleyi, E. tectifica, C. grandifolia, C. ferruginea* over very sparse grass cover (*Plectrachne pungens, Eriachne obtusa, Chrysopogon fallax*).

Land System	Landform	Soil	Vegetation
Seigal	Gently undulating to undulating rises with abundant, often linear rocky outcrops	Lithosols, minor siliceous and earthy sands	Mid-high open woodland of E. miniata, *E. tetrodonta*, *C. ferruginea*, *C. dichromophloia*, *Callitris intratropica* over *Plectrachne pungens*, *Sorghum plumosum.*
Rugged quartz sandstone plateaux and hills			
Bukalara	Rugged rocky plateaux and steep, linear ridges, on massive sandstones such as the Bukalara and Kombolgie Sandstones	Lithosols and shallow siliceous sands	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, Erythrophleum chlorostachys* over *Plectrachne pungens, Chrysopogon fallax, Eriachne obtusa.*
Lateritic plains and rises			
Langdon	Gentle colluvial slopes, mainly below areas of argillaceous rocks with some poorly drained depressions	Yellow Kandosols, some Chromosolic Redoxic Hydrosols and Aquic Vertosols	Mid-high open woodland of *E. tectifica*, *Erythrophleum chlorostachys*, *Brachychiton diversifolius*, *C. latifolia*, *C. confertiflora* over mid-dense grass cover (*Chrysopogon fallax*, *Sorghum plumosum*, *Sehima nervosum*).
Basalt plains and rises			
Nutwood	Plains and low rises on basalt and associated basic igneous rock	Brown, grey and red Vertosols, red Ferrosils and brown and red Kandosols	Mid-high open woodland of *Lysiphyllum cunninghamii*, *C. terminalis*, *C. confertiflora*, *E. pruinosa*, *E. patellaris*, *Erythroxylum ellipticum* over mid-dense grass cover (*Chrysopogon fallax*, *Aristida latifolia*, *Panicum* spp.).
Basalt hills			
Cliffdale	Gentle undulating to hilly terrain on basalt, dolerite, agglomerate and tuff, some dolerite; mostly rock outcrop with surface stone pockets of clayey soils	Leptic Rudosols, red Dermosols and black Vertosols	Mid-high open woodland of *E. pruinosa, E. tectifica, C. terminalis, Erythrophleum chlorostachys, Brachychiton diversifolius* over *Chrysopogon fallax, Sehima nervosum, Sorghum plumosum.*
Alluvial floodplains			
Lindsay	Floodplains and terraced, some lower slopes and small swamps, drainage floors and flats, with fine sandy materials	Yellow and brown Kandosols and Chromosolic and Kandosolic Redoxic Hydrosols	Low open woodland of *M. viridiflora*, *Grevillea pteridifolia*, *Brachychiton diversifolius* over *Chrysopogon fallax*, *Eriachne obtusa*, *Sorghum plumosum.*
McArthur	Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast	Grey and brown clays, red and yellow earths and siliceous sands	Mid-high open woodland of *C. terminalis*, *E. microtheca*, *Excoecaria parvifolia*, *Lysiphyllum cunninghamii*, *C. papuana* over *Chrysopogon* spp., *Eulalia fulva*, *Iseilema vaginiflorum.*



Path: Z:\01 EcOz_Documents\04 EcOz Vantage G\S\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure 2.3. Map of land systems within and surrounding EP 154.mxd

Figure 2-3. Map of land systems within and surrounding EP 154

3 FIELD ASSESSMENT

3.1 Methodology

Surveys were conducted from 13-15 July 2021, using a helicopter to both survey from the air and drop down onto the ground where access allowed. The field assessment aimed to collect data across the project footprint to:

- Provide an overview of the vegetation communities through the assessment of analogue sites.
- Assess the proposed location of waterway crossing for their current condition, values and potential impacts.
- Assess the likelihood of occurrence for threatened species and significant vegetation communities.
- Document the existing threatening processes including, pastoralism, fire, drought, erosion and weeds
- Undertake a weed survey.

Methodologies undertaken in the field are described below.

3.1.1 Vegetation assessment in analogue sites

Prior to field survey, aerial imagery and available land resource datasets were reviewed to help target sites of interest. Descriptions of vegetation types within the project footprint were based on available land system data at a scale of 1:250,000. Prior to landing, an assessment of the land systems was made from the air to ascertain a representative sample of the land systems. Assessment of the land systems included recording the surface soil types and dominant flora species at a spatially representative set of survey sites (i.e., Analogue Vegetation Sites). A minimum of two survey sites were assessed per land system. This was performed across the project footprint to collect baseline data from representative sites to address future rehabilitation in impacted areas.

The location of analogue vegetation sites are shown in Figure 3-1 and described in Appendix B.

3.1.2 Waterway crossings

Prior to field work, all waterways within the project footprint were mapped by using NR Maps layers at a scale of 1:250,000. Desktop research identified at least 36 drainage crossings in the project footprint. Of these, 14 presented contrasting riparian vegetation which were visited during field survey. Data collected during the surveys included, vegetation type, dominant upper strata species, weed presence/absence and erosion presence/absence. Surveyors recorded the location of riparian and drainage line vegetation on a handheld GPS when encountered along the survey transect. Photographs of the drainage channel were taken and any vegetation present.

The location of water crossing sites are shown in Figure 3-1 and described in Appendix C.

3.1.3 Threatening processes

During all site assessments, threatening processes operating at each site were documented. This included:

Pastoral impacts and/or feral animals

At each survey site, the current level of pastoral and/feral animal impacts were assessed based on the following categories – low (no / very little impacts; medium (some grazing and cattle trampling); high (surface soils and vegetation are highly disturbed, and erosion and weeds are present).

Fire / drought

General observations were documented within the project footprint during vegetation and watercourse assessments to determine level of impacts from fire and drought.

Weeds

Weed data collection is described separately below.

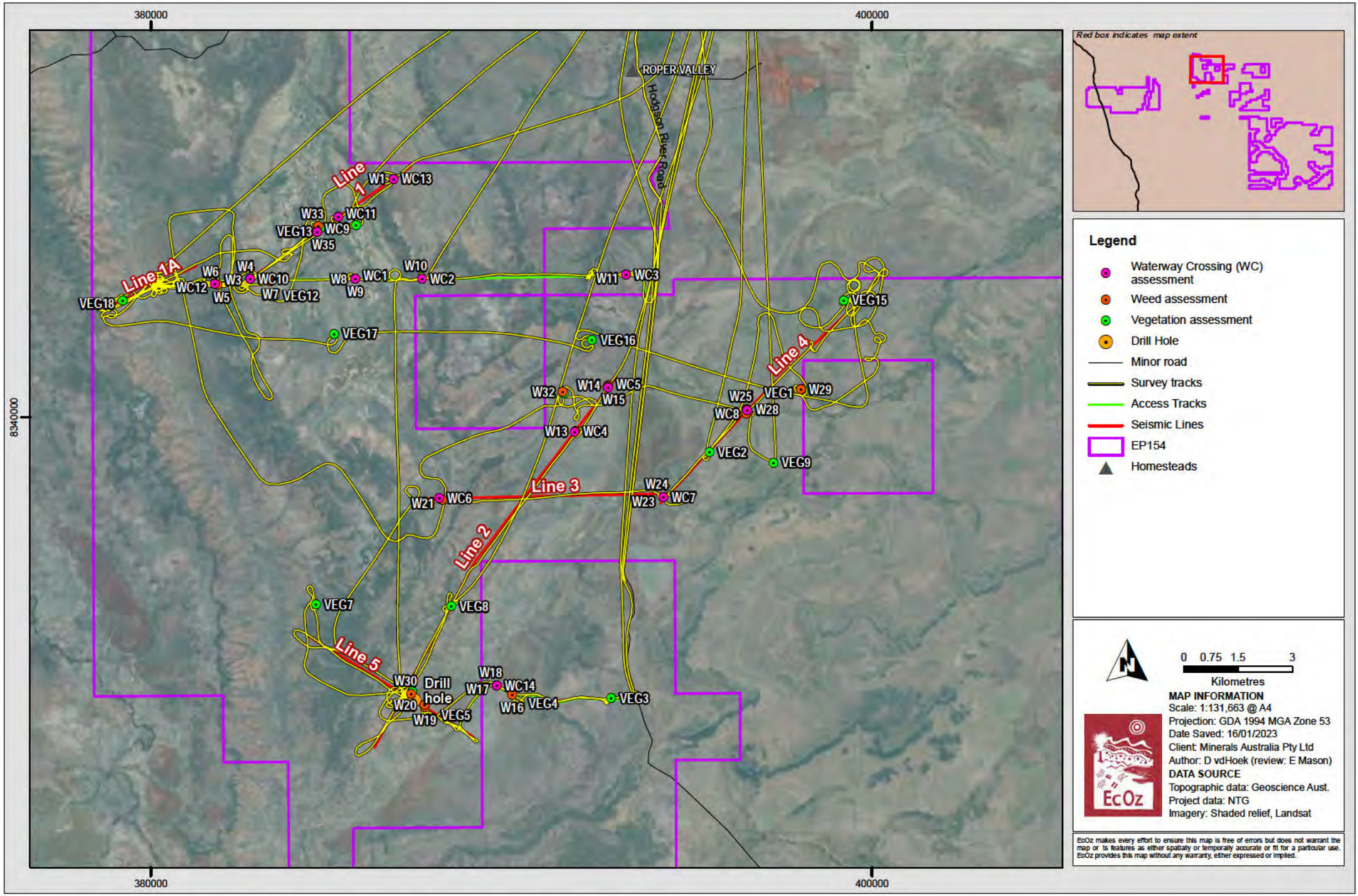
3.1.4 Weed survey

A weed survey was undertaken within the project footprint targeting priority species as outlined within the *Katherine Regional Weed Strategy 2021-2026* (DEPWS 2021). Baseline weed surveys were undertaken via helicopter and on-ground (where access allowed). Helicopter flyovers were undertaken by flying low to the ground at a slow pace and dropping down where infestations occurred. The following locations were surveyed for weed occurrences:

- The entire length of the seismic lines within EP 154 via helicopter. Key sites along seismic lines were surveyed on foot where access permitted (e.g., dropped in from a helicopter) and where sensitive environmental values exist (e.g., creek crossings).
- Drill Pads - walkover transects were performed in a 1 ha area proposed for the drill pad. These transects spaced 20 m apart were oriented in a North-South direction.
- All major tracks / roads, fence lines and other areas of disturbance (cattle).
- Waterway crossings.
- Analogue vegetation sites.

Weeds surveys were undertaken in accordance with the *NT Weed Data Collection Manual* (WMB 2015), with the following information collected at each survey site: species, seeding status, photographs and infestation level based on the size (diameter) and density. Density categories were:

- 1 = Absent, no weeds of this species in this area.
- 2 = < 1%, Very few, not many weeds e.g. single plant, perhaps with seedlings.
- 3 = 1 -10%, More than one or two isolated plants but not a lot e.g. a few small plants.
- 4 = 11-50%, A lot, up to half the area covered e.g.: a tree, dense patches of weeds.
- 5 = > 50%, Dominant cover is weed, more than half covered e.g. thickets, monocultures.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure 3-1. Map showing survey effort within investigation area.mxd

Figure 3-1. Map showing survey effort within the project area

3.2 Landform and Vegetation Communities

The project footprint is located mostly within sandstone plains and rises typical of the Gulf Fall and Uplands bioregion (Figure 2-3). Soils are mostly yellow earths with varying concentrations of sand. Waterways and drainage depressions are scattered throughout the area. The following sections outline the different types of landforms and associated vegetation communities within the project footprint according to Aldrick & Wilson (1992) survey. Appendix B provides a summary of the vegetation communities within analogue sites occurring in each of these landforms.

3.2.1 Sandstone rises

Sandstone rises are the most common landform in the project area. They are composed of gently undulating to undulating rises and rolling low hills on mainly argillaceous sediments with some linear rocky outcrops and shallow sandy soils. Lithosols, yellow earths, and minor earthy sands, shallow red and brown earths and podzolics. It supports mid-high open eucalypt woodland, often dominated by *Eucalyptus tectifica*, *Eucalyptus terminalis* and *Erythrophleum chlorostachys*. Representative vegetation communities occurring in this landform are described in Vegetation Sites 6, 7, 8, 11, 15, 16, and 18, Appendix B.

Figure 3-2. Photograph of a sandstone rise along seismic line 1A.

3.2.2 Sandstone plains

Very gently sloping pediplains, pediments, colluvial slopes and some alluvial to gently undulating plains and low plateaux with frequent, steeply incised valleys on sub-horizontally bedded massive sandstones and siltstones. Sandstone plains can present lithosols, earthy sands, yellow earths, yellow podzolics, or other soils with hard, mottled B horizons. This landform supports open eucalypt or *Melaleuca* woodlands. Representative vegetation communities for this landform are described in Vegetation Sites 1, 2 and 9, Appendix B.

Figure 3-3. Photograph of a sandstone plain along seismic line 4.

3.2.3 Alluvial Floodplains

Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast fringed by floodplains and terraces, some lower slopes and small swamps, drainage floors and flats, with fine sandy materials. Soils are grey and brown clays, brown, red, and yellow earths, siliceous sands, or yellow podzolics. This landform supports open eucalypt woodland dominated by *Eucalyptus polycarpa* or tall *Melaleuca* fringing riparian vegetation. Representative vegetation for this landform is described in Vegetation Sites 10, 12, 13, and 17, Appendix B.

Figure 3-4. Photograph of an alluvial floodplain along seismic line 4.

3.2.4 Rugged Quartz Sandstone plateaux and hills

Rugged rocky plateaux and steep, linear ridges, on massive sandstones such as the Bukalara and Kombolgie Sandstones. Lithosols and shallow siliceous sands occur in this landform. Typical vegetation is mid-high open woodland of *E. dichromophloia* with *E. miniata*, *E. tetrodonta* and *E. leucophloia*. The representative vegetation community occurring in this landform is described in Vegetation Site 14, Appendix B.

Figure 3-5. Photograph of a rugged quartz sandstone hill near seismic line 1.

3.2.5 Basalt plains and low rises

Plains and low rises on basalt and associated igneous rocks. Soil composed of brown, grey, and red clays, euchrozems and brown and red earths. Typical vegetation structure is mid-high open woodland of *Lysiphyllum cunninghamii* and *E. terminalis* with some *E. patellaris*. The representative vegetation community for this landform is described in Vegetation Site 5, Appendix B.

Figure 3-6. Photograph of a basalt low rise along seismic line 5.

3.2.6 Lateritic plains

Gentle colluvial slopes, mainly below areas of argillaceous rocks with some poorly drained depressions. Soils are yellow earths, yellow podzolic soils and brown clays. Dominant vegetation is mid-high open woodland of *E. tectifica*. Representative vegetation communities for this landform is described in Vegetation Site 3 and 4, Appendix B .

Figure 3-7. Photograph of a lateritic plain near the southern access track.

3.3 Significant vegetation

Significant vegetation communities are described in the *NT Land Clearing Guidelines* (DENR 2020). They are vegetation communities that are distinct and limited in extent or support important ecological values, and include rainforest, vine thicket, closed forest or riparian vegetation, mangroves, monsoon vines forest, sand-sheet heath, and vegetation containing large trees with hollows suitable for fauna. Groundwater-dependent ecosystems are also considered to be significant and are discussed in this section.

A review of existing vegetation mapping, land systems, and aerial imagery indicated that two sensitive vegetation types could occur within the survey area – riparian vegetation and vegetation containing large trees with hollows suitable for fauna. The location of these values is shown in Figure 3-10.

3.3.1 Riparian vegetation

Riparian vegetation is 'a distinct vegetation community occurring on the banks of rivers or streams that directly influences the adjacent water body' (DENR 2020). When in good condition, riparian vegetation is considered a sensitive vegetation type as it supports a unique selection of habitat features that are relied upon by a range of flora and fauna species. Riparian vegetation provides refuge habitat and habitat corridors; improves water quality by filtering terrestrial run-off; stabilises banks and reduces erosion; and supports terrestrial and aquatic habitats by maintaining natural light, temperature and oxygen levels within waterways (DENR 2018b).

In this report, two terms are used to describe vegetation along a watercourse:

- *Riparian vegetation* which differs to that in the surrounding landscape and which serves the ecological functions described above, and should therefore be considered sensitive under the *NT Land Clearing Guidelines* (e.g. Figure 3-8 left).
- *Drainage depression vegetation* which is similar to that in the surrounding landscape and whose only ecological function is bank stability (which can be replicated through erosion and sediment controls), and therefore is not sensitive riparian vegetation under the *NT Land Clearing Guidelines* (e.g. Figure 3-8 right).

Figure 3-8. Examples of significant riparian vegetation (left) compared with drainage line vegetation (right)

Desktop research identified at least 36 waterway crossings in the project footprint. Of these, 14 presented contrasting vegetation on the aerial. Field surveys were undertaken where waterways intersected the project footprint. Surveyors recorded the location of riparian and drainage line vegetation on a handheld GPS when encountered along the survey transect, and the dominant upper strata species of the vegetation. Photographs were taken to confirm the presence of drainage channels and any vegetation present. Appendix C presents a summary of the waterway crossing data.

Typical riparian and drainage line vegetation in the region consists of *Eucalyptus* and *Melaleuca* communities with tussock grass understoreys. Five of the 14 waterway crossing sites were considered to support riparian vegetation due to the presence of River Red Gum *Eucalyptus camaldulensis* along the banks. These sites include: WC1, WC3, WC5, WC6, WC7, WC8, WC10 and WC12. All other waterway crossing sites support drainage line vegetation.

Most inspected areas exhibited impacts from cattle and feral animals. Erosion was evident on the banks of eight of the watercourses sites visited (Water Crossing sites - WC1, WC4, WC6, WC8, WC9, WC10, WC11, and WC13). Declared weed Hyptis* (*Mesosphaerum suaveolens*) was observed in eight sites (WC2, WC5, WC6, WC7, WC8, WC10, WC12, and WC14) and environmental weeds at four of the sites (WC3, WC4, WC8, WC14).

The waterways and adjacent riparian and drainage line vegetation support suitable habitat for Mertens Water Monitor (*Varanus mertensii*) that is discussed further below.

a)

b)

c)

d)

Figure 3-9. Photos showing (a) vegetation along a drainage depression WC13, (b) an ephemeral creek WC11, (c) riparian vegetation and donkey tracks on the bed of Blackwater creek, and (d) bank erosion on Deadmans creek.

3.3.2 Large trees with hollows

Hollows in old growth forest and woodlands provide critical breeding and shelter for mammals, birds, reptiles and even some frogs in the NT (DENR 2018a). Many threatened species including, one that has potential to occur within the project footprint, Gouldian Finch (*Erythrura gouldiae*) is reliant on hollow bearing trees for breeding (see Section 4.3.2).

Old growth woodland supporting large trees with hollows is widespread across the project footprint. During field survey, this significant vegetation type was observed along seismic line 3 at the waterway crossing site WC6, and also covered the area proposed for the drill pad. Snappy gums (*Eucalyptus leucophloia*) are the most common hollow bearing trees in these vegetation communities and were also observed in Vegetation Sites 6, 7, 8, and 18 (Appendix D). Removal of large trees (>40 cm DBH) should be avoided where possible to minimise significant loss of nesting habitat for Gouldian finches and other fauna.

3.3.3 Wetlands

Wetlands are generally considered to be floodplains, lakes, billabongs and swamps (NRETAS 2010). They support distinct vegetation communities that rely on either permanent or seasonal surface water supply (Brock 1993). These areas often support a shallow water table. They are considered a sensitive vegetation type as they provide essential habitat for a diverse range of flora and fauna (including threatened and migratory species) and can be easily deteriorated by poor land management and planning.

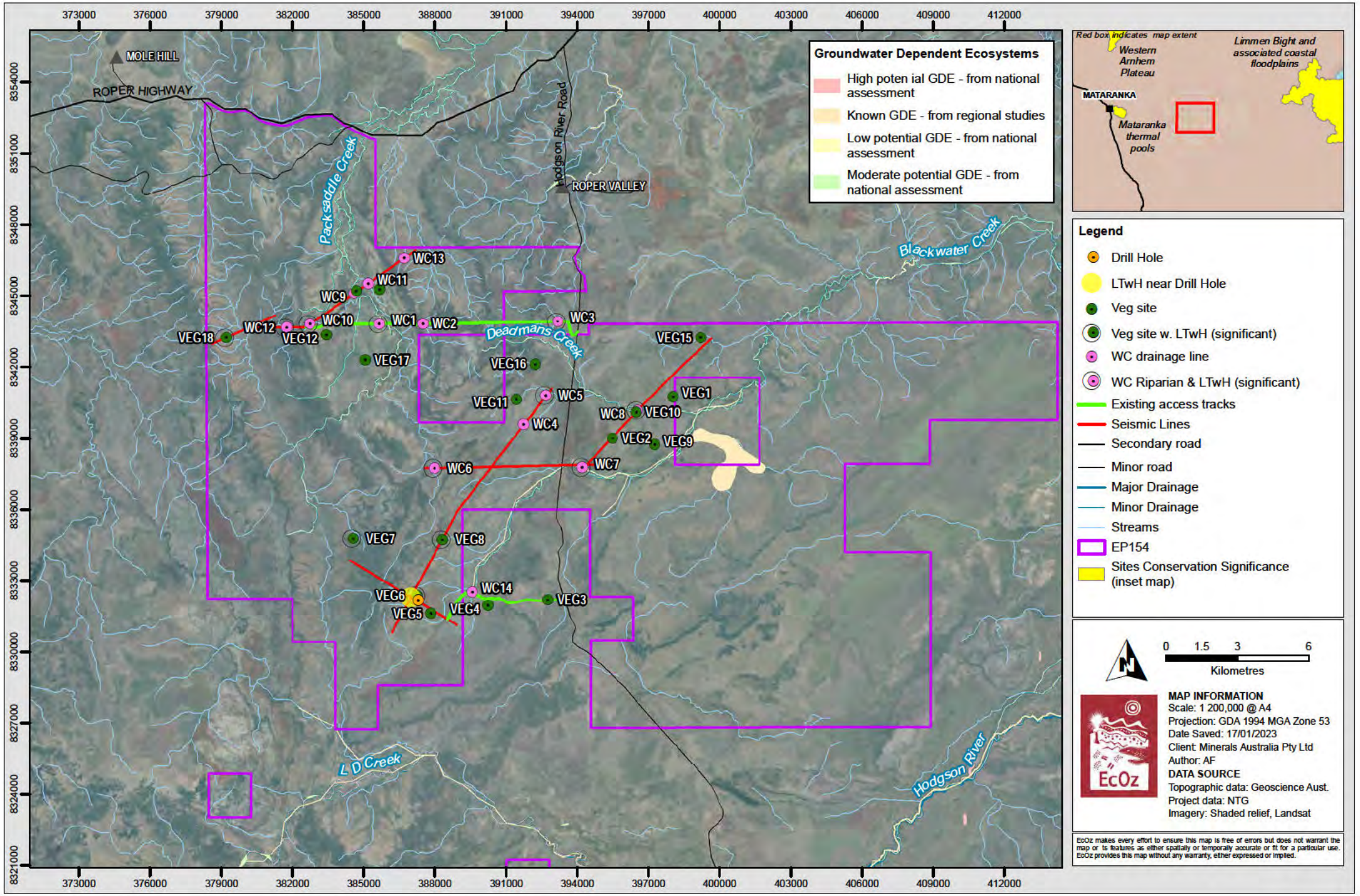
There are no wetlands within or immediately adjacent to the project footprint. The Limmen Bight (Port Roper) Tidal Wetlands System is an important wetland located 140 km east of the project footprint, encompassing the estuary of the Roper River. It is the second-largest area of saline coastal flats in the NT, meeting all six criteria for inclusion in the Directory of Important Wetlands in Australia. The Limmen Bight Tidal Wetlands is an internationally important site for migratory shorebirds along the East Asian-Australasian Flyway, with the occurrence of 50 species that are listed under international conventions or bilateral agreements protecting migratory animals. An erosion and sediment control plan must be implemented to minimise impacts to downstream values in the Roper River catchment.

3.3.4 Groundwater-dependant ecosystems

Groundwater-dependent ecosystems (GDE's) refer to 'natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, to maintain their communities of plants and animals, ecosystem processes and ecosystem services' (Richardson et al. 2011). These areas provide essential habitat for a diverse range of flora and fauna, and can be easily impacted by poor land management and planning.

Based on definitions from Eamus et al. (2006), the Atlas of Groundwater Dependent Ecosystems maps three types of GDE – *aquatic*, *terrestrial* (i.e. ecosystems dependant on surface expression of groundwater) and *subterranean* (i.e. ecosystems dependent on the sub-surface presence of groundwater, often accessed when roots penetrate via the capillary fringe which lies above the saturated zone of the water table). The Atlas classes each mapped GDE according to the degree of certainty that it is, indeed, a GDE.

The project area has not been surveyed for subterranean GDE's but Knapton (2009) assessments showed two known terrestrial GDE's, namely Blackwater Creek and the floodplain of one of its tributaries, both supporting *Melaleuca* woodlands. Blackwater Creek is crossed by seismic lines 3 and 4 along their eastern and southern ends, respectively. There are also four springs in the area deemed aquatic GDE's, three of them located in the surrounding Roper Valley, approximately 5 km northeast of the project footprint, and one in the Deadmans Creek, a tributary of Blackwater Creek, 1 km south of the northern access track. There are also moderate potential GDE's located around a lake in the Roper Valley and Packsaddle Creek. Packsaddle Creek is crossed by the northern access track and seismic line 1. Works must aim to minimise impacts on GDEs associated with Blackwater and Packsaddle Creeks through the minimisation of vegetation loss, control of erosion, and rehabilitation post-works.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure X-X - Map of important landforms.mxd

Figure 3-10. Map of important landforms and values within and surrounding EP154

4 THREATENED SPECIES ASSESSMENT

This section outlines the procedure and results of the threatened species 'likelihood of occurrence' assessment conducted for this report. The assessment was undertaken using available desktop information, as well as databases of existing records and potential species. The purpose of this assessment is to identify those species that may need to be included within the project's risk assessment, and those that can be reasonably excluded from further consideration because they are unlikely to occur within EP154. *Note: This process is not a risk assessment as it does not take into account project activities and their potential impacts.*

4.1 Categories

The International Union for the Conservation of Nature (IUCN) nominates a set of criteria used to identify species at risk of extinction. These criteria are used to define categories of risk which are used by the Northern Territory Government to determine which threatened species are listed under the *TPWC Act,* and by the Commonwealth Government to determine which threatened species are listed under *EPBC Act*. This report focusses on species that are listed as Vulnerable, Endangered or Critically Endangered under the *TPWC Act,* the *EPBC Act* or both.

4.2 Procedure

A 'likelihood of occurrence' assessment for threatened species was undertaken based on all the information available regarding the current state of the environment within EP154. The assessment considered the habitats present, historic regional records of threatened species, new threatening processes, any changes in the conservation status of species, and changes in surrounding habitat availability and quality. The following procedure was used to determine which threatened species have the potential to occur in EP154:

- Species records from the latest version of the NT Atlas were clipped to the Sturt Plateau (western side of EP154), and Gulf Uplands and Falls bioregion. Bioregions give a broad area with largely similar habitat characteristics and species assemblages. Clipping data to them ensures that all potential species are captured in order to undertake a project-specific 'likelihood of occurrence' assessment.
- EPBC Protected Matters Search Tool (PMST) was used to generate a report using a 50 km buffer from EP154. This PMST is an online enquiry tool managed by the Commonwealth Department of Agriculture, Water and the Environment which interrogates a range of existing flora and fauna data, as well as predictive modelling to speculate on the presence of species within a search area. The PMST uses a grid system to determine which protected matters it encapsulates for a particular search. The PMST report (Appendix B) was generated on 8 September 2021.
- For each threatened species, the likelihood of it occurring within EP154 was then assessed based on desktop information that relates to habitat requirements, distribution, number and dates of proximate records (obtained from NT Atlas), the ecological information described in Section 2, and the field survey results. Likelihood ratings are defined in Table 4-1.
- Threatened species that occur exclusively in marine environments were excluded.

Table 4-1. Ratings for the desktop threatened species likelihood of occurrence assessment

Likelihood	Definition
HIGH	It is expected that this species lives within EP154 because there is core habitat and recent proximate records.
MEDIUM	This species may live within EP154 because there is suitable habitat; however, there is evidence that lowers its likelihood of occurrence (known range contraction of the species in the region, no recent records with the search area, substantial loss of habitat within EP154 since previous records, species is naturally rare or occurs at a low density etc.).

Likelihood	Definition
LOW	This species may occur, as a vagrant, within EP154; however, there is only marginally suitable habitat.
NONE	There is strong evidence (no suitable habitat and/or the species is considered likely to be regionally extinct) that this species will not occur within EP154.

4.3 Likelihood of occurrence within EP154

Appendix E provides a list of 47 threatened species considered within the threatened species likelihood of occurrence assessment. The species with a high or medium likelihood of occurrence within EP154 are listed in Table 4-2. These species require consideration within the EMP. All other species can be excluded from further assessment because they are unlikely to occur within EP154. A meeting was held with the Flora and Fauna Division of the Department of Environment and Natural Resources (DENR) to ensure that these results aligned with the concerns of the department. Only those with a high likelihood of occurrence are discussed further below.

Table 4-2. Threatened species 'likelihood of occurrence' assessment (medium and high likelihood species only)

Likelihood	Species	Class	Status		Core habitat
			EPBC	TPWC	
HIGH	Mertens' Water Monitor (*Varanus mertensi*)	Reptile	-	VU	Riparian
	Gouldian Finch (*Erythrura gouldiae*)	Bird	EN	VU	Breeds on slopes with Snappy Gum (*Eucalyptus leucophloia*)
MEDIUM	Red Goshawk (*Erythrotriorchis radiatus*)		VU	VU	Riparian (nests in tallest trees)
	Ghost Bat (*Macroderma gigas*)	Mammal	VU	-	Roosts in caves
	Freshwater Sawfish (*Pristis pristis*)	Cartilaginous Fish	VU	VU	Rivers

EN = Endangered; VU = Vulnerable

4.3.1 Mertens' Water Monitor (*Varanus mertensi*)

Mertens Water Monitor is classified as Vulnerable under the *TPWC Act* and has been nominated for listing as Endangered under the Federal *EPBC Act*. This species has a broad geographic range, occupying coastal and inland waters across the far north of Australia from the Kimberley to the west side of Cape York Peninsula. It has been recorded across most of the North End and the Gulf Region in the NT. It is a semi-aquatic monitor seldom seen far from water and feeds mainly on fish, frogs and carrion, and also eat insects and small terrestrial vertebrates. Mertens Water Monitor is highly susceptible to Cane Toad poisoning (Ward et al 2006). Whilst population numbers have declined because of Cane Toads (Ward et al. 2006), there does not appear to be a range contraction for this species, since there are still many post-toad records across its historic distribution.

There were no sightings of Mertens Water Monitor during the July 2021 field survey. However, there are 19 records of this species within 50 km of EP154 in the NT Fauna Atlas, all within the Gulf Fall and Uplands bioregion, and eight of them in the Roper River. As such, this species is considered to have a high likelihood of occurrence within EP154 and the project footprint during the wet season, and more broadly throughout the whole Roper River basin. Minimisation of impacts to riparian vegetation and implementation of an erosion

and sediment control plan for waterway crossings will reduce the potential impacts to Mertens Water Monitor habitat.

4.3.2 Gouldian Finch (*Erythrura gouldiae*)

The Gouldian Finch is classified as Vulnerable under the TPWC Act and listed as Endangered under the EPBC Act. This species formerly occurred from the Cape York Peninsula in Queensland, through the Top End of the Northern Territory and through to the Kimberly region in Western Australia. In the last 100 years, this species has undergone significant population reduction and contraction across its range. The decline of this species has been attributed to habitat modification and reduced availability of grass seed from pastoral activity and altered fire regimes in savannah woodlands (O'Malley .2006).

Gouldian Finch occupy two different regions of the landscape on an annual cycle (Dostine et al. 2001). In the dry season and part of the late wet season, between February and October, the species lives within wooded hills that contain a group of smooth-barked *Eucalyptus* species commonly referred to as Snappy and Salmon Gums – including *Eucalyptus leucophloia, E. tintinnans* and, to a lesser degree, *E. miniata*. Hollows in these trees provide critical nesting sites. During this period, the species forages on the ground, feeding on seeds of native sorghum, and utilises small rocky waterholes that remain within the hills until the next wet. In the wet season, Gouldian Finches move from the hills into lowland drainages to feed upon seeds of perennial grasses, typically available from mid- December. These grasses include Soft Spinifex (*Triodia pungens*), Cockatoo Grass (*Alloteropsis semialata*) and Golden Beard Grass (*Chrysopogon fallax*) (Dostine and Franklin 2002). In the non-breeding season birds can disperse widely (Garnett et al. 2011), greatly increasing the possible range of this species.

The NT Fauna Atlas records 276 observations of Gouldian finches within 50 km of EP154. These records show they are widespread across the region. There were no sightings of this species during the July 2021 field survey. The proposed exploration activities present a potential threat to this species through the removal habitat, particularly the loss of large hollow bearing trees for nesting (in particular large *E. leucophloia*). Avoidance of large old trees (> 40 cm DBH) is recommended to minimise impacts on this species.

5 THREATENING PROCESSES

There are a number of threatening processes operating within EP154 and the project footprint. These are discussed below.

5.1 Weeds

Regional Context

Some species of introduced flora are declared weeds under the NT *Weeds Management Act* because of the harm they can cause. Class A weeds are to be eradicated by land owners and occupiers. Class B weeds must have their growth and spread controlled by land owners and occupiers. The remaining introduced flora species are referred to as *environmental weeds*. The Commonwealth Government has also categorised some species as Weeds of National Significance (WoNS).

Weed distribution is often related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds are most prevalent on land under pastoral lease, with infestations generally concentrated around infrastructure such as water points, fence lines and tracks, and also along the banks of watercourses where cattle and feral animals tend to congregate.

A review of the NT Weed Branch weed dataset shows that there are over 2,300 weed records for the general area of EP154 (within approximately a 20 km buffer). By far the most frequently reported species are:

- Chinee Apple* (*Ziziphus mauritiana*) (Class A)
- Parkinsonia* (*Parkinsonia aculeata*) (Class B)
- Hyptis* (*Mesosphaerum suaveolens*) (Class B)
- Lantana* (*Lantana camara*) (Class B)
- Neem* (*Azadirachta indica*) (Class B)
- Bellyache Bush* (*Jatropha gossypiifolia*) (Class B)

EP154 lies within the *Katherine Regional Weed Strategy 2021-2026* (DEPWS 2021). This plan focusses on the weeds that are most important to the region, categorising them as either:

- Category 1 – Priority weeds (present in the region, widely considered feasible to eradicate from the Region, typically evaluated as very high risk and have isolated and restricted distributions).
- Category 2 – Priority weeds or strategic control – including the eradication of outliers (species warranting strategic control across the landscape due to the high impact they have on land managers and on broader economic and environmental values).
- Category 3 – Weeds of concern (assessed by the weed risk management system as a medium to high risk, or have not been assessed, but have been identified by stakeholders as posing a threat to the values of the Region).
- Category 4 – Hygiene and biosecurity weeds (it is important for landholders to implement weed hygiene and other biosecurity measures to prevent the spread of weeds into clean areas, and to control these species where the opportunity arises).
- Category 5 – Alert weeds (have the potential to have a high level of impact to the region should it become established, the likelihood of the species naturalising and spreading in the region is perceived to be high).

All such weeds are listed in Table 5-1.

Table 5-1. Weed species relevant to EP154

Common name	Scientific name	WoNS	NT Class	Category in regional strategy	Records within project footprint (20km buffer)
Mesquite*	*Prosopis spp.*	Yes	A	1	-
Prickly Acacia*	*Vachellia nilotica (previously Acacia nilotica)*	Yes	A	1	Yes
Parthenium	*Parthenium hysterophorus*	Yes	A	1	Yes
Rubber Vine	*Cryptostegia spp.*	Yes**	A	1	-
Mimosa*	*Mimosa pigra*	Yes	A	1	Yes
Salvinia	*Salvinia molesta*	Yes	B	1	-
Gamba Grass*	*Andropogon gayanus*	Yes	A	2	Yes
Devils Claw	*Martynia annua*	-	A	2	Yes
Chinee Apple*	*Ziziphus mauritiana*	-	A	2	Yes
Bellyache Bush*	*Jatropha gossypiifolia*	Yes	A/B***	2	Yes
Grader Grass*	*Themeda quadrivalvis*	Yes	B	2	Yes
Neem*	*Azadirachta indica*	-	B	2	Yes
Parkinsonia	*Parkinsonia aculeata*	Yes	B	3	Yes
Lantana	*Lantana camara*	Yes	B	3	Yes
Rubber Bush†	*Calotropis procera*	-	B	3	Yes
Snake Weed	*Stachytarpheta spp.*	-	B	4	Yes
Hyptis	*Mesosphaerum suaveolens*	-	B	4	Yes
Sida species	*Sida acuta, S. cordifolia, S. rhombifolia*	-	B	4	Yes
Pond Apple	*Annona glabra*	Yes	A	5	-
Water Hyacinth	*Eichhornia crassipes*	Yes	A	5	-
Cabomba*	*Cabomba caroliniana*	Yes	A	5	-
Siam Weed	*Chromolaena odorata*	Yes	C	5	-
Brazilian Pepper	*Schinus terebinthifolius*	-	A	-	-

** Species must be eradicated or managed as directed by its Statutory Weed Management Plan*
**** Cryptostegia grandiflora *is a WoNs*
**** Most of EP154 is within a Class B management zone. The easternmost area is Class A.*
† Rubber Bush is considered high priority on the Sturt Plateau but declared class B only south of 16°30' S latitude

The Weeds Management Division of DEPWS was consulted on the survey approach and agreed that the lists covered all weeds for which surveys should be conducted. The agreed approach was to walk all current and proposed disturbance areas (i.e. infrastructure, access tracks, drill pads and crossings) to search for weeds, as any disturbance may provide opportunity for the establishment of weed seeds present within the soil.

Methodology for the weed survey is described in Section 3.1.

Weeds within the project footprint

A total of 40 sites were assessed for the occurrence of weeds within the project footprint. These sites include waterway crossing sites, analogue vegetation sites and other specific weed survey sites (Figure 5-3).

Four weed species were detected within the project footprint and are described further below in Table 5-2.

Table 5-2. Weed species observed during the field survey of EP154.

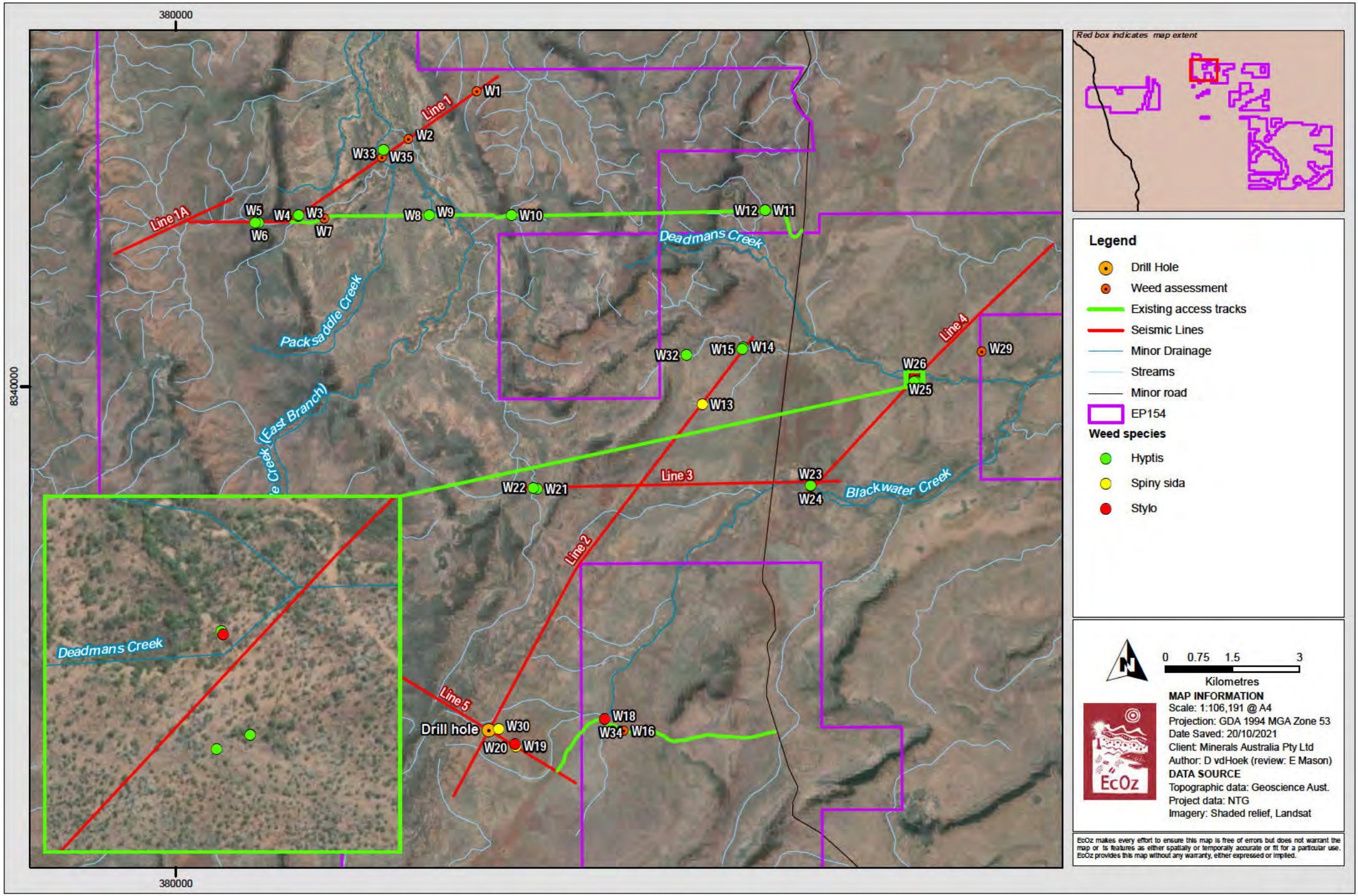
Species	Status	Occurrence
Hyptis (*Mesosphaerum suaveolens*)	Class B in the NT and Category 4 in Katherine Regional Weed Strategy.	WC2, WC5, WC6, WC7, WC8, WC10, WC12, and WC14
Spiny Sida (*Sida spinosa*)	Environmental weed	Seismic lines 2 (WC4), seismic line 5 and the drill pad
Stylosanthes hamata	Environmental weed	Seismic line 4
Stylosanthes scabra	Environmental weed	Seismic line 5

Thirteen occurrences of Hyptis (*Mesosphaerum suaveolens*), a declared weed species, was recorded during the July 2021 field survey. It is listed as Class B in the NT (Growth and Spread to be prevented) and a Category 4 weed – Hygiene and biosecurity weed – in the Katherine Regional Weed Strategy. It is widespread along the drainage lines, including within the project footprint. The field survey recorded multiple infestations near the seismic lines that represent a high risk of spread. The location of identified Hyptis infestations are presented in Figure 5-3 and representative photographs in Figure 5-1. Sites where this weed species was recorded include (water crossing sites - WC2, WC5, WC6, WC7, WC8, WC10, WC12, and WC14). These areas of infestation are considered a high risk for spread.

Figure 5-1. Photograph of Hyptis (*Mesosphaerum suaveolens*) infestations with details to its inflorescence.

Three other invasive species (environmental weeds) were recorded in the project footprint. Spiny Sida (*Sida spinosa*) infestations were recorded along seismic lines 2 (WC4), seismic line 5 and the drill pad. *Stylosanthes hamata* infestations were observed along seismic line 4 while *S. scabra* along seismic line 5. Spiny Sida is native to the neotropics and parts of tropical Asia, having become invasive in temperate parts of Australia. *S. hamata* and *S. scabra* were introduced as pasture plants and also have the potential to become weeds. The risk of spreading these species is high due to the location of the infestations in close proximity to the seismic lines increasing the likelihood of them being transported by machinery to other disturbed areas. Their location is mapped in Figure 5-3 and representative photographs of *S. scabra* are presented in Figure 5-2.

Figure 5-2. Photograph of *Stylosanthes spp.* with detail to its leaflets.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure 5 3. Map of weed occurrences and drainage within, or adjacent to, the project footprint.mxd

Figure 5-3. Map of weed occurrences within, or adjacent to, the project footprint on EP154

5.2 Pest animals

According to the NT Fauna Atlas, the introduced fauna species listed in Table 5-3 are widespread and abundant within the region, and hence likely to occur within EP154. Donkeys especially occur in high densities in parts of the region and contribute considerably to overgrazing. Cane Toads, Feral Cats and Feral Pigs are each listed as a Key Threatening Process under *EPBC Act*.

Table 5-3. Pest animals that may occur within EP154 (NT Atlas)

Common name	Scientific name	Habitats	Impacts
Feral Cattle	*Bos taurus*	Various	Erosion of soil and watercourses, weed spread, trampling and consumption of native flora, and sedimentation and increased nutrient levels in watercourses
Water Buffalo	*Bubalus*	Riparian areas & wetlands	
Donkey	*Equus asinus*	Various	
Horse	*Equus caballus*	Grassland & shrubland	
Wild Dog	*Canis lupus*	Various	Prey on many species of native animals
Feral Cat	*Felis catus*	Various	
Feral Pig	*Sus scrofa*	Riparian areas & wetlands	Physical damage to wetlands
House Mouse	*Mus domesticus*	Various	Compete with native species. May impact upon native vegetation via seed predation
Cane Toad	*Rhinella marina*	Various	Known to cause population reductions in a range of predatory species (due to poisoning by ingestion)
Asian House Gecko	*Hemidactylus frenatus*	Buildings & adjacent woodlands	Compete with, and predate upon, native species
Yellow Crazy Ant	*Anoplolepis gracilipes*	Monsoon rainforest	

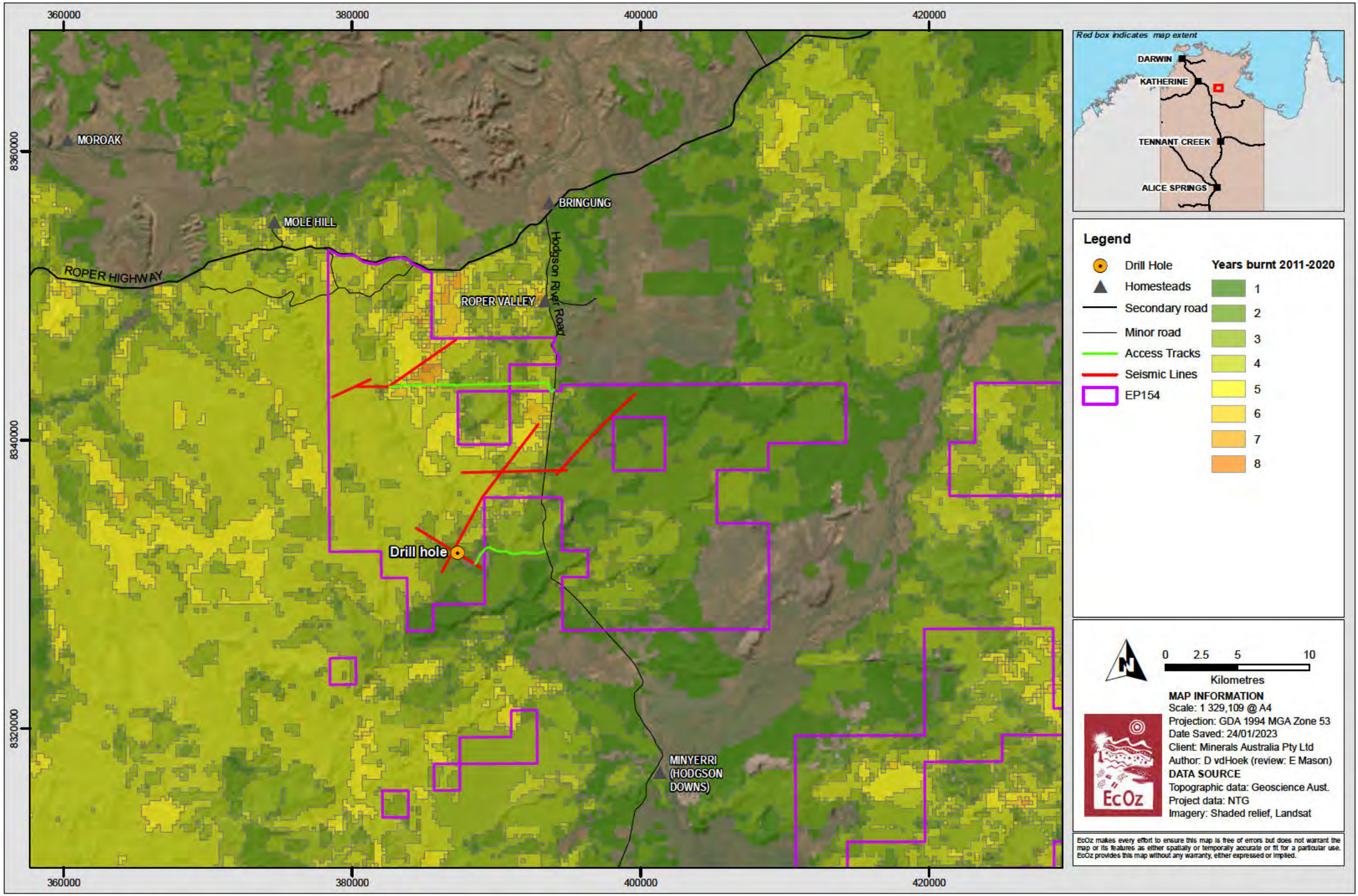
5.3 Pastoralism

EP154 is currently under freehold tenure – Alawa 1 (Hodgson Downs/Minyerri) and Mangarrayi Aboriginal Land Trust. The land where the project footprint is located used to be a pastoral station until 1991 and active pastoral properties still surround EP154. Impacts from pastoral activities on ecological values within and around the project footprint are deemed low. After 30 years of ceased pastoral activities there's little or no apparent impact of grazing and soil trampling in the surveyed sites. Vegetation Site 1 (Appendix D) was the only surveyed area where pastoralism disturbance could still be observed. Cumulatively, environmental impacts typically associated with pastoralism can have a negative influence on biodiversity. Pastoralism is implicated in the decline of some vertebrate species and changes in plant species composition in the Australian rangelands (Fisher et al. 2002). Pastoral impacts have particularly affected mammals – especially larger dasyurids and rodents, bandicoots and smaller macropods (Woinarski et al. 2001 – cited in DEWHA 2009).

5.4 Fire

Fires are a regular occurrence in the bioregion. Regional fire history and fire scar mapping was obtained through the Northern Australia and Rangelands Fire Information website. Given the area covered by EP154, the fire history is variable, with patches burnt between zero to seven times since 2010.

Late burn fires (from August onwards) are typically hotter than those occurring earlier in the dry season. They are often anthropogenic in origin, and their effect on native flora and fauna is usually more detrimental because of their intensity. Some parts of EP154 have experienced up to six late season burns in the last ten years, while others have none (Figure 5-4).



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19193 - Hancock - EMP EP154\01 Project Files\Report Maps\Figure 5 4. Map of fire history within and around EP 154.mxd

Figure 5 4. Map of fire history within and around EP 154

6 LAND CONDITION ASSESSMENT

Each survey site has been assigned a land condition category that is graded against the criteria outlined within Table 6-1. If a site aligned with two or more criteria within a row, it was assigned that condition category. Only vegetation assessment sites (analogue sites) and waterway crossing sites have been included within this assessment as the weed survey sites recorded weeds only and no other additional data, thus can't be assessed using this method.

Table 6-1. Ratings for the land condition assessment

Condition	Vegetation	Erosion	Weeds	Cattle
GOOD	Vegetation structure intact, all expected layers present	No erosion	No weeds	Negligible impact
AVERAGE	Vegetation structure altered, basic vegetation structure present	Some erosion	Few weeds	Some impact
POOR	Vegetation structure severely impacted, some strata are absent	Significant erosion	Many weeds	Significant impact

The land condition rating for each of the analogue vegetation sites and waterway crossing sites has been provided in Appendix B and Appendix C, respectively. All of the 18 analogue sites assessed were considered to be in good condition, despite a couple being recently impacted by fire (e.g. Vegetation Sites 12 and 17). Of the 14 waterway crossing sites assessed, four are considered in average condition (WC1, WC4 WC8, & WC10) due to weed invasion and some erosion and 10 sites are considered to be in good condition (WC2, WC3, WC5, WC6, WC7, WC9, WC11, WC12, WC13, WC14).

7 RECOMMENDATIONS

The proposed works will include the removal of native vegetation and fauna habitat along the seismic lines, access tracks and drill pad. These works will include areas supporting significant vegetation as per the NT Land Clearing Guidelines (DNRE 2020): riparian vegetation, areas supporting large hollow bearing trees and known and potential ground water dependent ecosystems. Works also have the potential to spread weeds and promote erosion along the waterways. Further, there is potential for the works to impact on nesting habitat for EPBC-listed Gouldian Finch, particularly within areas supporting Snappy Gum. The potential impacts to biodiversity values however, can be minimised if appropriate control measures are undertaken. As such, the following recommendations are made:

1) Travel between project area sites using existing tracks, roads, and trails only.
2) Where possible, minimise impacts to riparian vegetation through avoidance and or minimisation of native vegetation removal and protection of large old trees.
3) Avoid the removal of any large trees with DBH > 40 cm, especially the Snappy Gums (located primarily in the sandstone plains and rises) to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
4) If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
5) Prior to exploration works, a weed management plan must be prepared and implemented.
6) During exploration activities, all vehicles, plant, and equipment should be certified weed-free prior to entry into the project area. Weed hygiene protocols must be implemented to ensure that weeds are not introduced or spread through the site.
7) Control infestations and avoid the spread of Hyptis, Spiny sida and Stylo species. Weed control to focus on drainage crossings where infestations are established or any other areas of disturbance.
8) An erosion and sediment control plan must be developed as per the NT Land Clearing Guidelines (DENR 2020). This plan must outline measures to minimise impacts associated with waterway crossings, other erosion prone landforms and minimise downstream impacts outside the project footprint.
9) Produce a rehabilitation plan for all the disturbed areas, aiming to replicate the environmental conditions of the sites prior to the disturbances (i.e. refer to analogue sites).

8 SUMMARY OF EXPLORATION ACTIVITY SITES

This section provides a summary of the key findings within each of the proposed works areas. The summary includes the proposed works, ecological values, threatening processes, potential impacts and recommendations.

8.1 Seismic Line 1

- Seismic Line 1 is 7.93 km in length.
- Access to the seismic line will be along station tracks.
- The seismic line intersects the following Landscape class (Land systems): sandstone plains and rises (Arnold and Patterson), rugged quartz sandstone plateaux and hills (Bukalara), alluvial floodplains (Lindsay and McArthur) – see Table 2 1 and Section 3.2.
- There are 10 waterway crossing points that intersect Seismic Line 1. Four waterway crossing sites are located along Seismic Line 1 including, WC10, WC11 WC13 and Packsaddle Creek at WC9.
- Hyptis* was recorded along the drainage line at water crossing site (WC10) see Figure 5-3.
- All waterway crossing sites have a moderate erosion potential, except for WC10 that is considered to have a high erosion risk.
- Packsaddle Creek, crossed by Seismic Line 1 has a moderate potential to be a Ground Water Dependant (GDE) ecosystem.
- Potential habitat along waterways / riparian areas for TPWC-listed Mertens Water Monitor.
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm (especially those located within the sandstone plains and rises) should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

8.2 Seismic Line 1A

- Seismic Line 1A is 2.92 km in length.
- Access to the seismic line will be along station tracks.
- The seismic line intersects the following Landscape class (Land systems): rugged quartz sandstone plateaux and hills (Bukalara) and sandstone plains and rises (Emmerugga and Patterson):– see Table 2 1 and Section 3.2.
- There are three minor waterway crossings along Seismic Line 1A but none were assessed during the field survey.
- Vegetation site 18 is located adjacent to Seismic Line 1A. This site supports good quality open woodland, with a sparse shrub layer and tussock grass understorey. No weeds were recorded at this site.
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm, especially those located within the sandstone plains and rises should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

8.3 Seismic Line 2

- Seismic Line 2 is 12.35 km in length.
- Seismic Line 2 will be accessed from the Hodgson River Road.
- The seismic line intersects the following Landscape class (Land systems): Sandstone plains and rises (Kangaroo) and alluvial floodplains (McArthur) – see Table 2-1 and Section 3.2.
- There are three waterway crossing points along Seismic Line 2. Two of these were assessed during the field survey (WC4 and WC5).
- Environmental weed Sida spinosa* was recorded at WC4. Declared weed Hyptis* was recorded at WC5 (see Figure 5-3).
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm, especially those located within the sandstone plains and rises should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

8.4 Seismic Line 3

- Seismic Line 3 is 7.26 km in length.
- The seismic line intersects the following Landscape class (Land systems): sandstone plains and rises (Emmerugga, Kangaroo), alluvial floodplains (Lindsay, McArthur) and basalt plains and rises (Nutwood) – see Table 2 1 and Section 3.2.
- There are four waterway crossing points along Seismic Line 3. Two of these crossing sites were assessed during the field survey including: Blackwater Creek that crosses Seismic Line 3 at the eastern end (Water crossing site - WC7) and a first order stream near its western end that supports large old hollowing bearing trees (WC6).
- Hyptis* was recorded along the drainage line at both water crossing sites (WC6 and WC7) – see Figure 5-3.
- Potential habitat along waterways / riparian areas for TPWC-listed Mertens Water Monitor.
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm, especially those located within the sandstone plains and rises should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.
- Blackwater Creek is mapped as a known Groundwater Dependant Ecosystems and is crossed by Seismic Lines 3 and 4 along the eastern and southern sections, respectively.

8.5 Seismic Line 4

- Seismic Line 4 is 7.86 km in length.
- The seismic line intersects the following Landscape class (Land systems): sandstone plains and rises (Arnold, Emmerugga), alluvial floodplains (McArthur) and basalt plains and rises (Nutwood) – see Table 2 1 and Section 3.2.
- There are two waterway crossing points along Seismic Line 4. These include, Deadmans Creek (WC8) and Blackwater Creek (WC7) at the southern end.
- Potential habitat along waterways / riparian areas for TPWC-listed Mertens Water Monitor.
- Declared weed Hyptis* was recorded at WC8 and WC7. Stylosanthes sp. were recorded at WC 8 – see Figure 5-3.

- Blackwater Creek is mapped as a known Groundwater Dependant Ecosystem and is crossed by Seismic Lines 4 at the southern end.
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm, especially those located within the sandstone plains and rises should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

8.6 Seismic Line 5

- Seismic Line 5 is 5.3 km in length.
- The seismic line intersects the following Landscape class (Land systems): sandstone plains and rises (Emmerugga, Kangaroo) and basalt plains and rises (Nutwood) – see Table 2 1 and Section 3.2.
- There are no waterway crossing sites along Seismic Line 5.
- *Stylosanthes scabra* and *Sida spinosa* were recorded along or adjacent to this seismic line – see Figure 5-3.
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm, especially those located within the sandstone plains and rises should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
  Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

8.7 Access Track North and South

- The seismic access track intersects the following Landscape class (Land systems): Basalt hills and rises (landscape class: Nutwood), Lateritic plains and rises (landscape class: Langdon) and, Rugged quartz sandstone plateaux and hills (landscape class: Bukalara) - see Figure 2 3.
- Packsaddle Creek (east branch) is crossed by the northern access track (WC1).
- Deadmans Creek is crossed by Hodgson River Road. This crossing was not assessed during the field survey.
- No weeds were recorded along Hodgson River Road.
- Declared weed Hyptis* was recorded at waterway crossings along the northern access track.
- Packsaddle Creek, crossed by the northern access track has a moderate potential to be a Ground Water Dependant (GDE) ecosystem.
- Potential habitat along waterways / riparian areas for TPWC-listed Mertens Water Monitor.
- Avoid removal of large old hollow bearing trees along the waterways or woodland environs. Large Snappy Gums DBH > 40 cm, especially those located within the sandstone plains and rises should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

8.8 Drill hole

- The stratigraphic drill hole is located in the middle of seismic line 5.
- Access to the drill pad will be via seismic lines and station roads.
- Approximate clearance area of 2 ha to accommodate the 150 x 150m drill pad and buffer.

- The seismic access track intersects the following Landscape class (Land systems): sandstone plains and rises (Kangaroo).
- Environmental weed *Sida spinosa* was recorded within the drill pad – see Figure 5-3.
- Significant vegetation (remnant vegetation supporting large old hollowing bearing trees) is present within the drill pad area.
- Avoid removal of large old hollow bearing trees within the woodland environs. Large Snappy Gums DBH > 40 cm should be avoided to minimise any potential impacts to breeding habitat for EPBC-listed Gouldian Finches.
- If potential habitat EPBC-listed Gouldian Finch is proposed for removal, targeted assessment and evaluation of impacts will be required. This would include targeted field surveys.
- Implement the erosion and sediment control plan to minimise impacts on waterways and other erosion prone landforms.

