FY21-FY24 MINING MANAGEMENT PLAN AMENDMENT

Groote Eylandt Mining Company Limited (GEMCO)

Authorisation Number: 0126-01 (GEMCO Mine)

Reporting period: FY2021

Planning Period: FY2021 – FY2024

11 August 2021

CONTENTS

	Author	Reviewed By	Approved By
Date	11 August 2021	23 August 2021	
Name	Jeremy Barnett	Michael Smith	Mark Filtness
Signature			

I, Mark Filtness (Vice President Operations), declare that to the best of my knowledge the information contained in this mining management plan is true and correct and commit to undertake the works detailed in this plan in accordance with all the relevant Local, Northern Territory and Commonwealth Government legislation.

SIGNATURE:

DATE: 06/09/2021

Disclaimer

The information that relates to the Mineral Resource and Ore Reserve estimate of GEMCO was declared as part of the South32 Annual Resource and Reserve declaration in the FY20 Annual Report (www.south32.net) issued on 7 September 2020. South32 confirms that it is not aware of any new information or data that materially affects the information included in the original announcement. All material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed.

This document may contain forward-looking statements, including statements about plans, strategies and objectives of management; and anticipated productive lives of projects, mines and facilities. These forward-looking statements reflect reasonable expectations at the date of this document, however they are not a guarantee or predictions of future performance.

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AMENDMENTS

The approved GEMCO Mining Management Plan (MMP) describes Western Leases activities for the FY21-FY24 planning period (FY21-FY24 MMP). The FY21-FY24 MMP was submitted to the Department of Primary Industry and Resources (now the Department of Industry, Tourism and Trade (DITT)) on 25 November 2020 in support of an application to vary GEMCO's existing Authorisation (0126-01) under Section 38 of the *Mining Management Act 2001* (Northern Territory (NT)) (MM Act).

This document is the first amendment to the FY21-FY24 MMP sought under Section 41 of the MM Act and describes activities to be undertaken during this period within the GEMCO Eastern Leases (encompassing Mining Lease (ML) 31219, ML31220 and Access Authority (AA) 31711.

Table 0-1 is populated in accordance with Section 41(3) of the MM Act and confirms the amendments sought to the FY21-FY24 MMP.

Table 0-1: Amendments to the FY21-FY24 MMP

Amendment Number	Section	Amendment Description	DITT File Reference
1.	New document (this Amendment)	Amendment to GEMCO FY21-FY24 MMP to describe Eastern Leases activities	0126-01

1 INTRODUCTION

1.1 Operator Details

Groote Eylandt Mining Company Pty Ltd (GEMCO) is a manganese mining operation located on Groote Eylandt in the Northern Territory (NT) (refer Figure 1-1). GEMCO has been operating since 1964 and is currently owned by South32 Ltd (60%) and Anglo American Plc (40%).

Further details on GEMCO, South32 Ltd and Anglo American are provided in Section 1.1 of the FY21-FY24 MMP. There will be no change to the mine operator for the Eastern Leases.

1.1.1 *Organisational Structure and Responsibility*

The organisation structure for GEMCO's leadership team and contact details for the Manager Technical Services and Vice President Operations is described in Section 1.1.1 of the FY21-FY24 MMP. It is noted that Mark Filtness has taken up the role of GEMCO Vice President Operations since submission of the FY21-FY24 MMP.

GEMCO's organisational structure and responsibilities outlined in the FY21-FY24 MMP will continue to be implemented for the Eastern Leases.

1.2 Title Details

GEMCO undertakes mining and exploration activities across a number of mineral tenements on Groote Eylandt. This document seeks an Amendment to MMP Authorisation 0126-01 and pertains to activities within the GEMCO Mineral Tenements (approved but undeveloped) and Access Authority jointly termed the 'Eastern Leases'.

The Mineral Tenements and Access Authority associated with the Eastern Leases are listed in Table 1-1 and shown on Figure 1-2. ML31219 is referred to as the Northern Eastern Lease and ML31220 is referred to as the Southern Eastern Lease.

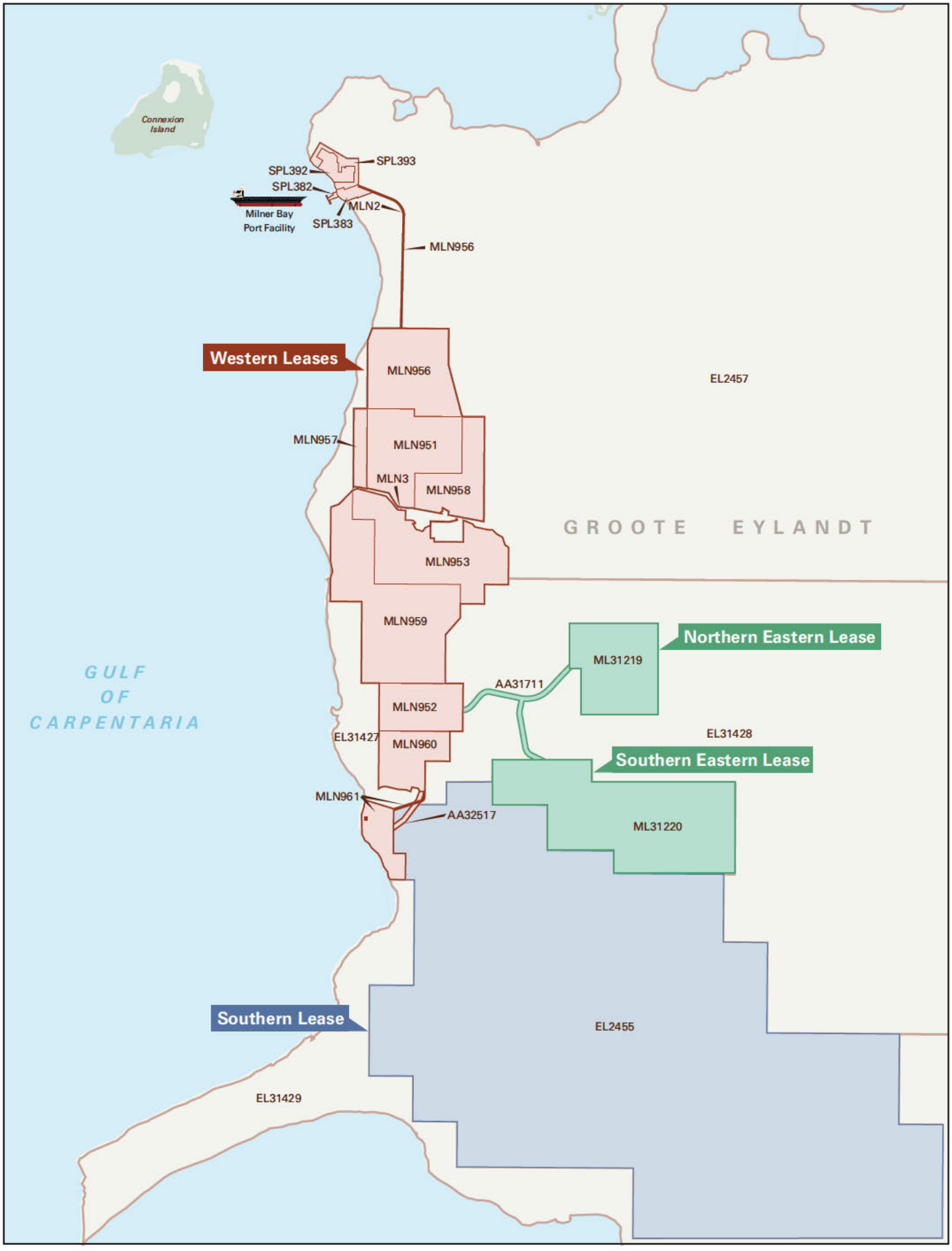
The AA31711 is held to provide a haul road access corridor connecting the two mining leases to GEMCO's existing operations at the Western Leases, specifically D Quarry (MLN 952). AA31711 was granted on 12 September 2017 and was amended in July 2020 to allow for a realignment of the Northern Eastern Lease access corridor (refer Section 3.1).

Figure 1-2 also illustrates the tenements held by GEMCO for the Western Leases (GEMCO's existing mine), and the Southern Lease (a GEMCO mineral exploration area). The Southern Lease is subject to separate Authorisation and is shown in Figure 1-2 for context only.

Table 1-1: Eastern Lease Mineral Tenements and Access Authority

Title Number	Title Holder	Activity	Grant Date	Expiry Date
ML31219	GEMCO	Mining and associated activities	04/08/2016	03/08/2041
ML31220	GEMCO	Mining and associated activities	04/08/2016	03/08/2041
AA31711	GEMCO	Access corridor for Eastern Leases	12/10/2017	03/08/2041


DARWIN
GROOTE EYLANDT
NORTHERN TERRITORY
ARAFURA SEA
North East Isles
Chasm Island
Bustard Island
Bickerton Island
Winchelsea Island
Northwest Bay
Hempel Bay
PORT LANGDON
MILYAKBURRA
Warwick Channel
Connexion Channel
Bartalumba Bay
Thompson Bay
Little Lagoon
Connexion Island
ALYANGULA
UMBAKUMBA
Milner Bay Port Facility
Rowell Highway
Angurugu-Umbakumba Road
Western Leases
ANGURUGU
GROOTE EYLANDT
GULF OF CARPENTARIA
Eastern Leases
Old River Road
Southern Lease
Dalumbu Bay
Marangala Bay
N
0
15
Kilometres
Legend
GEMCO Mining and Access Tenements, Eastern Leases
GEMCO Mining, Access and Exploration Tenements
Township
Public Road
Unsealed Public Road
Coordinate System: MGA Zone 53
SOUTH32
GEMCO Eastern Leases MMP
Figure 1-1
Location Plan
Date: May 2021
Author: JBA
Plan No: Location Plan
Scale: See scale bar
Figure No: 1-1



N

0 5

Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases (Mineral Leases) and Access Authority
- Western Leases (Mineral Leases/Special Purpose Leases) and Access Authority
- Southern Lease (Exploration Licence Granted)
- Exploration Licence Application

SOUTH32 GEMCO Eastern Leases MMP

Figure 1-2
GEMCO Tenements and Access Authorities

Date: May 2021	Author: JBA	Plan No: GEMCO Tenements
Scale: See scale bar	Figure No: 1-2	

1.3 Project Description

1.3.1 *Location*

GEMCO's mining operation is located on Groote Eylandt in the Gulf of Carpentaria, approximately 650 kilometres (km) south-east of Darwin and 50 km off the coast of Arnhem Land (refer Figure 1-1). A general description of Groote Eylandt is provided in Section 1.3.1 of the FY21-FY24 MMP.

GEMCO's Eastern Leases extend over an area covering approximately 45 square kilometres (km^2) on the south-western part of Groote Eylandt. The land within and surrounding the Eastern Leases comprises natural bush that is mainly eucalypt dominated open forest, woodland and shrubland. The most common eucalypts are Darwin Woollybutt and Darwin Stringybark, but a wide variety of other native plant species occur. Section 2.1.3 provides further detail on the fauna and flora recorded in the Eastern Leases.