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APPENDIX A LAND SYSTEMS WITHIN EP154

Land system	Landform	Soil	Vegetation	EP154 Cover (%)
Sandstone hills				
Cox	Undulating low hills on the Cox River Formation and some Corcoran Formation	Lithosols and earthy sands	Low open woodland of *Melaleuca citrolens, E. pruinosa, E. leucophloia* over *Chrysopogon fallax, Plectrachne pungens, Sorghum plumosum*	3.849
Favenc	Steep hills on mainly argillaceous sediments	Lithosols and brown earths	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, ,Erythrophleum chlorostachys* over *Plectrachne pungens, Chrysopogon fallax, Heteropogon triticeus*	0.941
Munyi	Steep to gently slopes on the Munyi Member of the Abner Sandstones and the Sherwin Ironstone Member of the Maiwok Subgroup of Roper sediments	Lithosols	Mid-high open woodland of *E. leucophloia* over *Plectrachne pungens*	0.451
OKeefe	Broad breached anticlines and dissects structural plateaux on sub-horizontally bedded sandstones with sandstone columns	Shallow siliceous sands	Mid-high open woodland of *E. miniata, E. tetrodonta, C. ferruginea, Erythrophleum chlorostachys, C. dichromophloia* over *Chrysopogon fallax, Sorghum plumosum, Plectrachne pungens*	0.573
Lateritic plains and rises				
Banjo	Gently undulating to almost level plains	Predominantly red kandosols with shallow to moderately deep Ferric, red, brown and yellow Kandosols with some Leptic Tenosols	Mid-high open woodland *of E. patellaris, C. terminalis, C. ferruginea, Erythrophleum chlorostachys, C. dichromophloia* over *Chrysopogon latifolius, Themeda australis, Sehima nervosum*	13.634
Bulwaddy	Generally undulating rises comprising frequent rises and associated slopes, almost level residual plains and closed clay depressions	Shallow Leptic Rudosols, gravelly red and brown Kandolsols and deep loamy red Kandosols	Mid-high ope woodland of *E. patellaris. C. ferruginea, C. dichromophloia, Erythrophleum chlorostachys, C. terminalis* over *Sorghum plumosum, Sehima nervosum, Chrysopogon latifolius*	1.764
Claravale	Gently undulating sandy terrain	Sandy gravelly brown Kandosols and sandy red Kandosols	Tall open forest of *E. miniata, E. tetrodonta, C. bleeseri, Erythrophleum chlorostachys, C. dichromophloia* over spinifex tall grass (*Sorghum spp, Sehima nervosum, Heteropogon triticeus*	0.495
Cresswell	Erosionally stable, gently undulating plains and rises on ferrugunised Lower Cretaceous sediments (laterite)	Ferruginous lithosols, lateritic podsolics, red and yellow earths, earthy sands and brown clays	Mid-high open woodland of *C. dichromophloia, C. bleeseri, E. tetrodonta, Erythrophleum chlorostachys* with isolated stands of *A. shirleyi* on crests over *Chrysopogon fallax, Plectrachne pungens, Sorghum plumosum*	5.338

Land system	Landform	Soil	Vegetation	EP154 Cover (%)
Dalglese	Pediplains, pediments and plains on detritus left by retreat of the Sturt Plateau, also sedentary on claystones which underlay the original laterite	Brown earths, yellow earths and brown clays	Mid-high open woodland of *E. pruinosa, C. terminalis, Erythrophleum chlorostachys, Melaleuca citrolens, Lysiphyllum cunninghamii* over sparse grass cover (*Chrysopogon fallax, Sehima nervosum, Heteropogon contortus)*	0.039
Elsey	Gently undulating to alsmost level plains characterised by large closed depressions	Sandy and loamy res Kandosols	Tall open woodland of *E. tetrodonta, Erythrophleum chlorostachys, C. ferruginea, E. tectifica, C. terminalis* over a moderately dense perennial grass cover (*Plectrachne pungens, Sehima nervosum, Chrysopogon spp.)*	1.589
Fletcher	Level to very gently undulating plains on ferruginous material (laterite) that has been re-exposed from a sub marine position, with swales in a sub-coastal orientation	Earthy sands and yellow podsolic soils	Tall open woodland of *E. tetrodonta, Melaleuca viridiflora, Brachychiton diversifolius, E. miniata, C. polycarpa* over *Chrysopogon fallax, Sorghum plumosum, Eriachne obtusa*	0.052
Horse Creek	Gently undulating plains on sandstone with deep sandy soils and isolated swampy depressions	Siliceous sands and earthy sands	Tall open woodland of *E. tetrodonta, E. miniata, Callitris intratropica, E. ferruginea, Erythrophleum chlorostachys* over *Plectrachne pungens, Eriachne obtusa, Aristida hygrometrica; Melaleuca viridiflora, C. polycarpa* occur on wetter areas	7.370
Inacumba	Gently undulating rises and undulating plains to low hills on ferruginised Lower Cretaceous sediments (laterite) and weathered sandstones	Lithosols	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, C. ferruginea, E. leucophloia* with isolated stands of A. *shirleyi* on steeper slopes over *Eriachne spp, Chrysopogon fallax, Plectrachne pungens*	3.459
Langdon	Gentle colluvial slopes, mainly below areas of argillaceous rocks with some poorly drained depressions	Yellow Kandosols, some Chromosolic Redoxic Hydrosols and Aquic Vertosols	Mid-high open woodland *of E. tectifica, Erythrophleum chlorostachys, Brachychiton diversifolius, C. latifolia, C. confertiflora* over mid-dense grass cover (*Chrysopogon fallax, Sorghum plumosum, Sehima nervosum*)	1.381
Mering	Undulating low gravely crests and slopes with isolated ridges	Leptic and Orthic Tenosols	Very variable, mid-high open woodland of C. *ferruginea, C. terminalis, E. patellaris* over *Triodia bitextura, Chrysopogon latifolius, Sorghum plumosum*	0.513
Running	Gently undulating plains and rises on ferruginised, mainly arenaceous sediments	Lateritic podzolics and lithosols	Tall open woodland of *E. tetrodonta, E. miniata, C. ferruginea, C. dichromophloia, E. phoenicea* over *Plectrachne pungens, Eriachne obtusa, Sorghum plumosum*	5.440
Tanumbirini	Gently sloping pediplains below, but isolated from lateritic escarpments	Lateritic yellow earths and brown clays	Mid-high open woodland of *E. chlorophylla, Erythrophleum chlorostachys, C. polycarpa, E. tetrodonta, Terminalia grandifolia* over *Chrysopogon fallax, Eulalia fulva, Plectrachne pungens*	0.037
Twin Springs	Gently undulating plains at high levels on superficially ferruginised areas of massive sandstones	Siliceous sands and sandy lithosols	Mid-high open woodland of *E. phoenicea, C. ferruginea, C. dichromophloia, Melaleuca nervosa, M. symphyocarpa* over *Plectrachne pungens, Eriachne obtusa, Pseudoraphis spinescens*	2.462

Land system	Landform	Soil	Vegetation	EP154 Cover (%)
Yungman	Gently undulating sandy terrain and low hills on deeply weathered Cretaceous sandstone and siltstone	Shallow Leptic Rudosols and sandy brown Kandosols	Mid-high open forest of *E. tetrodonta, C. bleeseri, S. miniata, Erythrophleum chlorostachys, C. ferruginea* over spinifex tall grass (*Plectrachne pungens, Sorghum spp, Heteropogon triticeus*)	0.826
Rugged quartz sandstone plateaux and hills				
Bukalara	Rugged rocky plateaux and steep, linear ridges, on massive sandstones such as the Bukalara and Kombolgie Sandstones	Lithosols and shallow siliceous sands	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, Erythrophleum chlorostachys* over *Plectrachne pungens, Chrysopogon fallax, Eriachne obtusa*	9.306
Glyde	Gently undulating plains at high levels on massive sandstones such as the Bukalara sandstone	Leptic Rudosols and Leptic Tenosols	Mid-high open woodland of *E. miniata, E. tetrodonta and C. dichromophloia* with some *E. phoenicea* over *Plectrachne pungens* and *Sorghum plumosum*	0.022
Alluvial floodplains				
Coolibah	Level to gently undulating plains on unconsolidated transported materials, rarely sedentary	Grey and brown clays, minor black earths	Mid-high open woodland of *E. microtheca, Excoecaria parvifolia over Chrysopogon fallax, Sorghum plumosum, Aristida spp.*	0.190
Frog	Broad sandy floodplains, terraces and lower colluvial slopes	Deep siliceous and earthy sands, sandy yellow earths and sandy solodic soils	Mid-high open woodland of *E. tectifica, C. terminalis, Erythrophleum chlorostachys, Brachychiton diversifolius, C. latifolia* over *Chrysopogon fallax, Sorghum plumosum, Sehima nervosum*	0.886
Hodgson	Old alluvial clay plains with multiple channels and many small billabongs and source materials from areas of eroding laterite	Aquic Vertosols	Migh-mid open woodland of *E. microtheca, Excoecaria parvifolia* with a sparse shrub layer of *Flueggea virosa, Carissa lanceolata*	0.007
Lindsay	Floodplains and terraced, some lower slopes and small swamps, drainage floors and flats, with fine sandy materials	Yellow and brown Kandosols and Chromosolic and Kandosolic Redoxic Hydrosols	Low open woodland of *M. viridiflora, Grevillea pteridifolia, Brachychiton diversifolius* over *Chrysopogon fallax, Eriachne obtusa, Sorghum plumosum*	0.545
McAuthur	Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast	Grey and brown clays, red and yellow earths and siliceous sands	Mid-high open woodland of *C. terminalis, E. microtheca, Excoecaria parvifolia, Lysiphyllum cunninghamii, C. papuana* over *Chrysopogon spp, Eulalia fulva, Iseilema vaginiflorum*	3.183
Surprise	Level to gently undulating plains on mainly unconsolidated, transported materials	Yellow and brown earths and cracking clays	Mid-high open woodland of *E. tectifica, C. latifolia, Erythrophleum chlorostachys, C. grandifolia, C. confertiflora* over *Themeda triandra, Chrysopogon fallax, Aristida spp.*	0.897
Weston	Dissected plateaux and low hills on weathered Cretaceous sediments with intervening valleys and sandy lower slopes on Kombolgie or Bukalara sandstones	Leptic Rudosols and Brown Kandosols	Mid-high open woodland of *E. tetrodonta, C. kombolgiensis, C/ bleeseri, E. miniata* over *Plectrachne pungens, Chrysopogon fallax, Sorghum plumosum*	0.540

Land system	Landform	Soil	Vegetation	EP154 Cover (%)
Wulkulyi	Seasonal and perennial swamps and poorly drained, low lying areas	Chromosolic Redoxic Hydrosols	Mid-high woodland of *Melaleuca nervosa, M. symphyocarpa, Excoecaria parvifolia, M. viridiflora, C. polycarpa* over *Pseudoraphis spinescens, Chrysopogon fallax, Sorghum plumosum*	0.273
Basalt hills				
Cliffdale	Gentle undulating to hilly terrain on basalt, dolerite, agglomerate and tuff, some dolerite; mostly rock outcrop with surface stone pockets of clayey soils	Leptic Rudosols, red Dermosols and black Vertosols	Mid-high open woodland of *E. pruinosa, E. tectifica, C. terminalis, Erythrophleum chlorostachys, Brachychiton diversifolius* over *Chrysopogon fallax, Sehima nervosum , Sorghum plumosum*	0.024
Basalt plains and rises				
Nutwood	Plains and low rises on basalt and associated basic igneous rock	Brown, grey and red Vertosols, red Ferrosils and brown and red Kandosols	Mid-high open woodland of *Lysiphyllum cunninghamii, C. terminalis, C. confertiflora, E. pruinosa, E. patellaris, Erythroxylum ellipticum* over mid-dense grass cover (*Chrysopogon fallax, Aristida latifolia, Panicum spp.*)	0.465
Clay plains				
Larrimah	Relict flood plains	Browns and grey Vertosols	Tall sparse shrubland of *Carissa lanceolata, Ventilago viminalis, Terminalia* volucris with scattered trees (*Lysiphyllum cunninghamii, Atalaya hemiglauca, E. microtheca* over *Aristida spp, Sorghum spp, Astrebla squarrosa*	0.027
Lateritic plateaux				
Lancewood2	Plateau margins, escarpments and rugged low hills and plateaux	Lateritic lithosols	Mid-high open forest of *Acacia shirleyi* over *Schizachyrium fragile, Chrysopogon fallax, Triodia bitextura*	0.992
Mais	Low broken plateaux with extensive stony surfaces and steep slopes	Leptic Rudosols with red-Orthic and Yellow-Orthic Tenosols in lower slopes and swales	Mid-high open woodland of *E. tectifica, Terminalia canescens, Erythrophleum chlorostachys, Terminalia platyptera* over *Cymbopogon bombycinus, Sorghum spp, Aristida spp.*	0.268
Weston	Dissected plateaux and low hills on weathered Cretaceous sediments with intervening valleys and sandy lower slopes on Kombolgie or Bukalara sandstones	Leptic Rudosols and Brown Kandosols	Mid-high open woodland of *E. tetrodonta, C. kombolgiensis, C/ bleeseri, E. miniata* over *Plectrachne pungens, Chrysopogon fallax, Sorghum plumosum*	0.540
Sandstone plains and rises				
Abner	Flat to slightly undulating plans on sub-horizontally bedded sandstones (Abner Sandstone)	Shallow siliceous sands and lithosols	Tall open woodland of *E. tetrodonta, C. polycarpa, Erythrophleum chlorostachys, E. miniata, Brachychiton diversifolius* over tropical tall grass (*Chrysopogon fallax, Sorghum spp, Heteropogon spp)*	0.174
Arnold	Very gently sloping pediplains, pediments, colluvial slopes and some alluvium, rarely sedentary	Yellow earths, yellow podsolics, and other soils with hard, mottled B horizons	Low open woodland *of Melaleuca citrolens, E. pruinosa* with sparse shrubs (*Terminalia canescens, Grevillea striata, Carissa lanceolata*) over very sparse grass cover (*Sorghum plumosum, Chrysopogon fallax, Plectrachne pungens*)	11.099

Land system	Landform	Soil	Vegetation	EP154 Cover (%)
Downs	Gently undulating plains and rises on mainly fine-grained sandstones	Sandy yellow earths and siliceous sands	Mid-high woodland of *Melaleuca viridiflora, C. polycarpa, C. latifolia, Erythrophleum chlorostachys, Brachychiton diversifolius* over *Chrysopogon fallax, Sorghum plumosum, Themeda triandra*	2.364
Emmerugga	Undulating to rolling low hills on mainly argillaceous sediments	Lithosols and shallow yellow earths	Mid-high open woodland of *C. latifolia, C. grandifolia, E. tectifica, C. confertiflora, Erythrophleum chlorostachys* over *Chrysopogon fallax, Themeda triandra, Sorghum plumosum*	3.763
Kangaroo	Gently undulating to undulating rises on mainly argillaceous sediments	Shallow yellow earths and yellow podsolics	Mid-high open woodland *of E. tectifica, C. terminalis, Erythrophleum chlorostachys, Terminalia platyphylla, Brachychiton diversifolius* over *Chrysopogon fallax, Sorghum plumosum, Heteropogon triticeus*	1.963
Lancewood3	Gently undulating plains and drainage floors on claystone	Grey and brown clays	Tall open grassland of *Chrysopogon fallax, Eulalia aurea, Iseilema vaginiflorum*	0.389
Lansen	Long, low, often terraced rises with linear outcrop on prominently bedded sandstones	Lithosols	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, C. ferruginea* over *Eriachne spp, Heteropogon contortus, Chrysopogon fallax; Lysiphyllum cunninghamii* on clay infills	0.837
McLeod	Gently undulating plains and low plateaux with frequent steeply incised valleys on sub-horizontally bedded massive sandstones and siltstones	Leptic Tenosols and Rudosols	Mid-high open woodlands *of E. tetrodonta, Callitris intratropica, C. ferruginea, Erythrophleum chlorostachys, E. miniata* over *Plectrachne pungens, Eriachne obtusa, Aristida hygrometrica*	0.170
October	Very rocky gently undulating rises on massive sandstones	Lithosols	Mid-high open woodland of *C. dichromophloia, E. phoenicea, Erythrophleum chlorostachys, C. ferruginea, E. tetrodonta* over *Plectrachne pungens, Chrysopogon fallax, Sorghum plumosum*	1.521
Patterson	Low hills, rises and undulating area on reddish platy sandstones and siltstones, often micaceous	Leptic Rudusols and Leptic Tenosols, shallow red and brown Kandosols	Mid-high open woodland *of E. leucophloia, Acacia shirleyi, E. tectifica, C. grandifolia, C. ferruginea* over very sparse grass cover (*Plectrachne pungens, Eriachne obtusa, Chrysopogon fallax*)	1.405
Seigal	Gently undulating to undulating rises with abundant, often linear rocky outcrops	Lithosols, minor siliceous and earthy sands	Mid-high open woodland of *E. miniata, E. tetrodonta, C. ferruginea, C. dichromophloia, Callitris intratropica* over *Plectrachne pungens, Sorghum plumosum*	5.604
Strangways	Hills, low rises, rises and undulating areas, sedentary on browns and green platy and flaggy siltstones and shales, usually micaceous	Vertosols, yellow Kadosols and Leptic Rudosols	Mid-high open woodland *of E. pruinosa, C. terminalis, Melaleuca citrolens, C. grandifolia, Lysiphyllum cunninghamii* over sparse grass cover (*Chrysopogon fallax, Sehima nervosum, Aristida spp.*)	2.108

Land system	Landform	Soil	Vegetation	EP154 Cover (%)
Tawarrila	Undulating rises to low hills with some rocky outcrops on sandstone	Lithosols and siliceous sands	Mid-high open woodland of *E. phoenicea, C. ferruginea, C. dichromophloia, E. tectifica over Plectrachne pungens, Eriachne obtusa, Chrysopogon fallax; C. polycarpa* dominating on lower slopes	0.767

C. = Corymbia, E. = Eucalyptus

APPENDIX B VEGETATION ANALOGUE SITES

Reference site	Site 1	Date	14-7-2021		
Vegetation type	Low open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	90	6	2	2	0
Other site notes	Plain with very gentle slope. Clay-loam soils with moderate drainage, some surface rock present < 2%. Disturbance – historic cattle station and fire damage.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	25	25	90
Height range (m)	6 – 8	1.5 – 2.5	< 1
Dominant species	*Eucalyptus pruinosa* *Melaleuca citrolens* *Terminalia platyptera*	*Petalostigma banksii* *Melaleuca citrolens* *Terminalia platyptera* *Carissa lanceolata* *Flueggea virosa* *Grevillea striata*	*Chrysopogon fallax* *Pseudopogonatherum* sp.
Land Condition	Good		

GDA 2020 MGA Zone 53
0398047E, 8340770N

Reference site	Site 2	Date	14-7-2021		
Vegetation type	Low open woodland, with sparse shrub and small trees in mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	90	4	1	5	0
Other site notes	Plain with very gentle slope. Dark brown clay soils with moderate drainage, large basalt rocks present. Little disturbance.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	10	5	90
Height range (m)	6 – 8	1.5 – 2.5	< 1
Dominant species	*Corymbia terminalis* *Bauhinia cunninghamii*	*Carissa lanceolata* *Bauhinia cunninghamii* *Hakea arborescens*	*Heteropogon contortum* *Chrysopogon fallax* *Sehima nervosum* *Iseilema vaginiflorum* *Dichanthium fecundum*
Land Condition	Good		

GDA 2020 MGA Zone 53
0395498E, 8339016N

Reference site	Site 3	Date	14-7-2021		
Vegetation type	Mid-tall open woodland, sparse shrub mid-storey with juvenile trees, and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	98	1	1	0	0
Other site notes	Plain slightly sloping, north aspect. Grey-brown sandy clay loam soils with high drainage potential, nil surface rock. Disturbance from old fire.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	20	< 5		98	
Height range (m)	8 – 12	0.5 – 1.5		< 1	
Dominant species	*Corymbia latifolia* *Erythrophleum chlorostachys* *Melaleuca nervosa*	*Corymbia latifolia*		*Chrysopogon fallax* *Setaria apiculata* *Aristida hygrometrica*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0392772E, 8332201N

Reference site	Site 4	Date	14-7-2021		
Vegetation type	Mid open woodland, with sparse shrub/sapling mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	98	1	1	0	0
Other site notes	Plain. Grey-brown well drained soils, no surface rock present. Disturbance from old fire, donkeys and buffalo present.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	20	< 5		98	
Height range (m)	6 – 8	1.5 – 2.5		< 1	
Dominant species	*Terminalia platyptera* *Eucalyptus pruinosa* *Brachychiton diversifolius* *Corymbia confertiflora*	*Terminalia platyptera*		*Aristida hygrometrica* *Chrysopogon fallax* *Panicum effusum*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0390252E, 8331964N

Reference site	Site 5	Date	14-7-2021		
Vegetation type	Open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	92	1	3	4	0
Other site notes	Sloping plain with easterly aspect. Dark brown clay-loam soils, surface mud-rock present. Little disturbance.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	25	5	92
Height range (m)	8 – 10	1 – 2	< 1
Dominant species	*Eucalyptus pruinosa* *Corymbia grandifolia*	*Carissa lanceolata* *Terminalia canescens* *Flueggea virosa* *Bursaria incana*	*Chrysopogon fallax* *Schizachyrium fragile* *Heteropogon contortus* *Grevillea mimosoides* *Mnesithea formosa*

GDA 2020 MGA Zone 53
0387836E, 8331628N

Land Condition	**Good**

Reference site	Site 6	Date	14-7-2021		
Vegetation type	Woodland, with sparse shrub and sapling mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	80	6	2	2	10
Other site notes	Sloping plain with northerly aspect. Brown clay-loam soils with moderate drainage, surface rock (mudstone) present. Little disturbance.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	30	5	80
Height range (m)	6 – 10	1 – 1.5	< 1
Dominant species	*Eucalyptus leucophloia* *Eucalyptus pruinosa*	*Carissa lanceolata* *ccc*	*Dodonaea oxyptera* *Chrysopogon fallax* *Panicum effusum* *Dichanthium fecundum* *Themeda triandra*

GDA 2020 MGA Zone 53
0387260E, 8332393N

Land Condition	**Good**

Reference site	Site 7	Date	14-7-2021		
Vegetation type	Closed *Acacia shirleyi* forest, with closed grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	90	5	0	5	0
Other site notes	Hillslope ~5% with westerly aspect. Grey-brown gravelly loam well drained soils, surface rock (mudstone) present. Old fire scars present.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	75	-		90	
Height range (m)	10 – 12	-		< 0.5	
Dominant species	*Acacia shirleyi* *Eucalyptus leucophloia*			*Mnesithea formosa* *Schizachyrium fragile* *Waltheria indica* *Rhynchospora minima*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0384579E, 8334796N

Reference site	Site 8	Date	14-7-2021		
Vegetation type	Closed *Acacia shirleyi* forest, with closed grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	95	2	0	3	0
Other site notes	Hillslope ~5% with northerly aspect. Grey brown sandy-loam gravelly soils, well drained with surface rock (mudstone) present. Old fire scars present.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	60	-		95	
Height range (m)	6 – 10	-		< 0.5	
Dominant species	*Acacia shirleyi* *Eucalyptus leucophloia*			*Mnesithea formosa* *Schizachyrium fragile* *Rhynchospora minima*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0388336E, 8334748N

Reference site	Site 9	Date	15-7-2021		
Vegetation type	Low open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	98	1	1	0	0
Other site notes	Slightly sloping plains. Brown loamy-clay soils with moderate drainage, no surface rock present. Disturbance – donkey tracks and old fire damage.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	15	5	98
Height range (m)	6 – 10	0.5 – 2	< 1
Dominant species	*Eucalyptus pruinosa* *Melaleuca nervosa* *Brachychiton diversifolius*	*Carissa lanceolata* *Terminalia canescens* *Eucalyptus pruinosa* *Acacia difficilis*	*Chrysopogon fallax* *Heteropogon contortus* *Panicum* sp. *Waltheria indica* *Dichanthium fecundum*
Land Condition	**Good**		

GDA 2020 MGA Zone 53
0397269E, 8338740N

Reference site	Site 10	Date	15-7-2021		
Vegetation type	Open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	85	2	12	0	1
Other site notes	Slightly sloping plain, westerly aspect. Yellow-brown silty clay loam moderately drained soils, no surface rock present. Disturbance from old fire, donkey tracks present.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	15	5	85
Height range (m)	8 – 10	0.5 – 3	< 1
Dominant species	*Eucalyptus pruinosa* *Eucalyptus patellaris* *Excoecaria parviflora*	*Eucalyptus pruinosa* *Bauhinia cunninghamii* *Flueggea virosa* *Brachychiton megaphyllus* *Acacia difficilis*	*Eragrostis tenellula* *Chrysopogon fallax* *Aristida hygrometrica* *Panicum sp.*
Land Condition	**Good**		

GDA 2020 MGA Zone 53
03964885E, 8340127N

Reference site	Site 11	Date	15-7-2021		
Vegetation type	Open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	30	10	40	0	20
Other site notes	Sloping plain with southerly aspect. Red-brown clay loam soils, moderate drainage with no surface rock present. Feral animal disturbance and some minor sheet erosion observed.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	15	5	30
Height range (m)	8 – 10	1 – 1.5	< 1
Dominant species	*Eucalyptus pruinosa* *Terminalia platyptera*	*Terminalia canescens* *Terminalia platyptera* *Melaleuca citrolens* *Grevillea striata* *Carissa lanceolata*	*Aristida hygrometrica* *Dichanthium fecundum* *Carissa lanceolata* *Waltheria indica* *Chrysopogon fallax* *Atalaya hemiglauca*
Land Condition	**Good**		

GDA 2020 MGA Zone 53
0391456E, 8340656N

Reference site	Site 12	Date	15-7-2021		
Vegetation type	Mid open woodland, with sparse shrub mid-storey and open tussock grassland (recently burnt).				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	8	12	80	0	0
Other site notes	Undulating plain with slight slope, northerly aspect. Orange-brown silty clay loam soils, no surface rock present. Disturbance from old fire, donkey tracks present.				

Vegetation	Upper stratum	Mid stratum	Ground stratum
% cover	20	2	8
Height range (m)	10 – 12	4 – 5	< 0.2
Dominant species	*Corymbia polycarpa* *Eucalyptus patellaris* *Erythrophleum chlorostachys*	*Petalostigma banksii* *Corymbia polycarpa*	*Carissa lanceolata* *Aristida hygrometrica* *Chrysopogon fallax* *Acacia platycarpa* *Heteropogon contortus*
Land Condition	**Good – despite recent impacts of fire**		

GDA 2020 MGA Zone 53
0383451E, 8343360N

Reference site	Site 13	Date	15-7-2021		
Vegetation type	Open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	95	4	1	0	0
Other site notes	Slightly sloping plain with westerly aspect. Brown silty clay loam soils, no surface rock present. Old fire scars present.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	25	5		92	
Height range (m)	8 – 10	1 – 3		< 1	
Dominant species	*Eucalyptus patellaris*	*Acacia platycarpa* *Eucalyptus patellaris* *Erythrophleum chlorostachys* *Terminalia canescens* *Flueggea virosa*		*Heteropogon contortus* *Dichanthium fecundum* *Eriachne* sp. *Erythrophleum chlorostachys* *Eucalyptus patellaris* *Chrysopogon fallax* *Carissa lanceolata*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0384708E, 8345242N

Reference site	Site 14	Date	15-7-2021		
Vegetation type	Woodland, with sparse shrub mid-storey and hummock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	8	12	80	0	0
Other site notes	Mid-slope on escarpment, southerly aspect. White-grey gravelly sand soils, well drained. Surface rock present. Disturbance from old fire.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	35	5		60	
Height range (m)	8 – 10	0.5 – 1.5		< 1	
Dominant species	*Eucalyptus phoenicea* *Grevillea heliosperma* *Acacia* sp.	*Jacksonia dilatata* *Grevillea heliosperma* *Acacia* sp. *Acacia humifusa*		*Triodia* sp. *Acacia humifusa* *Owenia vernicosa*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0385697E, 8345312N

Reference site	Site 15	Date	15-7-2021		
Vegetation type	Low open woodland, with sparse shrub mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	95	2	3	0	0
Other site notes	Slight slope with westerly aspect. Brown silty clay loam soils, no surface rock present. Old fire scars.				
Vegetation	Upper stratum	Mid stratum		Ground stratum	
% cover	20	5		95	
Height range (m)	6 – 8	1 – 5		< 1	
Dominant species	*Eucalyptus pruinosa* *Dolichandrone heterophylla* *Melaleuca citrolens* *Melaleuca nervosa*	*Dolichandrone heterophylla* *Bauhinia cunninghamii* *Flueggea virosa* *Hakea arborescens* *Melaleuca citrolens* *Terminalia platyptera*		*Dichanthium fecundum* *Mnesithea formosa* *Themeda triandra* *Grevillea striata* *Chrysopogon fallax* *Atalaya hemiglauca*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0399223E, 8343243N

Reference site	Site 16	Date	15-7-2021		
Vegetation type	Mid-tall woodland, with sparse shrub mid-storey and tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	60	10	0	30	0
Other site notes	Slope on top of escarpment with southern aspect. Dark brown sandy loam soils, surface rock present. Disturbance from old fire.				
Vegetation	Upper stratum	Mid stratum		Ground stratum	
% cover	40	5		60	
Height range (m)	8 – 12	0.5 – 1		< 0.5	
Dominant species	*Eucalyptus phoenicea* *Corymbia aspera* *Corymbia dichromophloia* *Owenia vernicosa* *Erythrophleum chlorostachys*	*Erythrophleum chlorostachys*		*Schizachyrium fragile* *Mnesithea formosa* *Eriachne* sp. *Jasminum molle*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0392238E, 8342134N

Reference site	Site 17	Date	15-7-2021		
Vegetation type	Open woodland, with no mid-storey and closed tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	5	1	94	0	0
Other site notes	Slightly sloping plain with northerly aspect. Light brown silty clay soils, no surface rock present. Very recent fire.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	20	-		5	
Height range (m)	10 – 12	-		< 1	
Dominant species	*Eucalyptus patellaris* *Corymbia confertiflora*			*Dichanthium fecundum* *Grewia* sp. *Sorghum plumosum*	
Land Condition	**Good - – despite recent impacts of fire**				

GDA 2020 MGA Zone 53
0385088E, 8342308N

Reference site	Site 18	Date	15-7-2021		
Vegetation type	Open woodland, with sparse shrub mid-storey and tussock grassland.				
Ground cover (%)	Vegetation	Leaf litter	Bare soil	Rock	Gravel
	80	1	1	15	3
Other site notes	Undulating slope with eastern aspect. Brown silty loam, well drained soils, surface rock present. Disturbance – old fire damage.				
Vegetation	**Upper stratum**	**Mid stratum**		**Ground stratum**	
% cover	20	2		80	
Height range (m)	8 – 10	1 – 4		< 1	
Dominant species	*Eucalyptus leucophloia*	*Petalostigma banksii* *Terminalia canescens*		*Mnesithea formosa* *Chrysopogon fallax* *Rhynchospora* sp. *Schizachyrium fragile* *Sehima nervosum*	
Land Condition	**Good**				

GDA 2020 MGA Zone 53
0379223E, 8343244N

APPENDIX C SUMMARY OF WATERWAY CROSSING SITES

Reference site		WC1		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	N	**Width**	20	**Depth**	0.5
Vegetation type		Low to mid open woodland of *Eucalyptus camaldulensis* and *Melaleuca viridiflora* over *Acacia holosericea* shrubland and *Ischaemum* sp. grassland.			
Weeds		Hyptis			
Erosion potential		Moderate, streambed erosion observed.			
Cattle Impact		Moderate, some erosion present.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Average			

WGS 84
133.9367, -14.9780

Reference site		WC2		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	NW	**Width**	5	**Depth**	0.5
Vegetation type		Low open woodland of *Terminalia platyptera* and *Melaleuca nervosa* over *Acacia holosericea* open shrubland and *Ischaemum* sp. grassland.			
Weeds		Hyptis			
Erosion potential		Low to moderate			
Cattle Impact		None observed.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
133.9538, -14.9780

Reference site		WC3		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	N	**Width**		**Depth**	
Vegetation type		Low to mid open woodland of *Eucalyptus camaldulensis* and *E. leucophloia* over *Acacia difficilis* and *A. hammondii* shrubland, and *Ischaemum* sp. and *Triodia* sp. grassland.			
Weeds		*Stylosanthes* sp.			
Erosion potential		Low to moderate			
Cattle Impact		None observed.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
134.0066, -14.9773

Reference site		WC4		**Date**	13-7-2021
Stream Order		Ephemeral creek or drainage line			
Direction	E	**Width**	10	**Depth**	0.5 - 1
Vegetation type		Low to mid mixed open woodland of *Corymbia confertiflora*, *C. polycarpa*, *Eucalyptus pruinosa* and *Brachychiton diverifolius*, over grassland of *Heteropogon contortus*, *Dichanthium fecundum* and *Chrysopogon fallax*.			
Weeds		*Sida spinosa*			
Erosion potential		High, some erosion observed.			
Cattle Impact		None observed, signs of feral animals			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Average			

WGS 84
133.9931, -15.0164

Reference site		WC5		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	S	**Width**	13	**Depth**	1
Vegetation type		Mid open woodland of *Eucalyptus camaldulensis* over *Terminalia bursarina* shrubland. Other species present include *Calytrix archaeta*, *Acacia platycarpa* and *Terminalia platyptera*.			
Weeds		Hyptis			
Erosion potential		Moderate, tracks from feral animals present			
Cattle Impact		None, signs of feral animals			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
134.0018, -15.0055

Reference site		WC6		**Date**	14-7-2021
Stream Order		Ephemeral creek			
Direction	N	**Width**	10	**Depth**	2
Vegetation type		Open woodland with Eucalyptus camaldulensis, Corymbia polycarpa over Acacia holosericea Antidesma sp. and Helicteres isora open shrubland, and Heteropogon contortus and Chrysopogon fallax closed grassland.			
Weeds		Hyptis			
Erosion potential		Moderate, channel erosion observed			
Cattle Impact		None observed, signs of feral animals.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
133.9581, -15.0330

Reference site		WC7		**Date**	14-7-2021
Stream Order		Ephemeral creek			
Direction	E	**Width**	20	**Depth**	4
Vegetation type		Woodland of *Eucalyptus camaldulensis*, *Terminalia bursarina* and *T. platyphylla* over *Helicteres isora* open shrubland and *Heteropogon contortus* grassland.			
Weeds		Hyptis			
Erosion potential		Moderate to high			
Cattle Impact		None observed, signs of feral animals.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
134.0159, -15.0331

Reference site		WC8		**Date**	14-7-2021
Stream Order		Ephemeral creek			
Direction	E	**Width**	15	**Depth**	3
Vegetation type		Mid Woodland of *Eucalyptus camaldulensis*, *Terminalia platyphylla*, and *T. platyptera*, over *Acacia difficilis* tall shrubland and *Aristida* sp. grassland			
Weeds		Hyptis and Stylosanthes sp.			
Erosion potential		High, channel erosion			
Cattle Impact		None observed, signs of feral animals.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Average			

WGS 84
134.0376, -15.0113

Reference site		WC9		**Date**	13-7-2021
Stream Order		Ephemeral creek/drainage line			
Direction	N	**Width**	15	**Depth**	1
Vegetation type		Low-mid open woodland of *Eucalyptus patellaris* over *Acacia holosericea* shrubland and *Themeda triandra* and *Pseudopogonatherum contortum* grassland.			
Weeds		None observed			
Erosion potential		Moderate, some erosion present.			
Cattle Impact		None, signs of feral animals			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway. Monitor the site for erosion development due to transit of heavy machinery			
Land Condition		Good			

WGS 84
133.9269, -14.9661

Reference site		WC10		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	N	**Width**	20	**Depth**	0.5
Vegetation type		Mid woodland of *Eucalyptus camaldulensis* over *Acacia holosericea* shrubland and *Ischaemum* sp. grassland.			
Weeds		Hyptis along banks			
Erosion potential		High, erosion present, creek still holding water.			
Cattle Impact		Significant trampling and grazing, likely donkeys.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway. Monitor the site for erosion development due to transit of heavy machinery			
Land Condition		Average			

WGS 84
133.9095, -14.9778

Reference site		WC11		**Date**	13-7-2021
Stream Order		Epemeral creek			
Direction	N	**Width**	20	**Depth**	1.5
Vegetation type		Low open *Eucalyptus microtheca* and *M. viridiflora* woodland over *Acacia umbellata* shrubland and *Heteropogon contortus* and *Ischaemum* sp. grassland.			
Weeds		None			
Erosion potential		Moderate. Some erosion present.			
Cattle Impact		None, signs of feral animals			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway. Seismic line should cross the drainage line transversely. Monitor the site for erosion development due to transit of heavy machinery.			
Land Condition		Good			

WGS 84
133.9326, -14.9630

Reference site		WC12		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	N	**Width**	50	**Depth**	1
Vegetation type		Mid open woodland of *Eucalyptus camaldulensis* and *Corymbia polycarpa* over *Terminalia bursarina* and *Calytrix archaeta* shrubland			
Weeds		Hyptis			
Erosion potential		Moderate			
Cattle Impact		None observed			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
133.9000, -14.9792

Reference site		WC13		**Date**	13-7-2021
Stream Order		Drainage line			
Direction	N	**Width**	20	**Depth**	0.5
Vegetation type		Low open *Melaleuca viridiflora* woodland over *Acacia umbellata*, *Petalostigma banksii* shrubland.			
Weeds		None observed, recent fire.			
Erosion potential		Moderate. Some erosion present			
Cattle Impact		None, signs of feral animals			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway. Seismic line should cross the drainage line transversely. Monitor the site for erosion development due to transit of heavy machinery			
Land Condition		**Good – despite recent impacts of fire**			

WGS 84
133.9470, -14.9533

Reference site		WC14		**Date**	13-7-2021
Stream Order		Ephemeral creek			
Direction	E	**Width**	8	**Depth**	1
Vegetation type		Low to mid woodland of *Terminalia bursarina* and *T. platyptera* over *Heteropogon contortus* and *Chrysopogon fallax* grassland.			
Weeds		Stylosanthes sp., Sida spp., Hyptis			
Erosion potential		Moderate, established track running through creek line.			
Cattle Impact		None observed, signs of feral animals.			
Recommendations		Implement the erosion and sediment control plan to minimise impacts to the waterway.			
Land Condition		Good			

WGS 84
133.9727, -15.0801

APPENDIX D PROTECTED MATTERS SEARCH TOOL REPORT

Australian Government

Department of Agriculture, Water and the Environment

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.

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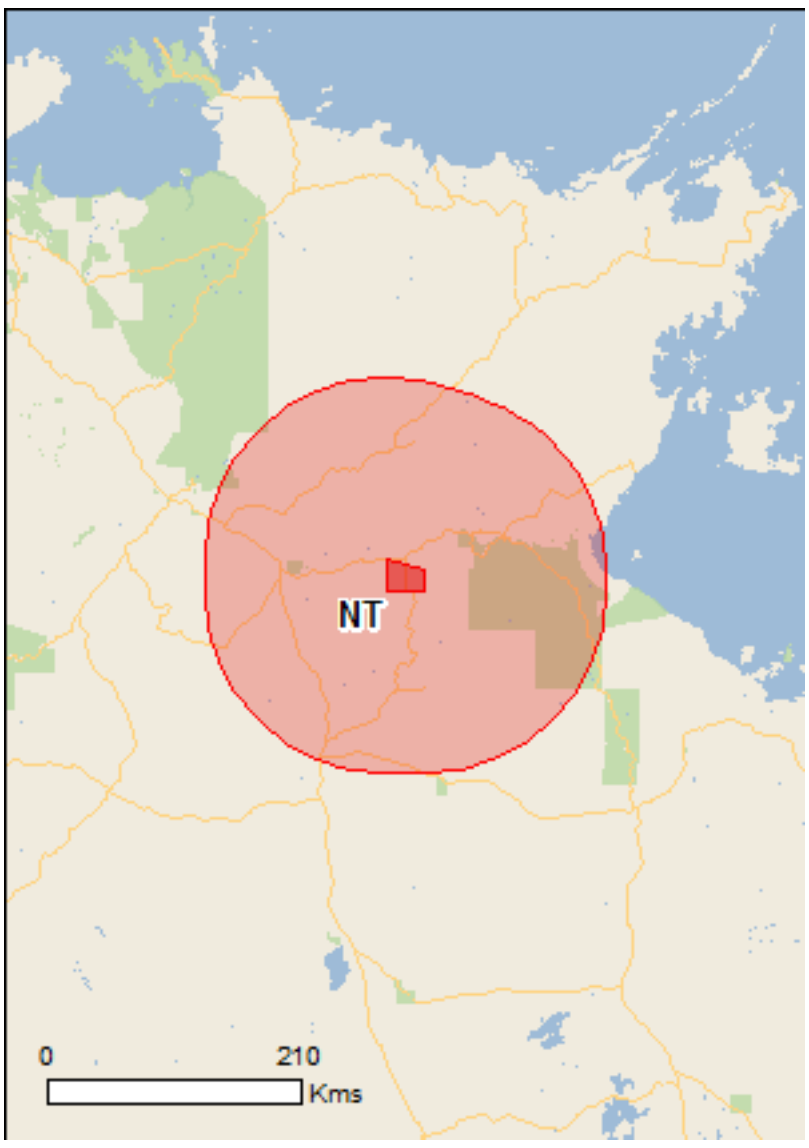

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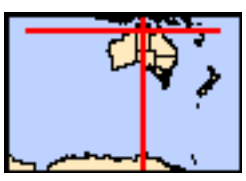

Summary

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:	1
National Heritage Places:	1
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	42
Listed Migratory Species:	50

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:	3
Commonwealth Heritage Places:	None
Listed Marine Species:	82
Whales and Other Cetaceans:	10
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
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:	7
Regional Forest Agreements:	None
Invasive Species:	27
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Kakadu National Park	NT	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Kakadu National Park	NT	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Kakadu national park	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North

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
Arnhem Plateau Sandstone Shrubland Complex	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Amytornis woodwardi		
White-throated Grasswren, Yirlinkirrkirr [564]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Species or species habitat likely to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat known to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Antechinus bellus Fawn Antechinus [344]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Hipposideros inornatus Arnhem Leaf-nosed Bat [86675]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Petrogale concinna canescens		
Nabarlek (Top End) [87606]	Endangered	Species or species habitat likely to occur within area
Phascogale pirata		
Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat likely to occur within area
Saccolaimus saccolaimus nudicluniatus		
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat known to occur within area
Trichosurus vulpecula arnhemensis		
Northern Brushtail Possum [83091]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides		
Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Acanthophis hawkei		
Plains Death Adder [83821]	Vulnerable	Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Elseya lavarackorum		
Gulf Snapping Turtle [67197]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Glyphis glyphis		
Speartooth Shark [82453]	Critically Endangered	Species or species habitat may occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may 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		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat likely to 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
Commonwealth Land -
Commonwealth Land - Kakadu National Park
Defence - TINDAL REMOTE RECEIVING SITE KING RIVER

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely 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 known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		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]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat likely to occur within area
Fish		
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Enhydrina schistosa](#) Beaked Seasnake [1126]		Species or species habitat may occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
[Hydrelaps darwiniensis](#) Black-ringed Seasnake [1100]		Species or species habitat may occur within area
[Hydrophis atriceps](#) Black-headed Seasnake [1101]		Species or species habitat may occur within area
[Hydrophis elegans](#) Elegant Seasnake [1104]		Species or species habitat may occur within area
[Hydrophis inornatus](#) Plain Seasnake [1107]		Species or species habitat may occur within area
[Hydrophis mcdowelli](#) null [25926]		Species or species habitat may occur within area
[Hydrophis ornatus](#) Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
[Hydrophis pacificus](#) Large-headed Seasnake, Pacific Seasnake [1112]		Species or species habitat may occur within area
[Lapemis hardwickii](#) Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
[Lepidochelys olivacea](#) Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Parahydrophis mertoni](#) Northern Mangrove Seasnake [1090]		Species or species habitat may occur within area
[Pelamis platurus](#) Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat may occur within area
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Species or species habitat may occur within area
[Delphinus delphis](#) Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Commonwealth ReservesTerrestrial		[Resource Information]
Name	State	Type
Kakadu	NT	National Park (Commonwealth)

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Bullwaddy	NT
Elsey	NT
Limmen	NT
Nitmiluk	NT
South-East Arnhem Land	NT
St Vidgeon	NT
Wongalara	NT

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		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Frogs		

Name	Status	Type of Presence
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		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
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Mimosa pigra Mimosa, Giant Mimosa, Giant Sensitive Plant,		Species or species

Name	Status	Type of Presence
ThornySensitive Plant, Black Mimosa, Catclaw Mimosa, Bashful Plant [11223] Parkinsonia aculeata		habitat likely to occur within area
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat may occur within area
Pennisetum polystachyon		
Mission Grass, Perennial Mission Grass, Missiongrass, Feathery Pennisetum, Feather Pennisetum, Thin Napier Grass, West Indian Pennisetum, Blue Buffel Grass [21194]		Species or species habitat likely to occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Vachellia nilotica		
Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Limmen Bight (Port Roper) Tidal Wetlands System	NT
Mataranka Thermal Pools	NT

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Gulf of Carpentaria coastal zone	North

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

-14.8941 133.8688,-15.1297 133.8688,-15.1297 134.1519,-14.9792 134.1519,-14.8941 133.8688

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.

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APPENDIX E THREATENED SPECIES 'LIKELIHOOD OF OCCURRENCE' ASSESSMENT

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
BIRDS				
Carpentarian Grasswren *Amytornis dorotheae*	EN	EN	**Habitat:** NT population is restricted to dissected, topographically complex, sandstone and conglomerate hills and plateaux with infrequent fires (Lewis & Woinarski 2006). The only recent observations were recorded in a site that had been burnt only twice in the preceding 12 years. All other historic sites with no recent observations had been burnt between three and eight times. **Distribution:** Gulf of Carpentaria hinterland – between Limmen River in the NT and Mount Isa in Qld. No records in the Borroloola area since 1986 despite several targeted surveys in the last decade (Martin & McKean 1986; Garnett et al. 2011). Within the NT, now restricted to a tiny isolated population approximately 6 km to the west of Calvert Hills Station in the Wollogorang area (TSSC 2016).	**NONE** • Suitable sandstone hills and plateaux habitat • No recent proximate records (despite area being well-surveyed) • Population considered locally extinct.
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. Lewis, M. and Woinarski, J. (2006). *Threatened Species of the Northern Territory - Carpentarian Grass-wren - Amytornis dorotheae*. Northern Territory Department of Environment and Natural Resources. https://nt.gov.au/__data/assets/pdf_file/0007/373543/carpentarian-grasswren.pdf [Accessed 1 May 2018]. Martin, K.C. and McKean, J.L. (1986). *A study of the distribution and status of the endangered carpentarian grasswren Amytornis dorotheae*. Report to the Conservation Commission of he Northern Territory, Palmerston, NT. Threatened Species Scientific Committee (2016). *Conservation Advice – Amytornis dorotheae – Carpentarian Grasswren.* Canberra: Department of the Environment. In effect under EP154BC Act from 05-May-2016. [online] Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/558-conservation-advice-05052016.pdf [Accessed 1 May 2018].			
White-throated Grasswren *Amytornis woodwardi*	VU	VU	**Habitat:** Confined to hummock grasslands, sometimes with open shrubland or woodland overstorey, mixed among dense boulder fields or sandstone pavements (Schodde 1982; Noske 1992) and escarpment drainage lines. **Distribution:** NT only – patchily distributed from Nitmiluk National Park to western Arnhem Land (Noske 1992).	**LOW** • Suitable sandstone hills and plateaux habitat • No proximate records
	Noske, R. (1992). The status and ecology of the white-throated grass-wren *Amytornis woodwardi*. *Emu*, Vol. 92, pp. 39-51. Schodde, R. (1982). *The fairy-wrens - A monograph of the Maluridae*. Landsdowne Editions, Melbourne.			
Red Knot *Calidris canutus*	EN	VU	**Habitat:** Roosts on sandy beaches, spits and islets, and mudflats; also in shallow saline ponds of saltworks (Rogers, 2001). **Distribution:** The north-west and south-east of Australia are the most important areas for this species	**NONE** • No suitable coastal habitat within EP.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			during the non-breeding season, but the Gulf of Carpentaria is an important staging area for birds migrating to the south-east and to New Zealand (Chatto, 2003).	
	Chatto, R. (2003). The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory. (Technical Report 73, Parks and Wildlife Commission of the Northern Territory, Darwin.) http://www.nt.gov.au/nreta/publications/wildlife/scien ce/pdf/2003_shorebirds_rpt76.pdf Rogers, D. (2001). Conservation and ecology of migratory shorebirds in Roebuck Bay, north-western Australia. Wetlands Unit, Environment Australia.				
Curlew Sandpiper *Calidris ferruginea*	CR	VU	**Habitat:** Mostly coasts and estuaries, less frequently inland freshwater wetlands (Geering et al. 2007). **Distribution:** A summer migrant from the northern hemisphere; some birds remain in Australia during the winter. Mostly widespread around the northern Australian coast, less common in the south, with few inland records (Garnett et al. 2011). Has declined due to habitat loss at migratory stop-over grounds along the flyway (Ward 2012).	**LOW** • No suitable habitat within EP. • One record from 2014 in the Roper River, 40 km northeast of the project footprint.
	Geering, A., Agnew, L. and Harding, S. (2007). *Shorebirds of Australia*. CSIRO Publishing, Collingwood, Australia. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing, Collingwood, Australia. Ward, S. (2012). *Threatened Species of the Northern Territory – Curlew Sandpiper - Calidris ferruginea*. Nor hern Territory Department of Environment and Natural Resources. https://nt.gov.au/__data/assets/word_doc/0009/373545/curlew-sandpiper.docx [Accessed 29 August 2018].			
Great Knot *Calidris tenuirostris*	CR	VU	**Habitat:** Coasts and estuaries with tidal mudflats – rarely away from coast. May roost during high tide on nearby beaches (Geering et al. 2007). **Distribution:** A summer migrant from the northern hemisphere; some birds remain in Australia during the winter. Mostly widespread around the northern Australian coast, less common in the south, with few inland records, centred around Alice Springs (Garnett et al. 2011).	**NONE** • No suitable coastal habitat within EP.
	Geering, A., Agnew, L. and Harding, S. (2007). *Shorebirds of Australia*. CSIRO Publishing, Collingwood, Australia. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing, Collingwood, Australia.			
Greater Sand Plover *Charadrius leschenaultii*	VU	VU	**Habitat:** Mostly coasts and estuaries with intertidal sand and mudflats – roosting on nearby beaches and rocky shores. Occasionally salt lakes, brackish swamps and shallow freshwater wetlands (DoE 2017). **Distribution:** A summer migrant from the northern hemisphere; some birds remain in Australia during the winter. Widespread around the Australian coast, less common in the south and inland. In the NT, recorded from most of the coastline (Garnett al. 2011).	**LOW** • No suitable coastal habitat within EP. • Three records from 1990 in the Limmen Bight River, 140 km southeast of the project footprint.
	Department of the Environment (2017). *Charadrius leschenaultii — Greater Sand Plover, Large Sand Plover*. Species Profile and Threats Database, Department of the Environment, Canberra. [online] Available at: http://www.environment.gov au/cgi-bin/sprat/public/publicspecies pl?taxon_id=877 [Accessed 1 May 2018]. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood,			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Australia.			
Red Goshawk *Erythrotriorchis radiatus*	VU	VU	**Habitat:** Prefers tall, open Eucalypt forest and riparian areas. Nests in large trees, frequently the tallest and most massive in a tall stand, nest trees are invariably within 1 km of permanent water (Debus & Czechura 1988; Aumann & Baker-Gabb 1991). Rarely breeds in areas with fragmented native vegetation (Aumann & Baker-Gabb 1991; Czechura 2001). Home range of up to 200 km^2 (Czechura & Hobson 2000). **Distribution:** Solitary and secretive hawk that is sparsely distributed across much of northern Australia, from the Kimberley in WA to south-eastern Qld. Within this range, generally confined to taller forests characteristic of higher rainfall coastal and sub-coastal areas (Debus 1998), but there are some isolated records of wandering birds from central Australia (Woinarski 2006).	**MEDIUM** • Preferred tall, open Eucalypt forest and riparian areas within EP • Numerous regional records in the last ten years • Proximate records 50 km northeast of the project footprint.
	Aumann, T. and Baker-Gabb, D. (1991). *A Management Plan for the Red Goshawk*. RAOU Report 75, Royal Australasian Ornithologists Union, Melbourne. Czechura G.V. and Hobson R.G. (2000). *The Red Goshawk* Erythrotriorchis radiatus *in northern Queensland: status and distribution*. Report to Queensland Parks and Wildlife Service. Czechura G.V. (2001). *The status and distribution of the Red Goshawk* Erythrotriorchis radiatus *on Cape York Peninsula, Queensland*. Unpublished report to Birds Australia. Debus, S. and Czechura, G. (1988). Field identification of the Red Goshawk *Erythrotriorchis radiatus*. *Australian Bird Watcher*, Vol. 12, pp. 154-159. Debus, S. (1998). *The Birds of Prey of Australia*. Oxford University Press, Melbourne. Woinarski, J. (2006). *Threatened Species of the Northern Territory - Red Goshawk - Erythrotriorchis radiatus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/206352/red-goshawk.pdf [Accessed 1 May 2018].		
Gouldian Finch *Erythrura gouldiae*	EN	VU	**Habitat:** Prefers areas with an adequate supply of seed from annual and perennial grasses (especially *Sorghum*), a nearby source of surface water and – in the breeding season – unburnt, hollow-bearing Eucalyptus trees (especially *E. tintinnans, E. brevifolia* and *E. leucophloia*) (Tidemann 1996; O'Malley 2006). **Distribution:** Patchily distributed across northern Australia from the Kimberley to north-central Qld (Dostine 1998; Franklin et al. 1999; Barrett et al. 2003; Franklin et al. 2005). In the NT, most known breeding populations occur in the North End. Non-breeding birds disperse widely (Garnett et al. 2011), greatly increasing the possible range of this species.	**HIGH** • Suitable *Eucalyptus leucophloia*, Sorghum species and surface water within EP. • Numerous recent records in the region and throughout the project footprint.
	Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). *The New Atlas of Australian Birds*. Royal Australian Ornithologists Union, Melbourne, Victoria. Dos ine, P. (1998). *Gouldian Finch Recovery Plan Erythrura gouldiae*. Gouldian Finch Recovery Team and Parks & Wildlife Commission NT, Darwin. Franklin, D.C., Burbidge, A.H. and Dostine, P.L. (1999). The harvest of wild birds for aviculture: an historical perspective on finch		

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	trapping in the Kimberley with special emphasis on the Gouldian Finch. *Australian Zoologist,* Vol. 31, pp. 92-109. Franklin, D.C., Whitehead, P.J., Pardon, G., Matthews, J., McMahon, P. and McIntyre, D. (2005). Geographic patterns and correlates of the decline of granivorous birds in northern Australia. *Wildlife Research*, Vol. 32, pp. 399-408. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010.* CSIRO Publishing. Collingwood, Australia. O'Malley, C. (2006). *National Recovery Plan for the Gouldian Finch (Erythrura gouldiae*). WWF-Australia, Sydney and Parks and Wildlife NT, Department of Natural Resources, Environment and the Arts, NT Government, Palmerston. Tidemann, S.C. (1996). Causes of the decline of the Gouldian Finch *Erythrura gouldiae*. *Biological Conservation International*, Vol. 6, pp. 49-61.			
Grey Falcon *Falco hypoleucos*	VU	VU	**Habitat:** A generally solitary desert falcon that occurs in areas of lightly-timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm (Ward 2012). **Distribution:** Sparsely distributed through much of the arid and semi-arid regions of Australia but has been recorded from all mainland states and territories. In the NT, the majority of records are from the southern half, but there are records all the way up to Darwin (Ward 2012). A study of breeding records from 2003 to 2011 documented 38 breeding events – all within the hottest climate classes of Australia – with the northern-most record occurring south of Daly Waters (Schoenjahn 2013).	**LOW** • Suitable habitat available (foraging). EP is too far north to be suitable for breeding. • Scattered regional records to the west and south of the project footprint more than 40 years ago.
	Schoenjahn, J. (2013), A hot environment and one type of prey: investiga ing why the Grey Falcon (Falco hypoleucos) is Australia's rarest falcon, *Emu*, Vol. 113, pp. 19-25. Ward, S. (2012). *Threatened Species of the Northern Territory - Grey Falcon - Falco hypoleucos*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/ data/assets/pdf_file/0020/206354/grey-falcon.pdf [Accessed 1 May 2018].			
Crested Shrike-tit (northern subspecies) *Falcunculus frontatus whitei*	VU	-	**Habitat:** Recorded in eight different woodland types in northern Australia, mainly those dominated by *Eucalyptus miniata, E. tetrodonta* or *E. bleeseri* (Robinson & Woinarski 1992). Nests have been found in the canopy of *E. tectifica, C. grandifolia* and *C. latifolia* at >12 m above the ground in open woodland habitat (Ward et al. 2009). **Distribution:** North-western Australia from the Kimberley in WA, across the North End of the NT to Borroloola (TSSC 2016). In the NT, recorded in very low densities in many isolated sub-populations (Garnett & Crowley 2000) between north-east Arnhem Land and semi-arid Victoria River District. Scarcity of records suggests that populations are at very low density (Woinarski 2004). Not known to have disappeared from any area where recorded historically (TSSC 2016).	**LOW** • Suitable *Eucalyptus* and *Corymbia* open woodland nesting and foraging habitat. • Last records from 2009, more than 80 km east of the project footprint, in the Sturt Plateau bioregion.
	Garnett, S.T. and Crowley, G.M. (2000). *The Action Plan for Australian Birds 2000*. Environment Australia and Birds Australia, Canberra, ACT. Robinson, D. and Woinarski, J.C.Z. (1992). 'A review of records of the Nor hern Shrike-tit *Falcunculus frontatus whitei* in north-western Australia'. *South Australian Ornithologist*, Vol. 31, pp. 111-117.			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Threatened Species Scientific Committee (2016). *Approved Conservation Advice for Falcunculus frontatus whitei - crested shrike-tit (northern)*. Canberra: Department of the Environment. In effect under EP154BC Act from 02-May-2016. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26013-conservation-advice-05052016.pdf [Accessed 1 May 2018]. Ward, S.J., Berghout, M. & Baker, B. (2009). Notes on the form and habitat of nests of the Northern Shrike-tit. *Northern Territory Naturalist,* Vol. 21, pp. 54-60. Woinarski, J.C.Z. (2004). *National multi-species Recovery Plan for the Partridge Pigeon [eastern subspecies] Geophaps smithii smithii; crested shrike-tit [northern (sub)-species] Falcunculus (frontatus) whitei; masked owl [north Australian mainland subspecies] Tyto novaehollandiae kimberli; and masked owl [Tiwi Islands subspecies] Tyto novaehollandiae melvillensis, 2004-2008*. NT Department of Infrastructure Planning and Environment, Darwin.			
Partridge Pigeon *Geophaps smithii*	VU	VU	**Habitat:** Open forests and woodlands with an understorey of grasses (Woinarski 2006). Prefers woodland dominated by *Eucalyptus tetrodonta* and *E. miniata* (Braithwaite 1985; Garnett et al. 2011; Higgins & Davies 1996). According to Fraser (2001), favour a structurally-patchy savanna understorey at a relatively intricate scale. In all seasons, prefer to feed in areas that have an open ground layer (e.g. following fire); however, more likely to nest where there is dense vegetation cover. Require the seeds of certain perennial grasses and sedges that are available early in the wet season when seed is otherwise scarce, particular the perennial grass species *Alloteropsis semialata* and *Chrysopogon*. The presence of these grasses may be crucial for survival at this time (Fraser 2001). Largely sedentary; however, can travel distances of 5 to 10 km in the wet season on search of food and water resources (Fraser 2001). Home ranges vary seasonally between 8 – 31 hectares Fraser (2001). **Distribution:** Historically, across the North End (from Kununurra in WA to Borroloola in the NT). Since early 20th century a severe range contraction from the western, eastern and southern parts of the former distribution (Higgins & Davies 1996; Woinarski et al. 2007). Currently, distribution is limited to sub-coastal NT from Yinberrie Hill in the south, Litchfield NP in the west and (western) Arnhem Land in the east (Garnett et al. 2011).	**LOW** • Suitable *Eucalyptus* woodland habitat. • Last records more than 40 years ago in the Roper River catchment, more than 50 km away from the project footprint.
	Braithwaite, R.W. (1985). *The Kakadu fauna survey: an ecological survey of Kakadu National Park*. Australian National Parks & Wildlife Service, Canberra. Fraser, F. (2000). Species profile: Partridge Pigeon Geophaps smithii. *Northern Territory Naturalist* 16, 38-39. Fraser, F., Lawson V., Morrison S., Christophersen P., McGregor S. and Rawlinson M. (2003). Fire management experiment for the declining partridge pigeon, Kakadu National Park. *Ecological Management and Restoration* 4, 94–102. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. Birds Australia, CSIRO Publishing, Melbourne. Higgins, P.J. and Davies S.J.J.F. (eds) (1996). *Handbook of Australian, New Zealand and Antarctic Birds. Volume Three: Snipe to Pigeons*. Oxford University Press. Melbourne, Victoria. Woinarski, J.C.Z. (2006). *Threatened Species of the Northern Territory - Partridge Pigeon (eastern subspecies) - Geophaps smithii*. Northern Territory Department of Environment and Natural Resources. [online] Available at:			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	https://nt.gov.au/__data/assets/pdf_file/0003/206355/partridge-pigeon.pdf [Accessed 1 May 2018]. Woinarski, J., Pavey, C., Kerrigan, R., Cowie, I. and Ward, S. (Eds) (2007). *Lost from Our Landscape: Threatened Species of the Northern Territory*. Northern Territory Government, Darwin			
Painted Honeyeater *Grantiella picta*	VU	VU	**Habitat:** *Acacia* and *Eucalyptus*-dominated woodlands and open forest, preferring habitats with more mature trees that host more mistletoe. Breeding times and seasonal movements (south to north) likely governed by the fruiting of mistletoe (Garnett et al. 2011). **Distribution:** Across eastern and northern parts of the country – but nowhere very numerous (Ward 2012). Many birds move after breeding to semi-arid regions such as north-eastern SA, central and western Qld, and central NT (TSSC 2015). Few NT records – most from the Barkly Tablelands – but no evidence of a breeding population in the NT, and the records are likely irregular visitors from south-eastern Australia (Ward 2012).	**LOW** • Suitable habitat available. • Irregular visitor to NT. • Most recent record from 2005 in Limmen National Park, 170 km away from the project footprint.
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing, Collingwood, Australia. Threatened Species Scientific Committee (TSSC) (2015). *Approved Conservation Advice for Grantiella picta (Painted Honeyeater)*. Canberra: Department of the Environment. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conserva ion-advice.pdf [Accessed 1 May 2018]. Ward, S. (2012). *Threatened Species of the Northern Territory – Painted Honeyeater - Grantiella picta*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0009/373554/painted-honeyeater.pdf [Accessed 1 May 2018].			
Bar-tailed Godwit (Western Alaskan subspecies) *Limosa lapponica baueri* **Bar-tailed Godwit (northern Siberian subspecies)** *Limosa lapponica menzbieri*	VU CR	VU VU	**Note:** Wilson et al. (2007) have shown that the two main Australian non-breeding regions belong to separate populations. Subspecies *menzbieri* is generally present in north-western Australia and breed in north-eastern Russia, and subspecies *baueri* is generally present in south-eastern Australia and breed in northern and western Alaska (Wilson et al. 2007). It is thought that both subspecies probably migrate to the NT. Due to the difficulties of distinguishing between the two, they are treated within the NT as *Limosa lapponica* and listed collectively as Vulnerable (Ward 2012). **Habitat:** Intertidal sand flats and mudflats. Also salt lakes and brackish wetlands near coasts, but rarely further inland (Geering et al. 2007). Roosts on sandy ocean beaches, rock platforms, and coral reef-flats (Marchant & Higgins 1993). **Distribution:** Widespread around the Australian coast. In the NT, reported all along the coastline; one of the more frequently recorded and abundant species in shorebird	**LOW** • No suitable coastal habitat within EP. • One record from 2014 in the Roper River, 75 km northeast of the project footprint.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			surveys by Chatto (2003).	
	Chatto, R. (2003). *The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory*. Technical Report 73, Parks and Wildlife Commission of the Northern Territory, Darwin. https://dtc.nt.gov.au/__data/assets/pdf_file/0008/279917/2003_shorebirds_rpt76.pdf [Accessed 1 May 2018]. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. Geering, A., Agnew, L. and Harding, S. (2007). *Shorebirds of Australia*. CSIRO Publishing, Collingwood, Australia. Marchant, S. and Higgins, P. (eds.) (1993). *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 2 - Raptors to Lapwings*. Oxford University Press, Melbourne, Victoria Wilson, J.R., Nebel, S. and Minton, C.D.T. (2007). Migration ecology and morphometrics of two Bar-tailed Godwit populations in Australia. *Emu*, Vol. 107, pp. 262–274. Ward, S. (2012). *Threatened Species of the Northern Territory –Bar-tailed Godwit – Limosa lapponica*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0008/373544/bar-tailed-godwit.pdf [Accessed 1 May 2018].			
Purple-crowned Fairy Wren (western subspecies) *Malurus coronatus coronatus*	EN	VU	**Habitat:** Riparian areas along the Victoria River, usually associated with areas of dense river grass – *Chionachne cyathopoda* (Rowley 1993; van Doorn & Low Choy 2009). Also known from *Pandanus aquaticus* habitat (van Doorn & Low Choy 2009). Generally confined to riparian habitats. **Distribution:** Occurs from the central Kimberly in WA to Victoria River in the NT. Within this range, almost entirely restricted to a narrow band around well-defined river channels. The extinction of the Ord River population in WA has isolated the Victoria River system populations from those in the Kimberley by 250 km, a distance which the subspecies would be unable to traverse (Skroblin et al. 2014).	**NONE** • EP located outside the species expected distribution.
	Rowley, I. (1993). The Purple-crowned Fairy-wren *Malurus coronatus*. I History, distribution and present status. *Emu,* Vol. 93, pp. 220-234. Skroblin, A., Cockburn, A. and Legge, S. (2014). The population genetics of the purple-crowned fairy-wren (*Malurus coronatus coronatus*), a declining riparian passerine. *Australian Journal of Zoology,* Vol. 62, pp. 251-259. van Doorn, A. and Low Choy, J. (2009). A description of the primary habitat of the Purple-crowned Fairy-wren *Malurus coronatus coronatus* in the Victoria River District, N.T. *Northern Territory Naturalist,* Vol. 21, pp. 24-33.			
Eastern Curlew *Numenius madagascariensis*	CR	VU	**Habitat:** Inter-tidal mudflats, salt lakes and brackish wetlands near coasts (Geering et al. 2007). May roost during high tide on nearby beaches. **Distribution:** A summer migrant from the northern hemisphere; some birds remain in Australia during the winter. Widespread in small numbers around the Australian coast (Garnett et al. 2011). Chatto (2003) considered the more important areas in the NT to be along the coast either side of Darwin, the Millingimbi to Buckingham Bay area, the Roper and Limmen Bight River mouths, and the Port McArthur area.	**NONE** • No suitable habitat within EP.
	Chatto, R. (2003). *The distribution and status of shorebirds around the coast and coastal wetlands of the Northern Territory*. Technical Report 73, Parks and Wildlife Commission of the Northern Territory, Darwin. [online] Available at: https://dtc.nt.gov.au/__data/assets/pdf_file/0008/279917/2003_shorebirds_rpt76.pdf [Accessed 1 May 2018].			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. Geering, A., Agnew, L. and Harding, S. (2007). *Shorebirds of Australia*. CSIRO Publishing, Collingwood, Australia.			
Australian Painted Snipe *Rostratula (benghalensis) australis*	EN	VU	**Habitat:** Fringes of permanent and temporary wetlands, swamps and inundated grasslands (Taylor et al. 2013). **Distribution:** Nomadic and scattered across Australia with no predictable occurrence (Rogers 2001), but could occur at any wetland or inundated grassland across its distribution, including nearly all of the NT and Qld (Garnett et al. 2011).	**LOW** • Only occurs as vagrant in the NT. • Last record from 2001, 78 km southwest of the project footprint.
	Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Collingwood, Australia. Rogers, D. (2001). Painted Snipe. *Wingspan*, Vol. 11 (No. 4), pp. 6-7. Taylor, R., Chatto, R. and Woinarski, J.C.Z. (2013). *Threatened Species of the Northern Territory - Australian pained snipe - Rostratula australis*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/206361/australian-painted-snipe.pdf [Accessed 1 May 2018].			
Masked Owl (northern subspecies) *Tyto novaehollandiae kimberli*	VU	VU	**Habitat:** Mainly in *Eucalyptus* tall open forests (especially those dominated by *Eucalyptus miniata* and *E. tetrodonta*), but also roosts in monsoon rainforests and forages in more open vegetation types, including grasslands (Woinarski & Ward 2012). Usually nests in tree hollows, within patches of closed forest (Garnett et al. 2011). Little else known about the subspecies, but the species in general is resident in pairs within a territory up to 3,000 hectares (Debus 2009). Nest in large hollows with an entrance more than 20 cm wide and that is greater than 10 m above the ground (Debus 2009). Breeding poorly known, but thought to occur between March and October (DEWHA 2010). **Distribution:** Poorly known, with few records from across a broad range in northern Australia. In the NT, records from the North End, Kakadu, Coburg Peninsula (majority of records) and south-west Gulf country (Woinarski & Ward 2012).	**LOW** • Potentially-suitable *Eucalyptus* habitat. • No recent regional records.
	Debus, S.J.S. (1993). The mainland masked owl Tyoto novaehollandiae: a review. *Australian Bird Watcher*. Vol. 15. Pp. 168-191. Department of the Environment, Water, Heritage and the Arts (DEWHA) (2010l). *Survey Guidelines for Australia's Threatened Birds. EPBC Act survey guidelines 6.2*. Canberra, ACT: DEWHA. Available from: http://www.environment.gov.au/epbc/publications/threatened-birds.html. Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). The Action Plan for Australian Birds 2010. CSIRO Publishing. Collingwood, Australia. Woinarski, J.C.Z. and Ward, S. (2012). *Threatened Species of the Northern Territory - Masked Owl (north Australian mainland subspecies) - Tyto novaehollandiae kimberli*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/word_doc/0008/373553/masked-owl-mainland-top-end.docx [Accessed 1 May 2018].			
MAMMALS (TERRESTRIAL)				
Fawn Antechinus	VU	EN	**Habitat:** Mostly in open forests and woodlands dominated by	**NONE** • Suitable habitat within EP154.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
Antechinus bellus			*Eucalyptus miniata* and/or *E. tetrodonta*, particularly where these forests have a relatively dense shrubby understorey (Friend 1985; Friend & Taylor 1985). Declines in areas with frequent intense fires (Corbett et al. 2003) but not necessarily common in areas where fire has been excluded for long periods (>20 years; Woinarski et al. 2004). Breeding occurs mid-June to late August, after which a synchronous male die-off occurs (TSSC 2015). **Distribution:** Restricted to the North End of the NT (Watson & Calaby 2008), with one record from Melville Island. Recent surveys have failed to record it across central and eastern Arnhem Land (TSSC 2015).	• No recent proximate records.
	Corbett L. K., Andersen, A.N. and Muller, W.J. (2003). Terrestrial vertebrates. In: Andersen, A.N., Cook, G.D. and Williams, R.J. (eds.). *Fire in Tropical Savannas: The Kapalga Experiment*. Springer-Verlag, New York: pp. 126–152. Friend, G.R. and Taylor, J.A. (1985). Habitat preferences of small mammals in tropical open-forest of the Northern Territory. *Australian Journal of Ecology,* Vol. 10, pp. 173-185. Friend, G.R. (1985). Ecological studies of a population of *Antechinus bellus* (Marsupalia: Dasyuridae) in tropical Australia. *Australian Wildlife Research*, Vol. 12 (No. 2), pp. 151-162. Threatened Species Scientific Committee (2015). *Approved Conservation Advice for Antechinus bellus – Fawn Antechinus*. Canberra: Department of the Environment. In effect under EP154BC Act from 03-Dec-2015. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/344-conservation-advice-2015123.pdf [Accessed 1 May 2018]. Watson, M.L. and Calaby, J.H. (2008). Fawn Antechinus: *Antechinus bellus*. In: Van Dyck, S. and Strahan, R. (eds.). *The Mammals of Australia: 3rd Edition*. Reed New Holland, Sydney. Woinarski, J.C.Z., Risler, J. and Kean, L. (2004). The response of vegetation and vertebrate fauna to 23 years of fire exclusion in a tropical Eucalyptus open forest, Northern Territory, Australia. *Austral Ecology,* Vol. 29, pp. 156–176.			
Brush-tailed Rabbit-rat *Conilurus penicillatus*	VU	EN	**Habitat:** Largely restricted to mixed *Eucalypt* open forest and woodland, or on dunes with *Casuarina* – seeming to prefer habitats that are not burnt annually, that have an understorey of predominantly perennial grasses and a sparse-to-moderate middle storey (Firth et al. 2006; Firth 2007; Kemper & Firth 2008). **Distribution:** Formerly widespread across northern Australia, but has declined extensively from Qld and lower rainfall areas of the Kimberley in WA and the North End in the NT. No recent records from much of the historically-recorded NT range between near the mouth of Victoria River (in the west) and Sir Edward Pellew island group (in east). Most recently known from Cobourg Peninsula, Tiwi Islands, Groote Eylandt and a small area within Kakadu National Park (Woinarski & Hill 2012).	**LOW** • Suitable habitat available • No proximate records in the last 50 years. • Species has undergone significant range decline. Likely that species is extinct from applicable bioregions.
	Firth, R.S.C. (2007). *Ecology and conservation status of the brush-tailed rabbit-rat Conilurus penicillatus*. PhD thesis, Charles Darwin University, Darwin, Northern Territory. Firth, R.S.C., Woinarski, J.C.Z. and Noske, R.A. (2006). Home range and den characteristics of the brush-tailed rabbit-rat *Conilurus penicillatus* in the monsoonal tropics of the Northern Territory, Australia. *Wildlife Research*, Vol. 33, pp. 397-408.			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Kemper, C M. and Firth, R.S.C. (2008). Brush-tailed Rabbit-rat. In: Van Dyck, S. and Strahan, R. (eds). *The Mammals of Australia*. Reed New Holland, Chatswood, NSW. Woinarski, J.C.Z. and Hill, B. (2012). *Threatened Species of the Northern Territory - Brush-tailed rabbit-rat, Brush-tailed tree-rat - Conilurus penicillatus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0016/205504/brush-tailed-rabbit-rat.pdf [Accessed 1 May 2018].			
Northern Quoll *Dasyurus hallucatus*	EN	CR	**Habitat:** Wide range of habitats, but since the arrival of Cane Toads generally restricted to the most suitable habitats which are rocky upland areas with numerous crevices and rock piles (Van Dam et al. 2002). Prime habitat in the NT consists of rocky sandstone escarpments and outliers (Braithwaite & Griffiths 1994). Home range varies from 35 to 100 ha (Oakwood 2002). Breeding occurs in May and June, with male die-off occurring shortly afterwards (Oakwood 2000). **Distribution**: Historically occurred in the NT from Borroloola in the south-east as far west as the NT/WA border (Woinarski et al. 2007), and extends into the Kimberley and Pilbara regions of WA. Dramatic range contraction and population crash associated with Cane Toad invasion. Now occurs across northern Australia in five regional populations – including the North End in the NT.	**LOW** • Some suitable refugia available. • Available records are undated and more than 75 km away from the project footprint. • Cane Toads known to be well established in area.
	Braithwaite, R.W. and Griffiths, A.D. (1994). Demographic variation and range contraction in the Northern Quoll, *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Wildlife Research*, Vol. 21, pp. 203-218. Oakwood, M. (2000). Reproduction and demography of the northern quoll, *Dasyurus hallucatus*, in the lowland savanna of northern Australia. *Australian Journal of Zoology*. 48:519-539. Oakwood, M. (2002). Spatial and social organization of a carnivorous marsupial, *Dasyurus hallucatus*. *Journal of Zoology*, London. 257:237-248. Van Dam, R.A., Walden, D.J. and Begg, G.W. (2002). *A preliminary risk assessment of cane toads in Kakadu National Park*. Supervising Scientist Report 164, Darwin, Northern Territory. Woinarski, J.C.Z., Rankmore, B.R., Fisher, A. and Milne, D. (2007). *The natural occurrence of northern quolls Dasyurus hallucatus on islands of the Northern Territory: assessment of refuges from the threat posed by cane toads Bufo marinus*. Report to Natural Heritage Trust.			
Western Quoll *Dasyurus geoffroii*	VU	EX	**Habitat:** In central Australia, occurred throughout a range of habitats (Pavey 2006). **Distribution:** Historically occurred throughout the arid interior of Australia including southern NT (), now restricted to the south-west of WA (Pavey 2006). Considered extinct in the NT since the 1960's.	**NONE** • Presumed extinct in the NT.
	Pavey, C. (2006). *Threatened Species of the Northern Territory - Western Quoll, Chuditch - Dasyurus geoffroii*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/205470/western-quoll.pdf [Accessed 1 May 2018].			
Arnhem Leaf-nosed Bat *Hipposideros inornatus*	EN	VU	**Habitat:** Caves or abandoned mine sites in cool draughty areas, close to water (Churchill 1998; Corbett & Richards 2002). Reported as foraging in riparian areas and in *Eucalypt* tall open forests (Woinarski & Milne 2015). **Distribution:** Restricted to the NT	**NONE** • Restricted range. Not recorded within the bioregion.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			and only known to occur on the western Arnhem Land sandstone massif (Deaf Adder Gorge and upper South Alligator River area) and from one site – Tolmer Falls – in Litchfield National Park (McKean & Hertog 1979) where population appears to be disappearing (Woinarski & Milne 2015).	
	Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney. Corbett, L. and Richards, G. (2002). *Bat survey: Gunlom land trust area*. Report to Parks Australia North, EWL Sciences, Darwin. McKean, J.L. and Hertog, A.L. (1979). Extension of range in the horseshoe bat. *Northern Territory Naturalist,* Vol. 1, p. 5. Woinarski, D. and Milne, D. (2015). *Threatened Species of the Northern Territory – Arnhem Leaf-nosed Bat – Hipposideros inornata*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/205524/arnhem-leaf-nosed-bat.pdf			
Golden Bandicoot *Isoodon auratus*	VU	EN	**Habitat:** Mainly in heathland and shrubland on sandstone sheets, avoiding vegetation with greater tree cover (Palmer et al. 2012; Southgate et al. 1996). **Distribution:** Formerly across most of northern, central and western Australia (across a broad range of habitats), but now only recorded population on mainland Australia is within the Kimberley. In the NT, confined to the offshore islands of Arnhem Land. The only records from mainland NT are from the north-east corner of Arnhem Land between 1950 and 1980 (Palmer et al. 2012). Now extinct on the mainland except in a few locations in the north-west Kimberley (TSSC 2015).	**NONE** • Now restricted to the north-west Kimberley and the offshore islands of Arnhem Land
	Palmer, C., Woinarski, J. and Hill, B. (2012). *Threatened Species of the Northern Territory - Golden Bandicoot - Isoodon auratus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0017/205505/golden-bandicoot.pdf [Accessed 1 May 2018]. Sou hgate, R., Palmer, C., Adams, C., Masters, M., Triggs, B. and Woinarski, J. (1996). Population and habitat characteristics of the Golden Bandicoot (*Isoodon auratus*) on Marchinbar Island, Northern Territory. *Wildlife Research*, Vol. 23, pp. 647-664. Threatened Species Scientific Committee (TSSC) (2015). *Approved Conservation Advice for Isoodon auratus auratus (golden bandicoot (mainland))*. Canberra: Department of the Environment. [online] Available at:http://www.environment.gov.au/biodiversity/threatened/species/pubs/66665-conservation-advice-01102015.pdf [Accessed 1 May 2018].			
Ghost Bat *Macroderma gigas*	VU	-	**Habitat:** Ranging from the arid Pilbara of WA to tropical savanna woodlands and north Qld. rainforests (TSSC 2016). Permanent roost sites are generally deep natural caves or disused mines (TSSC 2016). Move between a number of caves seasonally or as dictated by weather conditions, and require a range of cave sites (Hutson et al. 2001). Most breeding sites are caves with multiple entrances (TSSC 2016). **Distribution:** Geographically-disjunct colonies occur in the Pilbara and Kimberley in WA, NT north of approximately 17° latitude (including Elcho Island and Groote Eylandt), the Gulf of Carpentaria, eastern Qld from Cape York to near	**MEDIUM** • Suitable foraging habitat and possibly-suitable roosting habitat available. • A few records in the region from 1987. • Closest record around 4 km from the project footprint. • Closest known maternity site is at Pungalina-Seven Emu (an Australian Wildlife Conservancy property) – approximately 360 km to the south-east.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			Rockhampton, and western Qld (including Riversleigh and Camooweal districts) (TSSC 2016). Distribution likely influenced by the availability of suitable caves and mines for roost sites (Ward & Milne 2016). Only 14 breeding sites known (Worthington Wilmer 2012). Disperse widely when not breeding (TSSC 2016). In arid Australia, including southern NT until the early 1960's (Ward & Milne 2016).	
	Hutson, A. M., Mickleburgh, S. P. & Racey, P. A. (2001) Microchiropteran Bats - Global Status Survey and Conservation Action Plan. IUCN/SSC Chiroptera Specialist Group, Gland, Switzerland and Cambridge, U.K. Milne, D. and Ward, S. (2016). *Threatened Species of the Northern Territory – Ghost Bat - Macroderma gigas*. Northern Territory Department of Environment and Natural Resource. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0010/376138/ghost-bat.pdf [Accessed 1 May 2018]. Threatened Species Scientific Committee (2016). *Approved Conservation Advice for Macroderma gigas (ghost bat)*. Canberra: Department of the Environment. Available at:http://www.environment.gov.au/biodiversity/threatened/species/pubs/174-conservation-advice-05052016.pdf [Accessed 1 May 2018]. Worthington Wilmer, J. (2012). Ghost Bat *Macroderma gigas*. In: Curtis et al. (eds.). *Queensland's Threatened Animals*. CSIRO, Canberra: pp. 382-383.			
Greater Bilby *Macrotis lagotis*	VU	VU	**Habitat:** In the NT, occurs in hummock grasslands on sandy soils with a preference for palaeo-drainage lines (Southgate 1990). Has large foraging area and will move home range in search for food (Johnson 2008). **Distribution**: Historically widespread in arid Australia. Currently confined to arid WA, the Tanami Desert in the NT and south-western Qld (Woinarski et al. 2014).	**LOW** • Outside of expected distribution • No recent proximate records – considered locally extinct.
	Johnson, K.A. (2008). Bilby *Macrotis lagotis*. In: Van Dyck, S. and Strahan, R. (eds.). *Mammals of Australia*. Third Edition. Reed New Holland, Queensland Government, Queensland Museum: pp. 191-193. Sou hgate, R. (1990). Habitat and diet of the greater bilby *Macrotis lagotis* Reid (Marsupalia: Peramelidae). In: Seebeck et al. (eds.). *Bandicoots and Bilbies*. Surrey Beatty & Sons, Sydney, NSW. Woinarski, J., Burbidge, A. and Harrison, P. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing: pp. 203-205.			
Black-footed Tree-rat (Kimberley and mainland Northern Territory) *Mesembriomys gouldii gouldii*	EN	VU	**Habitat:** Woodlands and open forests with large trees and a moderately diverse mid-storey in near-coastal areas. Generally, require fruit and seed resources including *Pandanus* fruits, and fruiting trees and shrubs (Rankmore 2006). Shelters in tree hollows and occasionally *Pandanus* (Hill 2012). Thought to be more prevalent in woodlands with infrequent and low intensity fires (Price et al. 2005). **Distribution:** North End of NT, Kimberley region of WA and Cape York Peninsula south to Townsville in Qld. (Hill 2012). Has remained relatively abundant in the Darwin rural area and there are some recent records from Gunn Point (Price et al. 2005), the Lee Point Area and Middle Arm.	**NONE** • Not recorded within the bioregion.
	Hill, B. (2012). *Threatened Species of the Northern Territory- Black-footed Tree-rat - Mesembriomys gouldii*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0018/205515/black-footet-tree-rat.pdf			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Price, O., Rankmore, B., Milne, D J., Brock, C., Tynan, C., Kean, L. and Roger, L. (2005). Regional patterns of mammal abundance and their relationships to landscape variables in eucalypt woodlands near Darwin, northern Australia. *Wildlife Research*, Vol. 32, pp. 435-446. Rankmore, B.R. 2006. *Impacts of Habitat Fragmentation on the Vertebrate Fauna of the Tropical Savannas of Northern Australia; with Special Reference to Medium-sized Mammals*. PhD Thesis, Charles Darwin University, Darwin.			
Golden-backed Tree-rat *Mesembriomys macrurus*	-	CR	**Habitat:** In the NT, little known of the ecology apart that all three records were from riverine vegetation. In the Kimberley, known to occur in open Eucalypt forests with tussock grass understorey, rainforest patches, sandstone screes, beaches, and black soil plains (Woinarski et al. 2012). **Distribution:** Historically, known to have occurred in three localities in the NT (Parker 1973) with no new records in the last 30 years. In 1993, reportedly spotted in Kakadu National Park; however, further surveys of suitable habitats in the NT failed to locate the species (Lee 1995). Now only known to occur in some areas of the north-western Kimberley and associated offshore islands (Palmer et al. 2003).	**NONE** • Presumed extinct in the NT.
	Lee, A.K. (1995). *The Action Plan for Australian Rodents*. Australian Nature Conservation Agency, Endangered Species Program, Canberra. Palmer, C., Taylor, R. and Burbidge, A. (2003). *Recovery plan for the Golden Bandicoot Isoodon auratus and golden-backed tree-rat Mesembriomys macrurus 2004-2009*. Northern Territory Department of Infrastructure Planning and Environment, Darwin. Parker, S.A. (1973). An annotated checklist of the native land mammals of the Northern Territory. *Records of the South Australian Museum*, Vol. 16, pp. 1-57. Woinarski, J.C.Z., Palmer, C. and Hill, B. (2012). *Threatened Species of the Northern Territory - Golden-backed tree-rat - Mesembriomys macrurus*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0006/205476/golden-backed-tree-rat.pdf [Accessed 1 May 2018].			
Nabarlek (North End subspecies) *Petrogale concinna canescens*	CR	EN	**Habitat:** Isolated and rocky areas consisting of both sandstone and granite escarpments (Churchill 1997; Telfer et al. 2008). Shelters in caves and crevices during the day (Churchill 1997) and may move from these to forage in adjacent flat areas (Sanson et al. 1985). **Distribution:** Restricted to the North End of the NT in scattered populations from sandstone cliffs bordering the Arafura Swamp (Arnhem Land) in the east, to the Daly River catchment in the west (Ward & Woinarski 2012).	**NONE** • Not recorded within the bioregion.
	Churchill, S. (1997). Habitat use, distribution and conservation status of the Nabarlek, *Petrogale concinna*, and sympatric rock-dwelling mammals, in the Northern Territory. *Australian Mammalogy*, Vol. 19, pp. 297-308. Sanson, G.D., Nelson, J. and Fell, P. (1985). Ecology of *Peradorcas concinna* in Arnhem Land in a wet and a dry season. *Proceedings of the Ecological Society of Australia*, Vol. 13, pp. 65-72. Telfer, W.R., Griffiths, A.D. and Bowman, D.M.J.S. (2008). The habitat requirements of four sympatric rock-dwelling macropods of the Australian monsoon tropics. *Austral Ecology*, Vol. 33, pp. 1033-1044. Ward, S. and Woinarski, J. (2012). *Threatened Species of the Northern Territory - Nabarlek - Petrogale concinna*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0017/205523/nabarlek.pdf			
Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus*	VU	-	**Habitat:** In the NT, specimens have been collected from *Pandanus* woodland fringing the sedgelands of the South Alligator River and Eucalypt tall open forests (Friend &	**LOW** • Suitable habitat may occur in the form of hollow-bearing *Eucalyptus* trees. • No records in the region (despite recent surveys)

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
(nudicluniatus)			Braithwaite 1986; Churchill 1998) with more recent records from Howard Springs (Milne et al 2009). Most records occur within near-coastal habitats with one recent exception (Jasper Gorge) 150 km inland (Woinarski et al. 2014). **Distribution:** Widely distributed from India through south-east Asia to the Solomon Islands including north-eastern Qld and the NT. The north-eastern Australian population is described as the subspecies *S. s. nudicluniatus*, although it is not clear whether this should be applied to NT populations (Milne & Woinarski 2006).	• Most of EP154 is a significant distance from the coast.
	Churchill, S. (1998). *Australian Bats*. Reed New Holland, Sydney. Friend, G.R. and Braithwaite, R.W. (1986). Bat fauna of Kakadu National Park, Northern Territory. *Australian Mammalogy*, Vol. 9, pp. 43-52. Milne, D.J., Jackling, F.C., Sidhu, M., and Appleton, B.R. (2009). Shedding new light on old species iden ifications: morphological and genetic evidence suggest a need for conservation status review of the critically endangered bat, Saccolaimus saccolaimus. Wildlife Research36: 496–508. Milne, D. and Woinarski, J. (2006). *Threatened Species of the Northern Territory - Bare-rumped Sheathtail Bat - Saccolaimus saccolaimus*. Northern Territory Department of Environment and Natural Resources. https://nt.gov.au/__data/assets/pdf_file/0007/376117/bare-rumped-sheathtail-bat.pdf [Accessed 1 May 2018]. Woinarski, J., Burbidge, A. and Harrison, P. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing: pp. 511-514.			
Common Brushtail Possum *Trichosurus vulpecula vulpecula*	-	EN	**Habitat:** In Central Australia, riverine habitat that is close to rocky outcrops and moist gullies within the ranges or rocky slopes (Kerle et al. 1992). Habitat occurs on various geological substrates but is characterised by a diverse association of fire-sensitive plant species (Pavey and Ward 2012). **Distribution:** Occurs in isolated populations in southern NT. Most common in the southern NT within the MacDonald Ranges (Pavey and Ward 2012). Formerly had a much more extensive distribution in the NT. Common throughout much of the continent, including SA, Victoria, NSW, southern and south-western Qld, and much of WA (Pavey & Ward 2012).	**LOW** • No recent proximate records • Outside known distribution • Uncommon in northern NT.
	Kerle, J., Foulkes, J., Kimber, R. and Papenfus, D. (1992). The decline of the brushtail possum, *Trichosurus vulpecula* (Kerr 1798), in arid Australia. *Rangelands Journal*, Vol. 14, pp. 107-127. Pavey, C. and Ward, S. (2012). *Threatened Species of the Northern Territory - Common Brushtail Possum - Trichosurus vulpecula vulpecula*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0019/205525/common-brushtail-possum.pdf Woinarski, J.C.Z. (2004). In a land with few possums, even the common are rare: ecology, conservation and management of possums in the Northern Territory. In: Goldingay, R. and Jackson, S. (eds.). *The biology of Australian possums and gliding possums*. Surrey Beatty & Sons, Sydney: pp.51- 62.			
Southern Marsupial Mole *Notoryctes typhlops*	-	VU	**Habitat:** Most often sandy substrates, seemingly favouring coastal sand dunes and sand sheets with a cover of tussock grass or heath. Also shrubland, Eucalypt open forest, and the margins of coastal rainforest thickets (Woinarski 2004; Woinarski & Flannery 2008).	**NONE** • Lack of suitable dune habitat • No proximate records.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			Distribution: Restricted to the NT – mostly Groote Eylandt, but also central north-east Arnhem Land (Woinarski & Ward 2012). No confirmed records from the Australian mainland for at least 10 years (Woinarski et al. 2014).	
	Pavey, C. (2015). *Threatened Species of the Northern Territory - Southern Marsupial Mole - Notoryctes typhlops.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0016/205522/southern-marsupial-mole.pdf [Accessed 1 May 2018]. Benshemesh, J. and Schultz, M. (2008). *Survey of the underground signs of marsupial moles in the WA Great Victoria Desert*, Tropicana Joint Venture and the Department of Natural Resources, Environment and the Arts, NT Government				
Northern Brush-tailed Phascogale *Phascogale pirata*	VU	EN	**Habitat:** No detailed studies, but ecology is probably similar to that reported for phascogales in southern Australia (Rhind 1998). Most records are from tall open forests dominated by *Eucalyptus miniata* and *E. tetrodonta* (Rhind et al. 2008). Brush-tailed Phascogales are primarily arboreal and seldom feed on the ground. **Distribution:** Probably occurs naturally in low densities (Woinarski et al. 2014). Very few records exist; reported from West Island, east Arnhem Land, Coburg Peninsula, Kakadu, Litchfield and the Tiwi Islands. In the last 10 years only recorded from Kakadu, Coburg Peninsula and the Tiwi Islands, despite many extensive wildlife surveys across regions of the North End during that time (Woinarski et al. 2014).	**LOW** • No recent proximate records. • Outside known distribution. • Uncommon in northern NT.
	Rhind, S.G. (1998). *Ecology of the brush-tailed phascogale in jarrah forest of south-western Australia.* PhD thesis, Murdoch University, Perth, Western Australia. Rhind, S.G., Woinarski, J. and Aplin, K.P. (2008). Brush-tailed Phascogale. In: Van Dyck, S. and Strahan, R. (eds). *The Mammals of Australia.* Reed New Holland, Chatswood, NSW. Woinarski, J., Burbidge, A. and Harrison, P. (2014). *The Action Plan for Australian Mammals 2012.* CSIRO Publishing: pp. 125-127.				
Pale Field-rat *Rattus tunneyi*	-	VU	**Habitat:** Historically occurred in a wide range of habitats, but now primarily in dense vegetation along creeks (Aplin et al. 2008). **Distribution:** Higher rainfall areas of northern Australia, extending from Kimberley in WA to south-eastern Qld, including the North End of the NT (Braithwaite & Griffiths 1996).	**LOW** • Suitable habitat available. • A couple of records within 80 km from the project footprint (despite recent surveys in the region). • Species has undergone significant range decline.
	Aplin, K., Braithwaite, R. and Baverstock, P. (2008). Pale Field-rat: *Rattus tunneyi.* In: Van Dyck, S. and Strahan, R. (eds.). *The Mammals of Australia (3rd Edition).* Reed New Holland, Sydney, NSW. Braithwaite, R. and Griffiths, A. (1996). The paradox of *Rattus tunneyi*: endangerment of a native pest. *Wildlife Research,* Vol. 23, pp. 1-21. Cole, J. and Woinarksi, J. (2002). *Field Guide to the Rodents and Dasyurids of the Northern Territory.* Surrey Beatty & Sons, Chipping Norton, NSW. Woinarski, J.C.Z. (2000). The conservation status of rodents in the monsoonal tropics of the Northern Territory. *Wildlife Research,* Vol. 27, pp. 421-435.				
False Water Rat *Xeromys myoides*	VU	-	**Habitat:** Utilises both intertidal and freshwater habitats, with most records from mangrove forests,	**NONE** • No proximate records. • No preferred coastal habitat within EP154.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			saltmarsh, sedgelands, clay pans and freshwater *Melaleuca* wetlands (DoE 2017). **Distribution:** Three regions of coastal Australia: the NT, central south Qld and south-east Qld (DoE 2017). In the NT, known only from coastal North End with ten records at six sites – South Alligator River in 1903, Daly River floodplain in 1972, two sites on the Tomkinson River in 1975, Melville Island in 1975 and Glyde River floodplain in 1998 and 1999 (Cole & Woinarski 2002, Woinarski 2006).	
	Cole, J. and Woinarksi, J. (2002). *Field Guide to the Rodents and Dasyurids of the Northern Territory*. Surrey Beatty & Sons, Chpping Norton, NSW. Department of the Environment (2017). *Xeromys myoides - Water Mouse, False Water Rat, Yirrkoo*. Species Profile and Threats Database, Department of the Environment, Canberra. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66 [Accessed 1 May 2018]. Woinarski, J.C.Z. (2006). *Threatened Species of the Northern Territory - False water-rat, Water mouse - Xeromys myoides*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0008/376136/false-water-rat.pdf [Accessed 1 May 2018].			
Carpentarian Rock-rat *Zyzomys palatalis*	EN	CR	**Habitat:** Restricted to sandstone gorges and escarpments containing a core of dry or wet rainforest vegetation, mixed with woodland, scree slopes and permanent water, surrounded by savanna woodlands (Puckey & Woinarski 2006). **Distribution:** Restricted to the NT, where known only from five locations within a radius of 35 km (Puckey 2003) at Wollogorang Station in the Gulf of Carpentaria (Kitchener 1989).	**NONE** • No records within EP • Distribution highly restricted – outside of expected distribution.
	Kitchener, D.J. (1989). Taxonomic appraisal of Zyzomys (Rodentia, Muridae) with descriptions of two new species from the Northern Territory, Australia. *Records of the Western Australian Museum*, Vol. 14, pp. 331-373. Puckey, H. (2003). Additional records of the Carpentarian rock-rat *Zyzomys palatalis* at Redbank, close to the type locality. *Northern Territory Naturalist*, Vol. 17, pp. 43-45. Puckey, H. and Woinarski, J. (2006). *Threatened Species of the Northern Territory - Carpentarian Rock-rat - Zyzomys palatalis*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0008/205478/carpentarian-rock-rat.pdf [Accessed 1 May 2018].			
REPTILES (TERRESTRIAL)				
Plains Death Adder *Acanthophis hawkei*	VU	VU	**Habitat:** Floodplains in the North End and cracking soil plains inland (Webb et al. 2002). **Distribution:** Habitat mapping suggests the potential geographic range extends from western Qld, across the sub-coastal north of the NT to the north-eastern Kimberley of WA. Fragmented populations occur in the Mitchell Grass Downs of western Qld, the Barkly Tablelands on the NT/Qld border and east of Darwin (Fogg Dam) in the NT (TSSC 2012; Wuster et al. 2005). Susceptible to ingesting toxic Cane Toads (Phillips et al. 2009).	**LOW** • No preferred cracking clay soils within EP154. • No proximate records. However, the species has a disjointed distribution and EP154 falls between clusters of records to the north and the south.
	Phillips, B.L., Greenlees, M.J., Brown, G.P. and Shine R (2010). Predator behaviour and morphology mediates the impact of an invasive species: cane toads and dea h adders in Australia. *Animal Conservation*, Vol. 13, pp. 53-59. Webb, J.K., Chris ian, K.A. and Fisher, P. (2002). Fast growth and early maturation in a viviparous sit-and-wait predator, the			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	northern death adder (*Acanthophis praelongus*) from tropical Australia. *Journal of Herpetology*, Vol. 36, no. 3, pp. 505-509. Wuster, W., Dumbrell, A.J., Hay, C., Pook, C.E., Williams, D.J. and Fry, B.G. (2005). Snakes across the Strait: trans-Torresian phylogeographic relationships in three genera of Australasian snakes (Serpentes: Elapidae: *Acanthophis*, *Oxyuranus*, and *Pseudechis*). *Molecular Phylogenetics and Evolution*, Vol. 34. pp. 1-14. Threatened Species Scientific Committee (2015). *Approved Conservation Advice – Acanthophis hawkei – Plains Death Adder.* Canberra: Department of the Environment. [online] Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/83821-conservation-advice.pdf [Accessed 1 May 2018].		
Gulf Snapping Turtle *Elseya lavarackorum*	EN	-	**Habitat:** Large rivers and their associated overflow lagoons and oxbow lakes (Cogger 2000; Woinarski 2006). Found in deeper permanent pools most often with muddy, sandy or rocky bottoms. Also found in the middle reaches of rivers, upstream of saline regions and downstream of escarpments, including plunge pools. Steep rocky gorges, and river reaches with intact river banks seem to be preferred habitats (Thomson et al. 1997). **Distribution:** Rivers in far eastern NT and far western Qld which discharge into the south of the Gulf of Carpentaria. In the NT this includes the Robinson River (DoE 2017). Recent analysis of phylogenetic relationships proved that the snapping turtle species occurring in the Roper and Limmen-Bight catchments is *E.dentata* (Todd et al. 2014).	**LOW** • One record approximately 90 km west of the project footprint, in the Sturt Plateau. • Historical records in the Roper River have been confirmed as a closely-related *Elseya dentata*.
	Cogger, H.G. (2000). *Reptiles and Amphibians of Australia - 6th edition.* Reed New Holland, Sydney, NSW. Department of the Environment (2017). *Elseya lavarackorum - Gulf Snapping Turtle.* Species Profile and Threats Database, Department of the Environment, Canberra. [online] Available at: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67197 [Accessed 1 May 2018]. Thomson, S., White, A. and Georges, A. (1997). Re-evaluation of *Emydura lavarackorum*: identification of a living fossil. *Memoirs of the Queensland Museum*, Vol. 42 (No. 1), pp. 327-336. Todd, E., Blair, D., Georges, A., Lukoschek, V. and Jerry, D. (2014). A biogeographical history and timeline for the evolution of Australian snapping turtles (Elseya: Chelidae) in Australia and New Guinea. *Journal of Biogeography* 41 (5), pp 905-918. Woinarski, J. (2006). *Threatened Species of the Northern Territory - Gulf Snapping Turtle - Elseya lavarackorum.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0008/376181/gulf-snapping-turtle.pdf [Accessed 1 May 2018].			
Mertens' Water Monitor *Varanus mertensi*	-	VU	**Habitat:** Semi-aquatic, occupying edges of freshwater watercourses and lagoons, but seldom seen far from water (Christian 2004). **Distribution:** Across far northern Australia from the western Cape York Peninsula in Qld to the Kimberley in WA (Christian 2004). Widespread in the NT, occupying all of the North End river systems (Ward et al. 2006). Susceptible to ingesting toxic Cane Toads resulting in reduced abundance (Griffiths & McKay 2007).	**HIGH** • Suitable habitat available. • Recent records throughout the region.
	Christian, K. (2004). Varanus mertensi. In: Pianka et al. (eds.). *Varanoid lizards of the world.* Indiana University Press, Bloomington, Indianapolis. Griffiths, A.D. and McKay (2007). Cane toads reduce he abundance and site occupancy of Merten's water monitor (Varanus mertensi). *Wildlife Research,* Vol. 34, pp. 609-615. Ward, S., Woinarski, J., Griffiths, T. and McKay, L. (2006). *Threatened Species of the Northern Territory - Mertens Water Monitor - Varanus mertensi.* Northern Territory Department of Environment and Natural Resources. [online] Available			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	at: https://nt.gov.au/__data/assets/pdf_file/0018/206460/mertens-water-monitor.pdf [Accessed 1 May 2018].			
Mitchell's Water Monitor *Varanus mitchelli*	-	VU	**Habitat**: Semi-aquatic and arboreal, inhabiting margins of freshwater watercourses, swamps and lagoons (Ward 2012). **Distribution**: North End of the NT and Kimberley in WA (Schultz & Doody 2004). In the NT, recorded in most catchments flowing into the Timor Sea, Arafura Sea and the Gulf of Carpentaria (Ward 2012).	**LOW** • Suitable habitat available. • Only one record in the bioregion from 1996 in Elsey National Park, 66 km west of the Project Footprint.
Doody, J.S., Green, B., Rhind, D., Castellano, C., Sims, R. and Robinson, T. (2009). Population-level declines in Australian predators caused by an invasive species. Animal Conservation, Vol. 12, pp. 46-53. Schultz, T. and Doody, S. (2004). Varanus mitchelli. In: Pianka et al. (eds). Varanoid lizards of the world. Indiana University Press, Bloomington, Indianapolis. Ward, S. (2012). Threatened Species of the Northern Territory - Mitchell's Water Monitor - Varanus mitchelli. Northern Territory Department of Environment and Natural Resources. [online] Available at:https://nt.gov.au/__data/assets/pdf_file/0019/206461/mitchells-water-monitor.pdf [Accessed 30 May 2017].				
Floodplain Monitor *Varanus panoptes*	-	VU	**Habitat:** Broad range of habitats from coastal beaches to savannah woodlands (Christian 2004). Also common throughout floodplains grasslands and a variety of native woodlands (Ward et al. 2012). **Distribution:** Across northern Australia from the Kimberley in WA to Cape York Peninsula, and southwards through most of Qld. In the NT, recorded across most of the North End and the Gulf Region (Christian 2004). Highly susceptible to cane toad poisoning (Ujvari & Madsen 2009), and has experienced significant declines (Doody et al. 2009).	**LOW** • Suitable woodland within EP154. • No recent records. • Cane Toads known to be well established in area.
Christian, K. (2004). Varanus panoptes. In: Pianka et al. (eds). *Varanoid lizards of the world*. Indiana University Press, Bloomington, Indianapolis. Doody, J.S., Green, B., Rhind, D., Castellano, C., Sims, R. and Robinson, T. (2009). Population-level declines in Australian predators caused by an invasive species. *Animal Conservation*, Vol. 12, pp. 46-53. Ujvari, B. & Madsen, T. (2009). Increased mortality of naïve varanid lizards after the invasion of non-native cane toads (*Bufo marinus*). *Herpetological Conservation and Biology*, Vol. 4, pp. 248-251. Ward, S., Woinarski, J., Griffiths, T. & McKay, L. (2012). *Threatened Species of the Northern Territory - Yellow Spotted Monitor, Northern Sand Goanna, Floodplain Monitor - Varanus panoptes.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0006/206466/floodplain-monitor.pdf [Accessed 1 May 2018].			
CARTILAGINOUS FISH (FRESH WATER)				
Speartooth Shark *Glyphis glyphis*	CR	VU	**Habitat:** Tropical fresh water and marine environments (Bradshaw et al. 2008). May be restricted to low salinity environments such as freshwater or brackish areas of rivers (DoE 2017). **Distribution:** Papua New Guinea and Northern Australia. Considered to be very rare in Australia as few specimens have been collected (Cavanagh et al. 2003). Three distinct geographical locations in the NT and northern Qld (DoE 2017). In the NT, recorded in the Alligator River region across to Adelaide River, and the Bizant River (Ward and Larson 2012).	**LOW** • Marginally-suitable freshwater habitat within EP • No regional records.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Bradshaw, C.J.A., Fitzpatrick, B M., Steinberg, C.C., Brook, B.W. and Meekan, M.G. (2008). Decline in whale shark size and abundance at Ningaloo Reef over the past decade: the world's largest fish is getting smaller. *Biological Conservation*, Vol. 141, pp. 1894–1905. Cavanagh, R., Kyne, P., Fowler, S., Musick, J. and Bennett, M. (eds.) (2003). *The Conservation Status of Australian Chondrichthyans*. Report of the IUCN Shark Specialist Group Australia and Oceania Red List Workshop. The University of Queensland, School of Biomedical Sciences, Brisbane, Australia. Department of the Environment (2017). *Glyphis glyphis - Speartooth Shark*. Species Profile and Threats Database, Department of the Environment, Canberra. [online] Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82453 [Accessed 1 May 2018]. Ward, S. and Larson, H. (2012). *Threatened Species of the Northern Territory - Speartooth Shark - Glyphis glyphis*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0009/206388/speartooth-shark.pdf [Accessed 1 May 2018].		
Dwarf Sawfish *Pristis clavata*	VU	VU	**Habitat:** Tropical marine and estuarine habitats, entering estuarine or fresh waters to breed during the wet season and moving into marine waters following the wet season (Peverell 2005). **Distribution:** Indonesia, South-East Asia and northern Australia (Cavanagh et al. 2003). In the NT, known to occur around Darwin (including Buffalo Creek and Rapid Creek), in Kakadu National Park (Alligator River), Keep River and Victoria River (Thorburn et al. 2003).	**LOW** • Marginally-suitable freshwater habitat within EP. • No regional records.
	Cavanagh, R., Kyne, P., Fowler, S., Musick, J. and Bennett, M. (eds.) (2003). *The Conservation Status of Australian Chondrichthyans*. Report of the IUCN Shark Specialist Group Australia and Oceania Red List Workshop. The University of Queensland, School of Biomedical Sciences, Brisbane, Australia. Peverell, S.C. (2005). Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on their ecology. *Environmental Biology of Fishes,* Vol. 73, pp. 391-402. Thorburn, D.C., Peverell, S., Stevens, S., Last, J.D. and Rowland, A J. (2003). *Status of freshwater and estuarine elasmobranchs in Northern Australia*. Report to Natural Heritage Trust, Canberra.			
Freshwater or Largetooth Sawfish *Pristis pristis*	VU	VU	**Habitat:** Tropical marine and estuarine habitats, entering estuarine or fresh waters to breed during the wet season and moving into marine waters following the wet season (Peverell 2005). Of the four *Pristis* species reported to occur in Australia, is the one most often associated with freshwater, and has been recorded several hundred kilometres upstream (Thorburn et al. 2003). **Distribution:** Circumtropical, with distinct populations in the eastern Atlantic, western Atlantic, eastern Pacific and Indo-West Pacific – including northern Australia (TSSC 2014). In the NT, reported in Adelaide, Victoria, Daly, East and South Alligator, Goomadeer, Roper, McArthur, Wearyan and Robinson Rivers (TSSC 2014). May potentially occur in all large rivers of northern Australia from the Fitzroy River, WA, to the western side of Cape York Peninsula, Qld (DoE 2018).	**MEDIUM** • Suitable breeding habitat in seasonal watercourses within EP. • Reported in the Roper River; no other regional records.
	Department of the Environment (DoE) (2018). *Pristis pristis in Species Profile and Threats Database*, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. [Accessed 1 May 2018]. Peverell, S.C. (2005). Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on their ecology. *Environmental Biology of Fish----es,* Vol. 73, pp. 391-402. Threatened Species Scientific Committee (2014). *Approved Conservation Advice - Pristis pristis (largetooth sawfish)*. Canberra:			

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
	Department of the Environment. In effect under EP154BC Act from 11-April-2014. [online] Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/60756-conservation-advice.pdf [Accessed 1 May 2018].			
Green Sawfish *Pristis zijsron*	VU	VU	**Habitat:** Tropical waters – including marine inshore waters, river mouths, estuaries and lagoons – but not freshwater (Thorburn et al. 2003). Enters estuarine to breed during the wet season and moves back into marine waters following the wet season (Peverell 2005). **Distribution:** Northern Australia, South-East Asia and the Indian Ocean (Cavenagh et al. 2003). Most frequently encountered of the sawfish species in Australian waters (Last & Stevens 1994). Most commonly known from the Gulf of Carpentaria (Stevens et al. 2005). In the NT specimens have only been collected from Buffalo Creek in Darwin (Stirrat et al. 2006).	**NONE** • No estuarine habitat within EP154
	Cavanagh, R., Kyne, P., Fowler, S., Musick, J. and Bennett, M. (eds) (2003). *The Conservation Status of Australian Chondrichthyans*. Report of the IUCN Shark Specialist Group Australia and Oceania Red List Workshop. The University of Queensland, School of Biomedical Sciences, Brisbane, Australia. Last, P.R. and Stevens, J.D. (1994). *Sharks and Rays of Australia.* CSIRO, Melbourne. Peverell, S.C. (2005). Distribution of sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia, with notes on their ecology. *Environmental Biology of Fishes,* Vol. 73, pp. 391-402 Stirrat, S., Larson, H. and Woinarski, J. (2006). *Threatened Species of the Northern Territory - Green Sawfish - Pristis zijsron.* Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0006/206394/green-sawfish.pdf [Accessed 1 May 2018]. Thorburn, D.C., Peverell, S., Stevens, S., Last, J.D. and Rowland, A J. (2003). *Status of freshwater and estuarine elasmobranchs in Northern Australia.* Report to Natural Heritage Trust, Canberra.			
GASTROPODS				
Victoria's Land Snail *Trachiopsis victoriana*	-	VU	**Habitat:** Found in leaf litter at the base of large limestone boulders in a marshy sink. Also recorded buried in soil in open *Eucalyptus* woodlands (Solem 1985). **Distribution:** Reported in and around a limestone sinkhole adjacent to the Victoria Highway, 86km south west of Katherine (Solem 1985). Possibly naturally extremely restricted in range.	**NONE** • EP is outside the species' highly restricted distribution.
	Solem, A. (1985). *Camaenid land snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae) - V Remaining Kimberley genera and addenda to the Kimberley*. Records of the Western Australian Museum Supplement 20, pp. 707-981. Wilson, C., Woinarski, J., Kessner, V. and Braby, M. (2006). *Threatened Species of the Northern Territory - Victoria's Land Snail - Setobaudinia victoriana*. Northern Territory Department of Environment and Natural Resources. [online] Available at: https://nt.gov.au/__data/assets/pdf_file/0007/206539/setobaudinia-victoriana.pdf [Accessed 1 May 2018].			
FERNS				
Pale Wood Fern *Macrothelypteris torresiana*	-	EN	**Habitat:** Sheltered sandstone gorges associated with springs and groundwater seepages (Cowie & Westaway 2012). **Distribution:** Isolated populations in northern WA, eastern Qld, north-eastern NSW and the NT (two locations on Wollogorang Station in	**LOW** • Possibly-suitable habitat available • No records in the region.

Name	Status		Summary	Likelihood of occurrence
	Cth	NT		
			the Gulf region, adjacent to the Qld border) (Cowie & Westaway 2012). There are substantial areas of potentially-suitable habitat in Western Arnhem Land that are poorly surveyed at the scale and intensity necessary to exclude the possibility that more subpopulations exist; however, the chance of finding additional subpopulations in that area appears relatively low (Cowie & Westaway 2012).	
	Cowie, I. and Westaway, J. (2012*). Threatened Species of the Northern Territory - Macrothelypteris torresiana*. Northern Territory Department of Environment and Natural Resources. https://nt.gov.au/__data/assets/pdf_file/0006/208473/macrothelypteris-torresiana.pdf [Accessed 1 May 2018].			

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APPENDIX C ARCHAEOLOGICAL SURVEY REPORT EP144

Archaeological Impact Assessment
EP144 Exploration Project, Mittiebah Station
Northern Territory of Australia

Prepared for: Minerals Australia Pty Ltd &
EcOz Environmental Services

2021

Earthsea Pty Ltd

EARTHSEA HERITAGE SURVEYS

Document Version Control

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25 November 2021	Richard Woolfe, Ben Keys	Initial draft	Ben Keys	7 December 2021
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Archaeological Impact Assessment
EP144 Exploration Project, Mittiebah Station
Northern Territory of Australia
(FINAL)
21 April 2022

Prepared for: **Minerals Australia Pty Ltd and EcOz Environmental Services**

Prepared by: Ben Keys and Richard Woolfe
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Survey Area: Mittiebah Station, NT.

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1 Introduction

Earthsea Pty Ltd (Earthsea) has been engaged by EcOz Environmental Services, on behalf of Minerals Australia Pty Ltd, to undertake a Heritage Impact Assessment (HIA) of their proposed drill program on EP144, a petroleum lease on Mittiebah Station in the Barkly Tableland of the Northern Territory.

Minerals Australia are proposing to drill two petroleum exploration holes on Mittiebah Station located on the northern border of Alexandria Station. The project will involve drilling two deep holes each within a zone of approx. 1000 metres in radius (see Figure 2 below). To support this operation, Minerals Australia propose developing a camp site for the work crews.

An archaeological field assessment, coupled with a desktop study, was used to analyse potential risks to archaeological resources and areas of cultural significance within the proposed drill and campsite areas. Archaeologist Richard Woolfe and field assistant Raymond Daniell undertook the field assessment on site on October 5 and 6, 2021.

1.1 Scope of the Study

This study and report centred on assessing the significance and potential impacts to heritage features protected by the *NT Heritage Act 2011,* which include but not are limited to: archaeological sites of Aboriginal origin and some historical features associated with the post-contact to modern period. Sacred Sites mandated as 'sites of significance in the Aboriginal Tradition' by the *Northern Territory Aboriginal Sacred Sites Act (1989)* have been assessed in full by the Aboriginal Areas Protection Authority (AAPA) prior to the archaeological survey. The resulting Authority Certificate is attached to this report as Attachment A.

The aim of the study was to develop a Heritage Impact Assessment (HIA) that identifies cultural heritage risks for the Project and establish management strategies to mitigate impacts on Aboriginal archaeological sites and other heritage places during construction and operation of the exploration project:

1. Identify archaeological features within or proximal to the Project Area.
2. Provide a geophysical background to the area focusing on Indigenous land use practices and their impact on the archaeological record.
3. Provide an ethnographic and historical background to the Project Area.
4. Identify any archaeological or cultural heritage constraints, potential impacts, and risks within the proposed Project Area.
5. Detail the cultural and scientific significance of each archaeological feature identified and recommend mitigation strategies.
6. Develop management strategies and measures to minimise harm to Aboriginal and historic cultural heritage features and other areas of cultural significance.

1.2 Project Location, Land Tenure & Native Title

1.2.1 Project Location and Land Tenure

EP144 is located on Mittiebah Station (NT Portion 962) approx. 310 km east of the Stuart Highway and 140 km north of the Barkly Highway in the Northern Territory. Mittiebah Station is bound to the south by Alexandria Station (NT Portion 1), the third largest pastoral lease in Australia. Both Alexandria and

Mittiebah Stations are owned by the North Australia Pastoral Company (NAPCO). NAPCO owns 14 stations and cattle properties through Queensland and the NT, with Mittiebah being one of the largest at 695,500 hectares carrying 20,000 head of cattle.

EP144 is a petroleum exploration permit owned by Minerals Australia Pty Ltd and Jacaranda Minerals Ltd acquired on 21/5/2013. The joint venture is managed by Minerals Australia Pty Ltd with the exploration work undertaken by Minerals Australia Ltd (see Figure 2 below). The Project Area consists of two drill hole areas and existing access tracks. A camp site associated infrastructure is planned within the drill hole area on the boundary of Alexandria and Mittiebah (see Figure 3 below).

1.2.2 Native Title

The Native Title Representative Body Corporate (RNTBC) for the Project Area is the Northern Land Council. A search of the National Native Title Register on 1 November 2021 indicates that there are no native title claims, determinations, or Indigenous Land Use Agreements (ILUA) active in the Project Area.

1.2.3 Sacred Sites

Minerals Australia have applied for, and received, an Authority Certificate C2020/086 under the NT Aboriginal Sacred Sites Act 1989 (see Section 2 below for more details on the Act and its application). Certificate C2020/086 (Attachment A) details two Restricted Work Areas (RWAs) that are of interest to this Project:

1. RWA 1 is located in the [redacted] These RWAs encompass Recorded Sacred Site 6260-6. The conditions attached to this RWA state that no person shall enter, or no works shall take place or no damage shall occur. The certificate also notes that [redacted] was located in the sacred site survey and is noted in the Certificate.
2. RWA 2 is located on the [redacted]. This RWA represents the restricted work area associated with Recorded Sacred Site 6360-3. The conditions of RWA 2 prevent any ground disturbing works in the RWA.

It is important to note that the AAPA Certificate and attached map should be referenced by the company and its contractors in making decisions on where drilling should occur.