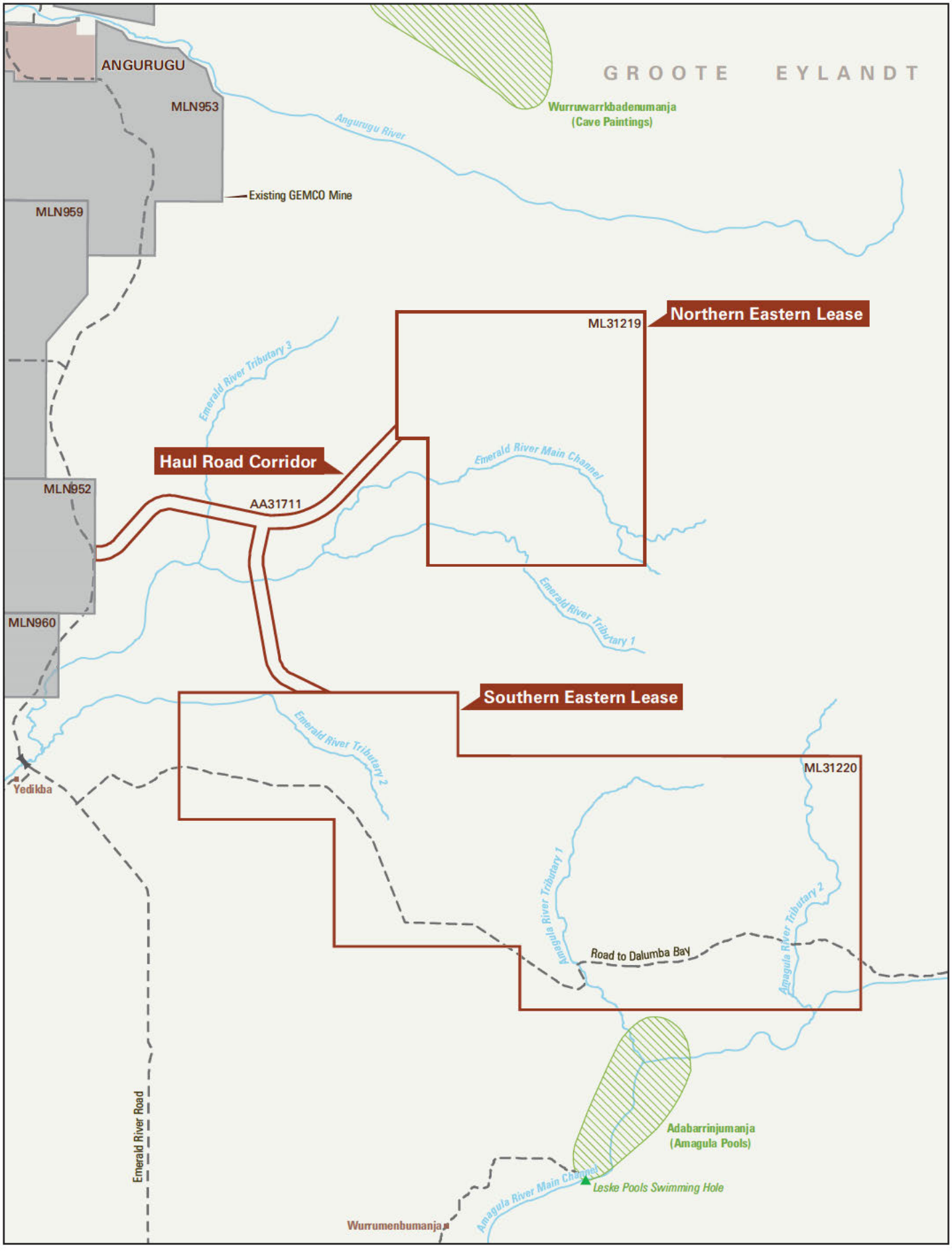
The Eastern Leases area is characterised by elevated rocky outcrops and gently sloping valleys with elevations ranging from approximately 10 metres (m) Australian Height Datum (AHD) to 120m AHD. Section 2.1.2 provides further detail on the topography of the area.

There are two river systems that traverse the Eastern Leases, being the Emerald River and the Amagula River (refer Figure 1-3). The Emerald River and Amagula River are predominantly used by the Traditional Owners for recreational purposes.

The Eastern Leases project layout is shown in Figure 1-4. Consistent with existing GEMCO operations, approved mining of the Eastern Leases will involve extracting manganese ore by open cut mining methods across multiple quarries. The overburden depth is shallow however, can extend to a depth of 25 m, with an ore horizon generally between 0.5 and 10 m thick.

Figure 1-4 provides a conceptual layout of the Eastern Leases and identifies the mine planning buffers for watercourses and white rock outcrops identified during studies for the *Eastern Leases Project Draft Environmental Impact Statement* (Hansen Bailey, 2015) (EIS).

The ore from the Eastern Leases will be hauled to the existing GEMCO infrastructure at the Western Leases for processing before transportation to the Milner Bay Port Facility.