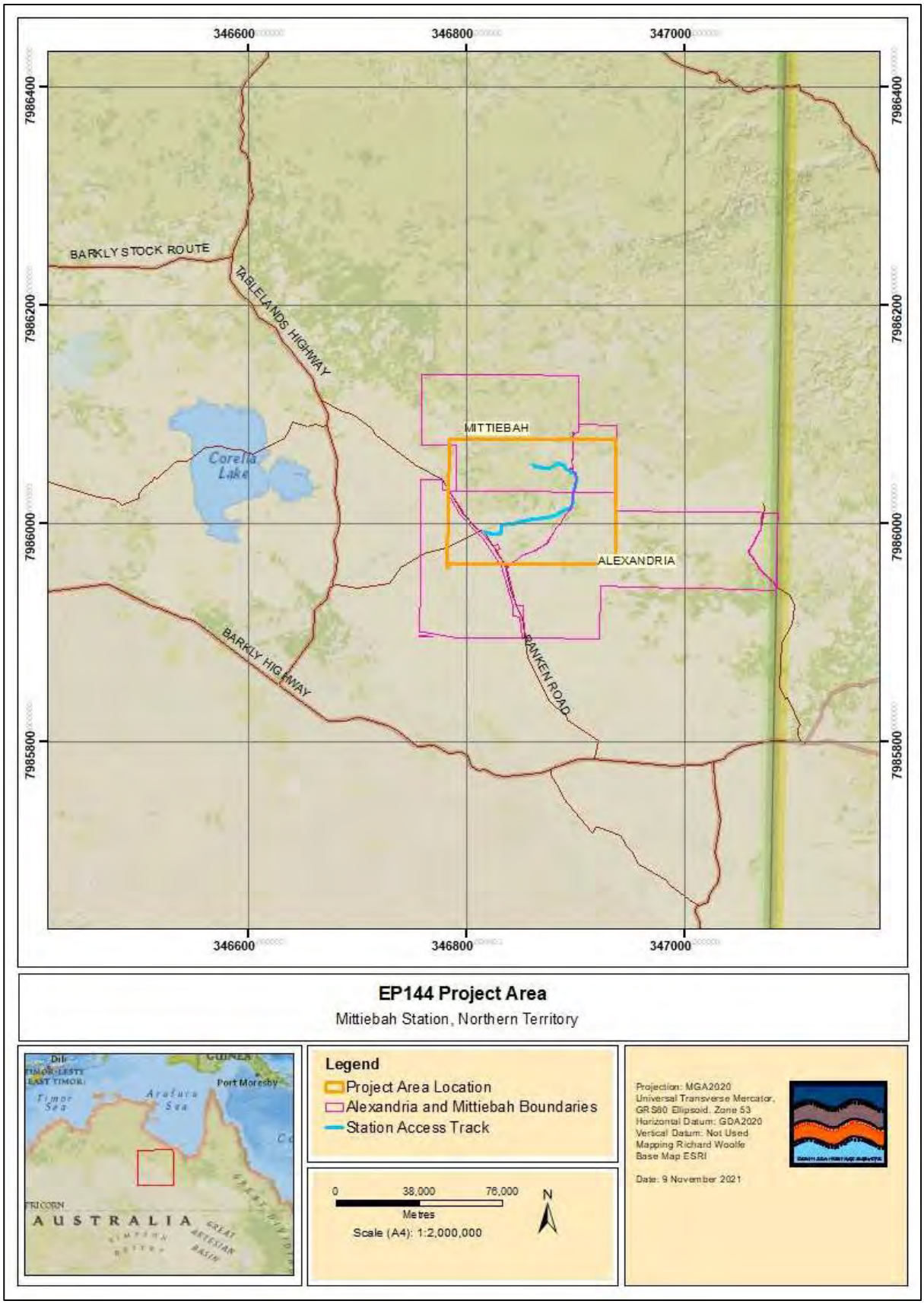

Figure 1: Project Location Mittiebah Station Northern Territory

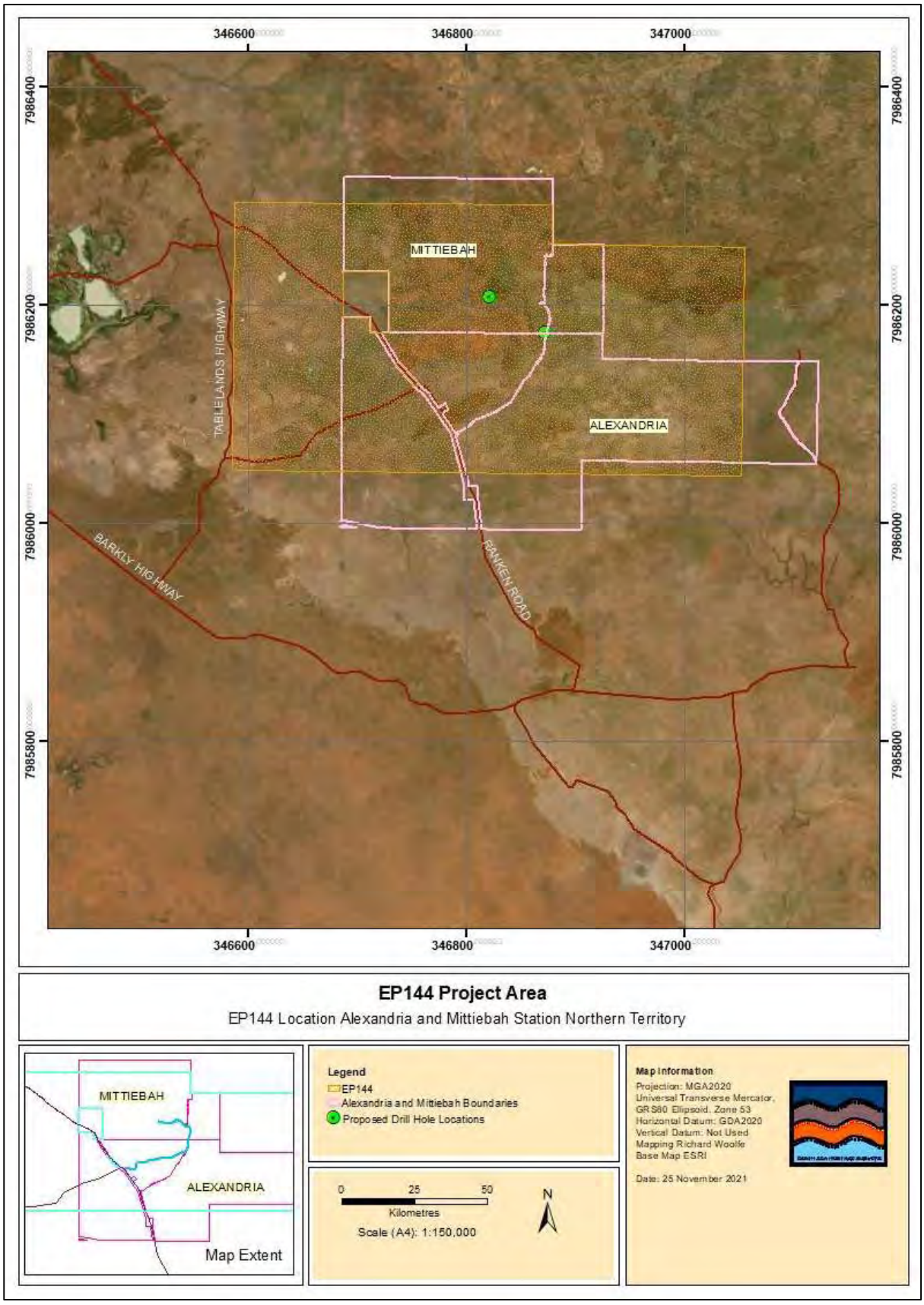

Figure 2: EP144 Petroleum Lease mapped over Mittiebah and Alexandria Station's boundaries.

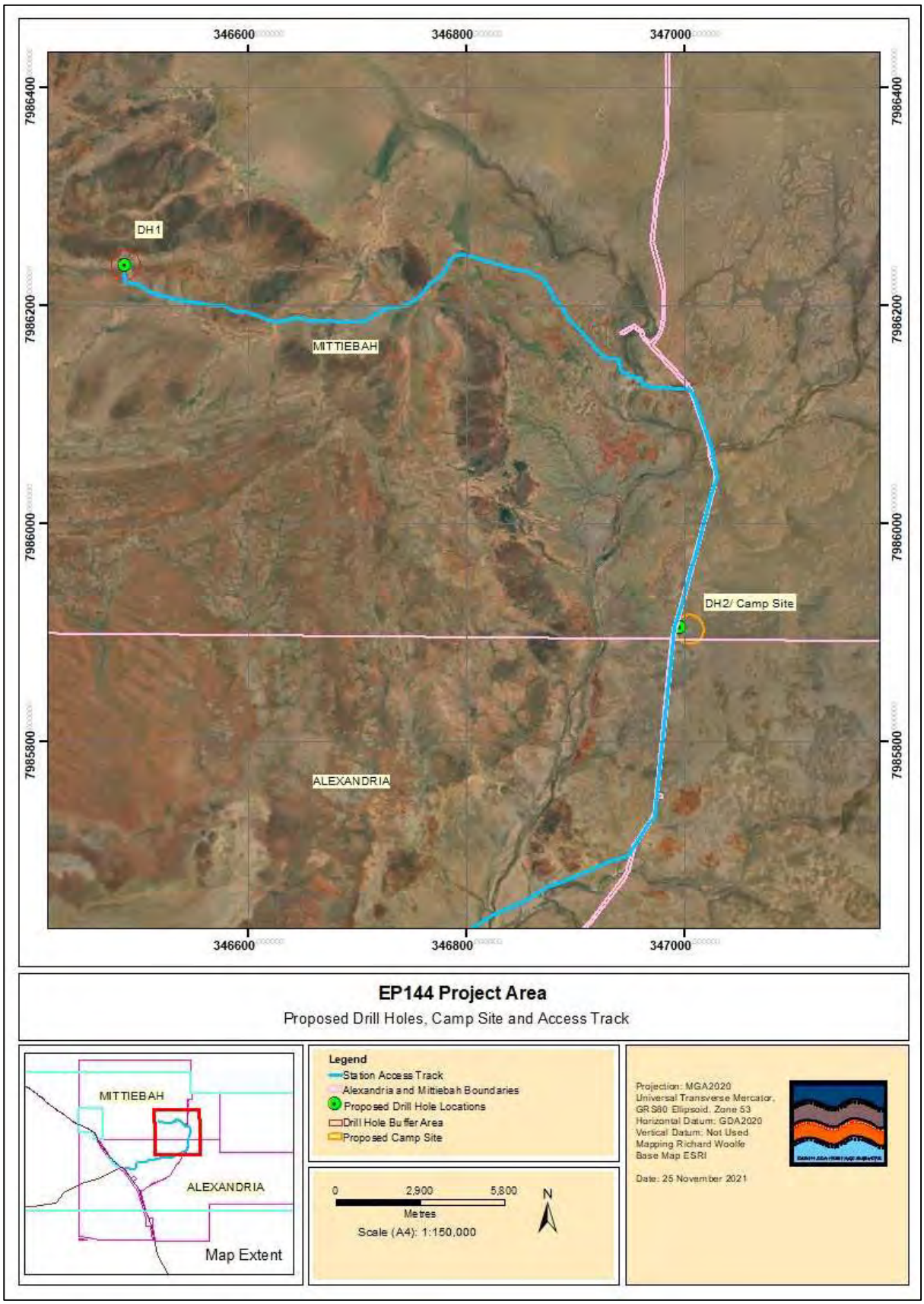

Figure 3: Project Area footprint including DH1 (northern drill hole), DH2 (southern drill hole) and proposed camp site.

1.3 Consultation

Earthsea uses an Indigenous engagement and participation approach in all heritage surveys in the Territory regardless of the land tenure. In this case, consultations with the Northern Land Council indicated that no Traditional Owner representatives would be available at the time of survey (October 2021). The AAPA Certificate process engaged the appropriate Site Custodians (Aboriginal elders responsible for Sacred Sites in a particular area) in the Cultural Heritage assessment of the area, including locating at least one archaeological artefact.

1.4 Cultural Heritage Field Team

The cultural heritage survey team consisted of Richard Woolfe (archaeologist) and Raymond Daniell (field assistant).

1.5 The Authors

Ben Keys and Richard Woolfe from Earthsea Pty Ltd (Earth Sea Heritage Surveys) co-authored this report. The following is a short description of both Consultant's qualifications and experience.

Project Manager: Ben Keys

Ben holds a Bachelor of Archaeology with Honours from Flinders University, South Australia. He has extensive experience in cultural heritage management and community consultation, coupled with the management of largescale developments such as mining projects in the Northern Territory. Ben also has a professional background in land access management and aspects of environmental management, including compliance. He has been an author of several published academic archaeological journal articles and has been invited to speak at mining industry conferences in the Northern Territory.

Principal Archaeologist: Richard Woolfe

Richard holds a Bachelor of Archaeology from the University of New England, a Grad Dip in GIS and Geomatics from Charles Darwin University and a Masters in Heritage Management and GIS from the University of New England. Richard has 19 years' experience in cultural heritage management consultancy in the Northern Territory and Queensland. Richard also has extensive experience in community consultation with Aboriginal groups and the wider community. Richard conducted the 2002-2003 review of the NT *Heritage Conservation Act 1991* and co-drafted the original instructions for the NT *Heritage Act 2011*.

2 Legislative Context

2.1 Statutory Considerations

The Barkly Region has a rich Indigenous cultural environment which includes a long history of human occupation and land use spanning at least at least 35,000 years (Smith 2013) and a recent past of that includes contact with European explorers, miners and pastoralists from the 1840's onwards.[1]

The significance of archaeological materials in a cultural context varies substantially depending upon one or a combination of its aesthetic, historic, scientific, social or spiritual values for past, present or future generations (Australia ICOMOS Burra Charter, 2013). Through time, these values can change or be impacted upon by both natural mechanisms and human intervention. As a result of this, legislators have passed heritage acts in all jurisdictions, some of which apply in the Project Area. The following section outlines the various statutes that may, or may not, apply in the Project Area.

2.1.1 Commonwealth Legislation:

***Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA).** This Act changed Aboriginal reserves within the Northern Territory to freehold title held in trust. The Act mandated the formation of Land Councils to act in the interests of Northern Territory Aboriginal people in the areas of land, access to lands, employment and the development of businesses. The Act also defined Sacred Sites as 'sites that are sacred, or otherwise significant, in the Aboriginal Tradition'. The Act protected these sites from damage, whether accidental or intentional. The *NT Aboriginal Sacred Sites Act* 1989 uses this definition of 'sacred' in its purpose of protecting these sites outside of Land Trust lands. On pastoral lease lands, the general process is for the AAPA to conduct the Sacred Site surveys with the relevant Site Custodians, then issue an Authority Certificate under the Act.

***Native Title Act 1993*.** Native Title is "the communal, group or individual rights and interests of Aboriginal people and Torres Strait Islander people in relation to land and waters, possessed under traditional law and custom, by which those people have a connection with an area which is recognised under Australian law (Section 223 NTA) (National Native Title Tribunal 2016)". The NTA establishes the processes to determine where native title exists, how future acts impacting upon native title land may be undertaken, and to provide compensation where future acts extinguish or are inconsistent with the existence or exercise of native title (DCP 2016). The Act gives Indigenous Australians who hold native title rights and interests (including native title claims) the right to access and use traditional lands, be consulted and, in some cases, to participate in decisions about activities proposed to be undertaken on the land. For native title to exist on a particular pastoral lease in the Territory, there must be a claim and determination by the Federal Court. A search of the National Native Title Register shows no such claim exists at time of writing this document.

***Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.** This Act is intended as a 'last resort' defence for significant sites, meaning that the Act is meant to provide emergency protection for Aboriginal and Torres Strait Islander heritage sites when all other avenues have been exhausted. Generally, an Aboriginal person or group of persons, must apply to the Minister to have protective

[1] Barkly Regional Council. 2015. Chronological Events within the Barkly Region. [ONLINE] Available at: https://www.barkly.nt.gov.au/uploads/pdfs/Chronological-Events-within-the-Barkly-Region.pdf. [Accessed 1 November 2021].

covenants placed over an area or site (DEE 2016). The power to provide such protection resides in Section 51 of the Constitution giving the Commonwealth powers on Aboriginal issues. Therefore, this Act may override all State and Territory cultural heritage acts.

To the knowledge of the Consultants, there are no known applications under this Act for any areas or features within the Solar Precinct or associated access corridor.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) commenced on 16 July 2000 with heritage amendments coming into effect on 1 January 2004. The EPBC provides for a National Heritage List of natural, historic and Indigenous places that are of outstanding significance to the nation. The EPBC also provides for a Commonwealth List that includes natural, historic and Indigenous places of significance that are owned or controlled by the Commonwealth. Ownership or control of these places allows the Commonwealth to protect or manage these places according to the significance of the place.

The Commonwealth Department of Environment and Energy administers the EPBC, including administration of the heritage lists and providing support to the Australian Heritage Council established under the Australian Heritage Council Act 2003. The Department maintains the Australian Heritage Database which includes places on both Commonwealth lists, all places on state registers and other places included in the former Register of the National Estate established in 1976. A search of the Commonwealth Heritage Database on 25 November 2021 return no heritage sites on Alexandria or Mittiebah Stations.

2.1.2 Northern Territory Legislation:

***Aboriginal Sacred Sites Act 1989*.** The NT Aboriginal Sacred Sites Act 1989 was enacted to complement the ALRA. Like the ALRA, the Aboriginal Sacred Sites Act protects sites that are 'sacred and otherwise of significance in the Aboriginal Tradition'. Sacred Sites are protected whether the location of the sites are known or not by any person or company seeking to do work on lands.

The Act is administered by the AAPA. AAPA can issue a Certificate indemnifying any proponent for an area upon application and payment of a fee. The Certificate will contain conditions limiting or preventing works in and around registered and recorded Sacred Sites. The Authority Certificate will contain maps outlining any restricted work areas in the area of application.

A survey is usually undertaken by a representative of AAPA in order to ascertain the views of the Site Custodians for the subject land. A Site Custodian is an Indigenous person who has special responsibility for an area and may or may not be a local Traditional Owner or Indigenous Elder.

***Heritage Act 2011*.** The NT *Heritage Act* came into effect on 1 October 2012. The Act provides protection for the same classes of places as the previous NT *Heritage Conservation Act 1991*, with some changes. As under the previous Act, members of the community can nominate areas, places, sites, buildings, shipwrecks and heritage objects to the register. If the Minister agrees that these features are of special significance to the heritage of the NT, the place is added to the register and receives statutory protection. The Act allows for processes to approve works and maintenance for a heritage place.

The NT *Heritage Act* provides a 'blanket' or 'presumptive' protection for Aboriginal and Macassan archaeological places and objects until an application is made to the CEO of the Department to do

works on Aboriginal or Macassan archaeological places and objects. Following an application, the CEO will seek advice of the Heritage Council, then refer the decision to the Minister (for larger sites for example) or back to the Heritage Council (for smaller sites). If a decision is made to not allow works on an archaeological place or object, then heritage protection will continue. A permit will generally only be issued if consultation with the relevant Traditional Owners or Custodians of the sites or their representatives has occurred. There are penalties for accidental or deliberate destruction of these sites.

2.2 Regulatory Organisations

Northern Land Council (NLC). The NT Land Councils are independent statutory authorities of the Commonwealth responsible under the ALRA and *Native Title Act* for assisting Aboriginal peoples in the NT to acquire and manage their traditional lands and seas. This includes assisting in Land Rights and Native Title Claims, managing traditional lands, protecting sites of significance in the Aboriginal Tradition. The Northern Land Council is also responsible for promoting the economic interests of Aboriginal peoples in the Top End. They do this by advocating for Traditional Owners interests in the development of resources on Land Trust and Native Title lands. The NLC is the registered Native Title Body for the Project Area.

Aboriginal Areas Protection Authority (AAPA). The AAPA is an independent statutory authority established under the *Northern Territory Aboriginal Sacred Sites Act 1989*. The Authority is responsible for the protection of Aboriginal sacred sites on land and sea across the Northern Territory. The AAPA seeks to implement a practical balance between sacred site protection and economic development.

Heritage Branch, NT Department of Territory Families, Housing and Communities. Heritage Branch is the regulatory authority responsible for administering most sections of the NT *Heritage Act 2011*. Heritage Branch is responsible for administering the NT Heritage Register, the NT Archaeological Database and providing logistical support for the NT Heritage Council.

2.3 Heritage and Sacred Site Register Searches

2.3.1 Northern Territory Heritage Registers

Heritage Register Database

There are no declared heritage places in the Project Area.

Archaeological Site Databases

The NT Archaeological Site Database maintained by the Heritage Branch, NT Department of Territory Families, Housing and Communities, records no known archaeological sites within the proposed Project Area.

The absence of records on the NT Archaeological Site Database does not reflect the lack of archaeological sites within the Project Area, but rather a lack of archaeological survey.

2.3.2 Aboriginal Sacred Sites Register

An Aboriginal Areas Protection Authority (AAPA) has provided an Authority Certificate for the Project as per Section 1.2.3 above. The certificate notes two Recorded Sacred Sites that are in the Project Area and may impact on the location of at least one drill hole.

2.3.3 Commonwealth Registers

A search of the Commonwealth Heritage Database, which includes both Commonwealth Registers, show no heritage places in the Project Area.

3 Physical and Environmental Setting

Archaeologically, understanding the environmental context of a region is also vitally important when analysing past human settlement behaviour through interpreting archaeological features and site patterns. Geomorphology, geology and hydrological variations, coupled with past land use practices can heavily influence the types of archaeological materials found, their condition, distribution patterns and predictability within a given land system.

From a survey methodological perspective, these environmental factors may also obscure the visibility of the archaeological record and thus reduce the effectiveness of the surveyor's ability to identify a site, its contents or extent.

The following section outlines the environmental and physical background for the project area so as to develop an understanding of the relationship between the environmental setting and archaeological resources recorded during the survey. This in turn may contribute to developing robust archaeological predictive models for the broader area.

3.1 Bioregions and Land Systems

The Project Area falls across the boundary of two bioregions:

1. Mitchell Grass Plains (Drill Hole 2 and the Camp Area) consisting of cracking clay plains occasionally dissected by seasonal watercourses, creeks and rivers. Drainage is largely to the south (Rawlings 2008:1). Vegetation is largely grassland with sparse tree coverage. Mitchell Grass once dominated the landscape but is being supplanted by exotics more suitable to cattle, including buffel grass.
2. Gulf Fall and Uplands (Drill Hole 1 Area) bioregion is characterised by dissected low hills and sandstone plateaus with eucalypt woodlands on spinafex grassland[2] Drainage is largely toward the coast (Rawlings 2008:1).

Land systems are mapped across the Northern Territory (NT) at a larger scale than bioregions and are more useful in archaeological analysis of land areas[3]. The land systems of the Barkly Region of the NT were first surveyed in the late 1940s and then presented in report form in 1952[4]. In recent times this land system mapping has been digitised to a GIS layer and updated. In the Project Area, examination of the 1952 data and the 2011 data available to the consultant show few differences other than more modern presentation (see Table 1 below).

There are three land systems in the Project Area, Barkly 2, Barkly 3 and Yelvertoft. The first two are both variations of the Mitchell Grass Plains Land Systems with little difference between the two in this area. The 1940s Land Systems Survey of the Barkly Tableland notes that the Mitchell Grass plains have a 'surface covering of chert pebbles'. Archaeological surveys in the Mitchell Grass plains (i.e. Earthsea 2016, Keys and Memmott 2016, Wallis and Collins 2013) indicate that much of the chert pebble lag

[2] https://www.awe.gov.au/sites/default/files/env/resources/a8015c25-4aa2-4833-ad9c-e98d09e2ab52/files/bioregion-gulf-fall-and-uplands.pdf

[3] http://www.ntlis.nt.gov.au/

[4] https://data.nt.gov.au/dataset/land-systems-of-barkly-region/resource/460b6e2b-ca1b-4672-b066-3fcef63845c6

deposit on the Mitchell Grass plains have been knapped by Aboriginal people in the past (see Section 4.3 Background Archaeology below).

The Yelvertoft Land System is characterised by hilly to undulating country with largely skeletal soils or truncated gravelly lateritic red earths. *E.brevifolia* or *E.dicromophloia* dominate the woodlands (Edgoose 1996:3). Drill Hole Area 1 is within the Yelvertoft Land System.

Table 1: Land Systems in the Project Area (Land Systems of the NT July 2011).

Land System Name	Map Unit	Geographic Zone	Class	Class Description	Land Surface
Barkly 2	B2	Mitchell Grass Downs	Clay plains	Level to gently undulating clay plains (black soil plains); cracking clay soils, heavy grey pedocals. Surface has a covering of chert pebbles.	Stable Tertiary land surface
Barkly 3	B3	Mitchell Grass Downs	Clay plains	Level to gently undulating clay plains (black soil plains); cracking clay soils, heavy grey pedocals. Surface has a covering of chert pebbles.	Stable Tertiary land surface
Yelvertoft	Y	Gulf Fall and Uplands	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Erosional land surface

3.2 Climate and Hydrology

3.2.1 Climate

The Project Area experiences a semi-arid climate influenced by the monsoonal climate characterising northern Australia. The climate is characterised by warm winters and hot summers, with rainfall coming from cyclonic and monsoonal systems during December to April. The nearest weather station is at Brunette Downs Station approx. 125 km to the northwest of the Project Area[5].

The long-term average annual rainfall, based on rainfall data from 1957-2021, is 425 mm, and the average number of rainy days is 38 per year. Rainfall can, however, be highly variable from year to year.

Within the Project Area it is anticipated that the majority of rainfall is either absorbed by the ground or lost via evaporation and evapotranspiration, with the regional annual average evaporation approximately 2,800, i.e. more than 6 times the annual average rainfall. Evaporation is highest in the months of October and November, which correlates with high temperatures and relatively low rainfall compared to the other summer months.

The coolest months are June/July, when the mean maximum temperature is approximately 27°C and the mean minimum temperature is approximately 11°C. Conversely the summer months are hot, when mean maximum temperatures are in the high 30's and mean minimum temperatures are in the mid-20's. December, for example, has a mean maximum temperature of 38.3°C and a mean minimum temperature of 24.5°C.

[5] https://www.farmonlineweather.com.au/climate/station.jsp?lt=site&lc=15085

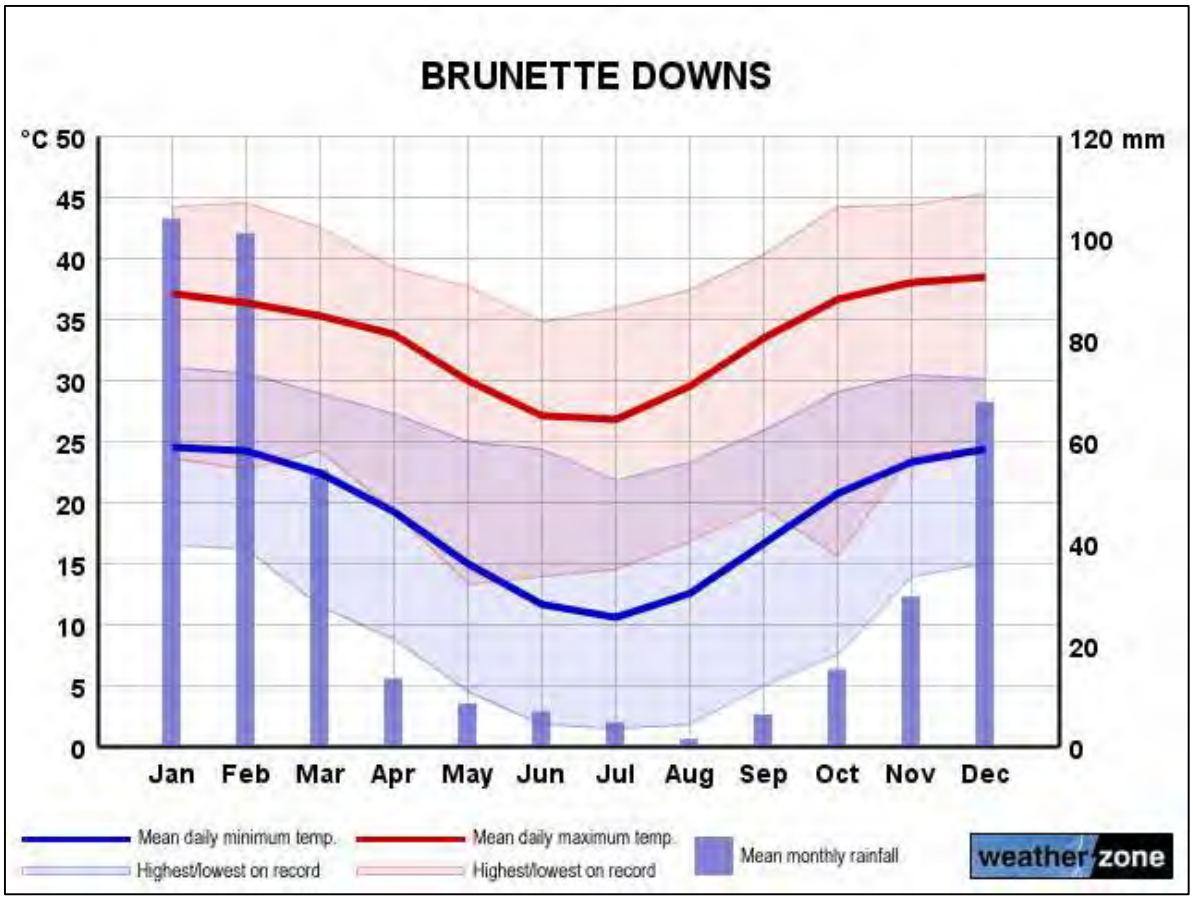

Figure 4: Mean monthly rainfall and temperature data for Elliot

3.2.2 Hydrology

The hydrology of the Project Area reflects the semi-arid climate and unpredictable nature of rainfall patterns. Mittiebah Station is located on the Playford River which originates near Mittiebah Station homestead then runs south and then southwest through Alexandria to Alroy Downs. The Buchanan River is a major tributary of the Playford, joining to the east of Alroy Downs.

There are two major unnamed tributaries that flow east to west into the Playford and a number flowing west to east to join the Playford between Mittiebah Station homestead and Alexandria Station Homestead[6]. The Playford and tributaries are generally dry apart from a number of recorded waterholes that may host archaeological materials. At least one waterhole, outside of the Project Area, is a sacred site (see Attachment A). Archaeological site distribution across northern Australia show a distinct positive correlation with fresh water resources, past or present. Hence the methodology for this survey focused on watercourses along with the drill hole areas.

3.3 Geology and Geomorphology

Outcropping geology is included in this study as it is a useful indicator of the possible stone raw materials available within the project footprint and the distance of the source rock from stone artefact scatters. Outcrops of fine grained sedimentary and metamorphic rocks with isotropic and conchoidal fracture properties were utilised to manufacture flakes, points and other tools used for a variety of

[6] Unnamed in the official 1:250,000 scale Joint Operations Graphic mapping produced by Geoscience Australia. There may be Aboriginal names and local names for these watercourses.

purposes. Fine to medium grained igneous rocks such as basalt and dolerites were used to manufacture flaked and ground edge stone axes. The flat surfaces on sand and siltstones were used to grind foods, sharpen implements and to produce rock art. Sandstone rock shelter surfaces were used for rock art of various types. Therefore, an understanding of the geology of a region is important in predicting the distribution of stone quarries, rock shelters, grinding surfaces and stone artefact scatters.

Whilst a full geological assessment was not undertaken within project footprint, the interpretations in Table 2 below have been derived from field observation coupled with regional outcropping geological information[7]. The surface geology of Mittiebah Station has been extracted from the NT Geological Survey GIS layers and simplified by removing unconsolidated sediment data, including the Mitchell Grass plains to the east of the Playford River, and merging identical units based on Formation and lithic description. This is then mapped and presented below as Figure 7. The primary lithic type and lithic descriptions are present below as Table 2 (Rawlings 2008:65).

Table 2: Outcropping Lithic Descriptions EP144 Project Area

Formation	Primary Lithic Type	Lithic Description	Lithic Description Notes
Crow Formation	Siltstone, sandstone, shale	Interbedded lithic micaceous siltstone and fine-grained sandstone, reddish-brown to grey shale, chalky white claystone, fine- to medium-grained, quartzose to sublithic sandstone; minor local reddish-brown, poorly sorted, feldspathic, micaceous,	ferruginous and lithic, medium- to very coarse-grained sandstone, pebbly sandstone and matrix-supported conglomerate
Ranken Limestone	Limestone	Bioclast and bioclast-ooid rudstone, commonly chertified	
Camooweal Dolostone	Dolograinstone	Intraclast dolograinstone; minor intraclast-ooid dolograinstone, oncoid dolofloatstone	
Crow Formation	Sandstone, conglomerate	White, silicified, fine- to very coarse-grained to pebbly, quartzose to lithic sandstone and local pebble to cobble conglomerate; minor glauconitic sandstone, interbedded white tabular shale and siltstone	
Helen Springs Volcanics	Basalt	Variably altered, locally amygdaloidal basalt and microdolerite: thin basal pebbly sandstone and conglomerate.	Pisolitic and massive ferricrete and laterite
Camooweal Dolostone	Dolostone	Dolostone, dolomitic limestone, planar microbial dololaminite with nodular chert; minor marl	
Wonarah Formation	Limestone, shale, siltstone	Limestone, shale and siltstone, commonly chertified or ferruginised; minor phosphorite; basal quartz sandstone. Predominantly sandy to gravelly skeletal soils, undifferentiated colluvium and alluvium	Predominantly sandy to gravelly skeletal soils, undifferentiated colluvium and alluvium

The dominant geological formation in the Mittiebah from an archaeological perspective is the Wonarah Formation rocks which are described as limestone, shale and siltstone commonly chertified or ferruginised. The Wonarah formation mapping in the Project Area closely corresponds to the chert rich stone artefact scatter located in Drill Hole Area 1 (see Section 6.1 below for results of the survey).

[7] Source: NT Geological Survey 1:250,000 Geological Mapping (Mt Drummond SE5312).

As noted above in Section 3.1, the Mitchell Grass Plains have concentrations of chert pebbles and rocks that are commonly flaked for stone tools.

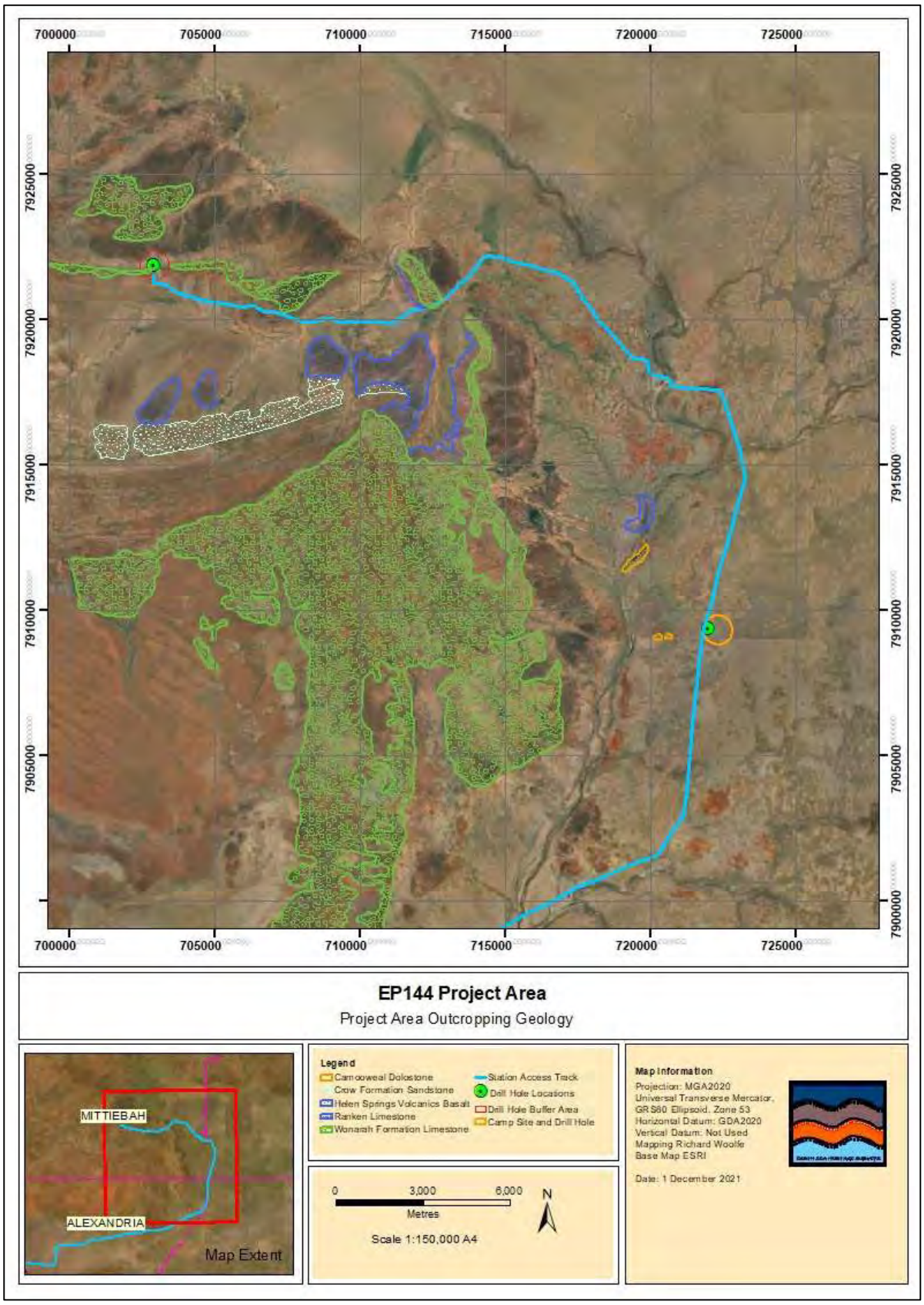

Figure 5: Project Area Outcropping Geology

3.4 Land Disturbance Factors

Land disturbance agents in the project footprint have had significant impact on the pre-contact environment, including:

1. Pastoral impacts within the Project Area have been significant, with land cleared for property infrastructure, intensive grazing, stock watering infrastructure, fencing, permanent yards and changes to the traditional fire regimes. In addition, stock tend to impact on water ways, with hard hooves promoting erosion and thereby increasing siltation of waterholes. It should be noted that Alexandria, including Mittiebah, was stocked in the 1880s, so this damage may have been done very early in the contact period. Changes to the nature of watercourses and waterholes make it difficult to reconstruct the pre-contact environment where Aboriginal stone artefact sites were deposited. Conversely, it is also true that increased erosion around waterways also makes sites and artefacts highly visible in the modern period.

2. Road construction and maintenance: the main road north from Ranken Road to Mittiebah cuts through at least three creek margin stone artefact scatters.

4 Cultural, Archaeological and Heritage Background

4.1 Historical Background.

The first European explorer to transit the Northern Territory was Ludwig Leichhardt, who transited the Gulf Area from Queensland to Port Essington in 1845 with a team of European and Aboriginal explorers. Leichhardt's track was approx. 200 km to the north of the Project Area and while well-watered, was not ideal for a stock route (Powell 2009:57). The Gregory brothers transited the Gulf Region in August 1865 using Leichhardt's route in reverse (Gregory 2002:167). McDouall Stuart followed in 1862 by transiting the Territory between Adelaide and Chambers Bay east of Darwin.

According to Powell (2009:75) the expansion of pastoralism in the Territory was driven by the advent of the Telegraph and the discovery of gold at Pine Creek. In 1870 Millner tried droving sheep along Stuart's route and then toward the Roper. Cattle and sheep were sent north along the Telegraph route in 1872-74, stocking Springvale Station near Katherine and others nearby (Powell 2009:76). Sheep proved untenable in the monsoonal north while cattle thrived.

In 1872, the first cattle were driven from western Queensland to the Territory Goldfields via Leichhardt's route (Powell 2009:76). This was followed by a few other small droving events until 1878, when Nat Buchanan set out from the Rankine River across the Barkly Tableland to the Tennant Creek Telegraph Station (Powell 2009:71). Buchanan, part explorer and part drover, discovered the Mitchell Grass plains to the west of the Rankine River. Ernest Favenc and Frank Scarr led separate parties across the Barkly by different routes, thereby opening up a vast expanse of land suitable for cattle. Between 1880 and 1885, many of the large runs were established across the NT, including Lake Nash, Brunette Downs, Avon Downs and Alexandria Downs on the Barkly. Alexandria Downs became Alexandria in 1877 when the lease was acquired by the North Australia Pastoral Company (NAPCO) who remain the owners of the lease[8]. Mittiebah Station was originally part of the Alexandria lease until resumed by the state in 1965. NAPCO re-acquired the area under the name Mittiebah Station in 2001.

4.2 Ethnohistory

According to the Horton Map (Horton 1996) Mittiebah Station is located at the boundary of three language groups:

1. *Waanyi* People to the north and northeast of the current Mittiebah Station homestead and south of the current Waanyi/ Garawa Aboriginal Land Trust.
2. *Wambaya* People to the northwest of the Playford River south of the current Mittiebah Station homestead.
3. *Wakaya* People to the south and southeast of the Playford River.

The following section draws heavily on the Nicholson River (Waanyi/Garawa) Land Claim Book published by the Northern Land Council in 1982 as part of the anthropological evidence in support of the Waanyi/ Garawa Land Claim (now the Waanyi/ Garawa Aboriginal Land Trust). The evidence provided in the Land Claim Book, along with the Horton Map, suggests that the Project Area lies on the approximate boundary between three major groups, the Waanyi, the Wakaya and the Wambaya. Despite this, the Land Claim Book indicates the closeness of the Waanyi with surrounding groups.

[8] https://napco.com.au/ assessed 2 December 2021

Trigger (1982:5) notes that the southwest corner of the Waanyi claim is said to impinge on Wambaya country.

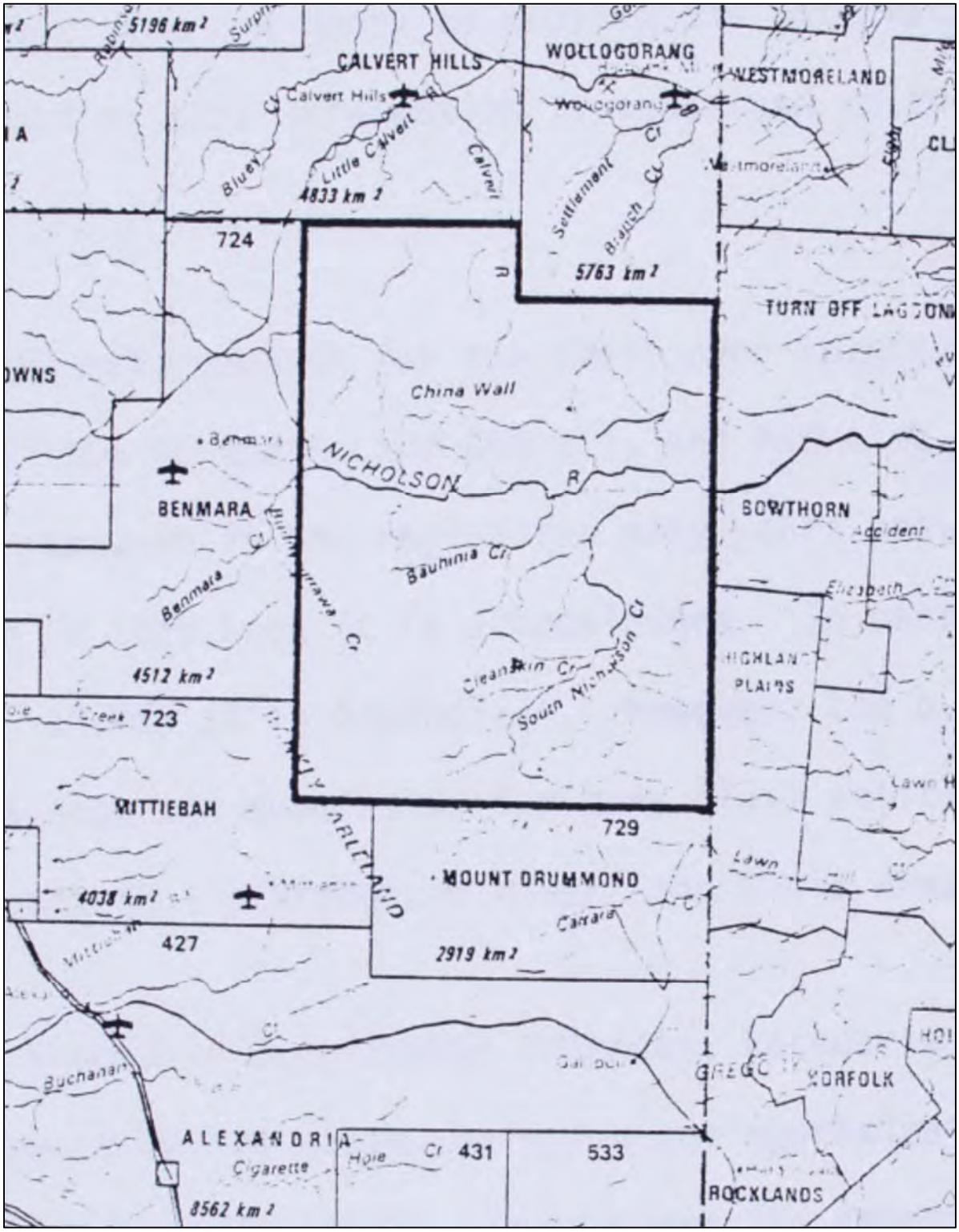

Figure 6: Nicholson River (Waanyi/ Garawa) Land Claim Area 1982. Mittiebah Project Area to SW approx. 30 km

Trigger (1982: 91) notes that the establishment of pastoral leases across most of the Barkly by 1885 led to conflict between pastoral workers and Aboriginal people. The conflict escalated with the establishment of the Turn Off Lagoons Police Station, located west of the modern community of Doomadgee, as a base for the Queensland Native Police. The land claim book notes the killing of whites and cattle and the reprisals by Pastoralists and the Native Police from the 1880s to at least

1910. Aboriginal people moved to escape the violence but continued passive or active resistance where they were. Mixed race children were removed from their families from the 1890s to through to the 1930s. Most went to Darwin, Mornington Island or to Mapoon on the Western Cape. Family relationships exist to the modern era between the estates on the Nicholson and Playford and these three communities. After the 1930s, Aboriginal people from the area moved predominantly to the Doomagee Mission (Trigger 1982:92).

Ethnographic work by Trigger and others note the concepts of time for people in the region. In summary, the informants for the land claim recognise:

1. Wanggala Time: the creative period, the dreaming, when the physical and social universe was shaped. Aboriginal law is created in this time. There is overlap with the next category of 'wild time'.
2. Wild Time: the period before European incursions and subsequent interactions with whites until the people were 'quietened down'. In the wild time, people belonged to bush, in other words the people were hunter gatherers. There were a number of shootings in the Waanyi area and possibly in the Alexandria/ Mittiebah area to the southwest.
3. Station Time: the period when people moved to the cattle stations around to work. People moved off their estates and on to others, sometimes forming close relationships to these lands. Ceremony and hunting still occurred on a widespread scale, maintaining connection to estates despite the changes in lifestyle and economy caused by pastoralism.
4. Mission Time: some people migrated to mission stations and towns such as Elliot, Borroloola and Doomadgee Mission while others stayed working on the Stations. Some worked on surrounding stations while living in the missions, sometimes in very restrictive circumstances.

4.3 Archaeological Background

The current Project Area has been subjected to few if any comprehensive archaeological research to date. The NT Archaeological Database indicates a single stone artefact recorded approx. 45km to the north-northeast of the Mittiebah Station homestead. The lack of comprehensive archaeological research in the Project Area is not due to the paucity of archaeological resources, but rather the lack of investigations in the region. This is particularly the case in northwest Queensland and the north-eastern section of the Northern Territory, despite propositions that this region may have played a significant role in colonisation of the continent (see Horton 1981; O'Connor and Veth 2000). In particular, Horton's (1981) proposed "water and woodland" colonisation model sees the savannah grassland belts of the region (such as the Mitchell Grass Downs) being critical corridors allowing people to move into the interior of Australia in the pre-LGM period.

Suggestions by Veth (1993) and others (e.g. Bird and Frankel 1991; Morwood and Hobbs 1995; Veth *et al.* 2005) that some areas of the better watered parts of Australia (including Lawn Hill, 180 km to the east of the study area (see Magee and Hughes 1982; Hiscock 1984, 1985, 1988) functioned as potential 'refuges' for people during the extremely arid LGM, certainly have support.

Other research, 300 km east of the Project area, has shown regular occupation of the Mitchell Grass Downs for at least the past 1800 years (Wallis et al. 2004; Wallis and Collins 2013). Importantly, from a temporal research perspective, these studies also demonstrate the potential preservation of datable organic material in open sites on the Mitchell Grass Downs. The proliferation of stone artefact assemblages was noted in these studies and in most of the previous mentioned studies proximal to Camooweal. Whilst Wallis and Collis (2013:60,61) suggest that detailed analysis of lithic assemblages

is largely absent from most studies, a number of key site features have been argued to be typical of the region, including but limited to:

- The majority of such sites comprise low density, surface concentrations;
- Silcrete is a dominant raw material along with chert, quartz and quartzite; The Mitchell Grass Plains west of Cammoweal including Avon Downs and Soudan have chert rich surface scatters almost continuously across the plain.
- Assemblages are dominated by unretouched flakes and cores, with few formal tools;
- Most sites are situated either on elevated ridges or creek terraces near major watercourses;
- The overall lack of intensively retouched items implies that for the most part, flakes were manufactured for expedient purposes only;
- Recycling and reuse of materials implies that the scatters were visited repeatedly, probably seasonally; and
- many sites have been disturbed by natural erosion processes, self mulching black soils, cattle trampling or modern development.

Comparable patterns have been noted in most studies closer to Camooweal with the exception for the dominance of silcrete as the raw material. Davies and Baker (1992) recorded an extensive lithic scatter east of Camooweal as part of an optic fibre cable corridor survey that was undertaken between Mt Isa and the Northern Territory boarder. Stone artefact densities of up to 19/m^2 were recorded in some areas. Their survey however was marked with a cautionary reminder for the limitations of sub-sampling as a survey methodology, with a significant site not being recorded on the Georgina River and subsequently destroyed through development (Moore and Sachs 1999).

Bird (1996) conducted the survey for the Georgina Bridge construction project noting a similar assemblage patterning as discussed previously in this section. Bird (1996) noted that artefact scatters were concentrated on both sides of the Georgina River, with artefacts consisting of flakes, cores, core fragments, blades, an adze and debitage. Bird (1996) also observed that all artefacts appeared to have been produced from locally-occurring sources of coloured chert and that the artefactual material covered an extensive area extending up to about 300 to 400 metres out from both river banks. It also extends for at least several hundred metres to the north and south.

Moore (2002:38) noted comparable artefact distribution patterns but further observed that buried archaeological deposits were also common in the skeletal soils of the Georgina River Floodplain; the average maximum depths of these archaeological deposits were 22.8cm. Whereas, excavations undertaken in wooded (Gidgee) black soil areas adjacent to Inca Creek, artefact material was being recovered at depths of up to 60cm, although the numbers decreased at depth (Moore 2005:12). Loy (2004:1) noted during his excavation of the bridge footings on the Georgina River that artefacts were being recovered from depths of 160cm, including hearth features.

5 Survey Methodology

5.1 Heritage Assessment Strategies.

This study employed a *heritage assessment* strategy to assess the likelihood of finding archaeological sites within the proposed impact areas of EP144 including the access road corridor. The *heritage assessment* survey strategy selected representative parts of the Project Area based on experience in similar environmental contexts, including site distribution patterns from regional studies plus geophysical and hydrological data. A stratified sampling methodology was developed ensuring that all representative land units and high-risk environments within the Project Area were adequately assessed[9]. The sampling strategy included:

1. Major creek crossings along the access track. Experience shows that water availability and archaeological site location have a strong correlation.
2. Outcropping geology, particularly rock outcrop that has conchoidal fracture characteristics. The chert lag deposits on the Mitchell Grass Plains and the Wonarah Formation limestones are both potential sources of material.
3. Rock shelters and rock shelter forming geological units have a strong relationship to rock art distribution.

Recommendations for appropriate heritage management strategies were then made based on the likelihood and types of sites occurring within a given land system. If, for example, no cultural heritage features were located during the survey of a given land system or surface geological unit, the methodology was extrapolated to suggest there is a very low risk of impacting sites protected under the NT *Heritage Act* 2011.

5.2 Archaeological Site Definition

5.2.1 Legal Definition NT *Heritage Act* 2011

The NT *Heritage Act 2011* (Sections 6-0) definition of Aboriginal archaeological places and objects as:

6 Meaning of *archaeological place* and *Aboriginal or Macassan archaeological place*[10]

(1) An ***archaeological place*** is a place that:
  (a) relates to the past human occupation of the Territory; and
  (b) has been modified by the activity of the occupiers.

(2) An ***Aboriginal or Macassan archaeological place*** is a place that:
  (a) relates to the past human occupation of the Territory by Aboriginal or Macassan people; and
  (b) has been modified by the activity of those people.

7 Meaning of *object*

(1) An ***object*** is a natural or manufactured object that is moveable.

[9] *High-risk environments* are those which have a high potential for containing cultural heritage features. These environments are identified following comprehensive background research.

[10] The Macassans were a seafaring group that interacted with Aboriginal people on the North Coast of Australia, leaving behind an archaeological record of their temporary camps, villages etc. They are included in the Act but not relevant to this study.

(2) An ***object*** includes an archaeological object but does not include a place.

8 Meaning of *archaeological object* and *Aboriginal or Macassan archaeological object*

(1) An ***archaeological object*** is a relic that:
- (a) relates to the past human occupation of the Territory; and
- (b) is in an archaeological place.

(2) An ***Aboriginal or Macassan archaeological object*** is a relic that:
- (a) relates to the past human occupation of the Territory by Aboriginal or Macassan people; and
- (b) is:
  - (i) in an Aboriginal or Macassan archaeological place; or
  - (ii) stored in a place in accordance with Aboriginal tradition, including, for example, in an Aboriginal keeping place.

9 Meaning of *relic*

(1) A ***relic*** is:
- (a) an artefact or thing given shape by a person; or
- (b) human or animal skeletal remains; or
- (c) something else prescribed by regulation.

(2) An artefact or thing can be of any material.

Examples for subsection (2)

1 A secret or ceremonial object.
2 A log or bark coffin.
3 Human remains.
4 Rock or wood carvings or engravings.
5 Stone tools.

(3) However, an artefact or thing made for sale is not a relic.

(4) In addition, a thing prescribed by regulation is not a relic.

The legal definition above is used in this study with the modification that 'place' is replaced by 'site' and 'object' is replaced by 'artefact'. The Act also separates artefacts made for profit in the recent past (i.e., bark paintings, spears, woomeras etc) with artefacts made in the past as part of Aboriginal people's use of the land.

5.2.2 Recording Archaeological Materials

According to McDonald (2005, p. 172), a landscape approach to recording archaeological materials represents a progression from past approaches which focused on sites alone and failed to recognise archaeological and cultural landscapes at an appropriate management scale. Where there are highly variable densities of cultural materials there is no choice but to define management units beyond the level of the isolated artefacts and sites. This study interprets this approach as meaning that artefacts, sites, continuous scatters and site complexes are related over the landscape, however definitions of each of these categories are necessary to provide an adequate management system for the archaeology of a survey area.

Following this approach, this study uses the following definitions of site type:

1. **Lithic or stone artefact scatters** containing flaked, ground stone artefacts and possibly hearthstones. Contact sites of Aboriginal origin may also include metals or flaked ceramics used for cutting. Artefact scatters may occur as surface scatters of material or as stratified deposits where there have been repeated occupations. Some lithic scatters are called **camp sites** which are high density lithic scatters with hearths and sometimes grindstones. Therefore, camping is the implied activity indicated by the archaeological record in these

places. For the purposes of recording, lithic scatters are divided into categories as outlined below.

2. **Stone Quarry** or primary reduction site. A site where stone for flaked or edge-ground artefacts have been extracted from an outcropping source of stone. This is a broad definition a stone quarry and there are further subdivisions of this site type. According to Hiscock and Mitchell (1993) most surface hard stone quarries have associated reduction sites.
3. **Knapping location**, consisting of one or more knapping floors, are discrete scatters of artefacts, anywhere in the landscape, resulting from stone being worked or reduced at that spot. The criteria for a knapping floor are that the original block of stone can be at least partially reconstructed from scattered flaked stone pieces (Hiscock and Mitchell 1993). A knapping floor can exist as a feature within the context of an open site or archaeological deposit. However, there are certain methodological problems in identifying such features arising from post-depositional processes.
4. **Stone Arrangements** can range from simple cairns to more elaborate arrangements. Some stone arrangements were used in ceremonial activities and represent sacred or totemic sites. Other stone features were constructed by Aboriginal people as route markers, territory markers, and walls of huts, animal traps, hides, or seed traps. Stone arrangements also exist as a result of historical activity, such as mineral tenement markers or isolated grave sites.
5. **Hearths** are a common feature in arid and semi-arid Australia, often comprising a number of stones arranged into a square or round formation. These were used as heat retaining rocks when cooking food. Rocks in hearths will show evidence of heating and are sometimes fragmented. There is often a diversity of raw materials within the hearth. Some, or all, of the rocks may have been brought to the area from a distance.
6. **Rock Art sites** include two main types of rock art, engravings and pounding's where the pattern is one of relief and the pictures were apparently produced by removing material from the rock surface and drawings, stencils and paintings where the material was added to the rock surface. Bees wax designs have also been recorded in the wider region.
7. **Rock shelter occupation sites** contain a deposit of cultural material that has built up over time containing flaked or ground stone artefacts, faunal material and other various items of Aboriginal material culture including ancestral human skeletal remains, wax designs, rock art, grinding hollows, and caches of material culture objects.
8. **Site complexes** are groups of sites in similar landscapes where the cultural materials are effectively continuous. Bird and Hallam (2006, p. 11) described these as integrated cultural landscapes with which have local variations in artefact densities with artefact distributions being effectively continuous.
9. **Culturally modified trees (CMT)** typically result from a sectional removal of bark (and sometimes timber) from a tree trunk or limb. CMTs range from small (15 x 5cm) lenticular apertures such as those resulting from sugarbag procurement, to large canoe CMTs which can present a scar several meters in length.
10. **Aboriginal Wells** have resulted from water procurement activities. These sites can vary in size and form, from hand dug depressions to natural features such as sink holes or drainage depressions. Sources of water across the arid landscape were vitally important in the seasonal land use patterns of Aboriginal people. As the only water source in some areas, wells were carefully curated, often with rocks placed over the entrance to a well to prevent fouling by animals. Rock art (e.g. petroglyphs), grinding groves, stone artefact scatters and sometimes burials are often located in association with wells.

11. **Burial** practises differ considerably throughout cultural groups in Northern Australia, and skeletal material can vary from highly fragmented bones to large burial complexes containing many individuals.
12. **Grinding hollows, grooves, and patches** are the physical evidence of grinding and processing materials on basement rock. Grinding hollows and patches where utilised to grind food and plant materials (i.e. wild rice, seeds, nuts, tubers, bulbs), as well as ochre for painting. Grinding patches and grooves may also have been utilised to prepare edge ground axes during production and maintenance.
13. **Historic/Contact sites** include sites of primarily Aboriginal cultural origin that include 'modern' materials to manufacture flaked artefacts. Sites that include foreign materials, such as glass, ceramics or metal that exhibit modification by Aboriginal people are regarded as *contact sites.*

5.3 Identifying stone artefacts

A requirement for successful Aboriginal archaeological heritage assessment involves the accurate identification of archaeological materials. Since the identification of stone artefacts is basic to the accurate recognition and measurement of the archaeological record, it is imperative that people undertaking archaeological surveys be able to differentiate between natural objects and artefacts. Principles of artefact identification employed in this survey follow those recommended by Hiscock (1984), Holdaway and Stern (2004) and Andrefsky (1998).

In summary, each time sufficient force is placed on the surface of an isotropic rock, it will fracture into two or more pieces. The fragment that has been struck contains the ring-crack, where fracture was initiated, and is called the flake. The flake is usually the smaller of the two pieces of stone. The larger fragment, from which the flake has been removed, is called the core. On both the flake and the core the surface that is struck is called the platform. Flakes are identified by the distinctive surface created when they are removed from the core. The classification of artefacts in this survey was based on identifiable characteristics outlined by Hiscock (1984). For an object to be classed as a flaked artefact, it needed to possess one or more of the following characteristics:

1. A positive or negative ring crack;
2. A distinct positive or negative bulb of percussion;
3. A definite eraillure scar in an appropriate position beneath a platform;
4. Remnants of flake scars (dorsal scars and ridges).

These characteristics indicate the application of an external force to a core. Artefact morphologies will be described by using the four types of artefacts as defined by Hiscock (1984, pp. 128-129):

1. Flake: Flakes exhibit a set of characteristics that indicate they have been struck from a core. The most indicative characteristics are ring-cracks, which show where the hammer hit the core. The ventral surface may also be deformed in particular ways, for example a bulb or eraillure scar.

2. Core: A piece of stone with one or more negative flake scars, but no positive flake scars.

3. Retouched Flake: A flake that has had flakes removed from it, identified by flake scars on or deriving from the ventral surface.

4. Flaked Piece: This is a chipped artefact which cannot be classified as a flake, core, or retouched flake. This category is used only when an artefact was definitely chipped but could not be placed in another group.

Other artefacts and implement types that have been identified in Northern Australia are listed below following characteristics as outlined by McCarthy (1976), Cundy (1989), Kamminga (1982) and Holdaway and Stern (2004):

1. Unifacial Points are flakes that have been retouched along the margins from one surface (either dorsal or ventral) to give or enhance its pointed shape. These unifacial points are sometimes symmetrical or leaf shaped.

2. Bifacial Points and axes are retouched onto both ventral and dorsal surfaces of a flake to enhance or give the artefact its point shape. These points and axes may have the platform removed and the proximal end rounded. Distribution largely in the Top End and Kimberley. Some bifacially flaked implements extend east to Cloncurry and south into the Barkley region and Central Australia.

3. Tulas are a specialised adze like tool common in the arid zones of Central Australia. The tula was a composite tool usually hafted into woomeras or other timber handles. The Tula was characterised a particular reduction sequence and a flake width broader than length. The Tula was resharpened continually until there the remaining blade length was too small for further reuse. At this stage it was commonly replaced in its hafting. The remaining blade is known as a Tula Slug.

4. Edge ground axes. Classified primarily by the shaping process of flaking, pecking and polishing. These generally have only one working edge that has been ground to a sharp margin but there are also examples with two leading edges.

5. Grindstones are characterised by a worn and abraded surface(s). The surface may either have a concave depression or a convex surface.

6. Hammerstones show use wear on the surface in the forms of abrasion, pitting and edge fracturing with some negative scarring from the process of producing stone tools.

7. Pounders are artefacts that are used primarily for processing food and plant materials.

8. Anvils are characterised by abraded and peck surfaces that are the result of using the surface to for bipolar reduction of cores.

5.4 Defining Site Boundaries

It is necessary to define site boundaries for the description of heritage places and the mitigation of impacts on these places. Boundaries of sites are often based on geographic features, such as rock shelters and shell middens, which are defined by easy to distinguish geographic features. Other sites, such as stone artefact scatters, groups of culturally modified trees, culturally significant areas are more difficult to define.