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0 2

Kilometres

Coordinate System: MGA Zone 53

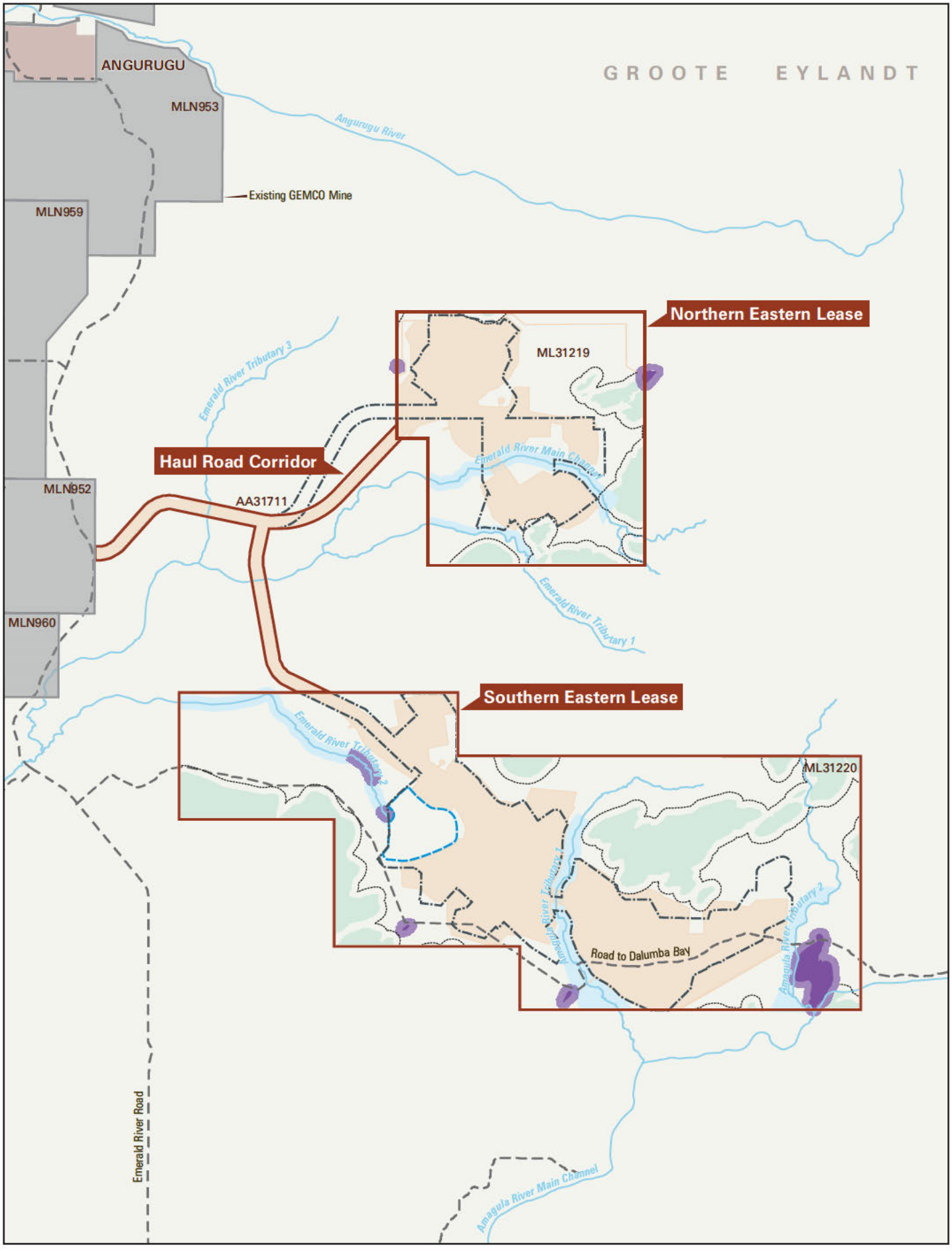
Legend

- Eastern Leases
- Western Leases
- Township
- Sealed Public Roads
- Roads and Public Access Tracks
- Watercourse
- Bridge
- Outstation
- Recreation Area (Public Access by Permit (Source: ALC Annual Report 18/19)

SOUTH32 GEMCO Eastern Leases MMP

Figure 1-3
Local Setting

Date: May 2021	Author: JBA	Plan No: Project Setting
Scale: See scale bar	Figure No: 1-3	



Legend

- Eastern Leases
- Western Leases
- EIS Disturbance Footprint
- Updated Project Disturbance Footprint (August 2021)
- Mine Planning Buffer (Watercourses)
- Upper Catchment Area
- White Rock Outcrop
- Cultural Sensitive Zone with Buffer
- White Rock 100m Buffers
- Watercourse

N

0 2

Kilometres

Coordinate System: MGA Zone 53

SOUTH32 GEMCO Eastern Leases MMP

Figure 1-4
Project Layout

Date: September 2021	Author: JBA	Plan No: Eastern Leases Project Layout
Scale: See scale bar	Figure No: 1-4	

1.3.2 *Project Summary and Improvements*

1.3.2.1 *History of Development*

GEMCO commenced operations in 1964 and currently operates the Western Leases in accordance with approvals under the MM Act, *Mineral Titles Act 2010* (NT) and a Mining Agreement with the Anindilyakwa Land Council (ALC). GEMCO has seen several capacity expansions during its Western Leases operations, with the most recent arising from the construction of the Sand Beneficiation Plant (SBP) in 2016.

The Eastern Leases was integrated into a series of exploration drilling campaigns from 2001. In recent years, exploration drilling on the Eastern Leases has intensified in order to provide accurate geological data and ore definition.

1.3.2.2 *Current Mine Status*

Section 4 provides additional information in relation to the commencement of construction and mining activities in the Eastern Leases proposed during the term of this Mining Management Plan Amendment (MMPA).

GEMCO exploration within the Eastern Leases will also continue during the term of this MMPA, with exploration programs planned to improve knowledge on ore quality and geological conditions (refer Section 4.3). This drilling will improve resource status and structural confidence.

2 SITE CONDITIONS

2.1 Physical Environment

2.1.1 *Climate*

Groote Eylandt experiences a tropical climate which is characterised by hot, humid summers (during which the majority of rainfall occurs) and dry winters. Further detail on the climate of Groote Eylandt is provided in Section 2.1.1 of the FY21-FY24 MMP.

2.1.2 *Land Systems*

2.1.2.1 *Topsoil and Subsoil*

The Eastern Leases are predominantly located on the Bundah land system and to a lesser extent the Yarrawirrie and Groote land systems with small areas intersecting the Effington land system. Soils are dominated by areas of deep brown to light grey brown sandy earths, loams and gradational contrast soils (B1, B1v, B2), with minor areas of clay loam subsoils relating to active drainage pathways (A1), rugged upland areas with very shallow soils and dense rocky outcrops (Q1) and a densely vegetated monsoonal vine thicket (V1). A summary of soil mapping units (SMUs) within the Eastern Leases is provided in Table 2-1.

Soil samples in the Eastern Leases are representative of the SMUs shown in Table 2-1 and were collected and analysed by GT Environmental (2015). No evidence of acid sulphate soils was identified and the risk of acid sulphate soils occurring is considered to be extremely low, given the geological origins, elevation and landforms.

The Eastern Leases are located on land with no past history of intensive development or agricultural activities. GEMCO exploration drilling activities commenced in 2001 and have been undertaken in accordance with procedures implemented to minimise land contamination and as such, there are no known instances of land contamination within the Eastern Leases.

2.1.2.2 *Topography and Geology*

Groote Eylandt is dominated by Proterozoic arenites of the Dalumbu Sandstone forming a relatively low-lying plateau on the central and southern portions of the island. Headwater drainage systems incise the quartz-arenites to form radial drainage patterns. The low-lying plains to the north of the plateau are predominantly Mesozoic and Cainozoic strata overlying the Bartalumba Basalts. The majority of the western shoreline consists of the low-lying onlapping Cretaceous sediments which hosts the manganese deposit. The majority of GEMCO's mining lease area consists of Cretaceous sediments with the exception of a discontinuous narrow strip along the eastern boundary where the Proterozoic sandstone outcrops.

Figure 2-1 shows the geology across Groote Eylandt, including the distribution of the manganese ore.

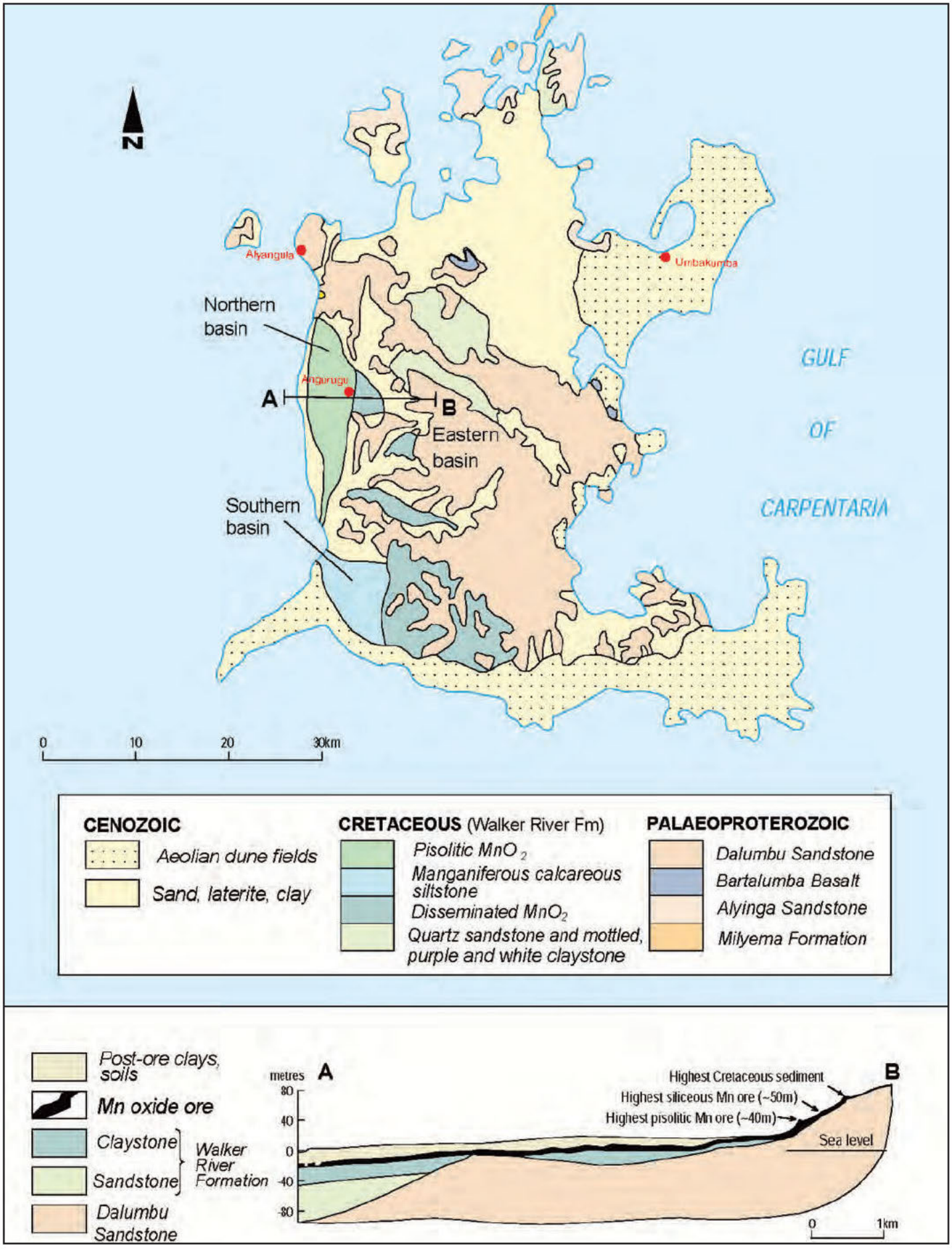
The Groote Eylandt manganese orebody is a sedimentary layer that gently undulates beneath the western plains of the island. It extends over an area of approximately 50 km^2 as an almost continuous horizon, varying in thickness up to 11 m and is essentially stratabound and strataform in character. The orebody consists of massive, pisolitic and oolitic manganese oxides. These oxides are thought to have originally been deposited as a chemical precipitate, forming a tabular sedimentary deposit in wave affected shallow sea-floor environments during a period of rising and falling sea levels. Following the deposition and subsequent cover by younger sediments, the western margins emerged from the sea during a worldwide drop in sea level. The depositional events were followed by a long period of tropical weathering which extensively modified the upper parts of the sediment profile. Pisolitic manganese oxides underwent partial to complete remobilisation and recrystallisation that resulted in the formation of hard cemented pisolite and massive manganese oxides.

Figure 2-2 presents an indicative geological stratigraphy representative of the current mining areas.

Lithologies intersected by GEMCO's mining operations are typically comprised of lateritic material that is not considered to be Potentially Acid Forming (PAF) in nature. Detailed assessment of overburden geochemistry completed for the EIS confirmed that Eastern Leases materials are generally non acid-forming (NAF) and will generate low salinity runoff, with minimal trace elements. GEMCO have developed a procedure for the monitoring and handling of material in the small area in the Southern Eastern Lease where PAF material was identified in the EIS (refer Section 5.6.3.12).