For the purposes of this study, cultural materials are defined as sites, background scatters and isolated artefacts when the following criteria are met:

1. Sites should have average artefact densities more than five times the average density of the background scatter in the same area and exceed five artefacts in at least one metre square.
2. A site boundary exists where the artefact densities are diminished sufficiently to be equal to the background density level or an environmental feature defines a boundary, such as a creek bed.
3. A background scatter is an area where the average artefact density is higher than the average background density but does not exceed five artefacts in a ten-metre diameter area. Effectively, a background scatter is small group of artefacts or a low-density scatter over a wide area that does not constitute a site. This is an arbitrary definition to aid recording in the field, particularly where artefact densities are high enough to make recording individual artefacts impractical but are not high enough to define as a site.
4. Isolated artefacts are single or multiple artefacts that do not satisfy the criteria for a site or a background scatter.

Table 3: Examples of Lithic Scatter types

Lithic Scatter Type	Definition	Example
Isolated Artefact	Single artefact that occurs in the environment as a result of single events, such as a hunter dropping a broken stone tool.	Single Bifacial Point located in an area with few other artefacts. Two flakes located together in an area with few other artefacts. Single artefact along a pathway to a large site.
Background Scatter	Scatter of artefacts across an area or even landscape that are the result of multiple events low intensity events. They may also be the result of post-depositional process, such as in self mulching soils	Small sites that have been disturbed by natural and human process after deposition. Mitchell Grass plains are a common example
Site	Higher density site resulting from multiple past uses.	Creek margin camp site, clusters of artefacts including grindstones, stone reduction sites
Site Complex	A number of sites, background scatters and isolated artefacts in a defined area that represent high intensity use of an area rather than just one location.	Site complexes around large quarry sites where people carried stone resources for further reduction

5.5 Site Recording and Survey Methodology

The survey employed a pedestrian sampling methodology for [redacted]) and the [redacted]. Both [redacted] areas were sampled at approx. 20-30% of total area to ensure understanding of the landscape and archaeological materials on the surface.

Using the methodological approaches outlined above, the following protocols were adopted to adequately record sites and artefacts:

1. The proposed [redacted] areas and [redacted] were mapped using a GIS (using both ArcGIS 10.6 and MapInfo 12.5). Geology and hydrology layers were added to the GIS to indicate areas likely to hold cultural sites/archaeological materials based on the desktop predictive modelling, outcropping geology, and past regional surveys.
2. The proposed survey areas were uploaded to a Trimble Nomad unit using GBM Mobile software and an Android Tablet using MAPPT field GIS software.

3. The sample areas were transacted at approx. 10–20 metre separation by the field team consisting of the following people:
    - Richard Woolfe
    - Raymond Daniell
4. All sites, heritage features and isolated artefacts were recorded using a set of standard recording forms linked to the GIS.
5. The location of all sites was recorded using datum GDA2020. The Nomad has been calibrated to 2-3 metre accuracy in open terrain.
6. The tracks of all transects were recorded using the tracking feature on the Nomad, with land characteristics and images recorded using MAPPT App.
7. Artefacts and historical features were photographed during the course of the survey recording.

The following characteristics are recorded of each site and some isolated artefacts:

1. Location using the UTM coordinate system MGA2020 on Datum GDA2020.
2. Environment: basic details of land unit, geomorphology, vegetation etc.
3. Site boundaries are recorded for each site using the Trimble Nomad and GBM Mobile software. Boundaries beyond the limits of the survey areas not recorded unless they were readily identifiable. In some instance it was likely the site boundaries extended hundreds of meters beyond the boundary of survey areas.
4. Site contents: basic details of types of artefacts, estimated density ($1m^2$ sample counts), raw materials etc.
5. Ethnographic origin: Aboriginal, European historical, etc.
6. Cultural and archaeological significance.
7. Disturbance factors, such as animal activity, erosion or road works.
8. Site visibility: estimate of how much of the ground surface was visible on site and in the surrounding area.
9. Estimation of the potential for sub-surface artefacts.
10. Site and artefact images. Images of artefacts in larger sites are a representative sample.

The results of this survey, along with a map of transects completed are presented in the next section.

6 Survey Results

6.1 Results Summary

The survey recorded [redacted], [redacted] and [redacted] during the two-day survey. Sites were located in three environmental contexts:

1. Site AS001 and [redacted] were located on the [redacted] area [redacted]. Chert was the dominant raw material recorded in these scatters, with sandstone portable grindstone fragments (less than 2%). Low density background scatters are common in Mitchell Grass plain contexts due to the presence of chert nodules in the soil.
2. Sites AS002, AS003 and AS004 were located [redacted]. These sites had high [redacted], indicating use over extended periods in the past, associated with the presence of [redacted]. They were possibly stop over points used by people transiting the area.
3. The [redacted] were likely associated with the recorded Sacred Site (6260-6) located on a [redacted]. The conditions of the Restricted Work Area associated with 6260-6 prevented the survey team from accessing the [redacted], however it was noted that [redacted] increased in density closer to the sacred site. Artefacts recorded in this area had a high type diversity, including [redacted]. Most [redacted] were chert, however some quartzites, sandstones and a quartz flake were recorded.

Table 4: Aboriginal archaeological sites recorded during survey

Site Name	Site Type	Site Description	Artefact Type	Raw Materials	Easting	Northing
AS001	Minor lithic scatter	High density artefact scatter	Flakes, broken flakes, flaked pieces, cores	Chert	[redacted]	[redacted]
AS002	Minor lithic scatter	Low density scatter with higher density clusters. Located on creek margins.	Flakes, flaked pieces, bifacial point, hammerstone	Chert, quartzite, chalcedony, sandstone	[redacted]	[redacted]
AS003	Minor lithic scatter	Low density scatter with higher density clusters. Located on creek margins.	Flakes flaked pieces, bifacial point, hammerstone	Chert, quartzite, chalcedony	[redacted]	[redacted]
AS004	Lithic scatter	Low density scatter with higher density scatter	Flakes, broken flakes, bifacial point, core, flaked pieces, tula blade, tula slug (3), retouched flakes	Chert, Quartz, Sandstone,	[redacted]	[redacted]
BS001	Background scatter	Low density artefact scatter on low gravelly rise	Flakes, flaked pieces, retouched flakes, cores	Chert	[redacted]	[redacted]
BS002	Background scatter	Low density artefact scatter on low gravelly rise	Flakes, flaked pieces	Chert	[redacted]	[redacted]

Table 5: Summary of site archaeological attributes

Site Name	Site Type	Artefact Type	Raw Materials	Area (sq metres)	Max Artefact Density	Est Total Artefacts	GSV
AS001	Minor lithic scatter	Flakes, broken flakes, flaked pieces, cores	Chert	80	[redacted]	[redacted]	50
AS002	Minor lithic scatter	Flakes, flaked pieces, bifacial point, hammerstone	Chert, quartzite, chalcedony, sandstone	215	[redacted]	[redacted]	70
AS003	Minor lithic scatter	Flakes flaked pieces, bifacial point, hammerstone	Chert, quartzite, chalcedony	4000	[redacted]	[redacted]	70
AS004	Lithic scatter	Flakes, broken flakes, bifacial point, core, flaked pieces, tula blade, tula slug (3), retouched flakes	Chert, Quartz, Sandstone,	5360	[redacted]	[redacted]	60
BS001	Background scatter	Flakes, flaked pieces, retouched flakes, cores	Chert	880	[redacted]	[redacted]	90
BS002	Background scatter	Flakes, flaked pieces	Chert	731	[redacted]	[redacted]	80

Table 6: Isolated artefacts recorded during survey

Name	Type	Raw Material	Retouch	Easting	Northing
001	Flaked piece	Chert	NR	[redacted]	[redacted]
002	Portable grindstone	Sandstone	NR		
003	Flaked piece	Chert	NR		
004	Rotated	Chert	NR		
005	Flake	Chert	Minor		
006	Tula slug	Chert	NR		
007	Flaked piece	Chert	NR		
008	Flake	Chert	NR		
009	Tula slug	Chert	NR		
010	Flaked piece	Chert	NR		
011	Portable grindstone	Sandstone	NR		
012	Flake	Chert	One Margin		
013	Tula blade	Chert	NR		
014	Flake	Chert	Two		
015	Portable grindstone	Sandstone	NR		
016	Flaked piece	Chert	NR		
017	Flaked piece	Chert	NR		
018	Flaked piece	Chert	NR		
019	Flake	Chert	One margin		
020	Flake	Chert	Two margins		
021	Flake piece	Chert	No		
022	Flake	Chert	No		
023	Flake	Chert	No		
024	Flake	Chert	No		
025	Flake	Chert	No		
026	Portable grindstone	Sandstone	No		
027	Flake	Quartz	No		
028	Flake	Chert	No		
029	Flake	Chert	No		
030	Flake	Chert	No		
031	Flake	Chert	No		
032	Uni core	Chert	No		
033	Flake	Chert	No		
034	Portable grindstone	Chert	No		
035	Flake	Chert	No		
036	Uni core	Chert	No		
037	Uni core	Chert	No		
038	Uni core	Chert	No		
039	Flake	Chert	No		

Name	Type	Raw Material	Retouch	Easting	Northing
040	Flake	Chert	No	[redacted]	[redacted]
041	Uni core	Chert	No	[redacted]	[redacted]
042	Flake	Chert	No	[redacted]	[redacted]
043	Flake	Chert	No	[redacted]	[redacted]
044	Flake	Chert	No	[redacted]	[redacted]
045	Uni core	Chert	No	[redacted]	[redacted]
046	Flake	Chert	No	[redacted]	[redacted]
047	Flake	Chert	No	[redacted]	[redacted]
048	Flake	Chert	No	[redacted]	[redacted]
049	Flake	Chert	No	[redacted]	[redacted]
050	Flake	Chert	No	[redacted]	[redacted]
051	Uni core	Chert	No	[redacted]	[redacted]
052	Flake	Chert	No	[redacted]	[redacted]
053	Flake	Chert	No	[redacted]	[redacted]
054	Uni core	Chert	No	[redacted]	[redacted]
055	Uni core	Chert	No	[redacted]	[redacted]
056	Flake	Chert	No	[redacted]	[redacted]
057	Flake	Chert	No	[redacted]	[redacted]
058	Uni core	Chert	No	[redacted]	[redacted]

6.2 Site Distribution Maps

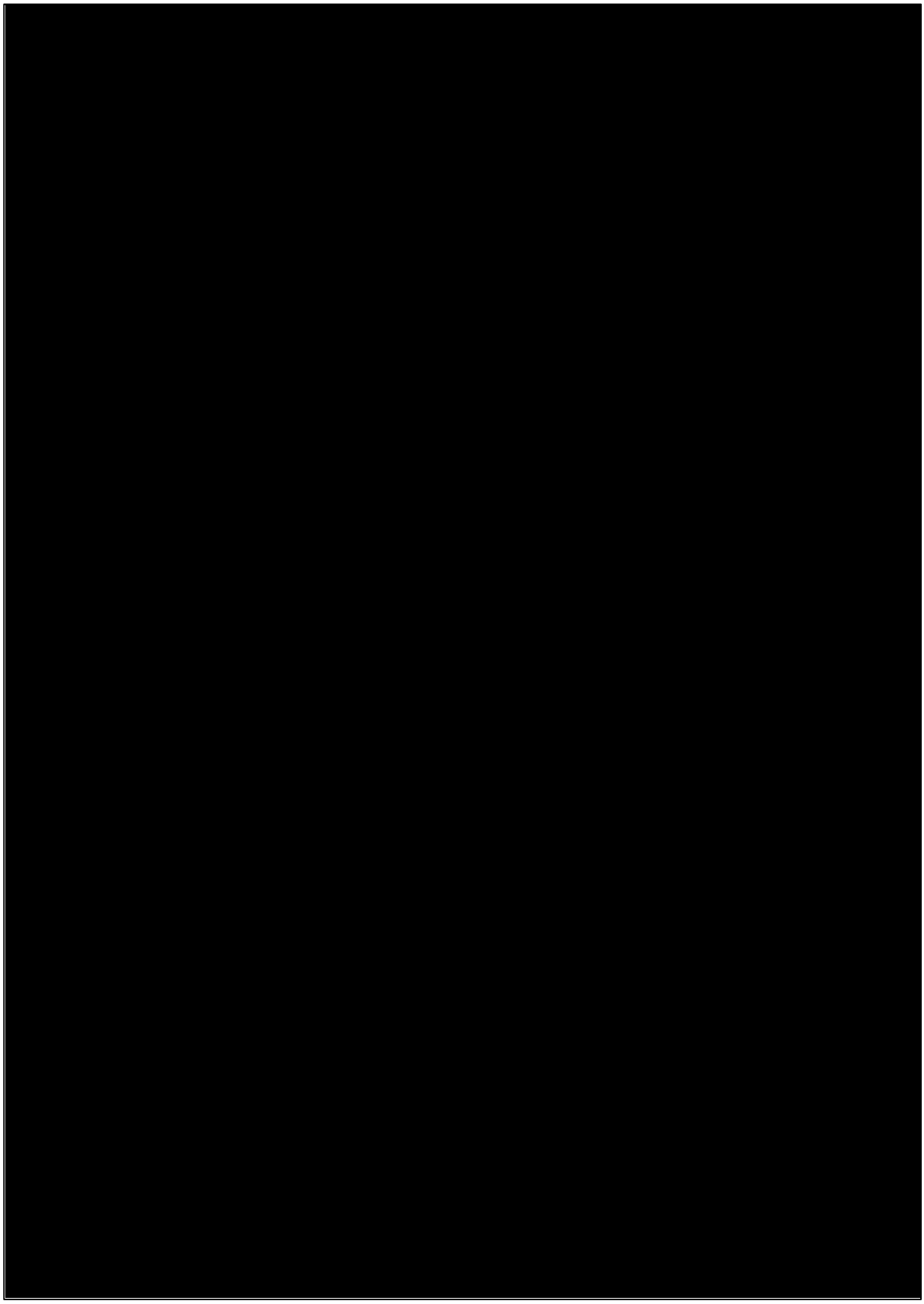

Figure 7: Site Distribution Map, Drill Hole Area 1

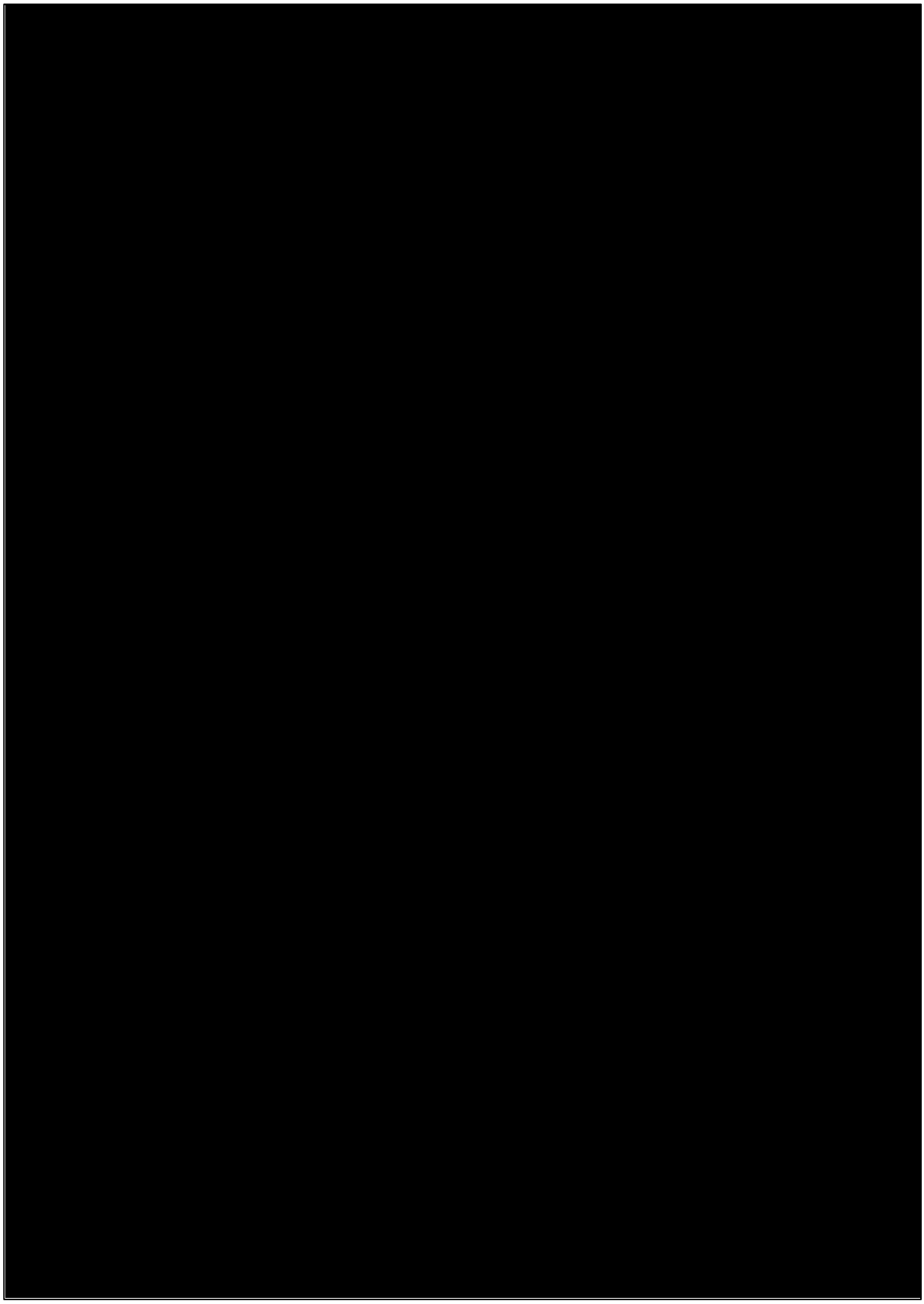

Figure 8: Site Distribution Map, Sites AS002 and AS003, Access Road, Playford River System

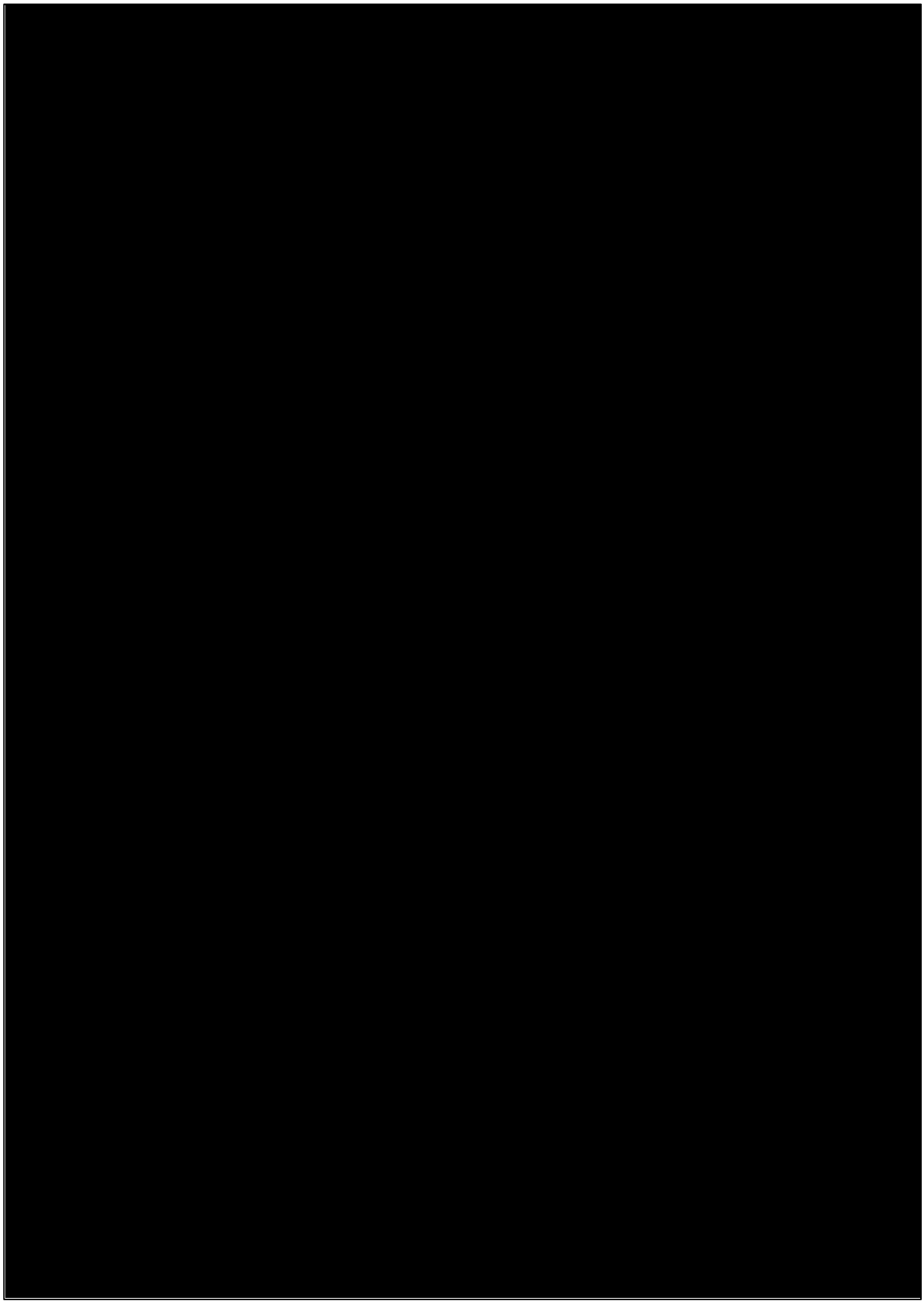

Figure 9: Site Distribution Map, Site AS004, Access Road, Playford River System

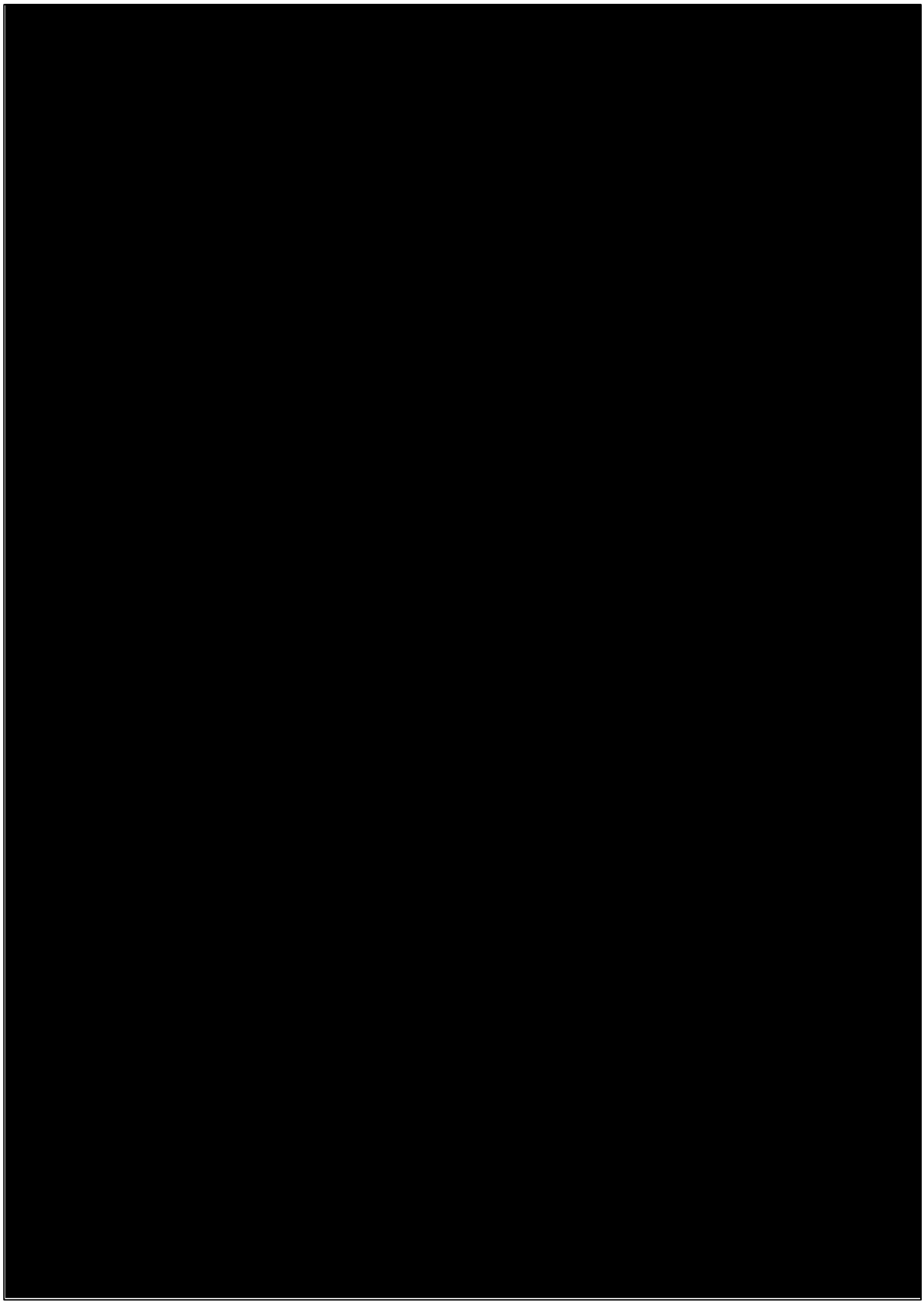

Figure 10: Site Distribution Map, Drill Hole Area 2 and proposed camp site.

6.3 Site and Isolate Images

Figure 11: Bifacial Point as isolated artefact in Drill Hole 1 Area.

Figure 12: Tula slug as an isolate Drill Hole Area 1

Figure 13: Chert bifacial point, Site AS003. Note tip breakage.

Figure 14: Site AS001 Mitchell Grass Plain exposure. Small site on gravel surface.

Figure 15: Chert artefact Site AS001

Figure 16: Small background scatter (BS002) on slightly raised gravel surface, Mitchell Grass Plains

7 Cultural Heritage Significance Assessment

7.1 Significance Assessment Guidelines

Cultural heritage management in Australia is underpinned by legislation, coupled with the ethics and principles established by heritage management practice over the last 50 years. In addition to statutory law, several guidelines have been developed to support the protection and management of Aboriginal heritage, including archaeological sites:

1. Ask First, A guide to respecting Indigenous heritage places and values (2002);
2. Engage Early, Guidance for proponents on best practice Indigenous engagement for environmental assessments under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (2016); and,
3. Practice Notes for the Australian ICOMOS Burra Charter 2013 (hereafter referred to as the "Burra Charter"). Legislative basis for the protection and conservation of Indigenous archaeological places and objects within the Project Area is discussed in Section 2.

The cultural heritage values of sites and objects recorded during the survey followed key Indigenous heritage management and significance assessment principles from the Burra Charter Practice Note, 'The Burra Charter and Indigenous Cultural Heritage Management, 2013' (see also The Burra Charter and Archaeological Practice, 2013). These are summarised below for reference:

Place	*Includes locations that embody spiritual value (such as Dreaming places, sacred landscapes and stone arrangements), social and historical value (such as massacre sites), as well as scientific value (such as archaeological sites). In fact, one place may be all of these things or may embody all of these values at the same time.*
Cultural Significance	Is very broadly defined to *include 'aesthetic, historical, scientific, social or spiritual value for past, present or future generations'. This definition captures places of cultural significance to Indigenous cultures. It also includes places that provide a physical location that is integral to the existence, observation and practice of intangible heritage. The Burra Charter definition of cultural significance encompasses all forms of spirituality, regardless of the culture from which it emanates. Similarly, aesthetic value is not limited to a 'western' perception of aesthetics.*
Knowledge and expertise of Indigenous peoples	*It is critical that assessments of cultural significance for Indigenous heritage places reflect the views and input of the relevant Indigenous knowledge-holders.*
Precise Assessments	*Practitioners must define the location and form of a place, and the values that it embodies, with sufficient clarity to inform an assessment or the development of policy.*
Changing Values	*Assessments of significance need to be responsive to the dynamic nature of Indigenous cultures.*
Defining Site Boundaries	*Assessments of significance that concentrate on the visual characteristics of a place and use those characteristics to establish a 'boundary' for the place, may fail to appreciate its broader cultural or spiritual setting.* Importantly, *heritage practitioners must not inappropriately privilege tangible places and objects over the intangible aspects of heritage.*

Maintenance, preservation, restoration, reconstruction and appropriate 'change' can be culture dependent	*Practitioners may identify conservation needs and responses that are at odds with those identified by the traditional owners of a place, with the potential for misunderstanding and conflict.*

These principles outlined in the Burra Charter are generally those by which most cultural heritage practices in Australia are determined, including the assessment of significance of individual heritage places and objects.

In summary, cultural heritage landscapes, places, sites and objects can be significant in a number of ways:

1. Significant to a group or many groups of people due to their connection to the past.
2. Significant to a specific group of people because they have religious or spiritual significance to those people (Sacred Sites, Dreaming Sites or Story Places for example),
3. Significant to a group or many groups due to the relationship of place in the wider context of an ecological and cultural landscape.
4. Significant because of their research potential: their importance of the site in answering questions about past and in some instance's current human behaviour.
5. Significant due to their representativeness or uniqueness: sites or places that are rare or unique and are therefore conserved as a representative example.

Following the assessment of significance, the future conservation of a heritage place is decided by weighing up the level of assigned significance against the practicality of conserving the place. In terms of Indigenous archaeological sites, these decisions should be made in direct consultation with Traditional Owners and guided by their views and input. To assess the practicality of conserving a heritage site, regulatory mechanisms are usually used to assess the condition of the place (whether it will survive for much longer) and the economic implications of deciding to apply permanent heritage protection.

7.2 Assessment Principles of Scientific and Research Significance

Scientific and research significance, including archaeological significance, is determined by assessing the ability of an object, site or area to add to the scientific knowledge of history or pre-history. This scientific knowledge for example, may include the ability of an object, site or area to provide an insight into past social patterns (e.g. trade and exchange networks), technologies, substance patterns, timings of occupation, and/or paleoenvironmental conditions.

Accordingly, in general the more information an object, site or area can add to understanding the past, the higher its scientific significance. Notwithstanding this, some sites or object may also have higher levels of scientific significance due to its aesthetics, rarity and representativeness rather than an ability to inform greater details about the past. Areas or sites so judged are often recorded in detail or conserved *in situ* because they may add to our understanding of the past. It also may involve conserving a place until all practical scientific observations can be made, for example, in the salvage of artefact scatters before a development commences.

Outside of research significance, archaeological sites such as stone artefact scatters, camp sites and quarries can also have an educational role in helping non-Indigenous people understand some aspects of traditional Aboriginal lifeways.

7.3 Significance of Cultural Heritage Features within the Project Area

A total of [redacted] and [redacted] were recorded during the survey. In general, the recording of the archaeological features was relatively brief owing to survey schedule limitations due to the remoteness of the Project Area and transect distances. Despite this, the attributes recorded for each site included: locational data, brief site descriptions, artefact sample counts, geomorphic and environmental contexts, condition and a photographic record. This information has been used to provide a significance rating for each archaeological site. Individual site significance assessments are presented in Table 7 below.

The [redacted] recorded in this survey are considered to be of low archaeological significance due to their general poor condition, their relatively small size and lack of rarity (similar sites are common throughout the region and across the NT). In addition, [redacted] such as these, can have scientific constraints due to bioturbation and other disturbance factors, thus limiting their depositional integrity and dating potential.

Despite this assessment, all sites are protected under the Act until the Minister or Heritage Council make a decision on their conservation or otherwise. Therefore, for practical reasons, all sites recorded in this study should be avoided unless there are no other alternatives (see Section 8 Recommendations below).

Table 7: Site significance assessments

Site Name	Site Type	Site Condition	Site Disturbance Factors	Archaeological Significance	Management
AS001	Minor lithic scatter	Medium	Cattle	Low	Avoid site where possible.
AS002	Minor lithic scatter	Poor	Cattle	Low	Avoid site where possible.
AS003	Minor lithic scatter	Poor	Erosion, track excavations, cattle	Low	Avoid site where possible.
AS004	Lithic scatter	Poor	Cattle, road, erosion	Low	Avoid site where possible.
BS001	Background scatter	Medium	Nil noted	Low	Avoid site where possible.
BS002	Background scatter	Medium	Nil noted	Low	Avoid site where possible.

8 Recommendations

The following section outlines general and area specific recommendations for Minerals Australia to mitigate impacts on Aboriginal archaeological sites in the EP144 work areas, ensuring compliance with the relevant legislation while allowing work to continue.

8.1 Potential for Previously Undetected Aboriginal Cultural Heritage

All representative land units within the EP144 Project Area were sampled as part of the archaeological assessment with additional targeted surveys of all [redacted] along the [redacted] The results of the survey can be summarised as:

1. [redacted]
2. [redacted] was sampled at approx. 20% of the surface area. A number of isolated artefacts were located there, but no sites. There is a large Sacred Site Restriction Works Area in [redacted].
3. [redacted] area was sampled at approx. 15%. A small [redacted] were located along with a number of isolated [redacted] appear to be located across the [redacted] however there is some variability in density. This is consistent with other findings in similar terrain (i.e. Keys and Memmott 2016).

Based on the results of this survey it is likely unrecorded archaeological features remain in some unsurveyed land units throughout the Project Area. It is also possible some undetected archaeological features may have been obscured by vegetation or sediment within the survey transects, however, these would be largely restricted to additional isolated finds or concentrations of stone artefacts. Additionally, there is a high potential for [redacted].

8.2 General Recommendations

This report recommends for following general recommendations:

1. Avoid impacts on Sacred Sites. The AAPA Authority Certificate conditions should be adhered to without exception. The Restricted Works Area in [redacted] is a no work/ no entry area. All staff and contractors should be made aware of these restrictions via inductions and toolbox meetings.
2. Avoiding impacts on recorded [redacted] unless there is no other alternative.
3. If there is no alternative to impacting on [redacted], then Minerals Australia Pty Ltd should seek a permit to [redacted] under Section 72 of the NT *Heritage Act*. The consultants can assist in this process.
4. All staff and contractors should be made aware of the existence of protected Aboriginal cultural and archaeological materials though site inductions and toolbox meetings.

8.3 Area Specific Recommendations

This report recommends the following in regard to individual sites recorded in this survey:

1. [redacted]
2. [redacted] An area of lower artefact density is shown on

Figure 19 below. It is recommended that the [redacted] A permit to disturb archaeological artefacts should also be considered with this approach. As the area has fewer artefacts, it may be possible to seek an administrative permit to disturb as per note below.

3. [redacted] (6360-3) noted on the Authority Certificate attached. [redacted]

8.4 Discovery of Human Remains

If human remains are discovered in the course of works, it is recommended that all work stop immediately, the area is flagged off and the Site Manager/ Supervisor call the Police and the Director of Heritage, NT Department of Territory Families, Housing and Communities.

8.5 Note of Permits to Disturb Archaeological Sites or Artefacts NT Heritage Act

As per Section 2.1.2 of the NT *Heritage Act* there are permit processes in place to disturb Aboriginal archaeological sites and artefacts. In all applications the proponent will be required to consult with the Aboriginal custodians of sites in the area prior to being granted a permit. In recent years, a fast permit approval process has been established to grant faster approvals for small numbers of isolated artefacts assessed as being of low archaeological and cultural heritage significance. The full process, applied to larger sites, will take longer to complete. For this reason, it is often expedient to avoid archaeological sites and artefacts where possible.

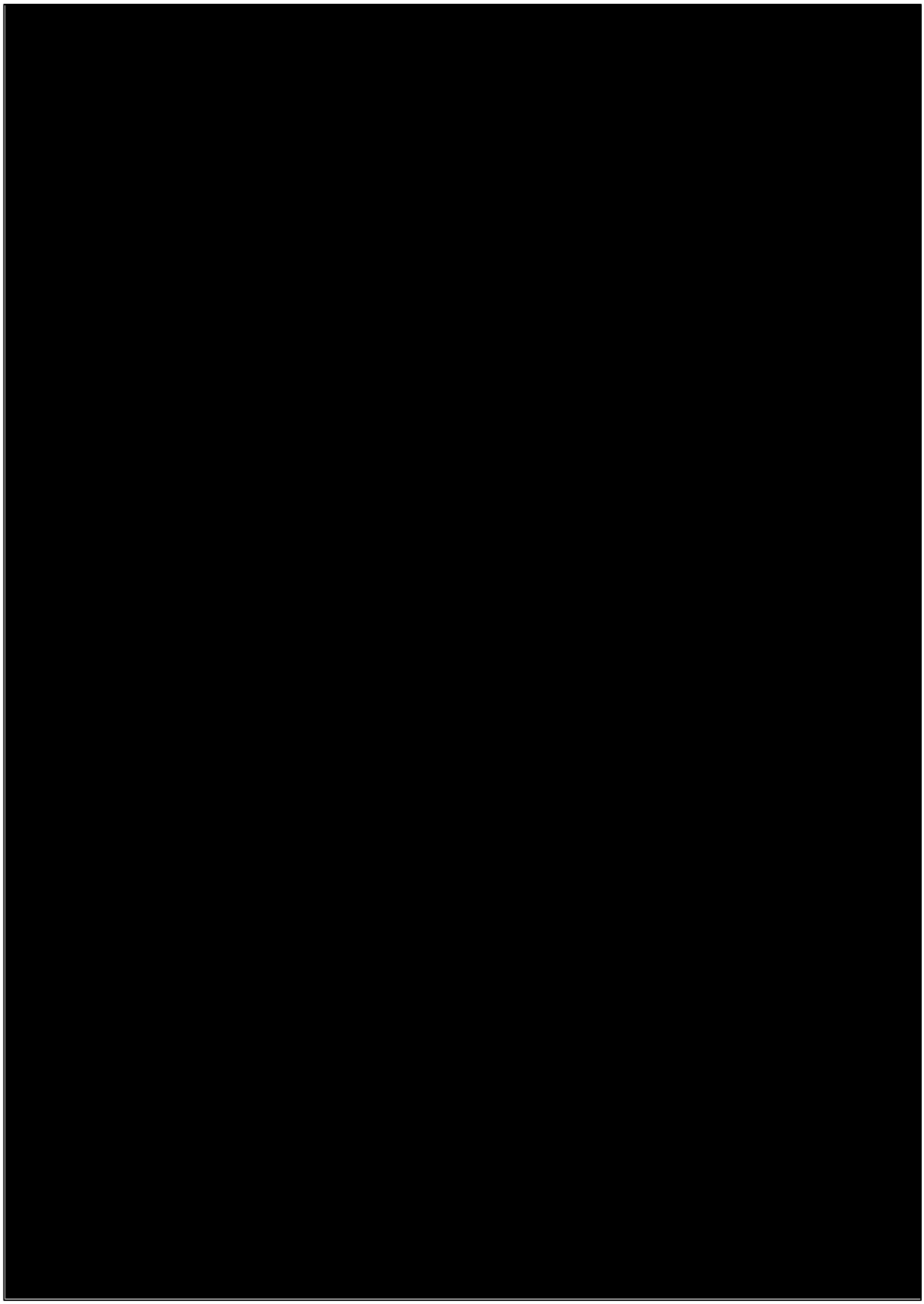

Figure 17: Low Artefact Density Area DH2 Camp Site

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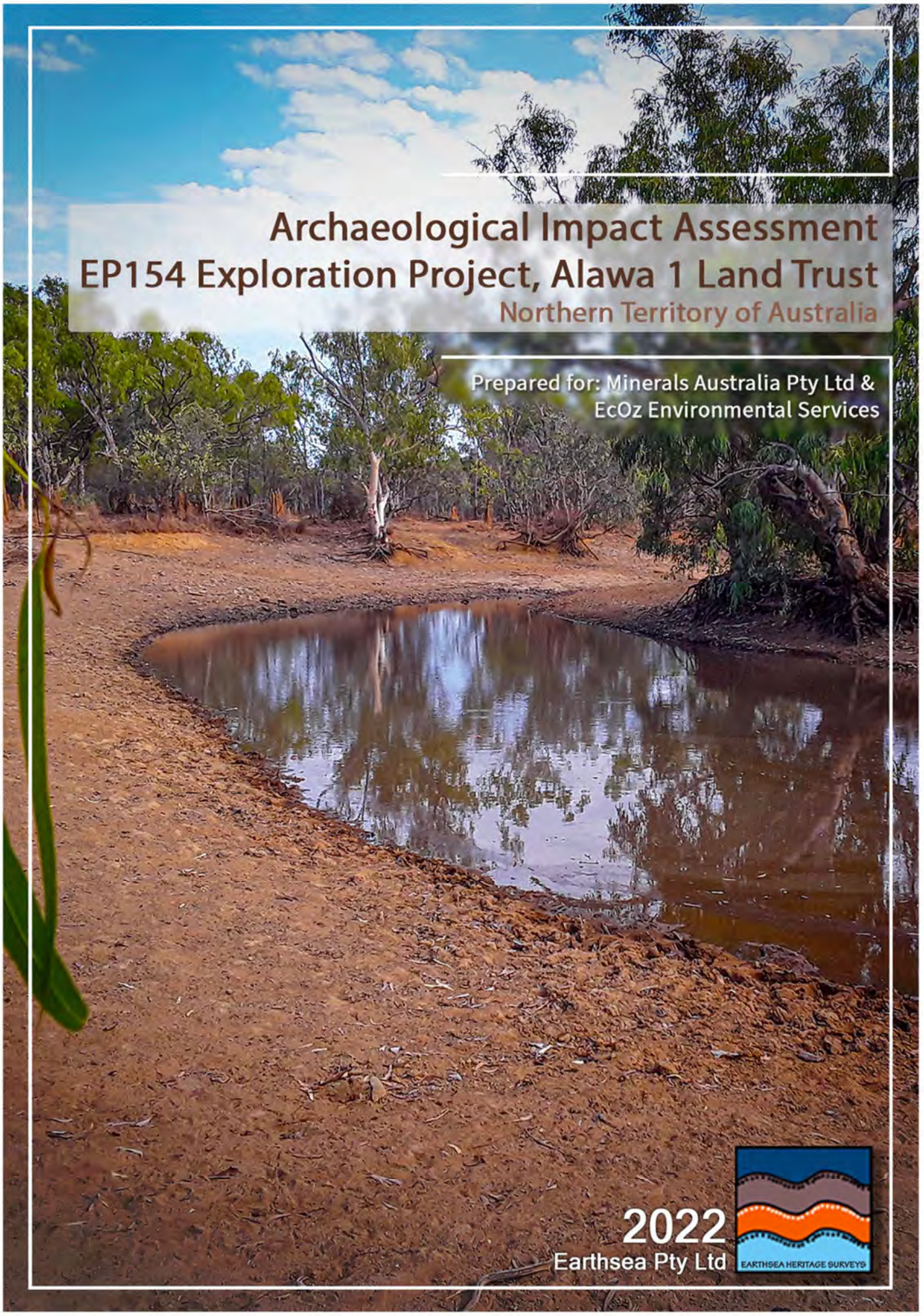
Appendix 1: AAPA Authority Certificate EP144

APPENDIX D ARCHAEOLOGICAL SURVEY REPORT EP154



Archaeological Impact Assessment
EP154 Exploration Project, Alawa 1 Land Trust
Northern Territory of Australia

Prepared for: Minerals Australia Pty Ltd &
EcOz Environmental Services

2022

Earthsea Pty Ltd

EARTHSEA HERITAGE SURVEYS

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Prepared for: **Minerals Australia Pty Ltd and EcOz Environmental Services**

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1 Introduction

Earthsea Pty Ltd (Earthsea) has been engaged by EcOz Environmental Services, on behalf of Minerals Australia Pty Ltd to undertake a Heritage Impact Assessment (HIA) of their seismic exploration program on EP154, a petroleum lease on the Alawa 1 Land Trust area in the Roper Valley, Northern Territory.

Minerals Australia are proposing to conduct an exploration program consisting of 43.6 km of seismic lines within a 100-metre-wide corridor on EP154 (see Figure 1 and 2 below). In addition, a stratigraphic drill hole will be located within a 250 x 250 metre area in the southern section of the Project Area. An existing track 5.73 km long will be upgraded where necessary and an access road 7.86 km long will be constructed to facilitate the movement of heavy machinery.

An archaeological field assessment, coupled with a desktop study, was used to analyse potential risks to archaeological resources and areas of cultural significance within the proposed drill area. Archaeologist Richard Woolfe undertook the field assessment on site between 28 September and 2 October 2021. The field team consisted of Senior Traditional Owners Trevor Willie and Bradley Farrar, Earthsea Field Assistant Raymond Daniell and Richard Woolfe.

1.1 Scope of the Study

This study and report centred on assessing the significance and potential impacts to heritage features protected by the *NT Heritage Act 2011,* which include but not are limited to: archaeological sites of Aboriginal origin and some historical features associated with the post-contact to modern period. Sacred Sites as defined by the NT *Aboriginal Sacred Sites Act* 1989 have been assessed by the Aboriginal Areas Protection Authority (AAPA) prior to the archaeological survey. The resulting Authority Certificate is attached to this report as Attachment A (see also Section 2.1.2 on legislation).

The aim of the study was to develop a Heritage Impact Assessment (HIA) that identifies cultural heritage risks for the Project and establishes management strategies to mitigate impacts on Aboriginal archaeological sites and other heritage places during construction and operation of the exploration project:

1. Identify archaeological features within or proximal to the Project Area.
2. Provide a geophysical background to the area focusing on Indigenous land use practices and their impact on the archaeological record.
3. Provide an ethnographic and historical background to the Project Area.
4. Identify any archaeological or cultural heritage constraints, potential impacts, and risks within the proposed Project Area.
5. Detail the cultural and scientific significance of each archaeological feature identified and recommend mitigation strategies.
6. Develop management strategies and measures to minimise harm to Aboriginal and historic cultural heritage features and other areas of cultural significance.

1.2 Project Location, Land Tenure & Native Title

1.2.1 Project Location and Land Tenure

The EP154 Project Area is located to the south of the Roper Highway either side of the Minyerri Road on the Alawa 1 Aboriginal Land Trust (NT Portion 671) and the Kewulyi (Roper River) Aboriginal Land

Trust (NT Portion 4777). Both portions were granted under the provisions of the Commonwealth *Aboriginal Land Rights (Northern Territory) Act* 1977. Both portions are freehold title under special conditions mandated by the Act. The owners are represented by the Northern Land Council.

EP154 is a petroleum exploration permit owned by Minerals Australia Pty Ltd and Jacaranda Minerals Ltd acquired on 20 March 2015. The joint venture is managed by Minerals Australia Pty Ltd with the exploration work to be undertaken by Minerals Australia Ltd (see Figure 2 below). The Project Area consists of 43.6 km of seismic line and 5.73 km of existing access track. A stratigraphic drill hole is located in the southwestern section of the Project Area within a 250 x 250 metre area. The original Hodgson Downs Station (Warrigundu Station) was purchased by the Aboriginal and Torres Strait Islander Commission in 1990 for the Alawa people.

1.2.2 Native Title

A search of the National Native Title Register on 1 November 2021 indicates that there are no native title claims, determinations, or Indigenous Land Use Agreements (ILUA) active in the Project Area. There may be an agreement between the proponent and the Aboriginal Land Trust representatives for the project, however this wasn't available to the consultants.

There is a native title claim on the adjacent property to the south of EP154 on parts of NT Por 700 Hodgson River Station (Pastoral Lease Number 1010): Native Title Determination NTD21/2013. The native title claim has been made by the following five estate groups:

- Murungun Yunulalda estate group
- Budal Lirijal estate group
- Mambali Amaling-Gan estate group
- Murungun Igalumba estate group; and
- Mambali Lajarirr estate group.

The above native title claim has been made on land outside the Project Area (i.e. EP153) and is not impacted by activities associated with EP154.

1.2.3 Sacred Sites

Minerals Australia were issued with Authority Certificate C2021/049 under the NT *Aboriginal Sacred Sites Act* 1989 on 28 July 2021 (see Section 2 below for more details on the Act and its application). Fifteen Recorded Sacred Sites and one Registered Sacred Site are shown on the certificate map. Certificate C2021/049 (Attachment A) details two Restricted Work Areas (RWAs) that are of interest to this Project:

[redacted]

[redacted]

It is important to note that the AAPA Certificate and attached map should be referenced by the company and its contractors in making decisions on where drilling should occur.

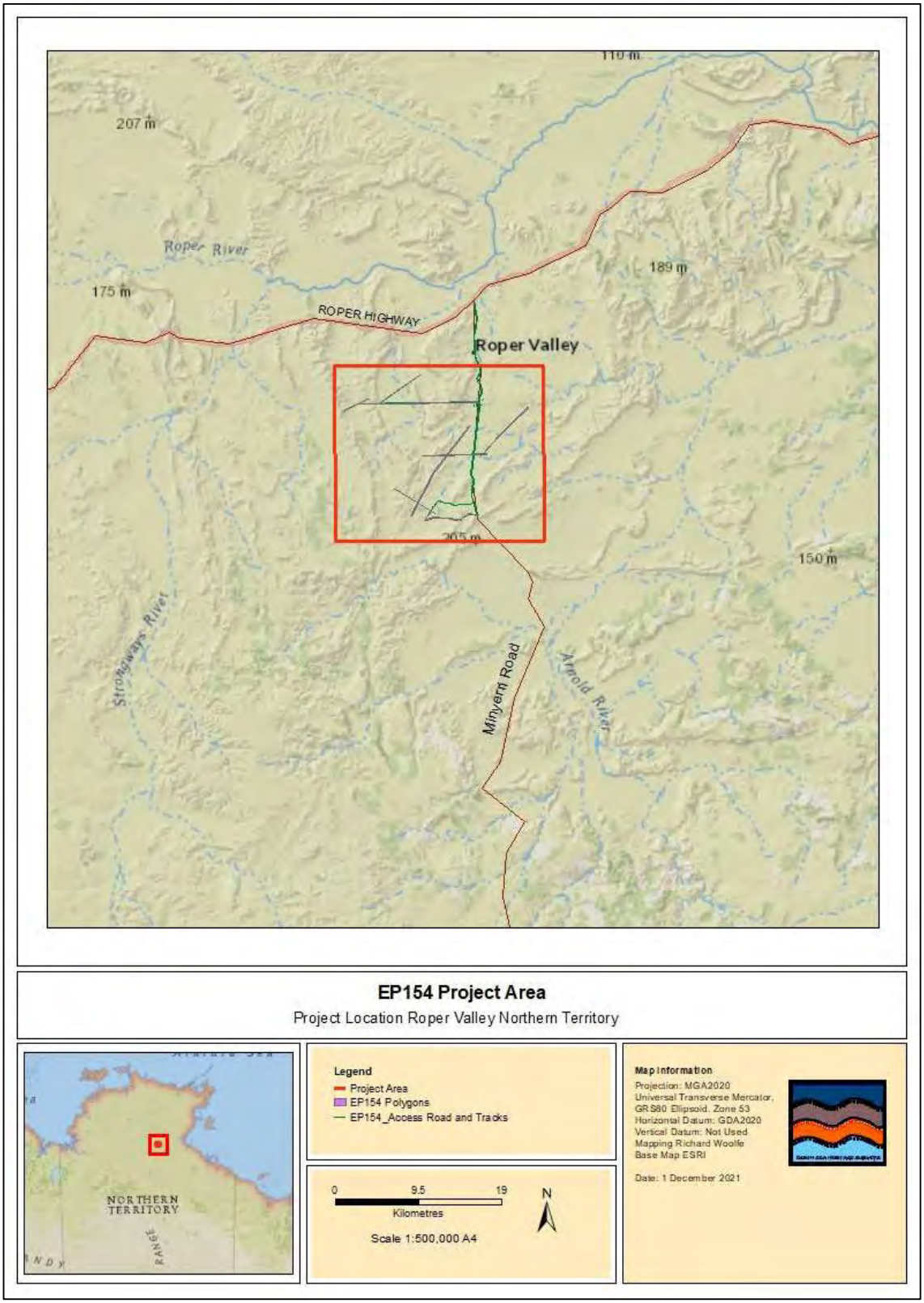

Figure 1: Project Location EP154 Roper Valley Northern Territory

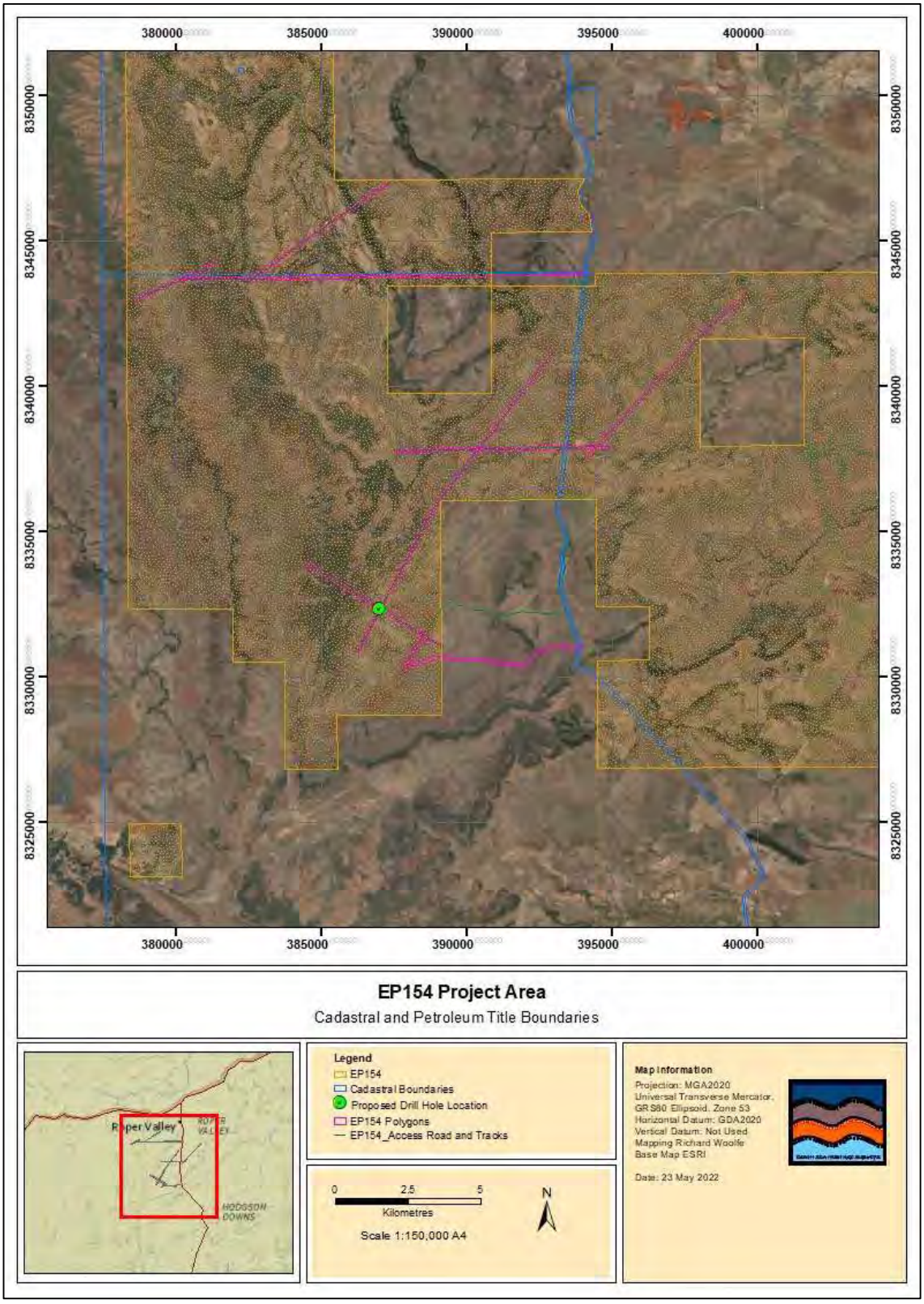

Figure 2: EP154 Project Area with Petroleum Title and Cadastral Boundaries

1.3 Consultation

Project Manager Ben Keys consulted with the Northern Land Council to arrange two Traditional Owner representatives to be on site for the duration of the survey. The two Traditional Owners, Trevor Willie and Bradley Farrar attended every day of the survey and were able to provide area and site-specific information on both archaeological and sacred sites in the Project Area.

1.4 Cultural Heritage Field Team

The cultural heritage survey team consisted of Richard Woolfe (archaeologist) and Raymond Daniell (field assistant). Senior Traditional Owners Trevor Willie and Bradley Farrar represented the land holders.

1.5 The Authors

Ben Keys and Richard Woolfe from Earthsea Pty Ltd (Earth Sea Heritage Surveys) co-authored this report. The following is a short description of both Consultant's qualifications and experience.

Project Manager: Ben Keys

Ben holds a Bachelor of Archaeology with Honours from Flinders University, South Australia. He has extensive experience in cultural heritage management and community consultation, coupled with the management of largescale developments such as mining projects in the Northern Territory. Ben also has a professional background in land access management and aspects of environmental management, including compliance. He has been an author of several published academic archaeological journal articles and has been invited to speak at mining industry conferences in the Northern Territory.

Principal Archaeologist: Richard Woolfe

Richard holds a Bachelor of Archaeology from the University of New England, a Grad Dip in GIS and Geomatics from Charles Darwin University and a Masters in Heritage Management and GIS from the University of New England. Richard has 19 years' experience in cultural heritage management consultancy in the Northern Territory and Queensland. Richard also has extensive experience in community consultation with Aboriginal groups and the wider community. Richard conducted the 2002-2003 review of the NT *Heritage Conservation Act 1991* and co-drafted the original instructions for the NT *Heritage Act 2011*.

2 Legislative Context

2.1 Statutory Considerations

The Roper Valley area has a rich Indigenous cultural environment which includes a long history of human occupation and land use spanning at least 35,000 years (i.e. Smith 2013) and potentially 53,000 years. The recent past includes contact with European explorers, miners and pastoralists from the 1840's onwards.

The significance of archaeological materials in a cultural context varies substantially depending upon one or a combination of its aesthetic, historic, scientific, social or spiritual values for past, present or future generations (Australia ICOMOS Burra Charter, 2013). Through time, these values can change or be impacted upon by both natural mechanisms and human intervention. As a result of this, legislators have passed heritage acts in all jurisdictions, some of which apply in the Project Area. The following section outlines the various statutes that may, or may not, apply in the Project Area.

2.1.1 Commonwealth Legislation:

***Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA).** This Act changed Aboriginal reserves within the Northern Territory to freehold title held in trust. The Act mandated the formation of Land Councils to act in the interests of Northern Territory Aboriginal people in the areas of land, access to lands, employment and the development of businesses. The Act also defined Sacred Sites as 'sites that are sacred, or otherwise significant, in the Aboriginal Tradition'. The Act protected these sites from damage, whether accidental or intentional. The *NT Aboriginal Sacred Sites Act* 1989 uses this definition of 'sacred' in its purpose of protecting these sites outside of Land Trust lands. The Project Area is situated with the Alawa 1 and Kewulyi Land Trusts.

***Native Title Act 1993*.** Native Title is "the communal, group or individual rights and interests of Aboriginal people and Torres Strait Islander people in relation to land and waters, possessed under traditional law and custom, by which those people have a connection with an area which is recognised under Australian law (Section 223 NTA) (National Native Title Tribunal 2016)". The NTA establishes the processes to determine where native title exists, how future acts impacting upon native title land may be undertaken, and to provide compensation where future acts extinguish or are inconsistent with the existence or exercise of native title (DCP 2016). The Act gives Indigenous Australians who hold native title rights and interests (including native title claims) the right to access and use traditional lands, be consulted and, in some cases, to participate in decisions about activities proposed to be undertaken on the land. For native title to exist on a particular pastoral lease in the Territory, there must be a claim and determination by the Federal Court. A search of the National Native Title Register shows no such claim exists at time of writing this document.

***Aboriginal and Torres Strait Islander Heritage Protection Act 1984*.** This Act is intended as a 'last resort' defence for significant sites, meaning that the Act is meant to provide emergency protection for Aboriginal and Torres Strait Islander heritage sites when all other avenues have been exhausted. Generally, an Aboriginal person or group of persons, must apply to the Minister to have protective covenants placed over an area or site (DEE 2016). The power to provide such protection resides in Section 51 of the Constitution giving the Commonwealth powers on Aboriginal issues. Therefore, this Act may override all State and Territory cultural heritage acts.

To the knowledge of the Consultants, there are no known applications under this Act for any areas or features within the Solar Precinct or associated access corridor.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) commenced on 16 July 2000 with heritage amendments coming into effect on 1 January 2004. The EPBC provides for a National Heritage List of natural, historic and Indigenous places that are of outstanding significance to the nation. The EPBC also provides for a Commonwealth List that includes natural, historic and Indigenous places of significance that are owned or controlled by the Commonwealth. Ownership or control of these places allows the Commonwealth to protect or manage these places according to the significance of the place.

The Commonwealth Department of Environment and Energy administers the EPBC, including administration of the heritage lists and providing support to the Australian Heritage Council established under the Australian Heritage Council Act 2003. The Department maintains the Australian Heritage Database which includes places on both Commonwealth lists, all places on state registers and other places included in the former Register of the National Estate established in 1976. A search of the Commonwealth Heritage Database on 25 November 2021 showed no historic heritage sites within the Project Area.