Table 2-1: Summary of Soil Mapping Units

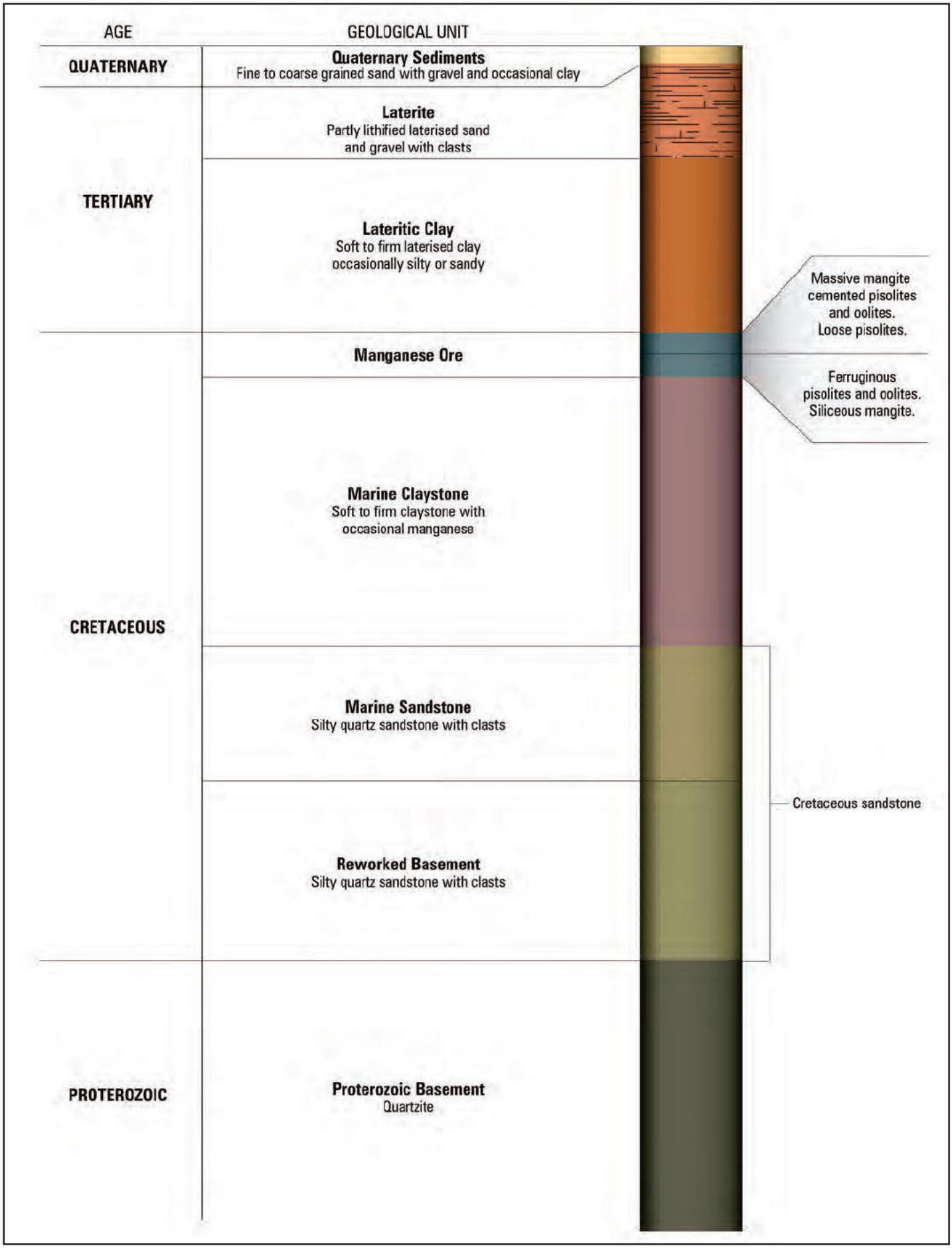
SMU	Description	Major Vegetation	Land System
B1	Dark brown to reddish brown loamy sands on undulating plains	Darwin Stringybark *(Eucalyptus tetrodonta)*, Darwin Woollybutt *(Eucalyptus miniata)*, Northern Cypress Pine *(Callitris intratropica)*, Long-fruited Bloodwood *(Eucalyptus polycarpa)*	Bundah
B1v	Light brownish grey to yellow brown loamy sands on undulating plains		
B2	Brownish black loamy sands on level to undulating plains	Darwin Stringybark	Yarrawirrie
V1	Very dense rocky undulating plain with dense vegetation	Monsoonal Vine Thicket	-
Q1	Rugged uplands on quartz sandstone with minor leptic rudosols	Darwin Stringybark, *Corymbia ferruginea*	Groote
A1	Alluival floodplains and gully areas in level to gently undulating plains	Broad-leaved Paperbark *(Melaleuca viridiflora)*, *Long*-fruited Bloodwood	Effington



SOUTH32 GEMCO Eastern Leases MMP

Figure 2-1
Geology of Groote Eylandt

Date: May 2021	Author: JBA	Plan No: Geology of Groote Eylandt
Scale: See scale bar	Figure No: 2-1	



SOUTH32 GEMCO Eastern Leases MMP

Figure 2-2
Typical Geological Profile

Date: May 2021	Author: JBA	Plan No: Typical Geological Profile
Scale: See scale bar	Figure No: 2-2	

2.1.2.3 *Vegetation*

The vegetation on Groote Eylandt is generally characterised by species and communities that are widespread across northern Australia, and strongly reflects the geology, topography and fire regime of the area.

The Vegetation Mapping Units (VMUs) within the Eastern Leases are listed in Table 2-2 and shown on Figure 2-3. The VMUs were developed in 2017 by the NT Department of Environment and Natural Resources (now Department of Environment, Parks and Water Security (DEPWS)) during an island-wide vegetation mapping review.

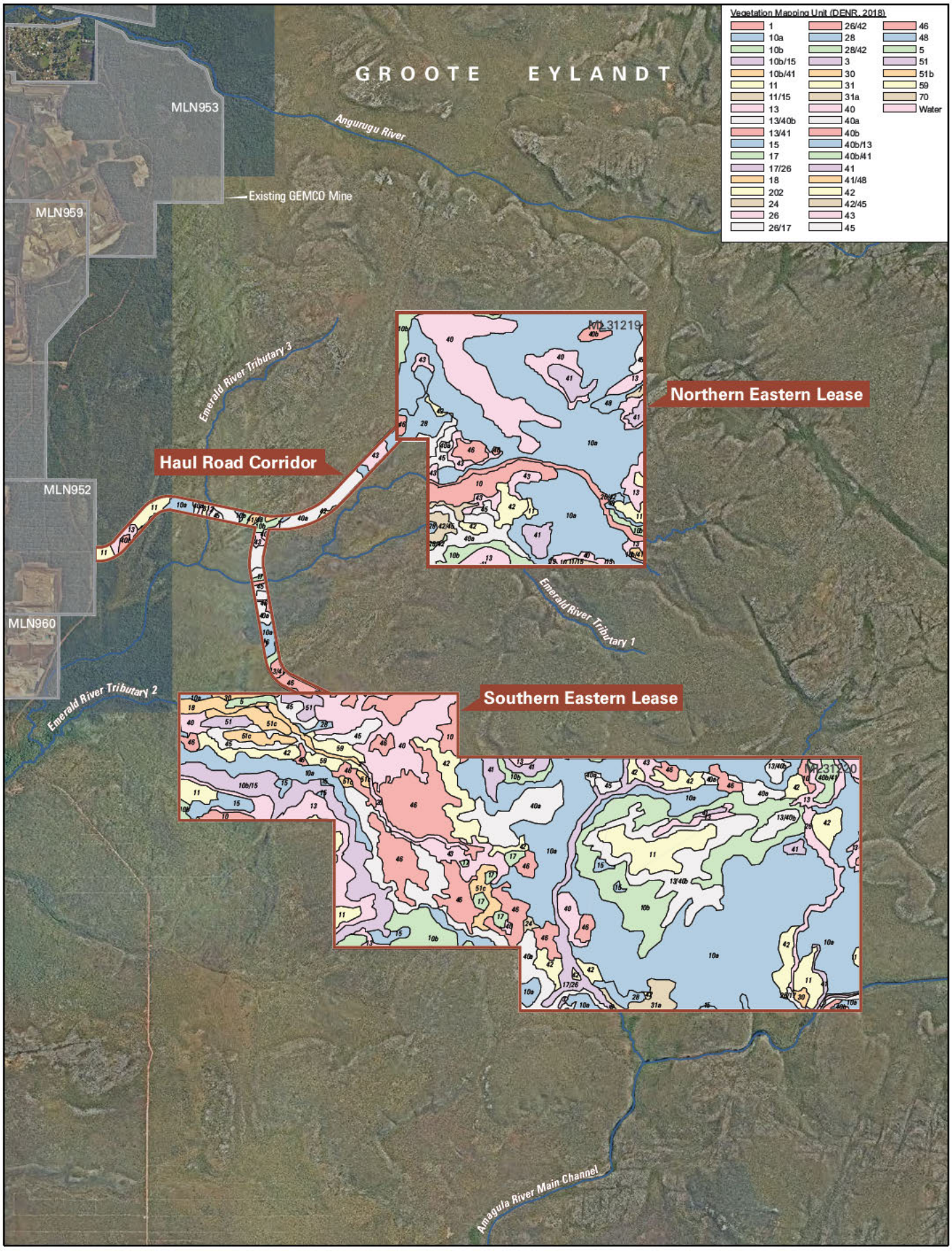
Table 2-2: Vegetation Mapping Units

VMU	Name
Individual VMUs	
1	Mangrove low closed-forest/closed-forest
3	Dry sub-coastal (inland) monsoon vine-forests (includes Quaternary sands not associated with drainage and not coastal (often at margins of sandplain and consolidated lithologies)
5	Riparian monsoon vine-forests with *Melaleuca cajuputi* and/or *Melaleuca leucadendra*
10a	*Eucalyptus tetrodonta/E. miniata* open-forest with low shrub or tussock grass understorey on lowland plains and rises
10b	*Eucalyptus tetrodonta/E. miniata* open-forest with low shrub and mixed tussock/hummock grass understorey on upland plateau surfaces, mostly associated with deeply weathered land surfaces
11	*Eucalyptus tetrodonta/E. miniata /Callitris intratropica* open-forest with mixed shrub/tussock grass understorey
13	*Eucalyptus tetrodonta/E. kombolgiensis* Woodland with shrubby or open hummock grassland understorey
15	*Callitris intratropica/Acacia spp.tall open corest, with shrubland complex on sandstone*
17	*Melaleuca viridiflora* or *Melaleuca cajuputi* or *Melaleuca leucadendra* or *Melaleuca ferruginea / Eucalyptus polycarpa/Eucalyptus biglerita* open-forest with Pandanus spiralis and Mixed tussock grassland understorey
18	*Melaleuca leucadendra* and/or *Melaleuca cajuputi / Dillenia alata +/- Melaleuca viridiflora* open forest with fern/sedge understorey (Swamp Forests - Emerald River) Gullies in sandstone
24	*Eucalyptus tetrodonta +/- E. minata* low open forest/woodland with low tree or mixed perennial tussock grass/*Sorghum interjectum* tussock grassland understorey
26	Riparian woodland to open-forest of *Melaleuca leucadendra*, *Corymbia polycarpa, Eucalyptus tetrodonta* on ephemeral rivers/streams in drier sub-coastal lowlands
28	*Melaleuca* spp. (*M. viridiflora/M. cajuputi/M. ferruginea*) woodland to low woodland on alluvial plains with sedge understorey
30	*Eucalyptus tetrodonta, Corymbia kombolgiensis, Corymbia polycarpa* woodland with shrubby understorey of monsoon vine thicket woodland on deeply weathered lowlands and stabilised coastal sands in the east
31	*Eucalyptus tetrodonta, Corymbia kombolgiensis, Melaleuca viridiflora/leucadendra, Corymbia polycarpa, Corymbia foelscheana open forest/woodland with shrubby understorey and tussock grasses on lowlands including stabilising sands in the east where transitional into VMU 30.*