2.1.2 Northern Territory Legislation:

***Aboriginal Sacred Sites Act 1989*.** The NT *Aboriginal Sacred Sites Act* 1989 was enacted to complement the ALRA. Like the ALRA, the *Aboriginal Sacred Sites Act* protects sites that are 'sacred and otherwise of significance in the Aboriginal Tradition'. Sacred Sites are protected whether the location of the sites are known or not by any person or company seeking to do work on lands.

The Act is administered by the AAPA. AAPA can issue a Certificate indemnifying any proponent for an area upon application and payment of a fee. The Certificate will contain conditions limiting or preventing works in and around registered and recorded Sacred Sites. The Authority Certificate will contain maps outlining any restricted work areas in the area of application. A survey is usually undertaken by a representative of AAPA in order to ascertain the views of the Site Custodians for the subject land. A Site Custodian is an Indigenous person who has special responsibility for an area and may or may not be a local Traditional Owner or Indigenous Elder.

***NT Heritage Act 2011*.** The NT *Heritage Act* came into effect on 1 October 2012. The Act provides protection for the same classes of places as the previous NT *Heritage Conservation Act 1991*, with some changes. As under the previous Act, members of the community can nominate areas, places, sites, buildings, shipwrecks and heritage objects to the register. If the Minister agrees that these features are of special significance to the heritage of the NT, the place is added to the register and receives statutory protection. The Act allows for processes to approve works and maintenance for a heritage place.

The NT *Heritage Act* provides a 'blanket' or 'presumptive' protection for Aboriginal and Macassan archaeological places and objects until an application is made to the CEO of the Department to do works on Aboriginal or Macassan archaeological places and objects. Following an application, the CEO will seek advice of the Heritage Council, then refer the decision to the Minister (for larger sites for example) or back to the Heritage Council (for smaller sites). If a decision is made to not allow works on an archaeological place or object, then heritage protection will continue. A permit will generally

only be issued if consultation with the relevant Traditional Owners or Custodians of the sites or their representatives has occurred. There are penalties for accidental or deliberate destruction of these sites.

2.2 Regulatory Organisations

Northern Land Council (NLC). The NT Land Councils are independent statutory authorities of the Commonwealth responsible under the ALRA and *Native Title Act* for assisting Aboriginal peoples in the NT to acquire and manage their traditional lands and seas. This includes assisting in Land Rights and Native Title Claims, managing traditional lands, protecting sites of significance in the Aboriginal Tradition. The Northern Land Council is also responsible for promoting the economic interests of Aboriginal peoples in the Top End. They do this by advocating for Traditional Owners interests in the development of resources on Land Trust and Native Title lands. The NLC is the registered Native Title Body for the Project Area.

Aboriginal Areas Protection Authority (AAPA). The AAPA is an independent statutory authority established under the *Northern Territory Aboriginal Sacred Sites Act 1989*. The Authority is responsible for the protection of Aboriginal sacred sites on land and sea across the Northern Territory. The AAPA seeks to implement a practical balance between sacred site protection and economic development.

Heritage Branch, NT Department of Territory Families, Housing and Communities. Heritage Branch is the regulatory authority responsible for administering most sections of the NT *Heritage Act 2011*. Heritage Branch is responsible for administering the NT Heritage Register, the NT Archaeological Database and providing logistical support for the NT Heritage Council.

2.3 Heritage and Sacred Site Register Searches

2.3.1 Northern Territory Heritage Registers

NT Heritage Register

There are no declared heritage places in the Project Area.

NT Archaeological Site Database

The NT Archaeological Site Database maintained by the Heritage Branch, NT Department of Territory Families, Housing and Communities, records [redacted]

Table 1: NT Archaeological Database, EP154

Site Number	Site Name	Site Type	Contents	Ethnic Origin	Easting	Northing	Site_Status
57680011	Karatji	Rock art, ceremonial ground	Rock art (pictographs	Aboriginal	Redacted	Redacted	Restricted
57680012	Kawulya	Well	NR	Unknown	[redacted]		Unrestricted

2.3.2 Aboriginal Sacred Sites Register

An Aboriginal Areas Protection Authority (AAPA) has provided an Authority Certificate for the Project as per Section 1.2.3 above. The certificate notes [redacted] that are in the Project Area.

2.3.3 Commonwealth Registers

A search of the Commonwealth Heritage Database, which includes both Commonwealth Registers and some State/ Territory register entries, indicates no heritage places in the Project Area.

3 Physical and Environmental Setting

Understanding the environmental context of a region is important when analysing past human settlement behaviour through archaeological site distribution. Geology, geomorphology and hydrology, coupled with past land use practices, can heavily influence the types of archaeological materials found, their condition, distribution patterns and predictability within a given land system.

From a survey methodological perspective, these environmental factors may also obscure the visibility of the archaeological materials and thus reduce the effectiveness of the surveyor's ability to identify a site, its contents or extent.

The following section outlines the environmental and physical background for the Project Area so as to develop an understanding of the relationship between the environmental setting and archaeological resources recorded during the survey. This in turn may contribute to developing robust archaeological predictive models for the broader area.

3.1 Bioregions and Land Systems

The Project Area falls across the McArthur GFU01 Bioregion (Gulf Fall and Uplands) Interim Biogeographical Regionalisation of Australia (IBRA, Version 7).

1. Gulf Fall and Uplands (Drill Hole and seismic survey transect areas) bioregion is characterised by dissected low hills and sandstone plateaus with eucalypt woodlands on spinifex grassland[1] Drainage is largely toward the coast (Rawlings 2008:1).

Land systems are mapped across the Northern Territory (NT) at a larger scale than bioregions and are more useful in archaeological analysis of land areas[2]. The land systems of the Roper River Region of the NT were first surveyed by Aldrick and Wilson (1992). In recent times this land system mapping has been digitised to a GIS layer and updated. The eleven land systems that occur within the Project Area are described below in Table 1 below.

[1] https://www.awe.gov.au/sites/default/files/env/resources/a8015c25-4aa2-4833-ad9c-e98d09e2ab52/files/bioregion-gulf-fall-and-uplands.pdf

[2] http://www.ntlis.nt.gov.au/

Table 2: Land Systems in the Project Area (Land Systems of the NT July 2011).

Land System Name	Geographic Zone	Class Description
Kangaroo	Gulf Fall and Uplands	Gently undulating to undulating rises on mainly argillaceous sediments
McArthur	Gulf Fall and Uplands	Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast
Arnold	Gulf Fall and Uplands	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop.
Lindsay	Gulf Fall and Uplands	Flood plains and terraces, some lower slopes and small swamps, drainage floors and flats, with fine sandy materials
Nutwood	Gulf Fall and Uplands	Plains and low rises on basalt and associated basic igneous rocks
Emmerugga	Gulf Fall and Uplands	Undulating to rolling low hills on mainly argillaceous sediments
Cliffdale	Gulf Fall and Uplands	Gently sloping sandy plains on colluvium overlying deeply weathered Cambrian sandstone, siltstone and limestone
Bukalara	Gulf Fall and Uplands	Rugged rocky plateaux and steep, linear ridges, on massive sandstones such as the Bukalara and Kombolgie Sandstones
Seigal	Gulf Fall and Uplands	Gently undulating to undulating rises with abundant, often linear rocky outcrops and shallow sandy soils
McLeod	Gulf Fall and Uplands	Gently undulating plains and low plateaux with frequent, steeply incised valleys on sub-horizontally bedded massive sandstones and siltstones
Patterson	Gulf Fall and Uplands	Low hills, rises and undulating areas on reddish platy sandstones and siltstones, often micaceous, of the Crawford and Burrell Creek Formations and the Kyalla Member (Maiwok Subgroup) of Roper sediments

3.2 Climate and Hydrology

3.2.1 Climate

The Project Area is located within the monsoonal tropics and features an almost rainless dry season from May to September and a wet season from November to March. April and October are transitional months. The nearest weather station is at Roper Bar Store approximately 60km north-east of the Project Area. However, this weather station is now closed and only had climate data for the 1976 to 2003 period. The next closest weather station at Ngukurr 80km to the east of the Project area (although closed since 2013) provides climate data from 1910 to 2012 (rainfall data from 1910 to 2012 and temperature data from 1956 to 2012). Therefore. Climate data for this report were obtained from Ngukurr Weather Station (Station 014609)[3].

The long-term average annual rainfall, based on rainfall data from 1957-2021, is 774.3 mm, and the average number of rainy days is 41.5 per year. Rainfall can, however, be highly variable from year to year. The highest rainfall is associated with the monsoon and occurs in January with an average of 182.8mm occurring in that month. The lowest rainfall of 0.7mm occurs in August.

Within the Project Area it is anticipated that the majority of rainfall is either absorbed by the ground or lost via evaporation and evapotranspiration, with the regional annual average evaporation approximately 2,219.2mm, i.e. approximately three times the annual average rainfall.

The coolest months are June to August when the mean maximum temperatures are in the high 20s and low 30s and the mean minimum temperature is approximately 15.2^{o}C. Conversely the spring to early autumn months are hot with all mean maximum temperatures for these months exceeding 35^{o}C. November is the hottest month and has a mean maximum temperature of 38.8^{o}C and mean minimum temperature of 24.9^{o}C. , when mean maximum temperatures are in the high 30's and mean minimum temperatures are in the mid-20's. December, for example, has a mean maximum temperature of 38.3^{o}C and a mean minimum temperature of 24.5^{o}C

3.2.2 Hydrology

The hydrology of the Project Area is complex and is characterised by a combination of ephemeral and perennial waterways and significant supplementation of watercourse flows through inputs from aquifers and springs. The dry season baseflow of some of the river systems is due to groundwater discharge from springs and seepage points (Faulks 2001). The numerous springs in the Mataranka area near Elsey Homestead are due to discharges from the regional limestone aquifer - Tindal Limestone (Faulks 2001). The springs are natural outflow points for groundwater occurring where the water table has been incised by the riverbed. The result is that the flow in the Roper River is maintained throughout the year.

The Roper River is located approximately 10km north of the Project Area. Pack Saddle Creek branches off the Roper River and flows south splitting into three branches just north of the northernmost seismic survey transect. The east branch of Pack Saddle Creek flows south to south-west through

[3] http://www.bom.gov.au/climate/averages/tables/cw_014609.shtml

approximately 12km of the Project Area and terminates just west of the southernmost seismic transect.

The Hodgson River is located approximately 27km to the east of the Project Area. Blackwater Creek branches off the Hodgson River and splits into two branches that course through the Project Area to the east and terminate approximately 4 to 5km west of Hodgson River Road within the Project Area. Another creek called LD Creek is located 8km to the south of the Project Area but does not have any associated streams that flow into the Project Area.

There are a number of minor unnamed tributaries that branch off Pack Saddle Creek and Blackwater Creek that flow through the Project Area[4]. One swamp and one billabong within the Project Area are sacred sites (see Attachment A). Archaeological site distribution across northern Australia shows a distinct positive correlation with freshwater resources, past or present. Hence the methodology for this survey focused on watercourses along with the drill hole areas.

3.3 Geology and Geomorphology

The surface geology of the Project Area has been extracted from the NT Geological Survey GIS layers and simplified by removing unconsolidated sediment data and merging identical units based on Formation and Lithic Description. This is then mapped and presented below as Figure 7. The primary lithic type and lithic descriptions are present below as Table 2 (Rawlings 2008:65).

The Project Area is located within the McArthur Basin Geological Region which is characterised by the presence of dolostone, sandstone, shale, felsic and mafic volcanic rocks and microgranite (Rawlings 1999). Outcropping geology is included in this study as it is a useful indicator of the possible stone raw materials available within the project footprint and the distance of the source rock from stone artefact scatters. Outcrops of fine grained sedimentary and metamorphic rocks with isotropic and conchoidal fracture properties were utilised to manufacture flakes, points and other tools used for a variety of purposes. Fine to medium grained igneous rocks such as basalt and dolerites were used to manufacture flaked and ground edge stone axes. The flat surfaces on sand and siltstones were used to grind foods, sharpen implements and to produce rock art. Sandstone rock shelter surfaces were used for rock art of various types. Therefore, an understanding of the geology of a region is important in predicting the distribution of stone quarries, rock shelters, grinding surfaces and stone artefact scatters.

Whilst a full geological assessment was not undertaken within project footprint, the interpretations in Table 2 below have been derived from field observation coupled with regional outcropping geological information[5]. The surface geology of Hodgson Downs (Warrigundu Station) has been extracted from the NT Geological Survey GIS layers. This is then mapped and presented below as Figure 7. The lithic descriptions are presented below as Table 2 (Dunn, 1963).

[4] Unnamed in the official 1:250,000 scale Joint Operations Graphic mapping produced by Geoscience Australia. There may be Aboriginal names and local names for these watercourses.

[5] Source: https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/81764

Table 3: Outcropping Lithic Descriptions EP154 Project Area

Formation	Lithic Description
Derim Derim Dolorite (Pdd)	Dolerite: medium- to coarse-grained, variably altered; composition dominated by plagioclase, clinopyroxene and Fe-Ti oxides.
(Prl)	Quartz sandstone: thin- to medium-bedded, trough cross-stratified, fine-grained, symmetrical ripple-marks, moulds of rip-up clasts, synaeresis cracks
(Prk)	Quartz sandstone: thin- to medium-bedded, fine-grained, trough cross-bedded, ripple-marks; interbedded siltstone and mudstone.
Velkerri Formation (Prv)	Mudstone and siltstone: variably grey to black, locally high organic carbon content, minor interbeds of glauconitic fine sandstone.
Kyalla Member (Pry)	Interbedded siltstone, mudstone and very fine-grained quartz sandstone: interference ripples, tool marks, synaeresis cracks.
Bessie Creek Sandstone (Pre)	Quartz sandstone: fine-, medium- and locally coarse-grained, trough cross-stratif cation, ripple-marks.
(Qa,Cz)	Undifferentiated alluvium and colluvium: unconsolidated gravel and sand of drainage channels, mud-rich sediments and soils of adjacent floodplains.

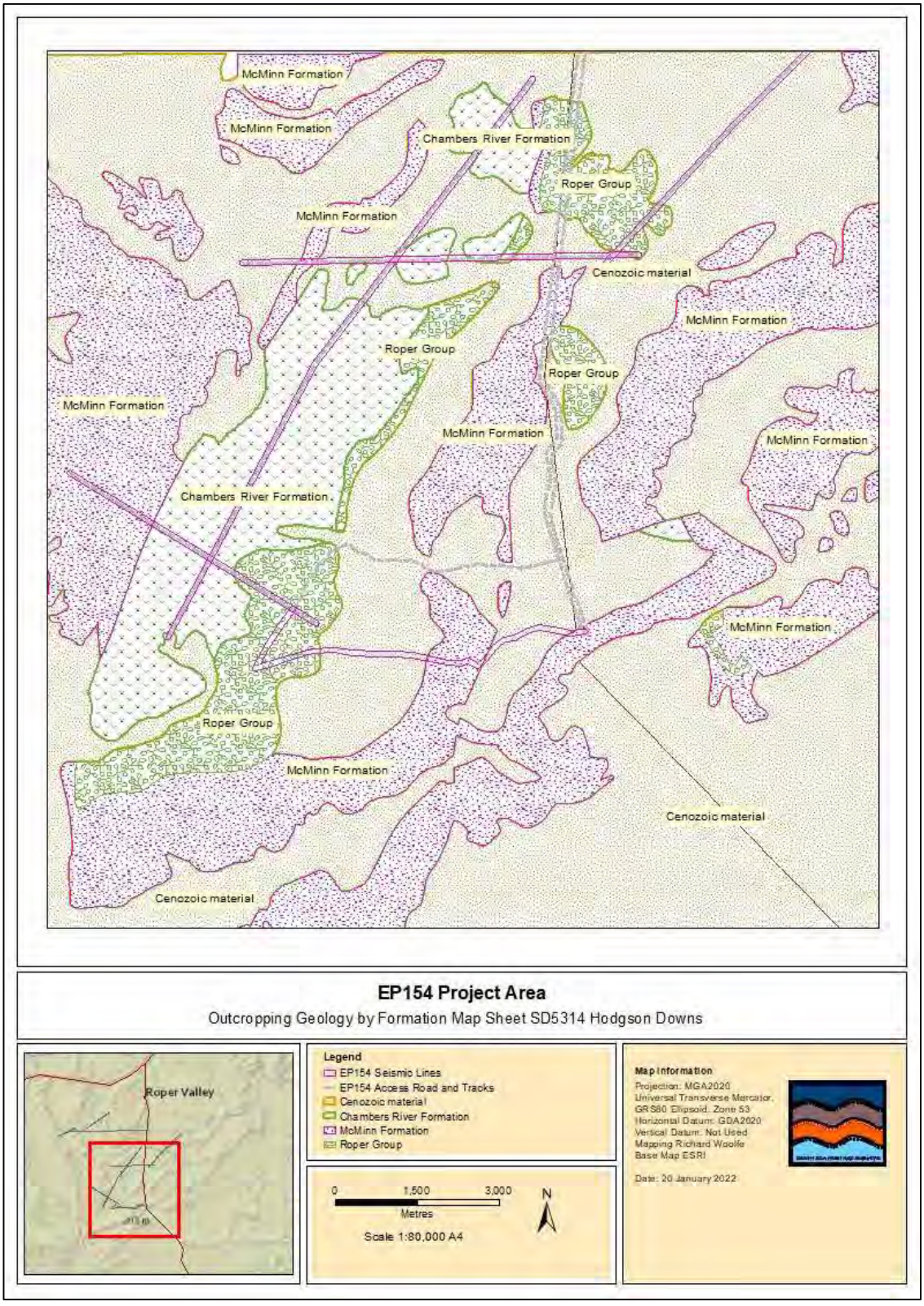

Figure 3: Project Area Outcropping Geology South (Map Sheet SD5134 Hodgson Downs) (Courtesy NT Geological Survey)

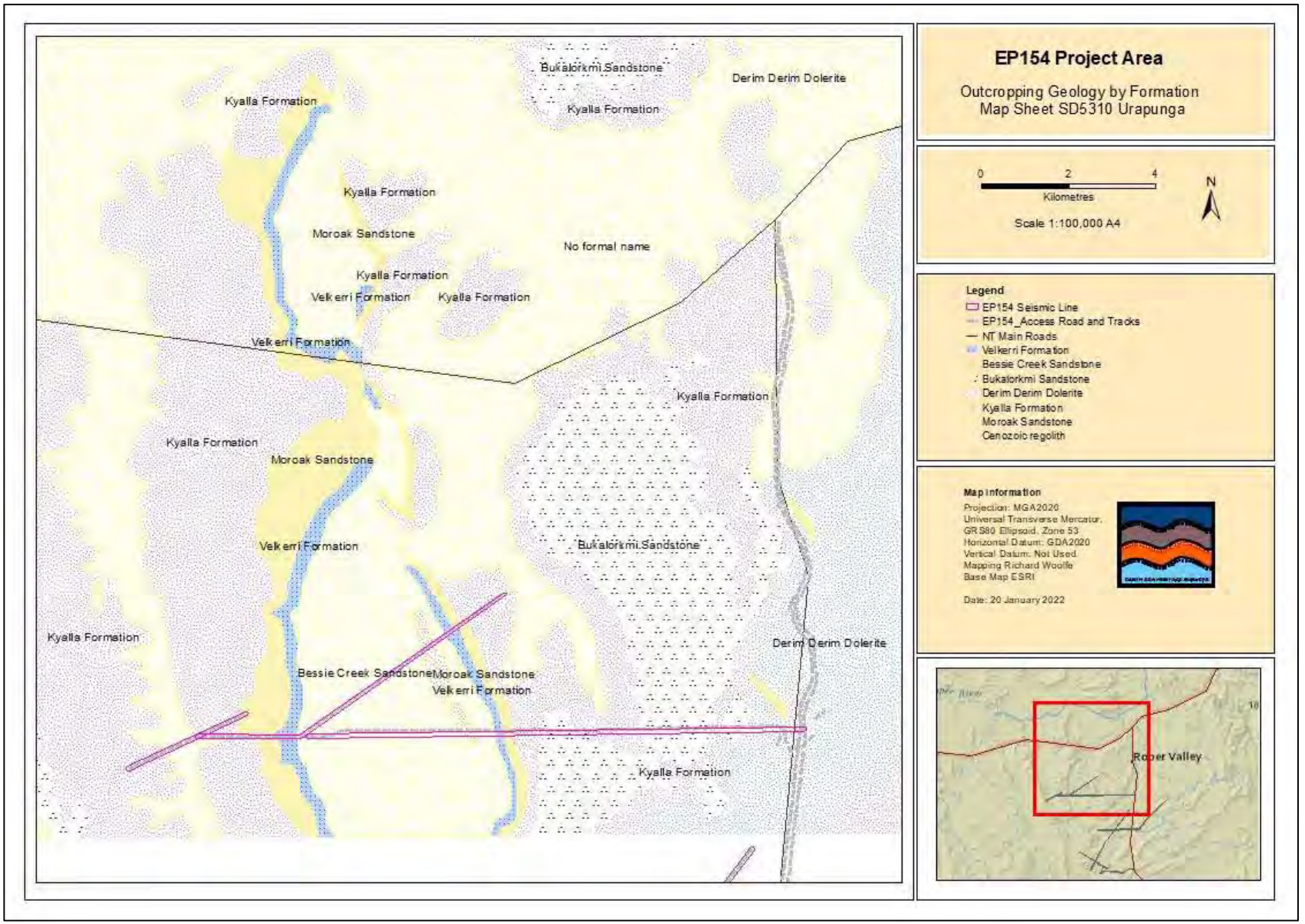

Figure 4: Project Area Outcropping Geology South (Map Sheet SD5134 Hodgson Downs) (Courtesy NT Geological Survey)

3.4 Land Disturbance Factors

Land disturbance agents in the project footprint have had significant impact on the pre-contact environment, including:

1. Pastoral impacts within the Project Area have been significant, with land cleared for property infrastructure, intensive grazing, stock watering infrastructure, fencing, permanent yards and changes to the traditional fire regimes. In addition, stock tend to impact on waterways, with hard hooves promoting erosion and thereby increasing siltation of waterholes. It should be noted that Hodgson Downs was an early era station, so this damage may have been done very early in the contact period. Changes to the nature of watercourses and waterholes make it difficult to reconstruct the pre-contact environment where Aboriginal stone artefact sites were deposited. Conversely, it is also true that increased erosion around waterways also makes sites and artefacts highly visible in the modern period.

2. Road and track construction and maintenance: the Minyerri Road and associated station tracks have impacted on archaeological sites in the past.

4 Cultural, Archaeological and Heritage Background

4.1 Historical Background.

The first European explorer to transit the Northern Territory was Ludwig Leichhardt, who transited the Gulf Area from Queensland to Port Essington in 1845 with a team of European and Aboriginal explorers. A digital map of Leichhardt's pathway reveals that his expedition passed within 36km to the northeast of the Project Area on October 27, 1845[7]. While the route that Leichardt traversed was well-watered, it was not ideal for a stock route (Powell 2009:57). Leichhardt named the Roper River in 1845 after one of the members of his expedition. The Gregory brothers transited the Gulf Region in August 1865 using Leichhardt's route in reverse (Gregory 2002:167).

According to Powell (2009:75) the expansion of pastoralism in the Territory was driven by the advent of the Telegraph and the discovery of gold at Pine Creek. In 1872, a depot was established on the Roper River for unloading supplies and construction materials in support of the Overland Telegraph Line (OTL). Up to 300 people occupied the depot site, and it was considered one of the largest European settlements in the Territory at the time (Powell 2009:75). Paddle steamers on the Roper supplied construction crews working on the OTL. There was a transitory military camp at Roper Bar during WWII and a store was established there after the war. The Leichhardt Memorial cairn, built by soldiers during the war, still stands near Roper Bar and the Old Police Station heritage site. The Roper became the southern boundary of Arnhem Land in the 1920s. This boundary was considered by the police a hard boundary, and Arnhem Landers were shot at if they attempted to cross[6].

In 1870, Millner tried droving sheep along Stuart's route and then toward the Roper. Cattle and sheep were sent north along the Telegraph route between 1872 and 1874, stocking Springvale Station near Katherine and other stations nearby (Powell 2009:76). Sheep proved untenable in the monsoonal climate while cattle thrived. In 1872, the first cattle were driven from western Queensland to the Territory Goldfields via Leichhardt's route (Powell 2009:76). This was followed by a few other small droving events until 1878, when Nat Buchanan set out from the Rankine River across the Barkly Tableland to the Tennant Creek Telegraph Station (Powell 2009:71). The Roper River depot was the destination of the first overland cattle drive from Queensland, mainly to ensure that the OTL workers were fed. Eventually, pastoral leases were set up along the Roper, including Hodgson Downs, Roper Valley and St Vidgeon stations.

Hodgson Downs (Warrigundu Station) was purchased by the Aboriginal and Torres Strait Islander Commission in 1990 for the Alawa people. In the past few years the Indigenous Land Corporation has invested in the area, completing 500km of additional fencing, new bores and quarters for staff.

The Minyerri community is close to the site of the Hodgson Downs Station Homestead. Conflicts occurred as white settlers began to move into Alawa territory and these first encounters resulted in one of the largest massacres recorded in the area. This included the killing of 30-40 Alawa in 1903 approx. 500 metres from the current Minyerri community (RAHC, 2010). This was thought to be one of the biggest massacres of the time. Alawa people were hunted down in an extermination policy developed by the pastoral company that took over the Hodgson Downs in 1903, and remnants took

[6] http://www.ntlis.nt.gov.au/heritageregister/f?p=103:303:::::NO:P303_PLACE_ID:190179# accessed 28 March 2022

refuge from the perpetrators by seeking the protection of pastoralists who would employ them, or on church missions who gave Alawa people sanctuary (Edmonds 2007).

4.2 Ethnohistory

The principal Aboriginal groups in the region prior to contact with Europeans included the Alawa, the Binbingka, the Marra, the Ngarnji, the Wilangarra and the Yanyuwa. The Church of England established the Roper River Mission in 1908 at the site of Ngukurr, as a refuge for the many different language groups following extensive conflicts with white settlers.

The Project Area and Hodgson Downs Station (Warrigundu Station) is owned by the Alawa language group through the Alawa 1 Land Trust. However, within the EP 154 permit area further west towards Mataranka, the land is owned by people of the Mangarrayi language group. To the east of the Project Area and Ngukurr, land is owned by people of the Mara language group (Horton 1996).

The Alawa language is a non-Pama-Nyungan language, classified together with Marrra and Warndarang as a subgroup although this is contested by Sharp (2008). According to the Ethnologue[7], the Alawa language had 18 remaining fluent speakers in 1991 and by 2013 this number had reduced to 12. Most Alawa speak Kriol and Australian English despite language revival efforts at the Minyerri School (Sharpe 2008). Tindale (1928) recorded 435 Alawa vocabulary entries during his work along the Roper.

Traditional Alawa territory is thought to have covered some 4,100 km^2 and extended from the southern tributaries of the Roper River, upstream from the mouth of the Hodgson River and west to Roper Valley. Alawa country extended to the south to Mason Bluff (Mount Mueller) and Hodgson Downs; east to the headwaters of Mountain Creek (Edmonds 2007).

Tindale (1974) described the traditional lifestyle of the Alawa as people who harvested and hunted the abundant food resources provided by their land such as a number of turtle species, ducks, crocodiles and fish. In addition to their hunting skills, Tindale was shown a refuge cave at Mountain Creek in 1922 which showed that food such as water lily seeds were preserved and stored (Tindale 1974). The seeds and roots of the water lilies were sun-dried and then rubbed with a red ochre prior to being wrapped in paperbark sheets (Clarke 2011). A number of resources and items obtained from the Alawa people, along with Tindale's notes and journals are now held in the SA Museum[8].

4.3 Archaeological Background

There have been few archaeological studies in the Roper Valley and its connected regions. The NT Government Heritage Branch's archaeological database records two sites approx. 5 km northeast of the Project Area as noted in Section 2.3.1. There are three studies available to the consultants close to the Project Area:

[7] https://www.ethnologue.com/language/alh

[8] https://www.samuseum.sa.gov.au/collection/archives/language_groups/alawa

1. Jung, S. 2012(A). *Draft EIS Appendix 1: Archaeological Report Haul Road.* Report for EcOz and Western Desert Resources, Roper Bar Iron Ore Project, NT Environmental Protection Authority.
2. Jung, S. 2012(B). *Draft EIS Appendix J: Archaeological Report Mine Site*. Report for EcOz and Western Desert Resources, Roper Bar Iron Ore Project, NT Environmental Protection Authority.
3. Earthsea (Martin-Stone and Woolfe). 2013. *An Assessment of the Archaeological Potential of Area C and the proposed haul road Sherwin Iron, 2013*. Report for EcOz and Sherwin Iron as a specialist report for the Sherwin Iron EIS, NT Environmental Protection Authority.
4. Earthsea (Woolfe). 2021. *An Archaeological Assessment of part of EL30384.* An unpublished report for Australian Ilmenite Resources, NT Heritage Library, Darwin.

Jung (2021A) surveyed a proposed 70 km haul road between the Western Desert Resources Mineral Lease and the port at Bing Bong. Jung recorded three stone artefact scatters, three background scatters of less than 10 artefacts each and two rock art sites along the route. Jung notes poor ground surface visibility (GSV) for most of the proposed route. There is little additional archaeological information or analysis in Jung's report that can be used to form a predictive model for the EP154 survey.

Most of the recorded sites are at the far eastern section of the haul road route aside the Limmen River. This area was surveyed by Dehne McLaughlin prior to 1997, with 84 recorded sites that are both archaeological and cultural. No other details exist in the NT Archaeological Database for this survey.

Jung's 2012(B) survey on ML28264 for the proposed Western Desert Resources mine, approx. 115 km east of the EP154 Project Area, recorded six background stone artefact scatters and three isolated artefacts. Jung notes that the proposed mine site area has few sources of permanent water. Jung extrapolates this to indicate that the area was used sporadically by people in the past possibly while transiting between river systems such as the Roper, Towns and Limmen.

Earthsea (Martin-Stone 2013) surveyed a part of [redacted] and not in EP154. Martin-Stone also recorded a small stone artefact scatter of over 100 artefacts including flakes, broken flakes, retouched flakes, unifacial points and bifacial points. Stone raw material recorded in the survey included cherts, siltstones and sandstone (grind stones).

Earthsea (Woolfe 2021) conducted a survey within part of EL30384 approx. 120 km north of the EP154 Project Area largely within the Derim Derim dolerite geological formation. The EL30384 project area was dissected by two large, braided channel tributaries of the Roper River, Mainoru River and Flying Fox Creek which were not within the surveyed area. The survey located [redacted]. This supports the view that this area and the hinterland of the Roper River was used sporadically by Aboriginal people, with most resources available along the larger waterways through the region.

4.4 Archaeological Predictive Model

The consultant's previous findings across Arnhem Land and in the Roper River region have demonstrated the following general patterns in the archaeological record:

- Surface lithic artefact scatters are the most frequently occurring archaeological site.
- Sites are most likely to occur less than 1000 metres from permanent water,
- Sites frequently occur on or near rock outcrops.
- Rock art sites are likely in areas where sandstone rock shelters form as a result of long term weathering.
- Lithics are most frequently manufactured from the most common raw materials in the local region, and
- There is a paucity of archaeological sites located on black soil plains and sand plains across the Top End. This is possibly a function of site formation processes rather than a cultural absence of artefacts (i.e., covering of sites by accumulating sediment).

There is insufficient evidence for EP154 at present to design a survey methodology using a predictive model based on past archaeological studies, hydrology, land system mapping or surface geology mapping. Therefore, the survey methodology (Section 5 below) will test the archaeological context by:

1. Sampling each surface geological formation intersected by the proposed seismic lines and tracks.
2. Sample watercourses and all larger creek within the Project Area.
3. Sample topographic highs across the Project Area to determine if these were used by Aboriginal groups in the past as secondary reduction areas (places used to prepare stone tools for use).
4. Sample at least 20% of the remaining proposed seismic lines.
5. Record sites that are known to the two Traditional Owners on the survey.

The archaeological survey will therefore use stratified random sampling and judgement (or purposive) sampling in the planned survey. These methods are in accordance with standard practice for field archaeology (see Burke & Smith, 2004:68).

5 Survey Methodology

5.1 Heritage Assessment Strategies.

The length of the proposed seismic lines and tracks alongside of the remoteness of the Project Area made physical examination of every square metre of ground impractical in terms of time and cost. Therefore, this study employed a *heritage assessment* strategy to focus on areas likely to hold archaeological materials. The *heritage assessment* methodology assessed the risk of locating archaeological sites or artefacts a based on:

1. Consultancy experience in similar environmental contexts.
2. Analysis of site distribution patterns using complete studies by other consultants and academic archaeologists.
3. Analysis of surface geology mapping (NT Geological Survey), particularly focusing on rock outcrops or lag deposits likely to contain resources used in the past by Aboriginal people (i.e. silcretes, quartz, cherts, quartzites).
4. Analysis of surface hydrology based on the higher likelihood of archaeological sites along permanent or seasonal water courses.
5. Analysis of land system and unit data correlating past information with similar land system data in the Project Area.
6. Analysis of topographical high points in the landscape. Archaeological sites are more likely on low rises and ridges rather than steep sided terrain.

The first half day of the survey was used to reconnoitre the Project Area by vehicle and helicopter to develop a sampling strategy. The survey sampling strategy ensured that the following areas were assessed:

1. All major creek crossings along the proposed seismic lines and access tracks
2. All major outcrops likely to hold isotropic rocks used by Aboriginal people in the past.
3. Areas adjacent to known Sacred Sites.
4. At least 20% sample of every land unit within the Project Area. This tests the theoretical model against reality to ensure no major sites are likely to be missed.

Recommendations for appropriate heritage management strategies were then made based on the likelihood and types of sites occurring within a given land system. If, for example, no cultural heritage features were located during the survey of a given land system or surface geological unit, the methodology was extrapolated to suggest there is a very low risk of impacting sites protected under the NT *Heritage Act* 2011.

5.2 Survey Logistics

As noted above, the Project Area included over 100km of proposed seismic line in a corridor 100 metres wide (1000 hectares). This precluded examining every square metre of land in the survey, keeping costs to a bare minimum. The sampling methodology still required the survey of a sizeable area of land, most of which was remote from existing tracks. Therefore, a helicopter was employed to access remote areas. A 4WD vehicle was used to survey the existing track in the southwestern section of the Project Area.

The survey also required the presence of Alawa Traditional Owners, Trevor Willie and Bradley Farrar. A vehicle was required to transport the Traditional Owners from their residences in Minyerri and Mataranka to the accommodation on the first day and later return them home.

5.3 Archaeological Site Definition

5.3.1 Legal Definition NT *Heritage Act* 2011

The NT *Heritage Act 2011* (Sections 6) definition of Aboriginal archaeological places and objects as:

6 Meaning of *archaeological place* and *Aboriginal or Macassan archaeological place*[9]

(1) An ***archaeological place*** is a place that:
  (a) relates to the past human occupation of the Territory; and
  (b) has been modified by the activity of the occupiers.

(2) An ***Aboriginal or Macassan archaeological place*** is a place that:
  (a) relates to the past human occupation of the Territory by Aboriginal or Macassan people; and
  (b) has been modified by the activity of those people.

7 Meaning of *object*

(1) An ***object*** is a natural or manufactured object that is moveable.

(2) An ***object*** includes an archaeological object but does not include a place.

8 Meaning of *archaeological object* and *Aboriginal or Macassan archaeological object*

(1) An ***archaeological object*** is a relic that:
  (a) relates to the past human occupation of the Territory; and
  (b) is in an archaeological place.

(2) An ***Aboriginal or Macassan archaeological object*** is a relic that:
  (a) relates to the past human occupation of the Territory by Aboriginal or Macassan people; and
  (b) is:
    (i) in an Aboriginal or Macassan archaeological place; or
    (ii) stored in a place in accordance with Aboriginal tradition, including, for example, in an Aboriginal keeping place.

9 Meaning of *relic*

(1) A ***relic*** is:
  (a) an artefact or thing given shape by a person; or
  (b) human or animal skeletal remains; or
  (c) something else prescribed by regulation.

(2) An artefact or thing can be of any material.
  Examples for subsection (2)
  1 A secret or ceremonial object.
  2 A log or bark coffin.
  3 Human remains.
  4 Rock or wood carvings or engravings.
  5 Stone tools.

(3) However, an artefact or thing made for sale is not a relic.

(4) In addition, a thing prescribed by regulation is not a relic.

[9] The Macassans were a seafaring group that interacted with Aboriginal people on the North Coast of Australia, leaving behind an archaeological record of their temporary camps, villages etc. They are included in the Act but not relevant to this study.

The legal definition above is used in this study with the modification that 'place' is replaced by 'site' and 'object' is replaced by 'artefact'[10]. The Act also separates artefacts made for profit in the recent past (i.e., bark paintings, spears, woomeras etc) with artefacts made in the past as part of Aboriginal people's use of the land.

5.3.2 Recording Archaeological Materials

According to McDonald (2005, p. 172), a landscape approach to recording archaeological materials represents a progression from past approaches which focused on sites alone and failed to recognise archaeological and cultural landscapes at an appropriate management scale. Where there are highly variable densities of cultural materials there is no choice but to define management units beyond the level of the isolated artefacts and sites. This study interprets this approach as meaning that artefacts, sites, continuous scatters and site complexes are related over the landscape. Despite this, definitions of each of these categories are necessary to provide an adequate management system for the archaeology of a survey area.

Following this approach, this study uses the following definitions of site type:

1. **Lithic or stone artefact scatters** contain flaked and ground stone artefacts and possibly hearthstones. Contact sites of Aboriginal origin may also include metals or flaked ceramics used for cutting. Artefact scatters may occur as surface scatters of material or as stratified deposits where there have been repeated occupations. Some lithic scatters are called **camp sites** which are high density lithic scatters with hearths and sometimes grindstones. Therefore, camping is the implied activity indicated by the archaeological record in these places. For the purposes of recording, lithic scatters are divided into categories as outlined below.
2. **Stone Quarry** or primary reduction site. A site where stone for flaked or edge-ground artefacts have been extracted from an outcropping source of stone. This is a broad definition a stone quarry and there are further subdivisions of this site type. According to Hiscock and Mitchell (1993) most surface hard stone quarries have associated reduction sites.
3. **Knapping location**, consisting of one or more knapping floors, are discrete scatters of artefacts, anywhere in the landscape, resulting from stone being worked or reduced at that location. The criteria for a knapping floor are that the original block of stone can be at least partially reconstructed from scattered flaked stone pieces (Hiscock and Mitchell 1993). A knapping floor can exist as a feature within the context of an open site or archaeological deposit. However, there are certain methodological problems in identifying such features arising from post-depositional processes.
4. **Stone Arrangements** can range from simple cairns to more elaborate arrangements. Some stone arrangements were used in ceremonial activities and represent sacred or totemic sites. Other stone features were constructed by Aboriginal people as route markers, territory markers, and walls of huts, animal traps, hides, or seed traps. Stone arrangements also exist as a result of historical activity, such as mineral tenement markers or isolated grave sites.
5. **Hearths** are a common feature in arid and semi-arid Australia, often comprising a number of stones arranged into a square or round formation. These were used as heat retaining rocks

[10] Place and Object are legal terms used in the NT Heritage Act 2011.

when cooking food. Rocks in hearths will show evidence of heating and are sometimes fragmented. There is often a diversity of raw materials within the hearth. Some, or all, of the rocks may have been brought to the area from a distance.

6. **Rock Art sites** include two main types of rock art, engravings and paintings. Engravings (petroglyphs) are produced by removing rock material in a pattern. Paintings (pictographs) are produced by drawing, stencils and paintings where material is added to the rock surface. Bees wax designs have also been recorded in the wider Arnhem Land region.
7. **Rock shelter occupation sites** contain a deposit of cultural material that has built up over time containing flaked or ground stone artefacts, faunal material and other various items of Aboriginal material culture including ancestral human skeletal remains, wax designs, rock art, grinding hollows, and caches of material culture objects.
8. **Site complexes** are groups of sites in similar landscapes where the cultural materials are effectively continuous. Bird and Hallam (2006, p. 11) described these as integrated cultural landscapes with which have local variations in artefact densities with artefact distributions being effectively continuous.
9. **Culturally modified trees (CMT)** typically result from a sectional removal of bark (and sometimes timber) from a tree trunk or limb. CMTs range from small (15 x 5cm) lenticular apertures such as those resulting from sugarbag procurement, to large canoe CMTs which can present a scar several meters in length.
10. **Aboriginal Wells** have resulted from water procurement activities. These sites can vary in size and form, from hand dug depressions to natural features such as sink holes or drainage depressions. Sources of water across the arid landscape were vitally important in the seasonal land use patterns of Aboriginal people. As the only water source in some areas, wells were carefully curated, often with rocks placed over the entrance to a well to prevent fouling by animals. Rock art (e.g. petroglyphs), grinding groves, stone artefact scatters and sometimes burials are often located in association with wells.
11. **Burial** practises differ considerably throughout cultural groups in Northern Australia, and skeletal material can vary from highly fragmented bones to large burial complexes containing many individuals.
12. **Grinding hollows, grooves, and patches** are the physical evidence of grinding and processing materials on basement rock. Grinding hollows and patches where utilised to grind food and plant materials (i.e. wild rice, seeds, nuts, tubers, bulbs), as well as ochre for painting. Grinding patches and grooves may also have been utilised to prepare edge ground axes during production and maintenance.
13. **Historic/Contact sites** include sites of primarily Aboriginal cultural origin that include 'modern' materials to manufacture flaked artefacts. Sites that include foreign materials, such as glass, ceramics or metal that exhibit modification by Aboriginal people are regarded as *contact sites.*

5.4 Identifying stone artefacts

A requirement for successful Aboriginal archaeological heritage assessment involves the accurate identification of archaeological materials. Since the identification of stone artefacts is basic to the accurate recognition and measurement of the archaeological record, it is imperative that people undertaking archaeological surveys be able to differentiate between natural objects and artefacts.

Principles of artefact identification employed in this survey follow those recommended by Hiscock (1984), Holdaway and Stern (2004) and Andrefsky (1998).

In summary, each time sufficient force is placed on the surface of an isotropic rock, it will fracture into two or more pieces. The fragment that has been struck contains the ring-crack, where fracture was initiated, and is called the flake. The flake is usually the smaller of the two pieces of stone. The larger fragment, from which the flake has been removed, is called the core. On both the flake and the core the surface that is struck is called the platform. Flakes are identified by the distinctive surface created when they are removed from the core. The classification of artefacts in this survey was based on identifiable characteristics outlined by Hiscock (1984). For an object to be classed as a flaked artefact, it needed to possess one or more of the following characteristics:

1. A positive or negative ring crack;
2. A distinct positive or negative bulb of percussion;
3. A definite eraillure scar in an appropriate position beneath a platform;
4. Remnants of flake scars (dorsal scars and ridges).

These characteristics indicate the application of an external force to a core. Artefact morphologies will be described by using the four types of artefacts as defined by Hiscock (1984, pp. 128-129):

1. Flake: Flakes exhibit a set of characteristics that indicate they have been struck from a core. The most indicative characteristics are ring-cracks, which show where the hammer hit the core. The ventral surface may also be deformed in particular ways, for example a bulb or eraillure scar.

2. Core: A piece of stone with one or more negative flake scars, but no positive flake scars.

3. Retouched Flake: A flake that has had flakes removed from it, identified by flake scars on or deriving from the ventral surface.

4. Flaked Piece: This is a chipped artefact which cannot be classified as a flake, core, or retouched flake. This category is used only when an artefact was definitely chipped but could not be placed in another group.

Other artefacts and implement types that have been identified in Northern Australia are listed below following characteristics as outlined by McCarthy (1976), Cundy (1989), Kamminga (1982) and Holdaway and Stern (2004):

1. Unifacial Points are flakes that have been retouched along the margins from one surface (either dorsal or ventral) to give or enhance its pointed shape. These unifacial points are sometimes symmetrical or leaf shaped.

2. Bifacial Points and axes are retouched onto both ventral and dorsal surfaces of a flake to enhance or give the artefact its point shape. These points and axes may have the platform removed and the proximal end rounded. Distribution largely in the Top End and Kimberley. Some bifacially flaked implements extend east to Cloncurry and south into the Barkley region and Central Australia.

3. Tulas are a specialised adze like tool common in the arid zones of Central Australia. The tula was a composite tool usually hafted into woomeras or other timber handles. The Tula was characterised a particular reduction sequence and a flake width broader than length. The Tula was resharpened continually until there the remaining blade length was too small for further reuse. At this stage it was commonly replaced in its hafting. The remaining blade is known as a Tula Slug.

4. Edge ground axes. Classified primarily by the shaping process of flaking, pecking and polishing. These generally have only one working edge that has been ground to a sharp margin but there are also examples with two leading edges.

5. Grindstones are characterised by a worn and abraded surface(s). The surface may either have a concave depression or a convex surface.

6. Hammerstones show use wear on the surface in the forms of abrasion, pitting and edge fracturing with some negative scarring from the process of producing stone tools.

7. Pounders are artefacts that are used primarily for processing food and plant materials.

8. Anvils are characterised by abraded and peck surfaces that are the result of using the surface to for bipolar reduction of cores.

5.5 Defining Site Boundaries

It is necessary to define site boundaries for the description of heritage places and the mitigation of impacts on these places. Boundaries of sites are often based on geographic features, such as rock shelters and shell middens, which are defined by easy to distinguish geographic features. Other sites, such as stone artefact scatters, groups of culturally modified trees, culturally significant areas are more difficult to define.

For the purposes of this study, cultural materials are defined as sites, background scatters and isolated artefacts when the following criteria are met:

1. Sites should have average artefact densities more than five times the average density of the background scatter in the same area and exceed five artefacts in at least one metre square.
2. A site boundary exists where the artefact densities are diminished sufficiently to be equal to the background density level or an environmental feature defines a boundary, such as a creek bed.
3. A background scatter is an area where the average artefact density is higher than the average background density but does not exceed five artefacts in a ten-metre diameter area. Effectively, a background scatter is small group of artefacts or a low-density scatter over a wide area that does not constitute a site. This is an arbitrary definition to aid recording in the field, particularly where artefact densities are high enough to make recording individual artefacts impractical but are not high enough to define as a site.
4. Isolated artefacts are single or multiple artefacts that do not satisfy the criteria for a site or a background scatter.

Table 4: Examples of Lithic Scatter types

Lithic Scatter Type	Definition	Example
Isolated Artefact	Single artefact that occurs in the environment as a result of single events, such as a hunter dropping a broken stone tool.	Single Bifacial Point located in an area with few other artefacts. Two flakes located together in an area with few other artefacts. Single artefact along a pathway to a large site.
Background Scatter	Scatter of artefacts across an area or even landscape that are the result of multiple events low intensity events. They may also be the result of post-depositional process, such as in self mulching soils	Small sites that have been disturbed by natural and human process after deposition. Mitchell Grass plains are a common example
Site	Higher density area resulting from multiple past uses.	Creek margin camp site, clusters of artefacts including grindstones, stone reduction sites
Site Complex	A number of sites, background scatters and isolated artefacts in a defined area that represent high intensity use of an area rather than just one location.	Site complexes around large quarry sites where people carried stone resources for further reduction

5.6 Site Recording and Survey Methodology

Using the methodological approaches outlined above, the following protocols were adopted to adequately record sites and artefacts:

1. The Project Area was mapped using a GIS (using both ArcGIS 10.6 and MapInfo 12.5). Geology, land system and hydrology layers were added to the GIS for analysis.
2. The proposed survey areas were uploaded to a Trimble Nomad unit using GBM Mobile software and an Android Tablet using MAPPT field GIS software.
3. The sample areas were transacted at approx. 10–20 metre separation by the field team consisting of the following people:
   - Richard Woolfe
   - Raymond Daniell
   - Trevor Willie
   - Bradley Farrar
4. All sites, heritage features and isolated artefacts were recorded using a set of standard recording forms linked to the GIS.
5. The field GIS used either MGA94 or GDA2020. All processed data was converted to MGA2020. using datum GDA2020. The Nomad has been calibrated to 2-3 metre accuracy in open terrain. The Android tablet has not been calibrated.
6. The tracks of all transects were recorded using the tracking feature on the Nomad, with land characteristics and images recorded using MAPPT App.
7. Artefacts and historical features were photographed during the course of the survey recording.

The following characteristics are recorded of each site and some isolated artefacts:

1. Location.
2. Environment: basic details of land unit, geomorphology, vegetation etc.
3. Site boundaries are recorded for each site using the Trimble Nomad and GBM Mobile software. Boundaries beyond the limits of the survey areas not recorded unless they were readily identifiable. In some instance it was likely the site boundaries extended hundreds of metres beyond the boundary of survey areas.

4. Site contents: basic details of types of artefacts, estimated density (1m^2 sample counts), raw materials etc.
5. Ethnographic origin: Aboriginal, Aboriginal contact site, European historical, etc.
6. Cultural and archaeological significance. Cultural significance was determined by Senior Traditional Owners Trevor Willie and Bradley Farrar.
7. Disturbance factors, such as animal activity, erosion or road works.
8. Site visibility: estimate of how much of the ground surface was visible on site and in the surrounding area.
9. Estimation of the potential for sub-surface artefacts.
10. Site and artefact images. Images of artefacts in larger sites are a representative sample.

The results of this survey, along with a map of transects completed are presented in the next section.

6 Survey Results

6.1 Results Summary

[redacted]

See Section 7 below for discussion of site significance.

Table 5: Aboriginal Archaeological Sites recorded EP154 (GDA2020)

Site ID	Site Type	Site Description	Artefact Types	Raw Material	Easting	Northing
AS001	Lithic scatter	Low density lithic scatter on margins of water course and billabong. Contact materials present	Retouched flakes, bifacial points (3), Unifacial point, flake, metals (horseshoe, saddle parts)	Quartzite, Chert, Metals	[redacted]	
AS002	Minor lithic scatter	Minor Lithic Scatter with two clusters of artefacts relatively close together.	Flakes, flaked pieces, unifacial point, retouched flake, knapping debitage	Quartzite Chert	[redacted]	
AS003	Minor lithic scatter	Minor Lithic Scatter	Flakes, broken flakes, flaked pieces	Chert, quartzite, siltstone	[redacted]	

Table 6: Isolated Artefacts recorded EP154 (GDA2020)

Site ID	Artefact type	Raw Material	Retouch	Easting	Northing
ISO001	Flake	Chert	No	[redacted]	[redacted]
ISO002	Uni core	Quartzite	No		
ISO003	Broken flake	Unidentified	No		
ISO004	Portable grindstone	Sandstone	No		
ISO005	Portable grindstone	Siltstone	No		
ISO006	Flake	Quartz	No		
ISO007	Broken flake	Quartz	No		
ISO008	Portable grindstone	Sandstone	No		
ISO009	Flake	Chert	No		
ISO010	Portable grindstone	Sandstone	No		
ISO011	Portable grindstone	Sandstone	No		
ISO012	Flake	Unidentified	No		
ISO013	Grindstone fragment	Sandstone	No		
ISO014	Flaked piece	Mudstone	No		
ISO015	Flake	Unidentified	No		

6.2 Site Distribution Maps

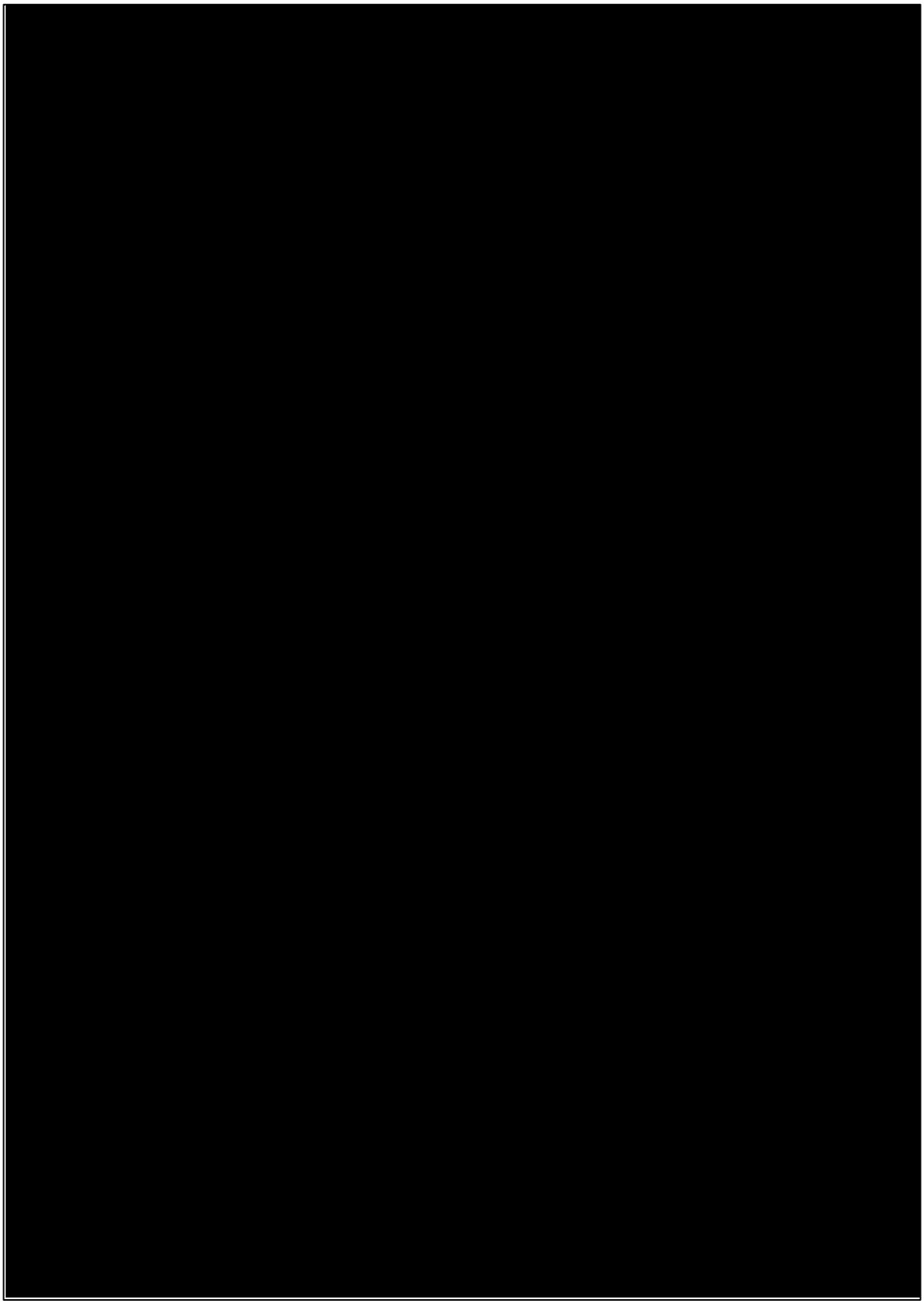

Figure 5: Site AS001

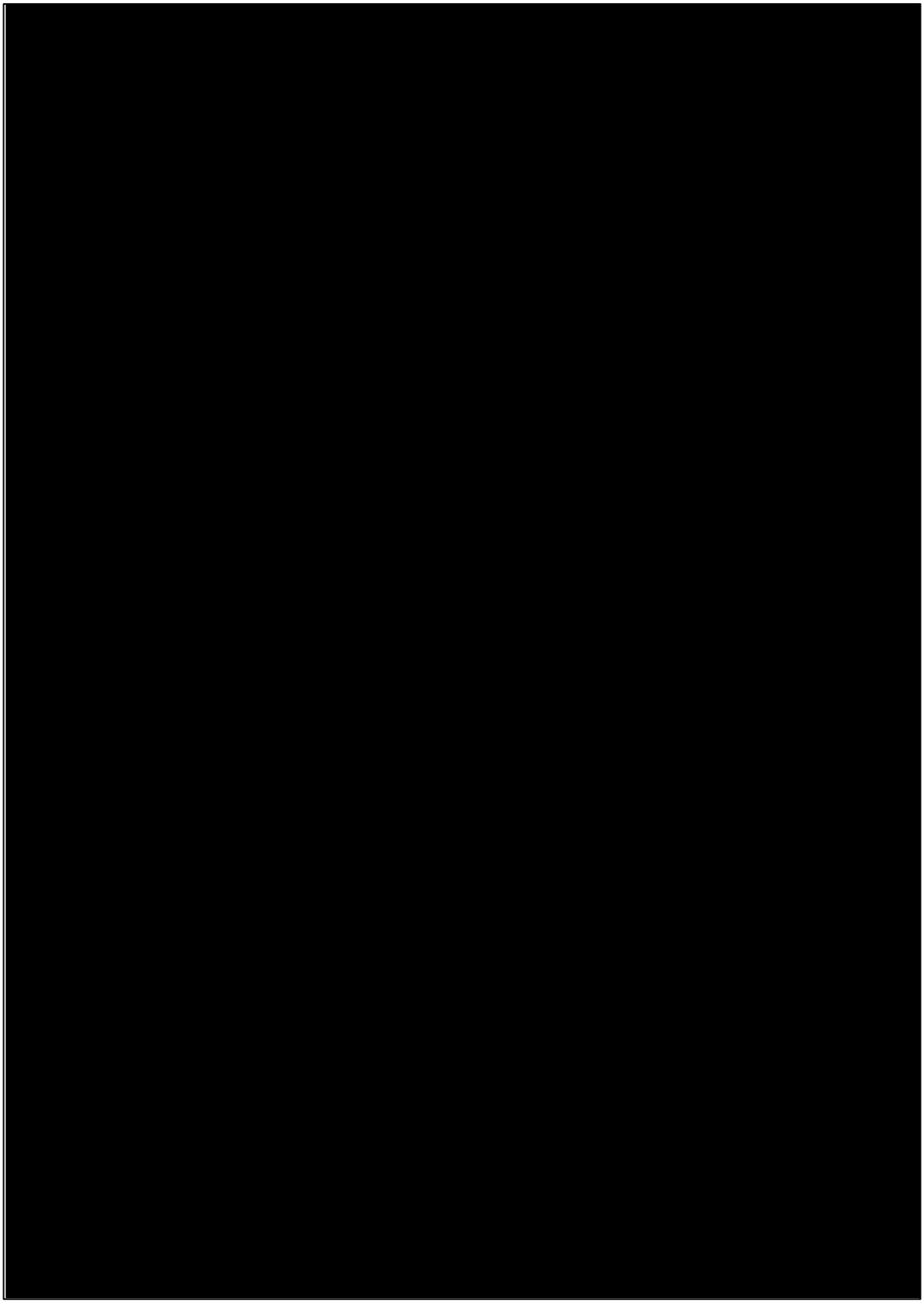

Figure 6: Site AS002 and AS003

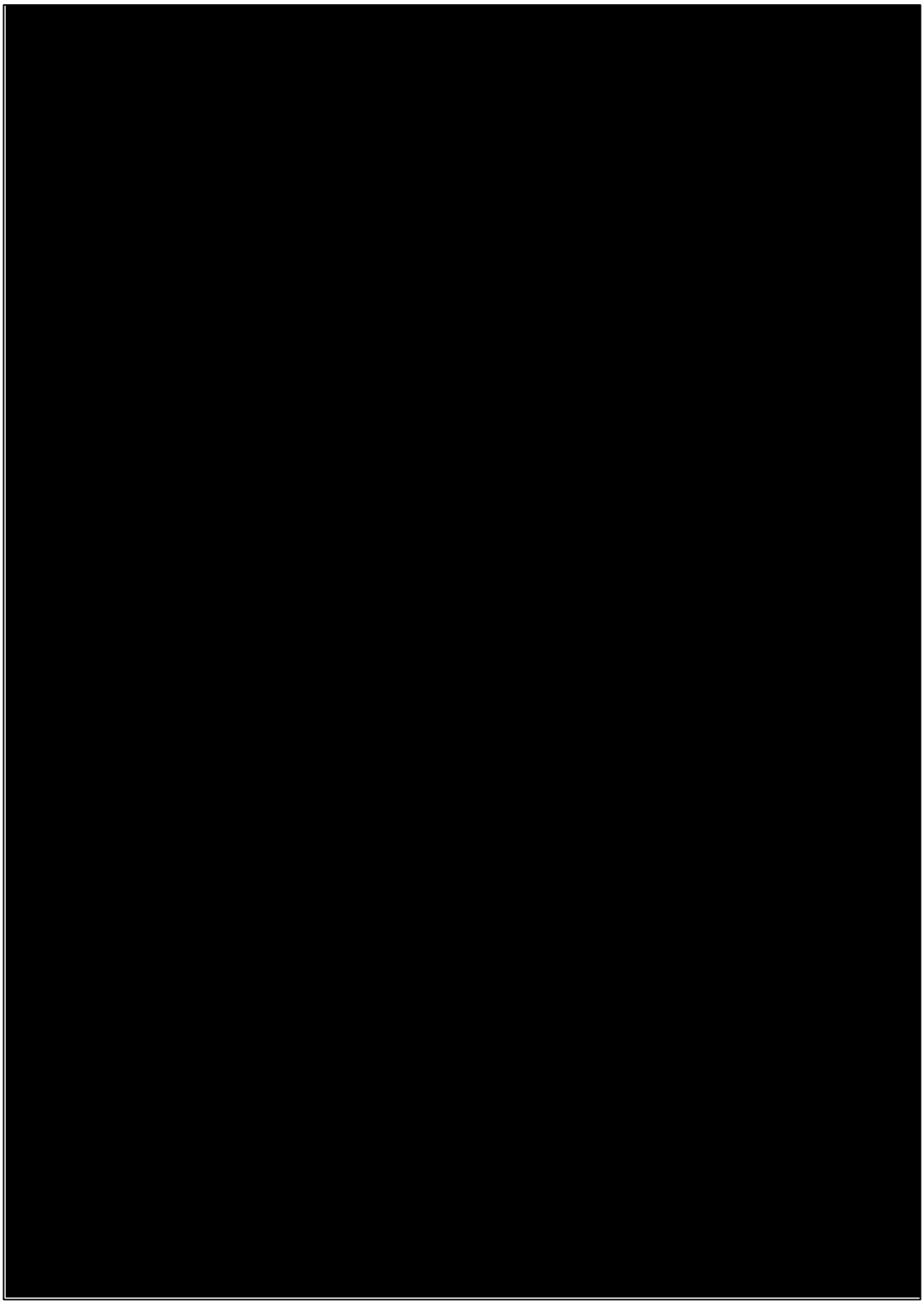

Figure 7: Site Distribution Map Camp and Drill Hole Area

6.3 Transects

Approx. 104 km of pedestrian transects were completed during the survey by two recording teams. These transects surveyed a large part of the seismic line, access tracks and the drill hole site. A slow vehicle transect (6.9 km at 10km per hour) was conducted along the existing station access track in the southwestern section of the Project. The crew surveyed a number of exposures (areas with very low vegetation cove) along this track forming a sample of low-risk sample areas. In addition, a number of individual locations were accessed and inspected from the helicopter or by 4WD vehicle.

6.4 Site and Isolate Images

Figure 8: [redacted]

Figure 9: Traditional Owner Bradley Farrar at [redacted]

Figure 10: Site AS001 Sandstone portable grindstone

Figure 11: Site ASO1 Saddle Buckle

Figure 12: Site AS001 horseshoe

Figure 13: Site AS002 Location

Figure 14: Site AS002 quartzite flake

Figure 15: [redacted]

Figure 16: Site AS003 location

Figure 17: Site AS003 Quartzite flake

7 Cultural Heritage Significance Assessment

7.1 Significance Assessment Guidelines

Cultural heritage management in Australia is underpinned by legislation, coupled with the ethics and principles established by heritage management practice over the last 50 years. In addition to statutory law, several guidelines have been developed to support the protection and management of Aboriginal heritage, including archaeological sites:

1. *Ask First*, A guide to respecting Indigenous heritage places and values (2002);
2. *Engage Early*, Guidance for proponents on best practice Indigenous engagement for environmental assessments under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (2016); and,
3. *Practice Notes for the Australian ICOMOS Burra Charter 2013* (hereafter referred to as the "Burra Charter"). Legislative basis for the protection and conservation of Indigenous archaeological places and objects within the Project Area is discussed in Section 2.

The cultural heritage values of sites and objects recorded during the survey followed key Indigenous heritage management and significance assessment principles from the Burra Charter Practice Note, 'The Burra Charter and Indigenous Cultural Heritage Management, 2013' (see also The Burra Charter and Archaeological Practice, 2013). These are summarised below for reference:

Place	*Includes locations that embody spiritual value (such as Dreaming places, sacred landscapes and stone arrangements), social and historical value (such as massacre sites), as well as scientific value (such as archaeological sites). In fact, one place may be all of these things or may embody all of these values at the same time.*
Cultural Significance	Is very broadly defined to *include 'aesthetic, historical, scientific, social or spiritual value for past, present or future generations'. This definition captures places of cultural significance to Indigenous cultures. It also includes places that provide a physical location that is integral to the existence, observation and practice of intangible heritage. The Burra Charter definition of cultural significance encompasses all forms of spirituality, regardless of the culture from which it emanates. Similarly, aesthetic value is not limited to a 'western' perception of aesthetics.*
Knowledge and expertise of Indigenous peoples	*It is critical that assessments of cultural significance for Indigenous heritage places reflect the views and input of the relevant Indigenous knowledge-holders.*
Precise Assessments	*Practitioners must define the location and form of a place, and the values that it embodies, with sufficient clarity to inform an assessment or the development of policy.*
Changing Values	*Assessments of significance need to be responsive to the dynamic nature of Indigenous cultures.*
Defining Site Boundaries	*Assessments of significance that concentrate on the visual characteristics of a place and use those characteristics to establish a 'boundary' for the place, may fail to appreciate its broader cultural or spiritual setting.*

	Importantly, *heritage practitioners must not inappropriately privilege tangible places and objects over the intangible aspects of heritage.*
Maintenance, preservation, restoration, reconstruction and appropriate 'change' can be culture dependent	*Practitioners may identify conservation needs and responses that are at odds with those identified by the traditional owners of a place, with the potential for misunderstanding and conflict.*

These principles outlined in the Burra Charter are generally those by which most cultural heritage practices in Australia are determined, including the assessment of significance of individual heritage places and objects.

In summary, cultural heritage landscapes, places, sites and objects can be significant in a number of ways:

1. Significant to a group or many groups of people due to their connection to the past.
2. Significant to a specific group of people because they have religious or spiritual significance to those people (Sacred Sites, Dreaming Sites or Story Places for example),
3. Significant to a group or many groups due to the relationship of place in the wider context of an ecological and cultural landscape.
4. Significant because of their research potential: their importance of the site in answering questions about past and in some instance's current human behaviour.
5. Significant due to their representativeness or uniqueness: sites or places that are rare or unique and are therefore conserved as a representative example.

Following the assessment of significance, the future conservation of a heritage place is decided by weighing up the level of assigned significance against the practicality of conserving the place. In terms of Indigenous archaeological sites, these decisions should be made in direct consultation with Traditional Owners and guided by their views and input. To assess the practicality of conserving a heritage site, regulatory mechanisms are usually used to assess the condition of the place (whether it will survive for much longer) and the economic implications of deciding to apply permanent heritage protection.

7.2 Assessment Principles of Scientific and Research Significance

Scientific and research significance, including archaeological significance, is determined by assessing the ability of an object, site or area to add to the scientific knowledge of history or pre-history. This scientific knowledge for example, may include the ability of an object, site or area to provide an insight into past social patterns (e.g. trade and exchange networks), technologies, substance patterns, timings of occupation, and/or paleoenvironmental conditions.

Accordingly, in general the more information an object, site or area can add to understanding the past, the higher its scientific significance. Notwithstanding this, some sites or object may also have higher levels of scientific significance due to its aesthetics, rarity and representativeness rather than an ability to inform greater details about the past. Areas or sites so judged are often recorded in detail or conserved *in situ* because they may add to our understanding of the past. It also may involve conserving a place until all practical scientific observations can be made, for example, in the salvage of artefact scatters before a development commences.

Outside of research significance, archaeological sites such as stone artefact scatters, camp sites and quarries can also have an educational role in helping non-Indigenous people understand some aspects of traditional Aboriginal lifeways.

7.3 Significance of Cultural Heritage Features within the Project Area

A total of [redacted] were recorded during the survey. In general, the recording of the [redacted] was relatively brief due to the time constraints of the survey schedule and the remoteness of the Project Area from the [redacted] Despite this, the attributes recorded for each site included: locational data, brief site descriptions, [redacted] counts, geomorphic and environmental contexts, condition and a photographic record. This information has been used to provide a significance rating for each archaeological site. Individual site significance assessments are presented in Table 7 below.

[redacted]

1. Senior Traditional Owners Trevor Willie and Bradley Farrar reported that the site was used by people prior to and following contact with Europeans. The site continued to be used in the pastoral period as a camp site for Aboriginal stockmen and their families as well as non-Aboriginal stockmen. While the site is not considered a sacred site in the meaning of the NT *Sacred Site Act* the two informants requested that this area be avoided in the course of works.
2. While few [redacted] this paucity of [redacted] is likely a result of geomorphological reasons including erosion and redeposition of sand deposits around the waterways. Low ground surface visibility was also an issue in some areas of the site. Therefore, the site is assessed as having high sub-surface artefact potential (meaning that it is highly likely that numbers of artefacts are buried in sediment around the site).

[redacted]

From an archaeological perspective, the sites and the [redacted] they contain are very common around the Northern Territory. They are also highly disturbed by pastoral activities and erosion, meaning that any scientific investigation of these sites would be difficult if not impossible.

The two Aboriginal informants had the view that the sites were not as significant as [redacted] or the [redacted] They were of the view that the sites should be avoided if possible or relocated if necessary.

In the Northern Territory, all Aboriginal archaeological sites are protected under the Act until the Minister or Heritage Council make a decision on their conservation or disturbance. Therefore, for practical reasons, all sites recorded in this study should be avoided unless there are no other alternatives (see Section 8 Recommendations below).

Table 7: Site significance assessments

Site Name	Site Type	Site Condition	Site Disturbance Factors	Archaeological Significance	Cultural Significance	Management
AS001	Lithic scatter	Medium	Cattle, erosion, flood scouring.	Medium high	Medium high	[redacted]
AS002	Minor lithic scatter	Poor	Cattle, erosion	Low	Low medium	
AS003	Minor lithic scatter	Poor	Cattle, erosion,	Low	Low medium	

8 Recommendations

The following section outlines general and area specific recommendations for Minerals Australia to mitigate impacts on Aboriginal archaeological sites in the EP154 work areas, ensuring compliance with the relevant legislation while allowing work to continue.

8.1 Potential for Previously Undetected Aboriginal Cultural Heritage

All representative land units within the EP154 Project Area were sampled as part of the archaeological assessment with additional focus on creek crossings, rock outcrops and topographic highs. The consultant estimates that between 50% and 60% of the total seismic line and access road alignment were surveyed during the field period. The areas left unsurveyed were largely low risk areas.

Based on the results of this survey it is unlikely further significant archaeological features remain in in the unsurveyed parts of the Project Area. It is also possible some undetected archaeological features may have been obscured by vegetation or sediment within the survey transects, however, these would be largely restricted to additional isolated finds. [redacted]

8.2 General Recommendations

This report recommends for following general recommendations:

1. [redacted] The AAPA Authority Certificate conditions should be adhered to without exception. All staff and contractors should be made aware of these restrictions via inductions and toolbox meetings.
2. All staff and contractors should be made aware of the existence of protected Aboriginal cultural and archaeological materials though site inductions and toolbox meetings.

8.3 Area Specific Recommendations

This report recommends the following in regard to individual sites recorded in this survey:

1. [redacted]

8.4 Discovery of Human Remains

If human remains are discovered in the course of works, it is recommended that all work stop immediately, the area is flagged off and the Site Manager/ Supervisor call the Police and the Director of Heritage, NT Department of Territory Families, Housing and Communities.

[11] [redacted]

8.5 Notes on Permits to Disturb Archaeological Sites or Artefacts

As per Section 2.1.2 of the NT *Heritage Act,* there are permit processes in place to disturb Aboriginal archaeological sites and artefacts. In all applications the proponent will be required to consult with the Aboriginal custodians of sites in the area prior to being granted a permit. In recent years, a fast permit approval process has been established to grant faster approvals for small numbers of isolated artefacts assessed as being of low archaeological and cultural heritage significance. The full process, applied to larger sites, will take longer to complete. For this reason, it is often expedient to avoid archaeological sites and artefacts where possible.

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Appendix 1: AAPA Authority Certificate EP154

APPENDIX E RISK ASSESSMENT EP144 & 154

Theme	Aspect	Activity	Possible impact and receptors	Impact source	Assumptions/Limitations/Information	L*	C*	IR*	Mitigation measures	Mitigation effectiveness	L*	C*	RR*	Uncertainty (RCI)	ALARP Rationale	Environmental outcome	Environmental performance standard (Performance measure)	Measurement criteria (monitoring and records)	Reporting	Responsibility	EOP Section
AIR	Air Quality	Clearing of disturbing vegetation	Dust generation impacting surrounding landholders, flora and fauna	Access track use, seismic line use, well pad creation and use and camp creation and use		B	2	Low Risk (6)	Preventative Use existing road and tracks where practicable and ensure tracks are suitable for the intended purpose and volume of traffic required. Site environmental inductions for all site personnel and contractors in relation to land management tasks. All vegetation clearing must be in accordance with the Federal, Territory and local government vegetation clearing requirements. Vehicle speed restrictions apply when travelling in permit (80 km/h on unsealed roads in proximity (<200 m) to sensitive receptors) or due to condition. Mitigative Disturbed areas will be stabilised in accordance with the Rehabilitation Plan. Use water trucks where applicable to manage dust emissions from vehicle movement on the site.	High	A	2	Low Risk (3)	Low	Industry standards for dust management has been adopted. Based on the remote location of the works these dust management methods should prevent any dust impacts on surrounding stakeholders/communities.	No dust disturbance to people and communities	Avoid disturbance to sites related to protected vegetation. Dust plumes won't affect people and communities	Rehabilitation completed as per the Rehabilitation Management Plan No complaints regarding nuisance dust during works.	Annual environmental performance report will be submitted to DEPWS reporting on: oAny dust complaints oRehabilitation activities	PM	A.3.1.5 Site Selection and Planning
AIR	Air Quality	Vehicles and plant	Dust generation impacting surrounding landholders, flora and fauna	Access track use, seismic line use, well pad creation and use and camp creation and use		C	2	Moderate Risk (8)	Preventative Use existing road and tracks where practicable and ensure tracks are suitable for the intended purpose and volume of traffic required. Site environmental inductions for all site personnel and contractors in relation to land management tasks. All vegetation clearing must be in accordance with the Federal, Territory and local government vegetation clearing requirements. Vehicle speed restrictions apply when travelling in permit (80 km/h on unsealed roads in proximity (<200 m) to sensitive receptors) or due to condition. Mitigative Disturbed areas will be stabilised in accordance with the Rehabilitation Plan. Use water trucks where applicable to manage dust emissions from vehicle movement on the site.	High	B	2	Low Risk (5)	Low	Industry standards for dust management has been adopted. Based on the remote location of the works these dust management methods should prevent any dust impacts on surrounding stakeholders/communities.	Minimise environmental nuisance at sensitive receptors	No significant dust plumes identified, no complaints from surrounding landholders	Rehabilitation completed as per the Rehabilitation Management Plan No complaints regarding nuisance dust during works.	Annual environmental performance report will be submitted to DEPWS reporting on: oAny dust complaints oRehabilitation activities	PM	A.3.1.5 Site Selection and Planning
AIR	Air Quality	Vehicles and plant	Greenhouse gases	Vehicle, plant and equipment operation		C	2	Moderate Risk (8)	Preventative Undertake selective clearing, such as only clearing when an alternative route is unavailable and avoiding trees. Progressively rehabilitating cleared areas once works have been completed. All vehicles and equipment used on site will be well maintained to minimise emissions. Vehicles to be switched off when not in use.		B	2	Low Risk (5)	Low	Clearing has been minimised to the smallest area possible to complete the activity. Mostly blade up preparation will take place. Vehicle emissions minimised	Minimising greenhouse gas emissions	Activity within approved footprint only. All clearing in approved areas, no unnecessary clearing. All vehicles serviced appropriately.	All vehicles service records current. Activity audit to show project activity within approved areas.	Annual environmental performance report will be submitted to DEPWS including: oVehicle service history		
AIR	Atmospheric Processes	Clearing or disturbing vegetation	Greenhouse gases	Clearing of vegetation		B	4	Moderate Risk (8)	Preventative Undertake selective clearing, such as only clearing when an alternative route is unavailable, and avoiding trees. Mitigative [illegible]	High	B	2	Low Risk (5)	Low	Clearing has been minimised to the smallest area possible to complete the activity. Mostly blade up preparation will take place.	Minimising greenhouse gas emissions	No impact outside of approved areas, no unnecessary clearing	Activity audit to show clearing is within proposed areas	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning
PEOPLE	Cultural and heritage	Clearing or disturbing vegetation	Damage to sacred sites or heritage	Access track use, seismic line use, well pad creation and use and camp creation and use		A	4	Low Risk (6)	Preventative A stop work will be implemented if artefacts are located during activities on site. The Project Manager will be notified immediately, who will then liaise with the NT Heritage Branch, for further instructions. Employees will be briefed on potential cultural heritage items that may be encountered and any No Go Zones. Recommendations of the Archaeological Surveys have been adopted, with campsites and seismic lines moved where required. If sites cannot be avoided along seismic line, these sections of the seismic line will be excluded from the survey. Known sacred sites will be flagged as no-go areas if works taking place nearby. Consultation with NLC in relation to Program meetings and ongoing engagement in relation to the Activity including annual updates. Mitigative Although a detailed survey has been undertaken, seismic lines will be moved to avoid archaeological sites and artefacts if they are located during activities on site.	High	A	2	Low Risk (3)	Low	Risk is as low as possible as the relevant stakeholders have been consulted with, and operational staff will be educated on sacred sites/heritage identification to reduce risk of impact as these sites/items are present.	No significant impact to Indigenous or non-Indigenous artefacts, Sacred Sites of non-Indigenous heritage site.	No non-compliances with Native Title Holder Exploration and AAPA certificate conditions including: oProject area All staff inducted	Areas used for activity within approved footprint by showing GPS tracks of vehicles are within approved areas. Induction records showing that all personnel have had a site induction. Records of any on-country meetings	Reporting to NT Heritage Branch if new finds are made. Annual environmental performance report will be submitted to DEPWS to include: oInductions oFootprint used/activity area oNumber of on-country meetings	PM	A.3.1.5 Site Selection and Planning
PEOPLE	Human health	All	Increased fire risk to humans	Accidental fire ignition, potential change to fire regime		C	4	High Risk (10)	Preventative A Bushfire Management Plan (BMP) has been developed that includes the following information: -Analysis of baseline fire information (at least 10 years) -Analysis of impacts of the proposed activities on the existing fire management regime Coordination with the landholder and other land users and consistency with the landholder's fire management obligations and strategies No hot works are permitted on total fire ban days Implementation of the interest holder's appropriate fire mitigation measures such as: -Monitoring of seasonal conditions and fuel loads -Maintenance of firebreaks to access trails and fire breaks around infrastructure -Communication system for monitoring bushfire risk in the area Annual fire mapping to monitor changes to fire frequency in the relevant area. Monitor the NAFI website and adhere to total fire ban days. Updates provided at daily toolbox meetings. Fire extinguishers fitted to all vehicles All personnel and contractors will be informed about the key features of the BMP as part of the induction Clean out vehicle engine bay regularly, with special attention on particular dates, to prevent grass getting on the hot vehicle components. Smoking only allowed in designated smoking areas.		B	3	Moderate Risk (6)	Low	The BMP outlines the industry standard controls that will be implemented to reduce the risk of fire. Fire extinguishing devices will be available at all work to control fires as needed. Equipment controls and safety mechanisms, as well as regular checking of fire danger will ensure this risk has been reduced to ALARP.	No fires caused by site activities.	No uncontrolled fires caused by project activities	Number of complaints Staff inductions	Complaints register identifying: Date and summary of issue How complaints were resolved and corrective actions taken Annual environmental performance report will be submitted to DEPWS including: oRegister of complaints oStaff inductions	PM	A.3.7 Fire Management
WATER	Hydrological Processes	Seismic and drilling activity	Reduction of groundwater environmental values	Drilling fluids contaminating groundwater		B	4	Moderate Risk (8)	Preventative All regional aquifers isolated by a minimum of two verified barriers during drilling operations. No use of chemicals or other substances that have potential to leave a residual toxic effect in the aquifer, will not be added to the drilling mud until aquifers have been isolated.	High	A	2	Low Risk (3)	Low	Methods implemented are industry best practice methodology, barriers will prevent impacts on groundwater quality	Quality and quantity of groundwater in the region is not adversely impacted	Aquifers isolated	Record that drilling supervisor verified that aquifers isolated before proceeding to the next stage.	Drilling supervisor records Annual environmental performance report will be submitted to DEPWS including above	PM	A.3.1.5 Site Selection and Planning A.3.4.5 Erosion and Sediment Control and Hydrology
WATER	Hydrological Processes	Seismic and drilling activity	Reduction of groundwater environmental values	Cross flow between formations through inappropriately well barrier design		B	4	Moderate Risk (8)	Preventative All regional aquifers isolated by a minimum of two verified barriers during drilling operations. Well barriers will be designed and installed by appropriately qualified people No use of chemicals or other substances that have potential to leave a residual toxic effect in the aquifer, will not be added to the drilling mud until aquifers have been isolated.	High	A	2	Low Risk (3)	Low	Methods implemented are industry best practice methodology, barriers will prevent cross flow	No cross flow between aquifers	Aquifers isolated	Record that drilling supervisor verified that aquifers isolated before proceeding to the next stage.	Drilling supervisor records Annual environmental performance report will be submitted to DEPWS including above	PM	A.3.1.5 Site Selection and Planning A.3.4.5 Erosion and Sediment Control and Hydrology
PEOPLE	Society and economy	Clearing or disturbing vegetation	Noise affecting cattle and people	Vehicle, plant and equipment operation.	Assuming cattle and people will be located within/adjacent to the project area of influence.	B	2	Low Risk (5)	Preventative Slow vehicles when passing cattle, people or sensitive receptors. Provide at least two weeks notification to households and businesses if operations are to be conducted within 10 km of the premises. Ensure site environmental inductions for all site personnel and contractors include noise, vibration and light emissions requirements. Ensure vehicle, machinery and equipment is maintained in good working order. Daily and ongoing consultation with station managers and station personnel Mitigative All nuisance related complaints from sensitive receptors investigated and reported upon.	High	B	1	Low Risk (2)	Medium	Remote location Landholders will be able to ensure cattle are located away from work fronts Vehicles well maintained and speed will be limited when within proximity to receptors.	No significant impacts to the community as a results of the activity	No significant nuisance noise levels on surrounding communities. No disruption to fauna and stock.	Number of complaints	Complaints register identifying: How complaints resolved and corrective actions taken Annual environmental performance report will be submitted to DEPWS including: oRegister of complaints	PM	A.3.1.5 Site Selection and Planning A.3.8 Noise

PEOPLE	Society and economy	Seismic and drilling activity	Noise and light pollution affecting cattle and people	Vehicle, plant and equipment operation.	Assuming cattle and people will be located within/adjacent to the project area of influence.	B	2	Low Risk (6)	Preventative Slow vehicles when passing cattle, people or sensitive receptors. Provide at least two weeks notification to households and businesses if operations are to be conducted within 10 km of the premises. All nuisance-related complaints from sensitive receptors investigated and reported upon. Ensure site environmental inductions to all site personnel and contractors include noise, vibration and light emissions requirements. Ensure vehicles, machinery and equipment is maintained in good working order. Daily and ongoing consultation with station managers and station personnel. Use directional lighting to limit light spread and emissions outside of the zone required. Lights will be turned off when no longer required, once activity has been completed.		B	1	Low Risk (3)		Remote location. Lighting will only be utilised when absolutely necessary, and when used will be directional and used for the minimum time required. Landholders will be able to ensure cattle are located away from work fronts. Vehicles well maintained and speed will be limited when within proximity to receptors.	No significant impacts to the community as a result of the activity	Minimise nuisance noise and light emissions to surrounding communities, exploration workers, fauna and stock.	All complaints investigated and resolved, with complaints and corrective actions recorded.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning A.3.8 Noise
PEOPLE	Society and economy	Accessing land	Restrict access/interfere with pastoral operations due to activities	Disturbance caused by project activities		B	2	Low Risk (6)	Preventative Daily engagement with station manager and station personnel during activities to monitor potential disturbances to cattle and identify any reasonable solutions to mitigate any observed effects.		A	2	Low Risk (4)	Low	Land access agreements and stakeholder consultation will ensure all parties are aware of access requirements and informed of activities. Nothing further can be done to reduce this risk.	No impacts or interference with pastoral operations due to activities	Ongoing stakeholder and other regional engagement shows no concerns regarding access to pastoral properties or impact on pastoral leaseholder's activities. No reports of impeded working activities.	All complaints investigated and resolved, with complaints and corrective actions recorded.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning
PEOPLE	Society and economy	Accessing land	Facilitation of unwanted access	Site is accessed incorrectly		A	2	Low Risk (3)	Preventative Site inductions are to ensure that all personnel are aware of and understand social constraints of working within the permit area, including conditions specified in the Land Access Agreement with the host pastoral leaseholder. Ensuring that any site gates/access points are closed to prevent unwanted access. Access tracks signed to prevent unauthorised access. Mitigative Progressively rehabilitating tracks after project activities complete, to minimise the ease of access.	High	A	1	Low Risk (1)	Low	Working with neighbouring groups and communities to facilitate working relationships, as well as ensuring access tracks are closed and rehabilitated will limit the time that unwanted access is possible.	Minimise unwanted access to project area	No complaints regarding unwanted access.	All complaints investigated and resolved, with complaints and corrective actions recorded.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning
PEOPLE	Society and economy	Vehicles and plant	Affecting operations of landholders and the use of their area	Vehicle, plant and equipment operation, and the presence of humans.		B	4	Moderate Risk (8)	Preventative Site inductions are to ensure that all personnel are aware of and understand social constraints of working within the permit area, including conditions specified in the Land Access Agreement with the host pastoral leaseholder. Work restrictions to be issued to all contractors relating to access constraints. Prior to commencement onsite, communicate with pastoral leaseholders for access permission. Provide details of the time and dates proposed to be on site, and the location, in advance of works commencing according to the regulations, including detailed maps showing pastoral infrastructure.		A	2	Low Risk (4)	Low	Land access agreements and stakeholder consultation will ensure all parties are aware of access requirements and informed of activities. Regular contact with landholders will ensure land use isn't significantly affected by work activities.	No significant impacts to the community as a result of the activity	No impacts to or complaints from pastoral landholder	All complaints investigated and resolved, with complaints and corrective actions recorded.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning
PEOPLE	Society and economy	Vehicles and plant	Increased traffic on roads due to project activities	Vehicles travelling during project activities		B	2	Low Risk (6)	Preventative Site inductions are to ensure that all personnel are aware of and understand social constraints of working within the permit area, including conditions specified in the Land Access Agreement with the host pastoral leaseholder. Engagement with landholders and community to communicate expected timeline of works and estimates of increased road traffic. Mitigative All complaints to be noted and responded to in a timely manner.		B	1	Low Risk (3)	Low	Engagement with stakeholders will ensure they are aware of work activities and the increased traffic this will bring.	No impacts to the community as a result from increased traffic associated with the activity	No complaints regarding increased traffic. No significant impacts to road/track condition	All complaints investigated and resolved, with complaints and corrective actions recorded.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning
LAND	Terrestrial Ecosystems	Clearing or disturbing vegetation	Removing habitat for threatened species	Vegetation impact for well pads, seismic lines and campsites facility facilities	RESULTS FROM FIELD SURVEY	B	4	High Risk (14)	Preventative Clearing only in small areas that are impassable, generally due to acacia thickets but still avoiding trees. Avoid clearing all large trees, notably: -Corymbia and Eucalypt species with a trunk diameter >35 cm at 1.3m above ground level will be avoided to minimise any potential impacts to breeding habitat for EPBC listed Gouldian Finches, and other species. -All large old hollow bearing trees along the waterways (e.g., Coolibah) or woodland environments will be avoided. If an active Grey Falcon nest (or suspected nest) is encountered, a minimum buffer of 800 m should be maintained around the active nest to reduce disturbance and potential impacts. Avoid and minimise impacts to cracking clay soils, habitat for the Plains Death Adder.	Medium	A	6	Moderate Risk (10)	Low	Selective clearing will ensure that the minimum area of vegetation will be cleared to complete the activities. Clearing is unavoidable in areas and methodology designed to minimise impacts on threatened species and the habitats.	Activities will not result in permanent removal of habitat for threatened species.	No clearing outside the proposed areas. No disturbance to high conservation areas. No clearing of large trees. In Blackwater Creek impact to 10% of shrubs. Rehabilitation undertaken progressively at the end of works	Activity audits show clearing adopts mitigation measures (avoiding large trees etc.), and is within proposed areas. Extent of areas rehabilitated.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning A.3.5 Biodiversity Protection
LAND	Terrestrial Ecosystems	Clearing or disturbing vegetation	Removing significant habitat	Vegetation impact for well pads, seismic lines and campsites facility facilities in areas containing sensitive vegetation	RESULTS FROM FIELD SURVEY	B	4	High Risk (14)	Preventative Clearing only in small areas that are impassable, generally due to acacia thickets but still avoiding trees. No clearing of all large trees, notably: -Corymbia and Eucalypt species with a trunk diameter >35 cm at 1.3m above ground level will be avoided to minimise any potential impacts to breeding habitat for EPBC listed Gouldian Finches. -All large old hollow bearing trees along the waterways (e.g., Coolibah) or woodland environments will be avoided. In the north section of seismic line between Hodgson Downs Road ensure an experienced field technician will provide the seismic team flagging a path to further reduce impacts to this important area.	Medium	A	6	Moderate Risk (10)	Low	Where reasonably possible, areas of sensitive habitat has been avoided. Clearing methodology will limit impacts on threatened species in areas where clearing is unavoidable.	Activities will minimise impact to significant vegetation	No clearing outside the proposed areas. No disturbance to high conservation areas. No clearing of large trees. In Blackwater Creek impact to 10% of shrubs. Rehabilitation undertaken progressively at the end of works	Activity audits show clearing adopts mitigation measures (avoiding large trees etc.), and is within proposed areas. Extent of areas rehabilitated.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning A.3.5 Biodiversity Protection
LAND	Terrestrial Ecosystems	Clearing or disturbing vegetation	Impact to integrity or quality of land and soils	Disturbance of soils caused by project activities, and increased erosion risk		B	2	Low Risk (5)	Preventative Development and implementation of an erosion and sediment control plan (ESCP). Minimised disturbance of riparian buffers and vegetation along drainage lines. Use existing roads, access tracks and seismic lines. Conduct clearing during the dry season. Only clearing vegetation if impassable such as acacia thickets, and avoiding trees. Works will cease if there is a forecast for 50mm of rain or more within the next 48 hours. Minimise number of creek/drainage line crossings to reduce erosion management. Well pads located outside of 1 in 100 year flood risk areas and are unlikely to be inundated as modelling indicates the locations are outside of the flood extent, the well pads will only be present onsite for a short period and works will be completed mostly in the dry season, with only a chance of extending into the wet season. If works continue into the wet season bunding of well pads will occur. Mitigative Rehabilitation and stabilisation of disturbed areas as per the Rehabilitation plan. Removed vegetation and/or topsoils to be respread over disturbed areas to assist rehabilitation. Using lighter machinery such as graders or smaller bulldozers, taking care not to over work tracks.	High	A	2	Low Risk (4)	Low	Selective clearing will ensure that the minimum area of vegetation will be cleared to complete the activities. Lighter machinery will lessen the impact on the areas that are cleared. Implementing an ESCP developed by a qualified professional that outlines industry standard controls will ensure risk are limited to ALARP. Wet season works are only to be used when dry to minimise erosion and impacts to soil. Rehabilitation plan implements industry best practice methodology and ongoing monitoring will ensure rehabilitation success.	Activities will not result in permanent impacts to the integrity or quality of land and soils.	No soil erosion and discharge of sediment or soil into waterways or established drainage systems. No new instances of erosion and sedimentation. Erosion and sediment controls established	1. ESCP implemented prior to commencement of the activity 2. Monthly visual inspection and monitoring of existing tracks, seismic lines and waterway crossings conditions. These will occur: (a) During siting of seismic lines and drill pads (baseline assessment) (b) After completion of a key phase of activity, such as construction of drilling/camp infrastructure, seismic line completion, completion of drilling and following the removal of site infrastructure. (c) After the wet season to look for signs of erosion (d) Annually (post wet) for up to 5 years. 4. Routine visual inspections of the creek and drainage line crossings. These will occur weekly or following a rainfall event (e.g. greater than 20 mm in a 24 hour period)	Annual environmental performance report will be submitted to DEPWS including: o Monthly track inspection reports o ESCP schedule o Creek and drainage line inspections	PM	A.3.1.5 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology
LAND	Terrestrial Ecosystems	Clearing or disturbing vegetation	Direct mortality of fauna	Interactions between fauna and vehicles/plant		B	4	Moderate Risk (8)	Preventative Clearing will be conducted in a single direction, allowing any fauna to move out of way of clearing activities. Halt clearing in the presence of any fauna. Slow vehicles when passing cattle or other wildlife.	Medium	A	3	Low Risk (4)	Low	Clearing methodology will limit direct mortality and industry standard	Minimised fauna deaths.	Injury to fauna minimised during the activity	Monitoring of vehicle speeds. Record any fauna encounters, injuries or deaths as result of the activities on fauna register for the duration of works. Daily inspection of sumps and fencing. Induction records	Annual environmental performance report will be submitted to DEPWS. Annual environmental performance report will be submitted to DEPWS to include: o Any records of vehicles driving above speed limits o Sump inspection and non-compliances o Induction records	PM	A.3.1.5 Site Selection and Planning A.3.5 Biodiversity Protection
LAND	Terrestrial Ecosystems	Vehicles and plant	Introducing or spreading weeds resulting in habitat degradation	Vehicles, plant and equipment bringing weeds into the project area, and/or spreading weeds within the project area	Regional Weed Management Plan is available for the Katherine Region	B	4	Moderate Risk (8)	Preventative A Weed Management Plan will be developed and implemented. All machinery and equipment to be certified weed free by a suitably qualified person prior to arrival at site. Control of declared weeds onsite as per the NT Weeds Management Act. All weeds removed will be and disposed of appropriately to ensure no further spread of weeds. Identification of any declared weed will be reported to the Weeds Branch in accordance with the NT Weeds Management Act.	High	A	2	Low Risk (4)	Medium	Weed management plan is in place and is guided by the Regional Weed management plan for Katherine. The plan outlines standard practice management techniques for the NT, that are proven.	No introduction of new or spread of existing weeds within the project area	The risk of exotic species and plant diseases being imported into or exported from the exploration permit area is avoided. The risk of spreading weeds within the seismic survey areas is avoided. Where weeds are identified they are treated in accordance with the Weed Management Plan.	A post wet-season weed survey will be conducted of seismic lines, and access tracks. All weed monitoring and survey activities will be recorded in accordance with the NT Weed Data Collection Guidelines.	Annual environmental performance report will be submitted to DEPWS. Records with identification of pest, if possible, will be maintained using GIS and provided to the NT Government's Declared Pest Weed Management Officer.	PM	A.3.6 Weed Management
LAND	Terrestrial Ecosystems	Vehicles and plant	Direct mortality or impacts to fauna	Interactions between fauna and vehicles/plant		D	2	Moderate Risk (12)	Preventative Site inductions will ensure that all personnel are aware of their obligations and know the correct procedures for fauna encounters. Vehicle movement will be restricted to existing access tracks and seismic lines. Common and road vegetation types will be focussed for access tracks because they will generally have lower habitat significance. Vehicle movement will be restricted to existing access tracks with a speed limit to 60 km/h. Driving at night will be restricted to daylight hours, wherever possible. Ensure site environmental inductions to all site personnel and contractors include the management of onsite vegetation and fauna, including site personnel to stay within designated access roads and work areas.	Medium	C	2	Moderate Risk (8)	Low	Speed limits will be reduced and track placement will limit direct mortality to ALARP. There will be no significant impact to species populations in the case of isolated direct mortality of individual fauna.	Minimised fauna deaths.	Injury to fauna minimised during the activity	No recorded incidents of vehicles travelling above speed limits. Record any fauna encounters, injuries or deaths as result of the activities on fauna register for the duration of works.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning A.3.5 Biodiversity Protection

LAND	Terrestrial Ecosystems	Vehicles and plant	Introducing pests or feral animals, impacting on native fauna	Feral animals or pests being transported or attracted onto site during operations		B	2	Low Risk (6)	Preventative Visual inspection of machinery and equipment will be undertaken prior to arrival and departure from site. All waste will be covered or contained within dedicated waste disposal bins that cannot be tampered with or opened by fauna, to reduce attraction of the site for feral animal and pest species. Staff will be informed of the dangers regarding feral animals and will not encourage or feed them on site. All rubbish, including food packaging, is to be disposed of in an appropriate container as soon as possible, to be transported off site.	High	A	2	Low Risk (4)	Low	Visual inspections are standard practice for identifying pests on vehicles and plant. No further actions can be taken to limit this impact.	No introduction of new or spread of existing pest species within the project area	Rubbish managed appropriately.	Site audits showing wastes managed appropriately	Annual environmental performance report will be submitted to DEPWS including: oWeed certificates for all vehicles oLocations of weed hygiene sites oRecords of plant and machinery inspections available oPost wet-season weed survey will be conducted of seismic lines and access tracks oStaff induction records oSite audits including waste management	PM	
LAND	Terrestrial Environmental Quality	Clearing or disturbing vegetation	Weed introduction and spread, impacting on surrounding land and vegetation quality (plant movement under vehicle movement)	Vehicles, plant and equipment bringing weeds into the project area, and/or spreading weeds within the project area		A	4	Low Risk (6)	Preventative A Weed Management Plan will be developed and implemented. The plan will include the following mitigation measures: o All machinery and equipment to be certified weed free by a suitably qualified person prior to arrival at site. o Control of declared weeds on site as per the NT Weeds Management Act. o All weeds removed will be and disposed of appropriately to ensure no further spread of weeds. o Identification of any declared weed will be reported to the Weeds Branch in accordance with the NT Weeds Management Act.	High	A	2	Low Risk (4)		Controls are industry standard for weed management. The introduction of weeds has been limited in line with standards and any weeds introduced or present on site will be identified and appropriately managed to reduce extent.	No introduction of new or spread of existing weeds within the project area	No new weeds introduced into the area. No existing weeds spread.	All vehicles certified as weed and pest free prior to arrival on site. Weed distribution not increased due to activity.	Annual environmental performance report will be submitted to DEPWS including: oWeed certificates for all vehicles oLocations of weed hygiene sites oRecords of plant and machinery inspections available oPost wet-season weed survey will be conducted of seismic lines and access tracks oStaff induction records oSite audits including waste management	PM	A.3.1.5 Site Selection and Planning A.3.5 Biodiversity Protection A.3.6 Weed Management
LAND	Terrestrial Environmental Quality	Seismic and drilling activity	Vibration affecting cattle and people	Vehicle, plant and equipment operation.		A	4	Low Risk (6)	Preventative Seismic operating hours for seismic line operation are established and communicated to personnel and contractors. Consult with pastoral landholders and take into consideration stock movements. Provide at least 2 weeks notification to households and businesses if operations are to be conducted within 100m of the premises. Work conducted in a progressive linear way allowing wildlife to avoid the area. Ensure site inductions for all site personnel include vibration requirements. Ensure vehicle, plant and equipment are maintained and in good order. Ongoing consultation with pastoral station manager and other relevant parties. Mitigative All nuisance related complaints to be investigated and acted upon		A	2	Low Risk (4)		Remote location Landholders will be able to ensure cattle are located away from work fronts Vehicles will maintained and speed will be limited when within proximity to receptors. Wildlife will be able to avoid the area of influence due to progressive work activities.	No significant impacts to the community as a result of the activity	No concerns from the community on vibration affecting people or stock.	Number of complaints Staff inductions	Complaints register identifying Date and summary of issue How complaints were resolved and corrective actions taken Annual environmental performance report will be submitted to DEPWS including oRegister of complaints	PM	A.3.1.5 Site Selection and Planning
LAND	Terrestrial Environmental Quality	Accessing land	Soil disturbance and degradation due to activities during wet weather	Vehicles, plant and equipment operating during wet weather		B	2	Low Risk (3)	Preventative Timing works to coincide with the dry season and complete the bulk of the activities prior to the onset of the wet season. Wet weather contingencies have been identified in the ESCP for any works that are scheduled close to the onset of the wet season. Due to the known ground conditions following rainfall events can make access impossible. The primary mitigation will be to monitor 7-day forecasts leading up to mobilising and daily during the program. Works will cease if there is a forecast for 50mm of rain or more within the next 48 hours.	High	B	2	Low Risk (3)	Low	Minimising access during wet periods and monitoring weather conditions ensures that work is completed during dry times, and minimises the impact on tracks. This reduces the risk to as low as possible.	Minimise track impacts and erosion	Minimise track degradation and erosion caused by activities.	Records show ESCP controls installed Records show works site inspected following rainfall events No evidence of active erosion	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology
LAND	Terrestrial Environmental Quality	Vehicles and plant, drilling activities	Contamination of soils	Inappropriate storage, handling of hazardous substances. Poor refuelling or fuel transfer practices leading to spills.		C	4	High Risk (14)	Preventative Designated waste storage will be located away from sensitive receptors areas such as waterways or drainage lines. All loading, unloading and refuelling operations will take place in designated areas, with portable bunding and away from sensitive receptors. Use, storage and handling of fuel, chemicals and oils on site: -must comply with WHS legislation and be in accordance with the approved safety data sheet -must be stored to prevent release to the environment and to contain any spills -liquid hydrocarbons, whether separated or mixed with other fluids at a concentration greater than 1% by volume, must not be stored in any open topped structure or pit Any hazardous chemicals or fuels that may cause environmental harm are to be stored within secondary containment. Secondary containment must meet all of the following: - sufficient capacity to hold 100% of the volume of the largest container stored in the area plus 10%, unless the container is equipped with individual secondary containment -permanently able to contain material or waste until it can be removed or treated -provide for separation of clean and dirty water -be compatible with the material or waste stored or used with in the containment -be resistant to physical, chemical and other failure during handling, installation and use -be maintained in good order at all times - secondary containment requirements can be met with double lined or double-walled storage tanks. All secondary containment (when in use)should be inspected weekly, unless being operated through the wet season during which they should be monitored daily. If the secondary containment is damaged or compromised, repairs must be carried out as soon as practicable. Inspection reports and maintenance records of secondary containment shall be kept. Mitigative In the event of a spill all contaminated material will be collected and disposed of via a licensed waste facility A spill management plan has been developed that outlines spill prevention, response procedures and spill clean-up processes (Appendix M). Materials that escape from primary containment or are otherwise spilled onto secondary containment shall be removed as soon as possible.	High	B	3	Moderate Risk (8)	Low	Chemicals and hazardous materials will be stored and per industry best practice. Appropriate spill kits and spill response procedures and materials will be available onsite minimising the risk consequence	No adverse impacts on soil, surface water or groundwater caused by hazardous substances utilised during the activity	No releases of contaminants. No releases of contaminants during transport	Number of spills of chemicals or hydrocarbons. Spill response records Daily inspection of fuel and chemical storage areas, including containment areas and structures, containers and spill kits Staff inductions	Spills reporting as needed Audits of fuel/chemical storage areas Staff inductions Annual environmental performance report will be submitted to DEPWS showing above records	PM	A.3.8 Containment of Contaminants C.7.2 Spill Management Plan
LAND	Terrestrial Environmental Quality	Vehicles and plant	Increased erosion and soil degradation	Disturbance of soils caused by project activities, and increased erosion risk		C	4	High Risk (14)	Preventative Implementing a Erosion and Sediment Control Plan (ESCP) for the site. Containing vehicle and plant movement to existing or constructed tracks where possible. Using lighter machinery such as graders or smaller bulldozers, taking care not to over work tracks. Over working these can lead to the loss of topsoil, compaction, formation of windrows and wheel rutting. Ground surface to be stabilised before the onset of the wet season. Works will cease if there is a forecast for 50mm of rain or more within the next 48 hours. Minimise number of creek/drainage line crossings to reduce erosion management. Mitigation Disturbed areas will be stabilised in line with the rehabilitation plan. Cleared vegetation will be uniformly respread over disturbed areas to assist with rehabilitation process through agencies of increased infiltration and retention of seed-bearing topsoil. If required, additional native seed mix from the area could be respread to speed up rehabilitation process.		B	3	Low Risk (4)	Low	Implementing an ESCP developed by a qualified professional that outlines industry standard controls will ensure risk are limited to ALARP. Watercourse crossings will only be used when dry to minimise erosion and impacts to soil. Selective clearing will ensure that the minimum area of vegetation will be cleared to complete the activities. Light machinery will lessen the impact on the areas that are cleared.	No impacts to soil integrity and quality caused by erosion during activities	No soil erosion and discharge of sediment or soil into waterways or established drainage systems. No new instances of erosion and sedimentation Erosion and sediment controls established	ESCP implemented prior to commencement of the activity Monthly visual inspection and monitoring of existing tracks, seismic lines and water waterway crossings conditions. These will occur: oDuring siting of seismic lines and drill pads (baseline assessment) oAfter completion of a key phases of activity, such as construction of drilling/ramp infrastructure, seismic line completion, completion of drilling and following the removal of site infrastructure. oAfter the wet season to look for signs of erosion oAnnually (post wet) for up to 5 years. Routine visual inspections of the creek and drainage line crossings. These will occur weekly or following a rainfall event (e.g greater than 20 mm in a 24 hour period)	Annual environmental performance report will be submitted to DEPWS including oMonthly track inspection reports oESCP schedule oCreek and drainage line inspections	PM	A.3.1.5 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology
LAND	Terrestrial Environmental Quality	Vehicles and plant	Disturbance of cattle/livestock	Vehicle, plant and equipment operation, and the presence of humans.		B	2	Low Risk (3)	Preventative Consult with pastoral leaseholders prior to scheduling of activities to take into consideration stock movements. Daily engagement with station manager and station personnel during activities to monitor potential disturbances to cattle and identify any reasonable solutions to mitigate any observed effects. Slow down vehicles when passing cattle. Daily and ongoing consultation with station manager and station personnel.		A	2	Low Risk (4)	Low	Remote location Landholders will be able to ensure cattle are located away from work fronts. Vehicles will be maintained and speed will be limited when passing cattle	No significant impacts to the community as a result of the activity	Minimise impacts of activity on surrounding cattle livestock	All complaints investigated and resolved, with complaints and corrective actions recorded.	Annual environmental performance report will be submitted to DEPWS	PM	A.3.1.5 Site Selection and Planning
LAND	Terrestrial Environmental Quality	Stream crossings	Impact to integrity or quality of land and soils	Stream crossing works	RESULTS FROM FIELD SURVEY	C	4	High Risk (14)	Preventative Implementing a Erosion and Sediment Control Plan (ESCP) for the site Containing vehicle and plant movement to existing or constructed tracks where possible. Using lighter machinery such as graders or smaller bulldozers, taking care not to over work tracks. Over working these can lead to the loss of topsoil, compaction, formation of windrows and wheel rutting. Ground surface to be stabilised before the onset of the wet season. Works will cease if there is a forecast for 50 mm of rain or more within the next 48 hours. Implement the suggested realignments, this will help avoid certain risks such as trees, areas of erosion etc. Minimise number of creek/drainage line crossings to reduce erosion management. Use existing station tracks to avoid having to make cuts. Deviate seismic lines to avoid cuts to drainage lines and avoid trees. Temporary stockpiling of soil, equipment and materials within watercourses, or on adjacent banks and floodplain, is to be avoided (unless integral to drainage control requirements) Mitigation Disturbed areas will be stabilised in line with the rehabilitation plan. Cleared vegetation will be uniformly respread over disturbed areas to assist with rehabilitation process through agencies of increased infiltration and retention of seed-bearing topsoil. If required, additional native seed mix from the area could be respread to speed up rehabilitation process.		B	3	Low Risk (4)	Low	Implementing the mitigation measures and an ESCP developed by a qualified professional that outlines industry standard controls will ensure risks are limited to ALARP. Watercourse crossings will only be used when dry to minimise erosion and impacts to soil.	No impacts to soil integrity and quality caused by erosion during activities	No soil erosion and discharge of sediment or soil into waterways or established drainage systems. No new instances of erosion and sedimentation Erosion and sediment controls established	ESCP implemented prior to commencement of the activity Monthly visual inspection and monitoring of existing tracks, seismic lines and water waterway crossings conditions. These will occur: oDuring siting of seismic lines and drill pads (baseline assessment) oAfter completion of a key phases of activity, such as construction of drilling/ramp infrastructure, seismic line completion, completion of drilling and following the removal of site infrastructure. oAfter the wet season to look for signs of erosion oAnnually (post wet) for up to 5 years. Routine visual inspections of the creek and drainage line crossings. These will occur weekly or following a rainfall event (e.g greater than 20 mm in a 24 hour period)	Annual environmental performance report will be submitted to DEPWS including oMonthly track inspection reports oESCP schedule oCreek and drainage line inspections	PM	A.3.1.5 Site Selection and Planning A.3.4 Erosion and Sediment Control and Hydrology

LAND	Terrestrial Environmental Quality	Rehabilitation	Ineffective ongoing degradation of land and soil	Rehabilitation works		B	4	Moderate Risk (9)	Preventative Correct implementation of the rehabilitation plan will ensure the following: - Works areas are progressively rehabilitated as soon as possible following the completion of works. - Stockpiled vegetation is re-spread over disturbed areas to facilitate vegetation regrowth and limit erosion.		A	2	Low Risk (4)	Low	Rehabilitation plan implements industry best practice methodology and ongoing monitoring will ensure rehabilitation success.	No permanent disturbance footprint remaining onsite following rehabilitation	Disturbed areas returned to pre-disturbance condition.	Rehabilitation monitoring identifies that environmental conditions are restored to levels identified in pre-disturbance site assessments. Monitoring will take place at the end of the wet season (February to June) approximately between six and nine months post rehabilitation works, yearly for the first three years post rehabilitation works and annually until successful rehabilitation criteria have been met and signed off by the Project Manager	Annual environmental performance report will be submitted to DPIR including rehabilitation activities	PM	A.3.9 Rehabilitation
LAND	Terrestrial Environmental Quality	Accommodation/staffing	Soil contamination	Wastewater from camp/accommodation Overtopping of drilling sumps		B	4	Moderate Risk (8)	Preventative A Waste Management Plan will be implemented (Appendix L). Designated waste storage areas will be located away from sensitive receptors such as waterways or drainage lines. Wastewater will be treated to the required environmental guidelines for advanced secondary effluent (Class "B"). Removal and disposal of hazardous wastes to be in accordance with NT hazardous waste disposal requirements. Sufficient waste receptacles will be provided onsite and any work areas. Waste will be segregated for ease of disposal. All staff to be informed of the waste management plan and regular inspections will ensure compliance. A WOMP will be developed to cover well activities. The Project will not commence until a WOMP has been approved. Drilling sumps and cuttings pits will be designed, constructed and operated with sufficient freeboard to prevent overtopping in a 1 in 1000 rainfall event. Freeboard levels to be maintained are: -EP164 – 0.5 m in dry season and 0.85 m in wet season -EP158 – 0.5 m in dry season and 1.2 m in wet season Sump freeboard will be inspected daily. Drilling sumps and cuttings pits will be designed and constructed with 0.5 m high bunds to prevent water entry from overland flow. Drilling sumps and cuttings pits will be inspected daily to check integrity. For all drilling chemicals to be used they must have been approved for use in drilling petroleum wells by the Commonwealth Government, Department of Health and listed on the Australian Inventory of Chemical Substances which is maintained under the National Industrial Chemicals Notification and Assessment Scheme. No drilling fluid additives that are used in the process contain benzene, toluene, ethylbenzene or xylene.	High	A	3	Low Risk (4)	Low	All waste will be collected, treated and disposed of correctly. This reduces the risk to ALARP as there are no further actions that can be taken to reduce risk. The Code of Practice requires storages of wastewater to meet the 0.1% AEP freeboard requirement. This indicates that industry standards for wastewater management and storage have been adopted, limiting the risk. Drilling sumps and cuttings pits will be designed, constructed and operated with sufficient freeboard to prevent overtopping in a 1 in 1000 rainfall event.	No adverse impacts on soil, surface water or groundwater caused by wastewater management	No releases of wastewater during transport. All wastewater treated to the required effluent class. No exceedance of freeboard in sumps. No release of wastewater.	Number of spills of wastewater. Spill response records. Weekly inspection of wastewater disposal areas. Daily inspections confirm wastewater levels do not exceed freeboard. Daily inspection of sump and wastewater areas.	Spills reporting as needed. Audits of wastewater storage areas. Staff inductions. Annual environmental performance report will be submitted to DPIR showing above records.	PM	A.3.8 Containment of Contaminants C.7.2 Spill Management Plan
LAND	Terrestrial Environmental Quality	All activities	Prevention of works. Deterioration of soil and water quality.	Flooding		B	4	Moderate Risk (8)	Preventative Well pads to be placed outside of flood risk areas as per the 1 in 100 year flood modelling (Appendix Q and R) Mitigative If works continue into the wet season, bunding or well infrastructure will occur.	High	A	4	Low Risk (4)	Low	Well pads are unlikely to be inundated by 1 in 100 year flooding as modelling indicates the locations are outside of the flood extent, the well pads will only be present onsite for a short period and works will be completed mostly in the dry season, with only a chance of extending into the wet season. If works continue into the wet season bunding of well pads will occur.	No impacts to soil integrity and quality caused by erosion from the project	No soil erosion and discharge of sediment or soil into waterways or established drainage systems. No new instances of erosion and sedimentation. Erosion and sediment controls established	ESCP implemented prior to commencement of the activity Monthly visual inspection and monitoring of existing tracks, seismic lines and water waterway crossings conditions. These will occur: during siting of seismic lines and drill pads (baseline assessment) after completion of a key phases of activity, such as construction of drilling/camp infrastructure, seismic line completion, completion of drilling and following the removal of site infrastructure. after the wet season to look for signs of erosion annually (post wet) for up to 5 years. Routine visual inspections of the creeks and drainage line crossings. These will occur weekly or following a rainfall event (e.g. greater than 20 mm in a 24 hour period).	Annual environmental performance report will be submitted to DPIR	PM	A.3.1.5 Site Selection and Planning A.3.4.1 Erosion and Sediment Control and Hydrology
LAND	Terrestrial Environmental Quality	All activities	Contamination of soils	Onsite disposal of drill muds and cuttings		B	4	Moderate Risk (8)	Preventative Onsite disposal to only take place following testing and characterisation of waste, and if approved by a contaminated site auditor. If onsite disposal is approved, environmental harm will not result from the proposed disposal in compliance with section C.4.1.2(i) of the Code. If onsite disposal is not approved, will be removed from site for disposal at a licensed waste facility.	High	A	4	Low Risk (4)	Low	Drill muds will only be disposed of on site if they meet the required criteria	No adverse impacts on soil, surface water or groundwater caused by wastewater management.	No exceedance of freeboard in sumps. No release of wastewater.	Number of spills of wastewater. Spill response records. Daily inspections confirm wastewater levels do not exceed freeboard. Daily inspection of sump and wastewater areas.	Annual environmental performance report will be submitted to DPIR	PM	A.3.8 Containment of Contaminants C.7.2 Spill Management Plan
LAND	Terrestrial Environmental Quality	Vehicles and plant	Contamination of soils	Transportation of chemicals, fuels and wastes		B	4	Moderate Risk (8)	Preventative All loading, unloading and refuelling operations will take place in designated areas, with portable bunding and away from sensitive receptors. During the wet season, the transport of chemicals and wastewater on unsealed roads will be avoided if possible. If required, roads will be scouted to check suitability and condition prior to transport. Mitigative In the event of a spill all contaminated material will be collected and disposed of via a licensed waste facility. A spill management plan has been developed that outlines spill prevention, response procedure and spill clean-up processes (Appendix M).	High	A	2	Low Risk (4)	Low	Chemicals and hazardous materials will be stored and transported and per industry best practice. Appropriate spill kits and spill response procedures and materials will be available onsite minimising the risk consequence. Transport routes will be scouted prior to mobilising during the wet season.	No adverse impacts on soil, surface water or groundwater caused by hazardous substances utilised during the activity	No release of contaminants during transport	Number of spills of chemicals or hydrocarbons. Spill response records. Staff inductions	Annual environmental performance report will be submitted to DPIR	PM	A.3.8 Containment of Contaminants C.7.2 Spill Management Plan
LAND	Terrestrial Environmental Quality	Vehicles, plant and drilling activities	Direct mortality of fauna	Storage of drilling wastewater in open ponds		B	4	Moderate Risk (8)	Preventative Drilling sumps will be appropriately fenced to prevent wildlife access to the wastewater and prevent potential drowning Mitigative Sumps will be inspected daily and fence repaired as needed.	High	A	2	Low Risk (4)	Low	Fencing of ponds will reasonably limit fauna access to these areas.	No fauna injury or deaths	No injury or deaths to fauna	Daily inspection of sumps and fencing. Record any fauna encounters, injuries or deaths as a result of the activities on fauna register for the duration of works. Induction records	Annual environmental performance report will be submitted to DPIR	PM	A.3.1.5 Site Selection and Planning A.3.5 Biodiversity Protection

APPENDIX F ESCP EP144

Erosion & Sediment Control Plan
EP 144
Minerals Australia

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ACRONYMS

AEP	Average Exceedance Probability
BOM	Bureau of Meteorology
CPESC	Certified Professional in Erosion and Sediment Control
DENR	NT Department of Environment and Natural Resources (Northern Territory)
DPIR	NT Department of Primary Industry and Resources
EHS	Environment Health and Safety
EMP	Environment Management Plan
EP	Exploration Permit
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
IECA	International Erosion Control Association
NT	Northern Territory
RCD	Rock Check Dam
RFD	Rock Filter Dam
RUSLE	Revised Universal Soil Loss Equation

1 INTRODUCTION

Minerals Australia Pty Ltd (Minerals Australia), a wholly owned subsidiary of Hancock Prospecting, is the operator of Exploration Permit (EP) 144 which is located 100km northeast of the Barkly Roadhouse on the Barkly Highway in the Northern Territory (NT), and covers approximately 15,012 km^2. EP144 is situated on Aboriginal land and is the subject of an Exploration and Coexistence Deed between Minerals Australia Pty Ltd, Jacaranda Minerals Ltd (a co-shareholder) and the Northern Land Council (NLC).

Minerals Australia proposes a works programme on EP144 involving drilling of two exploratory stratigraphic core drill holes (approximately 1000m and 500m in depth), to obtain stratigraphic information and to test potentially favourable geological structures and possible hydrocarbon potential in the un-explored South Nicholson River Basin.

Minerals Australia have engaged EcOz Environmental Consultants Pty Ltd (EcOz) to develop the Erosion and Sediment Control Plan (ESCP) associated with the above exploration activities as per their Environmental Management Plan (EMP)

1.1 Purpose and Objectives

This ESCP has been prepared to provide a best-practice framework for implementation of effective erosion and sediment control associated with Minerals Australia's work activities within the project area.

Objectives of the ESCP are:

- To take all reasonable and practical measures to minimise actual or potential environmental harm resulting from soil or water movement resulting from work activities
- To maintain, and where practical, enhance the land use capabilities of disturbed areas with respect to land's soil, water and vegetation attributes.
- To prevent soil loss from the site and deposition offsite; and minimisation of associated risks to water quality and air quality.
- To ensure satisfactory stabilisation of the site at completion of works.

1.2 Scope

This ESCP provides the overarching guidance demonstrating drainage, erosion and sediment control principles, practices and methods to be implemented throughout project.

This ESCP has been reviewed by an Associate Certified Professional in Erosion and Sediment Control (CPESC) in accordance with the guideline Best Practice Erosion and Sediment Control (IECA 2008). The ESCP:

- Identifies areas vulnerable to erosion and sedimentation (including receiving waters).
- Includes an overarching erosion risk and hazard assessment.
- Details the management strategy and specific measures to be implemented to effectively manage erosion, and potential sediment mobilisation associated with the project activities.
- Includes details of both temporary and permanent erosion and sediment control methods and treatments to be implemented for all stages of the project (pre, during and post works).
- Includes information regarding proposed timing and staging of works, responsibilities, maintenance and monitoring requirements, and reporting procedures.

2 PROJECT AREA

2.1 Project Location

EP144 is located over the Mittiebah perpetual pastoral lease, approximately 100 km north-east of the Barkly Roadhouse on the Barkly highway.

The proposed activities involve construction of two stratigraphic drill holes, one at each of two separate locations. Drill Hole 1 (Hole 1) is to a depth of 500 m. Drill Hole 2 (Hole 2) is to a depth of 1000 m. Locations of the core drill holes are provided in Table 2-1. For the purpose of the work program and environmental and significant site surveys the location of the planned holes has been assigned as the centre of a 1 km radius buffer area. The final location for the stratigraphic hole could be anywhere within this buffer area.

Hole 1 is approximately 19 km west of Mittiebah Road. Access to the site will be via the Mittiebah Road off Ranken Road for approximately 65 km, and then 19 km along an existing station road. Additional clearing will be required to clear the access route to transport associated drilling equipment. Hole 2 is located adjacent to Mittiebah Road.

Refer to Figure 2-2 and Figure 2-3 for a visual of the project.

Table 2-1. Location of stratigraphic core dill holes for EP144 (GDA94 Zone 53)

Drill Hole Name	Depth (m)	Latitude	Longitude
Hole 1	~500	-18.78491	136.925386
Hole 2	~1000	-18.88828	137.11023

2.1.1 Titleholder's Details

Business name:	Minerals Australia Pty Ltd. And Jacaranda Minerals Pty Ltd.
Contact person:	Peter Collings, Chief Geologist
Postal address:	Locked Bag 2, West Perth, WA 6972
Contact details:	*(08) 9429 8272* *peter_collings@hancockexplorationhq.com.au*

2.2 Project Components

Minerals Australia proposes to undertake drilling of two stratigraphic drill holes and the construction of a campsite that will be located close to Hole 2. The following key activities are included:

- Vegetation clearing.
- Grading, excavation, stockpiling, compaction of soil material.
- Respreading of any removed vegetation on disturbed areas following completion of the program, to promote regeneration.
- Removal of all surface infrastructure and rehabilitation.

2.3 Extent of ground disturbance

Civil works involve vegetation clearing; grading, excavation, stockpiling and compaction of soil material and provision of construction access and drilling of wells, as described below.

2.3.1 Access roads

Existing access tracks will be utilised wherever possible during site activities. Maintenance of tracks may be required before, during and following project activities. This may include grading, patching and watering.

2.3.2 Drill pads

Each of the two drill pads will have the following characteristics

- 150 m x 150 m drill pad footprint – one for each drill hole.
- Drill pads will be fully fenced, and entry equipped with gates or grids.
- Establishment of ESCs as described in Section 5.1.
- Clearing required at Hole 1; minimal clearing required at Hole 2 – total approximately 10 ha of vegetation clearing.
- Drill depth to 5000 m for Hole 1 and 1000 m to Hole 2.
- Drill holes are approximately 100 mm in diameter.
- Excavation of two sumps (25 m x 25 m x 2 m) per hole to contain drilling fluid.
- No requirement for establishment of gravel pits.

2.3.3 Camp site

One campsite will be required to accommodate the drill rig crew/s for both drill holes.

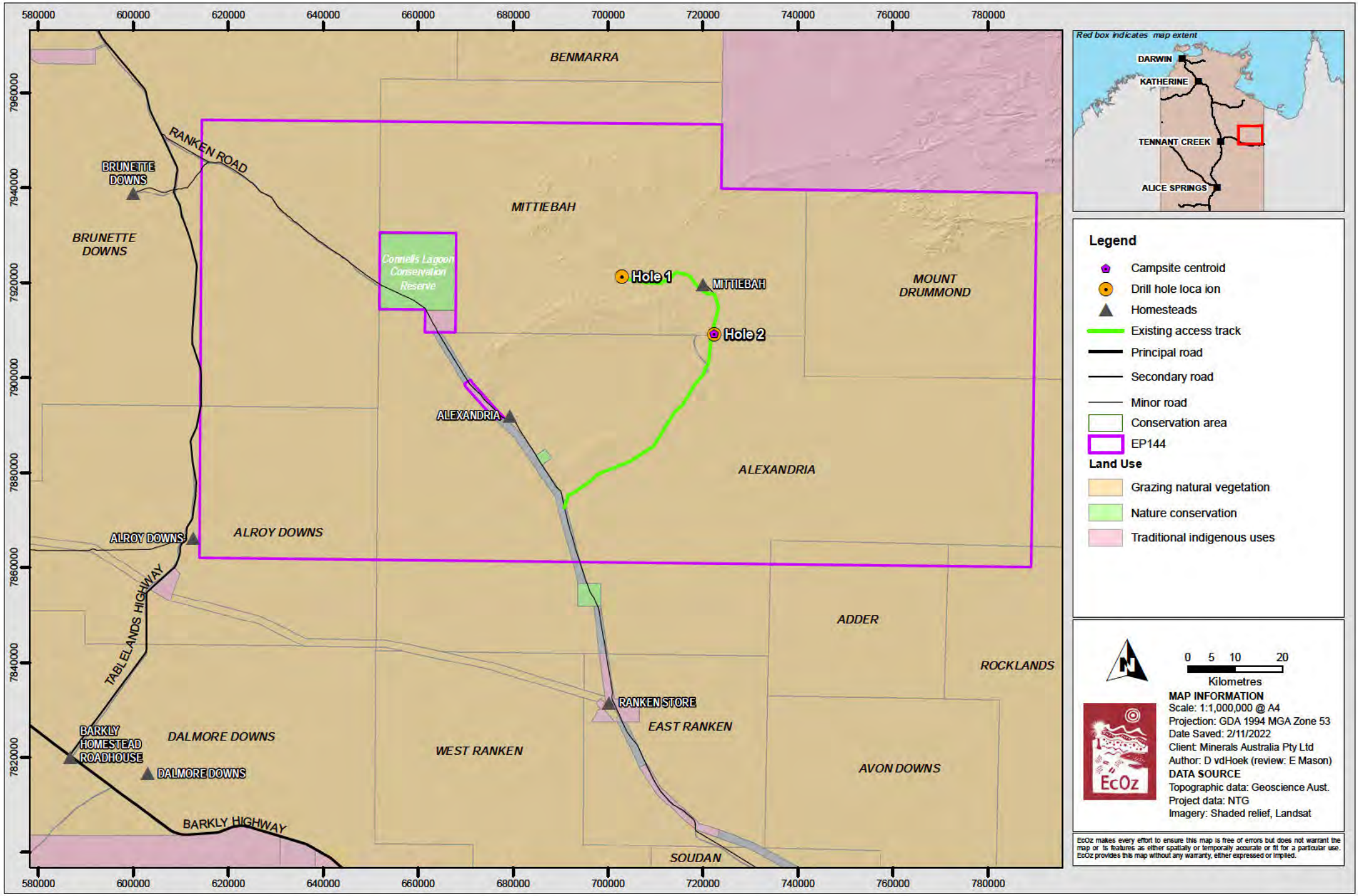
The camp will be sited on a central location on Alexandria/Mittiebah station on ground conducive to camping. The camp will be located on a previously disturbed area wherever possible with a total area of approximately 1 ha. This camp will accommodate approximately 30 people. The camp will occupy an area approximately 100 m by 100 m in size.

A typical crew camp is shown in Figure 2-1.

Figure 2-1. A typical camp layout

2.4 Project schedule

Drilling is scheduled to be undertaken between May and November 2023 and is expected to take approximately two to three months to complete.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage G\S\EZ19181 - Hancock - EMP EP144\01 Project Files\Report maps\Figure 1 1 Map of the location of EP144, the proposed exploratory works and surrounding land use.mxd

Figure 2-2. Map of the location of EP144 and surrounding land use

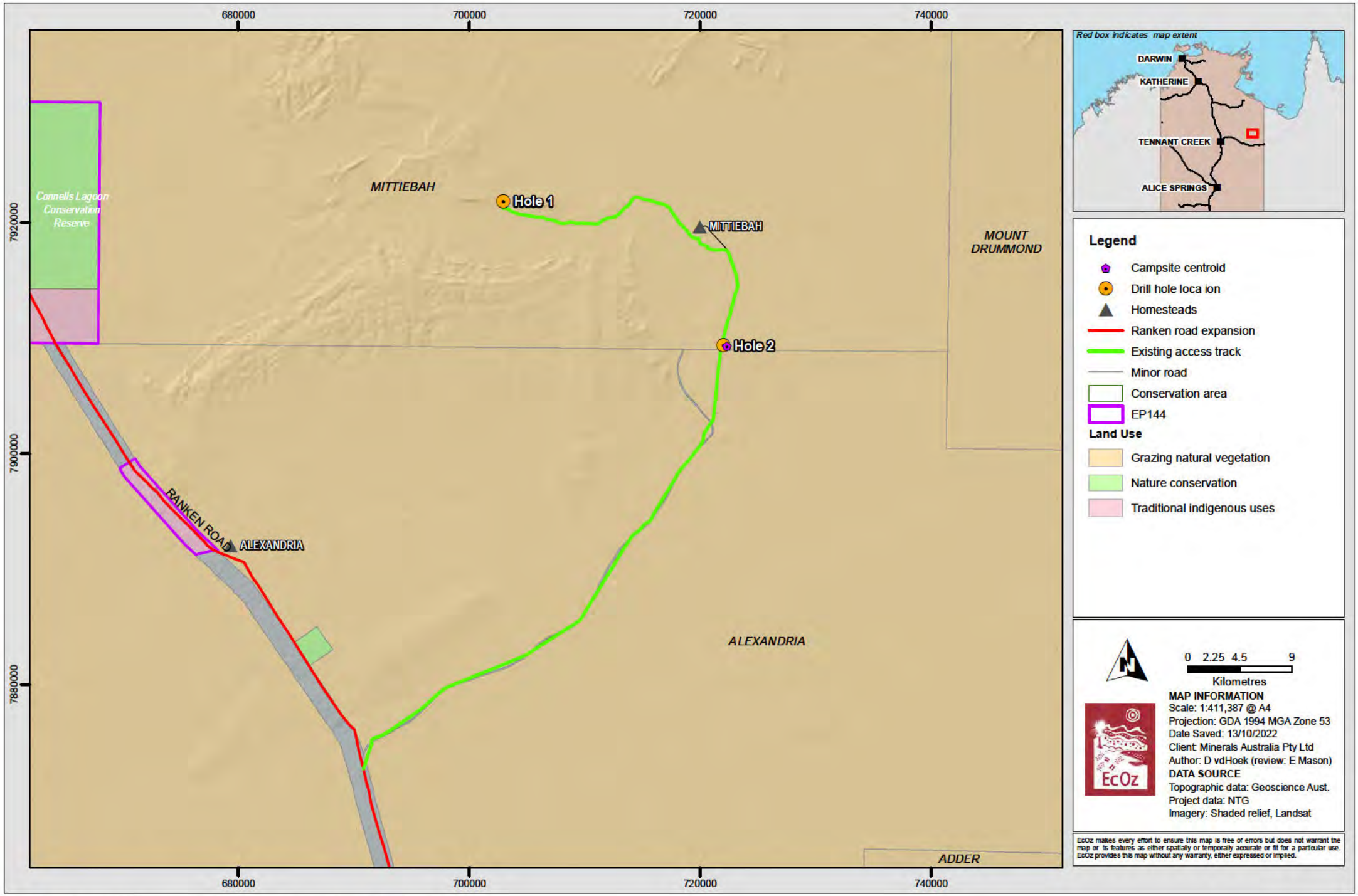


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Figure 2-3. Key project infrastructure

3 SITE CHARACTERITICS

3.1 Climate and rainfall

The region experiences a hot desert climate generally, characterised by hot dry summers and cool dry winters, with a low average annual rainfall restricted between November to March. The closest long-term Bureau of Meteorology weather station is Brunette Downs (station number 015085), located within EP144. Mean annual maximum temperature recorded at that station is 33.6 °C, while the mean annual minimum is 18.8 °C. Extremes averages oscillate between 10.6 °C in July and 38.3 °C in December. Median annual rainfall is 370.9 mm; however, the amount of rainfall in the region is highly variable. If heavy rainfall occurs, it is generally in the December, January, February quarter and can result in flash flooding in the waterways (BoM 2021). Figure 3-1 presents the BOM (2021) data showing the average monthly rainfall and temperatures extremes for Brunette Downs weather station.

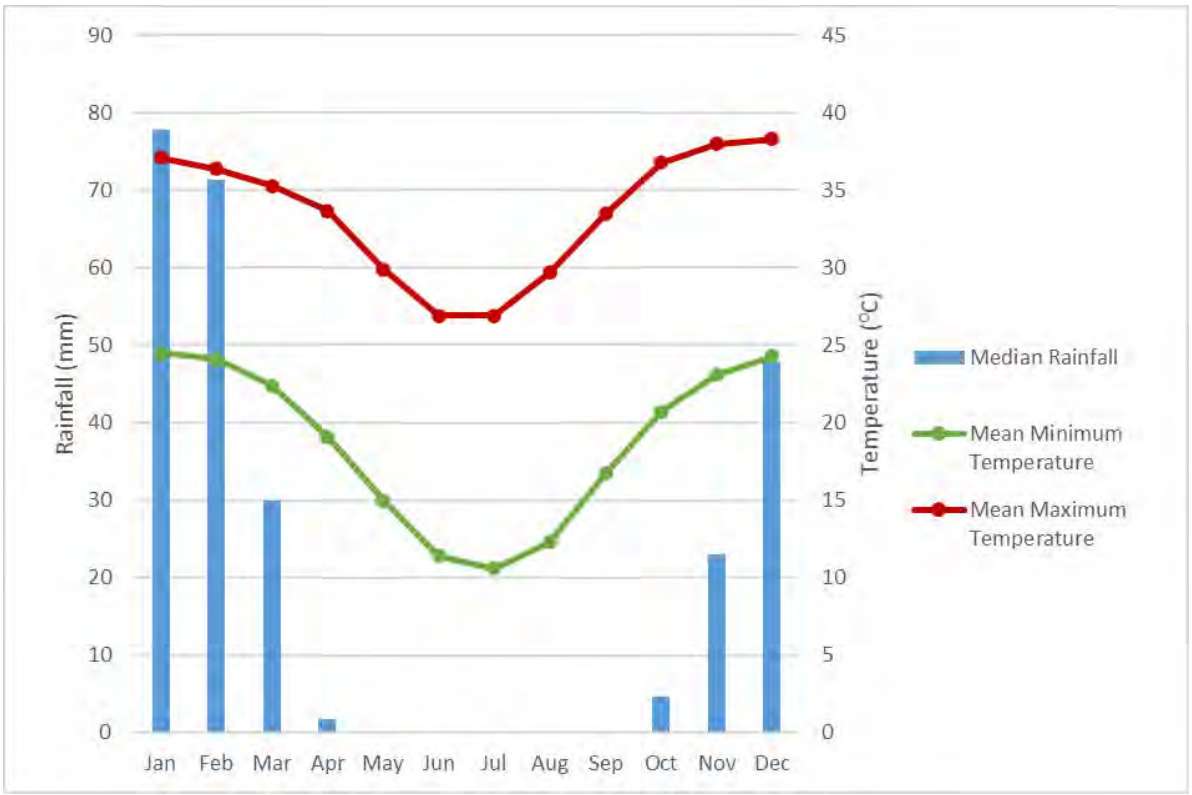


Figure 3-1. Average monthly rainfall and temperature at Brunette Downs Station

3.2 Land systems and units

Christian and Stewart (1968) define a land system as 'an area or group of areas throughout which there is a recurring pattern of topography, soils and vegetation'. These have been mapped across the NT by different surveys and are at a significantly smaller scale than a bioregion (i.e. bioregions constitute many different land systems). Within each land system, a set of component land units is defined. In some areas of the NT, mapping has been undertaken to the level of detail of land units. Land unit mapping was undertaken at a scale of 1:100,000 for NT Portion 962 – Mittiebah Station where Hole 1 is located, however, there is no land unit mapping for the NT Portion 1 – Alexandria Station, where Hole 2 and the proposed camp site are located.

Land system mapping of the region was undertaken by Christian et al. (1954) at a scale of 1:250,000. A summary of the land systems relevant to the project areas of disturbance are detailed in Table 3-1.

Table 3-1. Summary of the land systems relevant to the project footprint

Project location	Land system	Land unit	Description	Soil
	Clay plains			
Hole 2 and Campsite	Barkly 2	-	Level to gently undulating clay plains (black soil plains); cracking clay soils	Vertosols
	Barkly 3	-	Level to gently undulating clay plains (black soil plains); cracking clay soils	
	Sandstone plains and rises			
Hole 1	Yelvertoft	1.3, 1.5	Dissected low hills formed on Constance Sandstone with patchy sandy soils; very gravelly	Rudosols

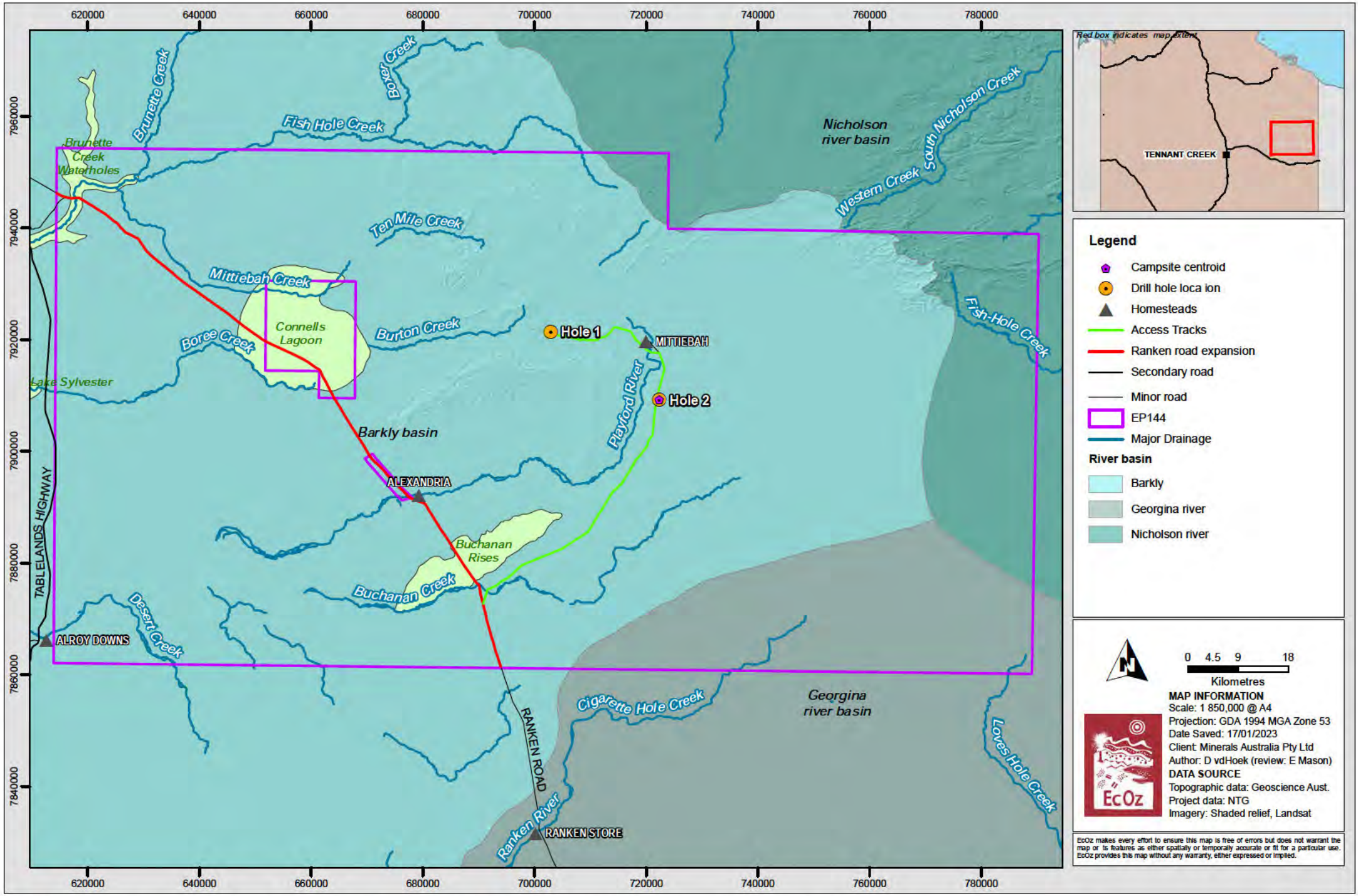
3.3 Surface water and drainage

EP144 predominantly lies within the Victoria River-Wiso catchment, except for the north-eastern corner of the EP which is within the Nicholson-Leichardt River catchment, and the south-eastern corner which is within the Diamantina-Georgina Rivers catchments (see Figure 3-2). The lease area is crossed by two watercourses: Playford River (stream order 5) and one of its tributaries Buchanan Creek (stream order 3) (see Figure 3-2). Mittiebah Creek is the other order 5 watercourse in the area, turning into Brunette Creek after encountering the Fish Hole Creek. All of these watercourses are ephemeral, flowing only after major rain events, however, they support some permanent freshwater pools (e.g. Mitchiebo Waterhole, in the source of Playford River).

A site walkover conducted in July 2021 identified there are no permanent watercourses within or near the project footprint, however five waterway or drainage line crossings were identified along the access route (Table 3-2). The major waterways crossed by the project footprint are the Playford River and Buchanan Creek. Watercourses within the project footprint were heavily impacted by cattle, with compacted soil and loss of groundcover vegetation resulting in an increased risk of erosion within this landform. The drainage lines intersecting the project footprint are not steep and easily trafficable, requiring very minor cuts (if any) for the transit of vehicles and machinery.

Table 3-2. Summary of water crossings identified along access route

Reference site	Location	Stream order	Erosion potential
Waterway Crossing 1	136.6858, -19.0574	5 – Playford River	Low. Ranken Rd. crossing at this drainage site is covered with concrete.
Drainage Site 2	137.1170, -18.8429	4 – Wild Cow Creek	Moderate. Shallow drainage depression
Drainage Site 3	137.0650, -18.9767	2 – Eastern Creek	High. Wide open channel, steep denuded banks
Drainage Site 4	137.0482, -19.9857	5 – Playford River	Moderate. Wide channel, steep banks
Drainage Site 5	137.8069, -19.1995	3 – Buchanan Creek	Moderate. Denuded banks



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ19181 - Hancock - EMP EP144\01 Project Files\Report maps\Figure 2.2. Map of hydrological boundaries and sites of botanical significance within and surrounding EP 144.mxd

Figure 3-2. Map of catchments and significant watercourses within and surrounding EP144 project area

4 EROSION HAZARD AND RISK

Inputs and equations used to assess erosion hazard and risk for the project area are detailed in the sections below.

4.1 Erosion hazard

Erosion hazard is assessed using the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This is commonly used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. The RUSLE is represented by the following equation:

A = R * K * L * S * P * C, where:

Factor	Description	Value	Comment
A	estimated soil loss (tonnes/ha/yr)	variable	As calculated per catchment
R	rainfall erosivity factor	824	Calculated on rainfall data for the region (Section 4.1.1)
K	soil erodibility factor	0.036	0.036 adopted – gravelly sands (Section 4.1.2)
LS	slope length/gradient factor	variable	Based on catchment characteristics. (Section 4.1.3)
P	erosion control practice factor	1.3	Construction phase condition (Section 4.1.5)
C	ground cover and management factor	0.37	Based on proposed surface cover. (Section 4.1.4)

4.1.1 Rainfall erosivity (R–factor)

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is a product of two components: total energy (E) and maximum 30-minute intensity for each storm (Landcom 2004). Due to the remote location of the project, an appropriate R-factor has not been predetermined for the region therefore it can be calculated using the following formula as per the IECA Guidelines:

$$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$$

Where S is the 2 year ARI, 6 hour rainfall event [mm]

According to BOM, for the project area S is determined to be 5.07mm/hour. Therefore using the above formula, the adopted R-factor for the project is 824.

4.1.2 Erodibility (K-factor)

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008). Soil texture is the principle component affecting K, but soil structure, organic matter and profile permeability also contribute. In the absence of site specific soil data, the soil description of the relevant land systems has been used to adopt a default K-factor. A K-factor of 0.036 represents a conservative erodibility value based on soil description (gravelly sands for Hole 1); as per IECA 2008 *Table E5 - Typical K-factors based on Unified Soil Classification System.* Note that the clay soil description at Hole 2 and the campsite would allow for a lower K-factor of 0.025 or lower, however 0.036 has been adopted for all sites as a conservative measure.

4.1.3 Slope (LS–factor)

The LS-factor describes the combined effect of slope length and slope gradient on soil loss. Based on the land systems description and the size of the disturbance areas, the drill pads and campsite are anticipated to have slopes of less than 2%. The access road to Hole 1 will potentially traverse topography up to 8 % slope (dissected low hills), with road surface formed with a side slope of 4%.

4.1.4 Cover and management factor (C–factor)

The cover and management factor is a measure of the level of soil surface protection provided by various groundcovers. It includes proportion of vegetation, rock, hardstand, paving, soil binders, matting and associated non-erodible material. The C-factor for the project will vary depending on stabilisation and management of surfaces exposed by construction and operation. C-factors for various surface are summarised in Table 4-1.

Table 4-1. Adopted C-factors

Surface type	% cover	C-factor
Concrete, bitumen	100	0
Vegetation (highly variable)	25 - 80	0.37 – 0.025
Soil stabiliser (eg. Vital Bon-Matt HR or Bon-Matt RDS (S72))	80	0.025
Rock	80-100	0.025 - 0
95% compacted gravel/soil surface (eg. haul roads/pads)	25	0.37
Bare soil, erosive surface	0 - 20	1 - 0.44

4.1.5 Erosion control practice factor (P–factor)

The P-factor measures the combined effect of all support practices and management variables. It also represents structural methods for controlling erosion (IECA 2008). The nominated P-factor for all areas without permanent stable groundcover is 1.3 (based on the default construction phase condition).

4.1.6 Estimated soil loss

Potential soil loss calculations and associated erosion hazard for defined project areas are provided within Table 4-2.

Table 4-2. Soil loss and erosion hazard

Project Areas	Drill Hole 1		Drill Hole 2		Camp Site
	Road access	Drill pad	Road access	Drill pad	
Rainfall erosivity (R)	824	824	824	824	824
Soil erodibility (K)	0.036	0.036	0.036	0.036	0.036
Slope length (L)	10	100	10	100	100
Slope gradient (S)	8	2	8	2	2
Length/gradient (LS)	0.53	0.58	0.53	0.58	0.58
Erosion control practice (P)	1.3	1.3	1.3	1.3	1.3
Ground cover in disturbed catchment - %	25	25	25	25	25
Ground cover in disturbed catchment (C)	0.37	0.37	0.37	0.37	0.37
Soil Loss (t/ha/yr)	8	8	8	8	8
Soil Loss Class	1	1	1	1	1
Erosion Hazard	Very low	Very low	Very low	Very low	Very low

4.2 Erosion risk

Erosion risk refers to the evaluation of the “risk” of soil erosion when consideration is given to both the degree of erosion and the likelihood of the erosion occurring (IECA 2008). In the absence of a site specific risk assessment procedure, erosion risk rating is determined from the 2 year ARI monthly rainfall depth for Brunette Downs (Table 4-3).

Erosion risk ratings range from very low through May to September coinciding the with the Top End dry season, up to moderate through October to April (wet season).

Table 4-3. Monthly erosion risk rating (based on Brunette Downs)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall depth (mm)	77.8	71.4	30.0	1.8	0.0	0.0	0.0	0.0	0.0	4.7	23.0	47.8
Rating	Moderate		Very Low									Moderate

4.3 Erosion and sediment control requirements

Recommended erosion and sediment control measures are based upon the relationship between erosion hazard (as determined from Table 4-2) and erosion risk (Table 4-3). The reliable and prolonged dry season provides a low risk of erosion from rainfall throughout these months, although wind erosion potential (dust) is significant.

It is essential that erosion and sediment control measures are fully implemented prior to the 1st October in preparation for the wet season. Table 4-4 summarises erosion and sediment control requirements for all stages of civil construction and operation across a full calendar year. Typical measures to be implemented during works are discussed in Section 5. Additional specific design, timing and location are to be provided within Progressive ESCP's and associated engineering drawings.

Table 4-4. Erosion risk and ESC requirements during construction

Erosion Risk Rating	Monthly Rainfall Depth	Period	Erosion & Sediment Control Requirements
Very low	0 to 30mm	May - Sep	• ESCs not required for activities which do not disturb groundcover • Unfinished earthworks are suitably stabilised if rainfall is reasonably possible • Sediment control to be installed around areas of erosion risk prior to 1st October (wet season commencement)
Moderate	45+ to 100mm	Octo - Apr	• Areas of erosion risk protected within 20 days completion (or cessation) of earthworks or inactivity [1] • Sediment control fully installed & maintained
Notes:	[1] Areas of erosion risk may be protected using the following types of cover: hardstand, soil binder (eg. polymer), placement of mats, blankets (eg. geotextile, jute) or vegetative cover (min 75% for all areas, with min 90% for drainage channels).		

5 EROSION AND SEDIMENT CONTROL - SPECIFIC AREAS AND ACTIVITIES

5.1 Drill pads

The drill pads will be constructed by blading and/or slashing of vegetation within the approved boundary. Surface groundcover and soil disturbance will be avoided as far as practical. Layout of physical ESCs are provided in Appendix A. Physical controls include the following:

- Perimeter topsoil berm to divert clean water and enable treatment of site water (1:2 batters; seeded with suitable groundcover species)
- Mulch/cleared vegetation bund around the perimeter down-gradient of surface water flow
- Whoa Boy at vehicle entrance points to the drill pad
- Rock filter dams within the stabilised topsoil stockpile/bund on the down-gradient of surface water flow.
- Compacted hardstand surface
- Application of soil binder (polymer) for erosion control and dust suppression where necessary (ie. in event of lack of vegetation cover and/or excessive dust).

Refer to Appendix B for ESC design detail.

Upon completion of drilling activities, rehabilitation of the drill pad area is to incorporate:

- Removal of any drill spoil.
- Light cross ripping to a depth not exceeding 100mm (only where soil disturbance has been undertaken).
- Re-spreading of topsoil and stripped vegetation across disturbed areas (where initial stripping took place).

5.2 Site roads/access

Project access is to be predominantly via both existing roads and pastoral tracks. Where additional or new access roads are required, the road design shall include the following:

- 4 metre carriage width
- Formed with 4% side-slope
- Minimum 200 mm surface coarse, compacted to 95% MMDD
- Drainage (table drains and mitre drains).

Access roads are to be constructed and maintained consistent with the following principles (refer to Appendix B for ESC design detail):

5.2.1 Route selection

The following should be applied to route selection to minimize erosion:

- Reuse existing access roads wherever possible.
- Minimise disturbance to soil and vegetation.

- Minimise the number of watercourse and drainage line crossings.
- Reduce the catchment area above the road by locating the road along a ridge or as high as possible on side slopes.
- Locate roads to avoid:
    - Steep cross-slopes
    - High erosion hazard soils
    - Areas of riparian vegetation
    - Perched water tables, swamps, or areas of poor drainage
    - Unstable geology, steep topography or rock outcrops.

5.2.2 Design and construction

The following are to be applied during design and construction:

- Roads are to be graded to a crown, or with crossfall drainage.
- Watercourse crossings and associated approaches are to be protected from erosion.
- Road runoff to be directed to stable outlets (vegetated or rocky areas).
- Upon completion of construction, roads no longer required are to be ripped, topsoiled and revegetated (returned to the pre-disturbance condition).

5.2.3 Cross banks

Where access road runoff cannot be adequately controlled by cross fall drainage (eg. observation of rills along road surface), construct cross banks consistent with the following:

- Interval spacing based on contributing catchment area, length of slope and site observations.
- Level outlets, enabling discharge of runoff into undisturbed areas (not directly into watercourses).
- 300mm consolidated effective height, 2-3m crest width.
- Cross drains (excavated dished drains) may be used for low road grades in place of cross banks.

5.2.4 Drainage

The following will apply to drainage:

- V-shaped drains, with regular discharge to mitre drains, are proposed for upgraded access road sections. This design requires significantly less clearing than alternative profiles (eg. trapezoidal); and suits the construction methodology (ie. grader). Drainage will incorporate check dam controls (eg. rock check dam, filter bag/tube) to provide flow energy dissipation in addition to providing sediment control.
- A regular monitoring regime is to be implemented with additional controls implemented if erosion is identified. This may include additional check dams, application of suitable soil binder, or upgrading of drainage profile (subject to project approvals).

5.3 Watercourse crossings

Road access to both drill holes requires traverse of several ephemeral watercourses, requiring installation of (or upgrade to) stable crossings.

Crossings are to be bed level crossings, constructed flush with the existing invert level of the specific watercourse. Crossings will incorporate a stable rock base, hardstand approaches and flow diversion berms (to shed road runoff), designed to be stable in a 1 in 1 year event.

Crossings are to be constructed in accordance with the following requirements:

- Temporary stockpiling of soil, equipment and materials within watercourses, or on adjacent banks and floodplains, is to be avoided (unless integral to drainage control requirements).
- Where possible, crossings should be constructed at right angles in locations where the stream is straight.
- Access road runoff is to be prevented from directly entering the watercourse by construction of flow diversion banks (rollovers) immediately upslope to divert flow.

The method to create access ramps at creek crossings is described and illustrated below (Figure 5-1):

- Select crossing where bank is lowest, avoiding trees and dense vegetation (if possible).
- Construct ramp by pushing material away from the creek bank.
- Build a cross bank (using the pushed up material) at the top of the ramp. This directs water away from the ramp, reducing the chance of gully erosion development if rainfall occurs prior to rehabilitation.
- Ramp to be constructed at right angles to direction of flow.
- These techniques are to be undertaken on both approaches of the creek.

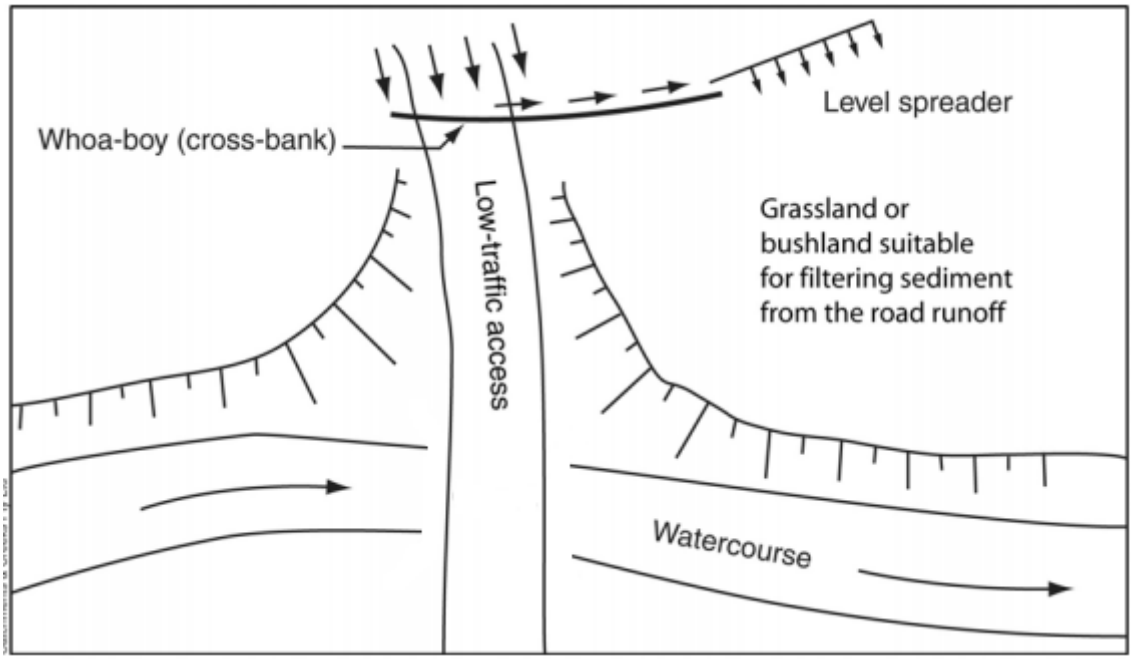


Figure 5-1. Construction technique for water crossing (IECA, 2008)

Rehabilitation should involve pushing and compacting material (used to make the low bank) back to its original position. If available, spread any surface vegetation that was removed for the creation of the ramp (as this will help reduce surface water velocity).

5.4 Vegetation clearing

Vegetation clearing associated with exploration activities is to be undertaken in accordance with applicable approvals. Clearing methodology is to incorporate the following:

- Clearing activities to be implemented consistent with the *NTG Land Clearing Guidelines* (DENR 2019) where possible.
- Vegetation clearing shall be kept to the minimum amount necessary to allow access and/or approved activities.

- Areas of protected vegetation and significant areas of vegetation are to be retained, and must be clearly identified prior to the commencement of clearing.
- Approved areas for native vegetation clearing to be clearly identified.
- Previously cleared areas shall be utilised where possible for laydown and turn around points.
- Disturbance to natural watercourses and associated riparian zones must be limited to the minimum practicable.
- Cleared vegetation is to be retained and reused in site rehabilitation wherever possible.

5.5 Topsoil & spoil management

Earthworks are to incorporate the stripping and preservation of topsoil for reuse. The depth of topsoil stripping is dependent upon soil type, however ideally the top 50 mm should be retained separately from other material (contains most of the biological activity and nutrients required for successful rehabilitation).

Topsoil is to be stripped and stockpiled as a bund along the perimeter of the drill pads (inside the cleared vegetation windrow where present). This enables separation of clean and dirty stormwater runoff, in addition to allowing for progressive rehabilitation.

Where additional stockpile sites are required, these areas will be located and constructed as follows:

- Located at least 5 m from existing remnant vegetation, minor flow lines and hazard areas.
- Constructed along the contour as low, flat elongated mounds.
- Topsoil stockpiles are to be constructed less than 2 m in height where available space allows.
- Protected upslope by earth diversion banks to divert run-on water and downslope by either mulch, sediment fence or similar Type 3 sediment control.

5.6 Ancillary areas

Ancillary areas include temporary infrastructure required to support the construction program and include construction accommodation camps, site compounds, lay-down areas, turn-around points and above ground facilities.

The erosion and sediment control principles and strategies discussed within this document will equally apply to all ancillary areas.

6 SITE STABILISATION

Following the completion of project activities, long-term protection of the site from erosion will be provided by appropriate cover, typically vegetation.

Photo points (geo-referenced) will be established to provide a balanced representation of the ground condition and various landform and vegetation types encountered, and enable rehabilitation success to be effectively monitored. The process is repeated after the drilling program is completed. The revisit intervals are proposed immediately after rehabilitation works have been completed post decommissioning, following the first wet season, one year after rehabilitation works, and three years after rehabilitation (although the return period is determined by weather/road conditions and current activity in the region). Revisits may also be targeted, with emphasis on sensitive areas and areas potentially subject to erosion such that environmental impact of re-accessing remote locations is minimised in consultation with, and on the advice of, an independent environmental consultant.

Stabilisation of the project area will incorporate the following practices:

- Progressive rehabilitation of disturbed areas (timing of progressive rehabilitation will depend on exploration outcomes and the potential for reservoir development and production).
- Management of topsoil to ensure preservation of its long-term value (refer Section 5.5).
- Removal of all rubbish and waste.
- Removal of above ground infrastructure so that in the event the civils works rehabilitation such as the reprofiling of access roads and lease pads can occur unimpeded.
- Lightly scarifying or rolling all disturbed areas to break up consolidated surfaces.
- Reshaping of drilling sites and access (if required) to ensure pads and roads are safe, stable and do not pose a long-term erosion risk.
- Back filling of pits. Pits to be levelled off, mixed with dry stockpiled fill material, and capped with at least 100 mm of topsoil.
- Spreading of stockpiled topsoil material and trees, shrubs and grasses across the drill pad and areas not needed for future monitoring and maintenance.
- Selected plant species for revegetation are appropriate for site conditions and endemic to local vegetation communities.
- Erosion and sediment controls are to remain in place until minimum 70 % self-sustaining groundcover (or groundcover % consistent with adjacent undisturbed areas) is achieved for disturbed areas.

7 MANAGEMENT AND IMPLEMENTATION

7.1 Responsibilities

Key personnel roles and responsibilities are detailed within the EMP and summarised in Table 7-1 below.

Table 7-1. Key personnel roles and responsibilities

Role	Responsibility
Project Manager	• Ensure overall compliance with the EMP. • Ensure relevant environmental legislative requirements, performance outcomes, performance standards, measurement criteria and requirements in the implementation strategy in this EMP are communicated to the activity key personnel; and audited. • Undertake consultation with relevant persons throughout project planning and implementation. • Document consultation with relevant persons. • Ensure any commitments to relevant persons are undertaken.
Site Manager	• Ensure adequate resources are in place to meet the requirements within the EMP (i.e. implement relevant management plans such as this ESCP). • Undertake daily environmental checks as described within the EMP. • Ensure incidents and non-conformances are managed as per EMP. • Report environmental incidents to the Project Manager and ensure reporting and investigations are undertaken. • Ensure records and documents are managed so they are available and retrievable. • Ensure non-conformances identified are communicated and actions completed.

7.2 Training and awareness

Minerals Australia staff and contractors undertaking work in the field are required to undertake an induction process. At a minimum, the induction will cover:

- Activity description
- Environmental impacts and risks; and associated controls to be implemented
- Roles and responsibilities
- Incident and non-conformance reporting and management.

7.3 ESC installation and maintenance

The installation and maintenance of all ESC measures is to be overseen by a suitably qualified person. Installation is to be consistent with this ESCP and any associated progressive ESCP's.

All required temporary erosion and sediment control measures must be fully operational and maintained in proper working order until permanent stabilisation is achieved. If ESCs are observed to have reduced capacity, damage or insufficient effectiveness, they are to be repaired, improved or substituted as follows:

- Identified soil erosion areas are to be resolved as soon as possible, with additional control measures implemented to prevent recurrence.
- All sediment control devices (other than sediment basins) must be de-silted and made fully operational as soon as reasonable and practicable after runoff-producing rainfall, or if the

sediment retention capacity of the device falls below 75% of the design retention capacity (IECA 2008).

- Sediment removed from areas of deposition is to be incorporated within subsoil stockpile areas and/or buried on-site.

Spare materials including geo-fabric, sediment fence material, mulch and rock are to be stored on-site to enable repairs to be conducted within a short timeframe.

7.4 Monitoring & reporting

ESC measures will be inspected in accordance with the EMP, including:

- weekly during work activities
- as soon as reasonably practical after receiving significant rainfall events (i.e. >10 mm in 24 hr period).

Visual assessment will be carried out of surface water runoff structures, drainage structures and erosion control structures to ensure they are operating efficiently.

Environmental objectives and targets for erosion and sediment control are to be documented in the EMP. Where monitoring identifies that environmental objectives are not being achieved, corrective actions will be enacted. If significant erosion is recorded, a CPESC will be engaged to advise on suitable controls.

7.5 Updates and variations

ESCP's are dynamic documents, typically requiring updating as construction and operational stages progress and site characteristics alter. Any alterations to the implementation of erosion and sediment controls within specific areas will be recorded and outlined in progressive ESCP's. This may include the following scenarios:

- Controls require alteration due to change in work practices or new stage of works is commenced.
- Controls require alteration due to change in seasonal conditions (e.g. dry season vs wet season).
- Changes occur in slope gradients and drainage paths, with their exact form unpredictable before works start.
- A change in the project design occurs that potentially impacts on ESC requirements.
- The desired outcome (e.g. protection of receiving environments) is not being achieved.

8 REFERENCES

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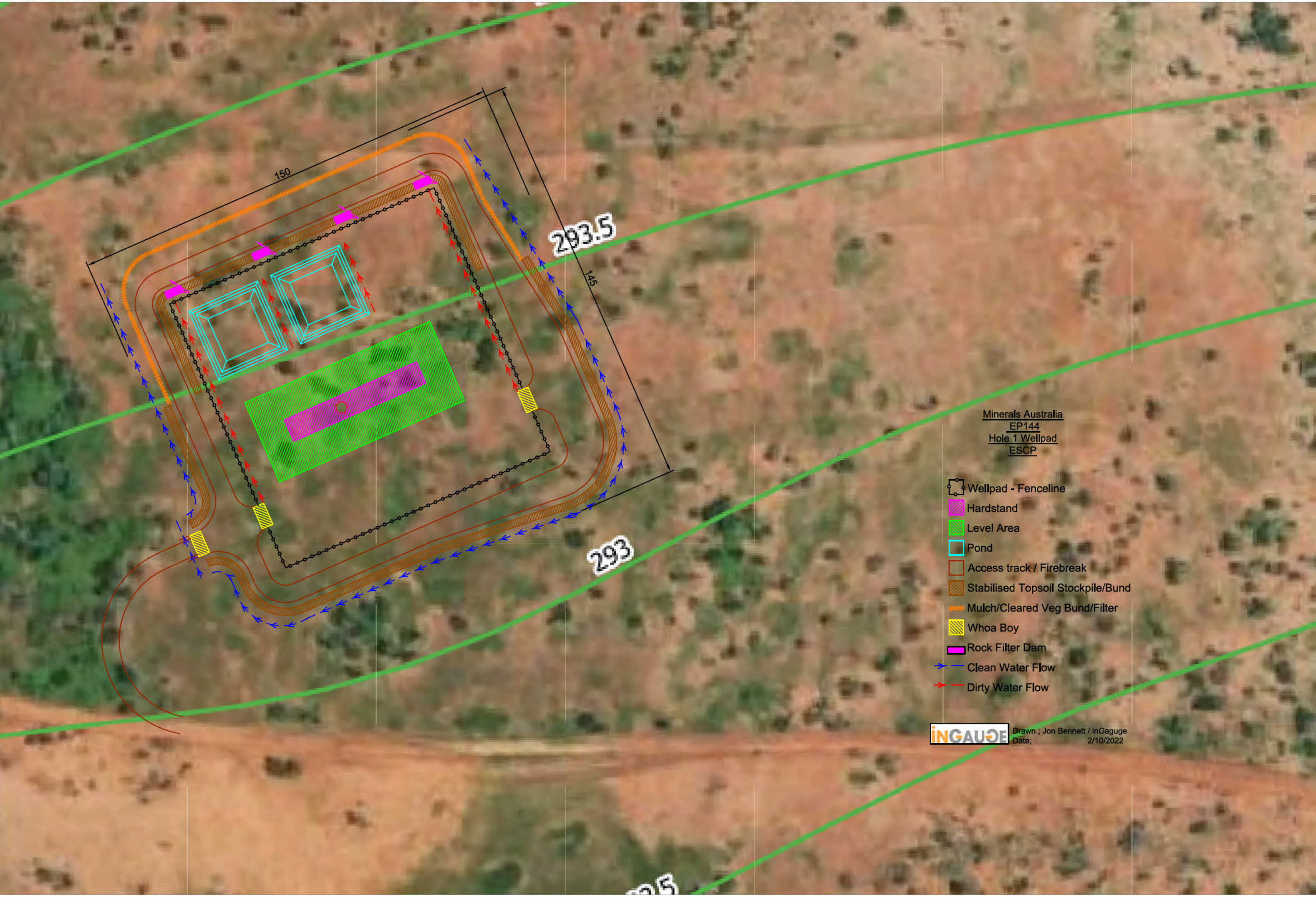
International Erosion Control Association (IECA) (2008). *Best Practice Erosion and Sediment Control.* Picton, NSW.

Landcom (2004). *Managing urban stormwater; soils and construction vol. 1, 4th edition*. New South Wales Government.

APPENDIX A ESCP SITE LAYOUT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Minerals Australia
EP144
Hole 1 Wellpad
ESCP
Wellpad - Fenceline
Hardstand
Level Area
Pond
Access track / Firebreak
Stabilised Topsoil Stockpile/Bund
Mulch/Cleared Veg Bund/Filter
Whoa Boy
Rock Filter Dam
Clean Water Flow
Dirty Water Flow
inGAUGE
Drawn ; Jon Bennett / inGaguge
Date; 2/10/2022


263
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Minerals Australia
EP144
Hole 2 Wellpad
ESCP
Wellpad - Fenceline
Hardstand
Level Area
Pond
Access track / Firebreak
Stabilised Topsoil Stockpile/Bund
Mulch/Cleared Veg Bund/Filter
Whoa Boy
Rock Filter Dam
Clean Water Flow
Dirty Water Flow
inGAUGE
Drawn ; Jon Bennett / inGaguge
Date; 2/10/2022

APPENDIX B ESCP STANDARD DESIGNS

Minerals Australia
EP145
Hole 1 Wellpad
ESCP

Wellpad - Fenceline
Hardstand
Level Area
Pond
Access track / Firebreak
Stabilised Topsoil Stockpile/Bund
Mulch/Cleared Veg Bund/Filter
Whoa Boy
Rock Filter Dam
Clean Water Flow
Dirty Water Flow

INGAUGE
Drawn : Jon Bennett / inGaguge
Date: 2/10/2022

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TYPICAL DESIGNS

Rock Check Dam (RCD) & Rock Filter Dam (RFD)

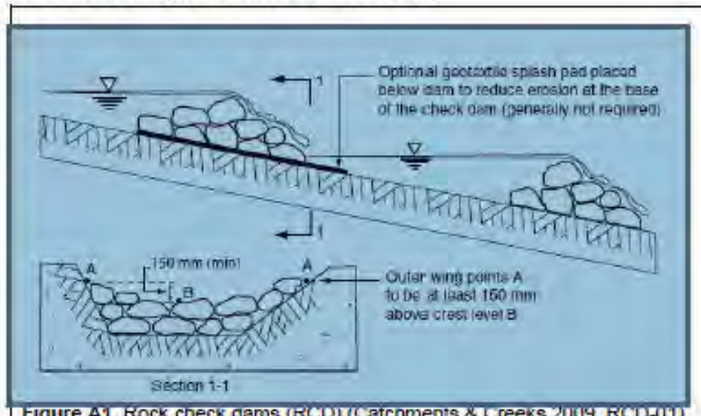
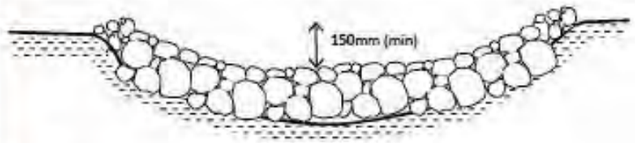


Figure A1. Rock check dams (RCD) (Catchments & Creeks 2009, RCD-01)



Notes:

- Rock to be clean (zero fines), sized 150-300mm (approx.)
- RCD to be extended up the channel bank to prevent outflanking
- RCD to be constructed with 150mm invert
- RCD may be installed as outlet incorporated within mulch berm (MB) and/or earth berm (EB).
- RCD to be covered with geotextile where indicated

Figure A2. Rock check dam (RCD) – typical design

Notes:

- Rock to be clean (zero fines), sized 40-75mm (approx.)
- RFD height 400 mm min
- RFD to be wrapped in geotextile (Bidum® A14 equivalent)
- RFD may be installed as outlet incorporated within mulch berm (MB) and/or earth berm (EB).

Figure A3. Rock filter dam (RFD) – typical design

Mulch Berm (MB) & Earth Berm (EB)

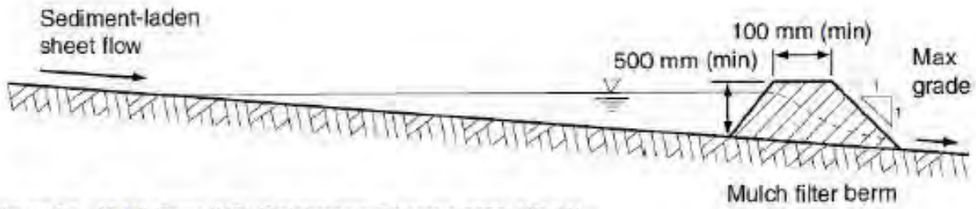


Figure B1. Mulch Berm (MB) (Catchments & Creeks 2009, MB-01)

Notes:

- Design adopted from Catchments & Creeks (2010) *Mulch Filter Berms MB-01.*
- Berm to be located within the property boundary, preferably along the contour, and away from areas of concentrated flow
- Ends of berm to be turned up to minimise risk of flow bypassing around the ends

Notes:

- EB constructed from topsoil whenever material is available
- EB to be protected from erosion (vegetation, soil binder, blankets or matting)

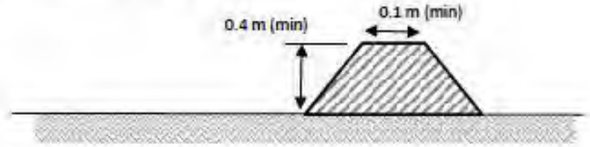


Figure B2. Earth Berm (EB)

Sediment Fence (SF)

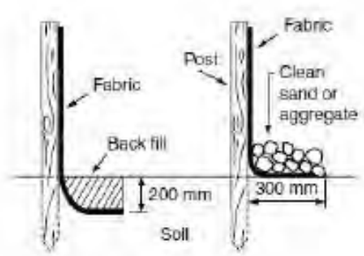


Fig C1. Sediment fence anchoring (Catchments & Creeks 2009, SF-01)

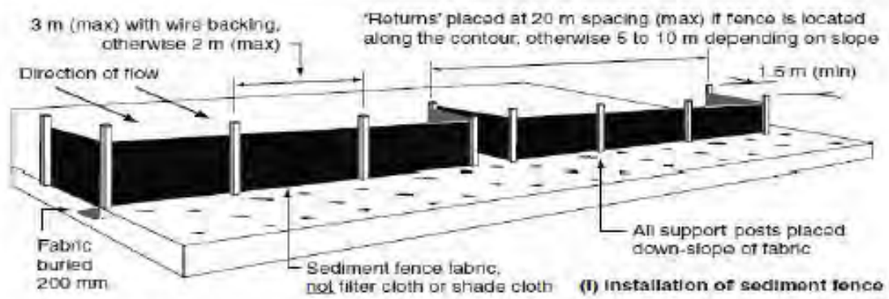


Fig C2. Sediment fence installation (Catchments & Creeks 2009, SF-01)

Revision	Date	Drawn	Approved		Description
1	05/11/2021	JD/AF	JR		Sent to client

PREPARED BY:

ENVIRONMENTAL CONSULTANTS

PREPARED FOR:

Minerals Australia Pty Ltd.

Exploration Permit 144 – Primary ESCP

Typical Designs

Period: TBC

NOT TO SCALE	EZ19191	REVISION:1

TYPICAL DESIGNS

Cross drains/banks

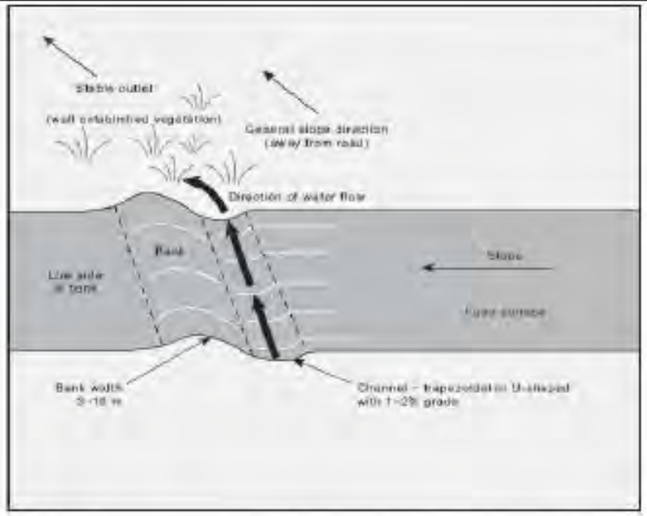


Figure D1. Typical Cross Bank Construction (DECC 2008, modified from Beatty 1995)

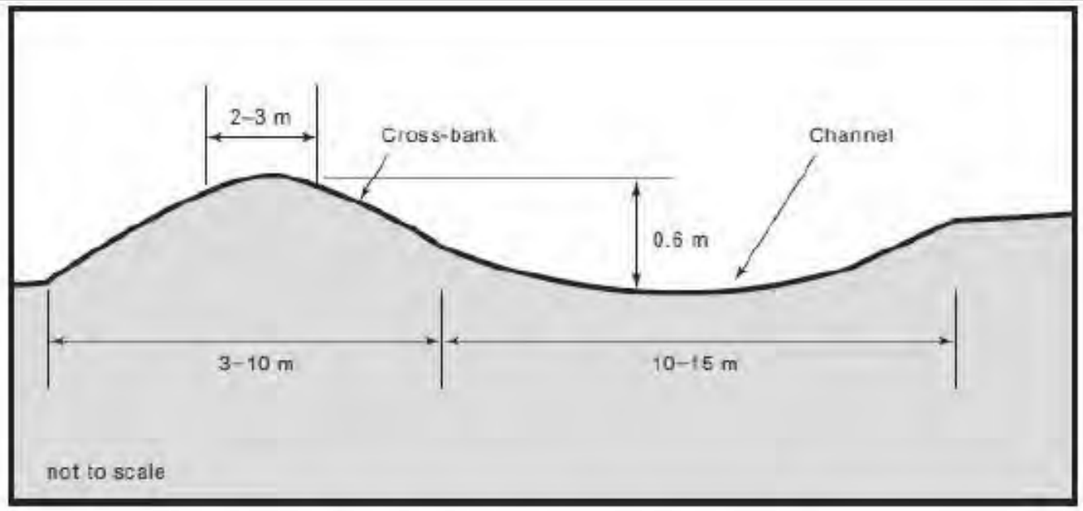


Figure D2. Typical Cross Bank – Cross Section (DECC 2008, modified from Beatty 1995)

Table D1. Maximum distance of water flow along road surfaces

Road grade (%)	Maximum distance (m)
< 2	250
2 - 5	150
6 - 10	100

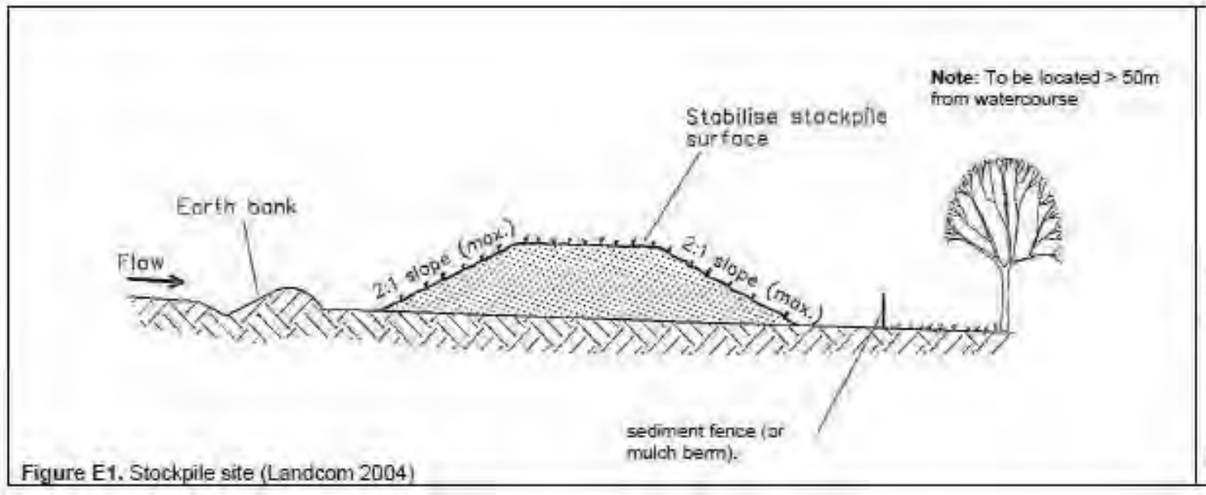


Figure E1. Stockpile site (Landcom 2004)

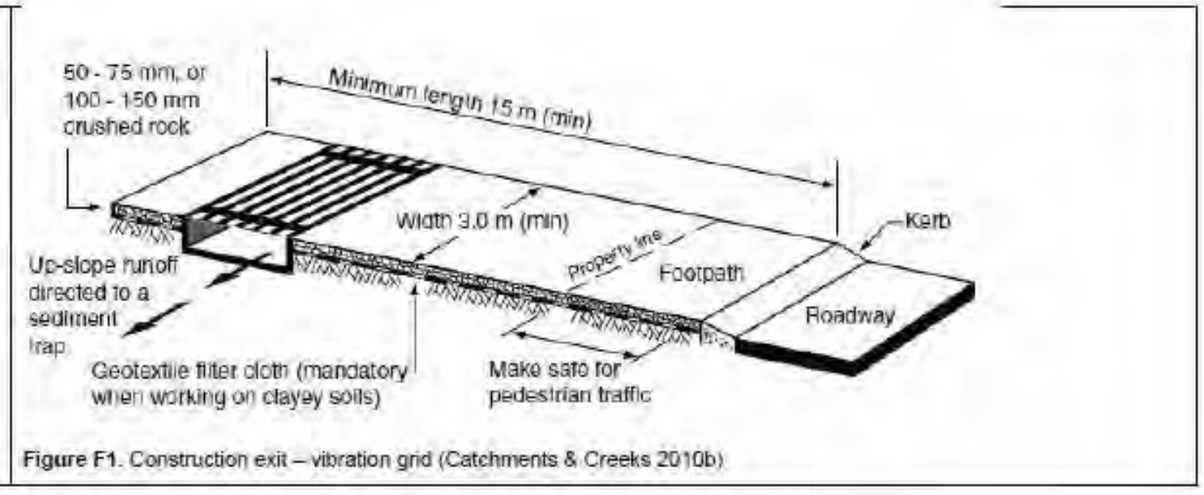


Figure F1. Construction exit – vibration grid (Catchments & Creeks 2010b)

Revision	Date	Drawn	Approved		Description
1	05/11/2021	JD/AF	JR		Sent to client

PREPARED BY:

ENVIRONMENTAL CONSULTANTS TERRITORY PROUD

PREPARED FOR:

Minerals Australia Pty Ltd.

Exploration Permit 144 – Primary ESCP

Typical Designs

Period: TBC

NOT TO SCALE	EZ19191	REVISION:1

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