VMU	Name
31a	*Eucalyptus tertodonta, Corymbia kombolgiensis, Melaleuca viridiflora/leucadendra, Corymbia polycarpa, Corymbia foelscheana open forest/woodland with shrubby understorey and tussock grasses on lowlands including stabilising sands in the east where transitional into VMU 30.*
40	*Eucalyptus tetrodonta/E. miniata / E. polycarpa +/- Callitris intratropica* woodland with low shrub or tussock/hummock grass understorey
40a	*Eucalyptus tetrodonta/E. miniata +/- E. polycarpa* woodland with low shrub and tussock grass dominated understorey on lateritic plains and low rises (generally lowlands)
40b	*Eucalyptus tetrodonta +/- E. miniata +/- Callitris intratropica* woodland to open woodland with low shrub/hummock/tussock grass understorey on shallow rocky soils usually derived from sandstone. Plateaus, hills and rises.
41	*Callitris intratropica / Eucalyptus tetrodonta / E. kombolgiensis* open- woodland with hummock grassland understorey
42	*Eucalyptus polycarpa /E. tetrodonta /E. miniata* woodland with sedge spp./ low shrub understorey
43	*Melaleuca viridiflora / Eucalyptus polycarpa / Grevillea pteridifolia* open woodland with *Asteromyrtus symphyocarpa and Vetiveria elongata* tussock grassland
45	*Eucalyptus polycarpa* open- woodland with sedges, short tussock grass understorey. Also, areas of grassland
46	*Eucalyptus tetrodonta/E. miniata* low woodland with tussock grass understorey
48	*Eucalyptus tetrodonta* and/or *Corymbia kombolgiensis +/- Corymbia polycarpa, Corymbia ferruginea* open woodland to woodland with *Acacia* spp., *Grevillea* spp., *Terminalia carpentariae* and mixed hummock/tussock grasses on sandstone
51	Alluvial woodland to open-woodland with Cor*ymbia bella, Corymbia polycarpa* and *Eucalyptus biglerita +/- Corymbia grandifolia, Corymbia foelscheana, Corymbia confertiflora, Eucalyptus tetrodonta, Eucalyptus tectifica, Erythrophleum chlorostachys*
51b	*Eucalyptus biglerita/Corymbia bella* open woodland
59	*Eucalyptus tetrodonta/Erythrophleum chlorostachys/Corymbia polycarpa* woodland on lateritic lowland plains
70	Dry Sandstone shrublands +/- emergent *Corymbia kombolgiensis*
202	Cleared
Combination VMUs	
10b/15	See VMU descriptions in table above
10b/41	See VMU descriptions in table above
11/15	*Eucalyptus tetrodonta/E. iniate /Callitris intratropica* open-forest with mixed shrub/tussock grass understorey / *Callitris intratropica* open forest; *Acacia* spp. Tall shrubland complex on sandstone
13/40b	See VMU descriptions in table above
13/41	See VMU descriptions in table above
17/26	See VMU descriptions in table above
26/17	Riparian woodland to open-forest of *Melaleuca leucadendra*, *Corymbia polycarpa, Eucalyptus tetrodonta* on ephemeral rivers/streams in drier sub-coastal lowlands / *Melaleuca viridiflora* or *Melaleuca cajuputi* or *Melaleuca leucadendra* or *Melaleuca ferruginea* / *Eucalyptus polycarpa*/*Eucalyptus biglerita* open-forest with Pandanus spiralis and Mixed tussock grassland understorey

VMU	Name
26/42	See VMU descriptions in table above
28/42	See VMU descriptions in table above
40b/13	See VMU descriptions in table above
40b/41	See VMU descriptions in table above
41/48	See VMU descriptions in table above
42/45	See VMU descriptions in table above

GEMCO is currently working to align Eastern Leases vegetation community mapping with the DEPWS (2017) VMUs.



Legend

- Eastern Leases
- Watercourse

N

0 2

Kilometres

Coordinate System: MGA Zone 53

SOUTH32 GEMCO Eastern Leases MMP

Figure 2-3
Vegetation Communities

Date: May 2021	Author: JBA	Plan No: Vegetation Communities
Scale: See scale bar	Figure No: 2-3	

2.1.3 *Flora and Fauna*

Cumberland Ecology (2015) completed the most recent comprehensive assessment of the Eastern Leases as part of the EIS. Multi-season terrestrial flora and fauna surveys were conducted in accordance with the NT Environment Protection Authority (NT EPA) flora and fauna survey requirements, and guidance published under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The surveys were informed by the results of a desktop assessment and included involvement by several members of the ALC and Land & Sea Rangers.

In 2019, Cumberland Ecology undertook an additional survey to confirm the vegetation communities located within the realigned section of the Northern Eastern Lease access corridor (AA 31711).

2.1.3.1 *Flora*

Species of Conservation Significance

The Commonwealth Protected Matters Search Tool (DAWE, 2020) indicates that threatened ecological communities or flora species listed under the EPBC Act are not likely to be present on Groote Eylandt. The Northern Territory NR Maps tool (DEPWS, 2020) and NRM InfoNet database (NT Government, 2020) hold records for one threatened flora species on Groote Eylandt, namely *Hernandia nymphaeifolia* (Lantern Tree), which is listed as Vulnerable under the *Territory Parks and Wildlife Conservation Act 1976* (NT) (TPWC Act). All records of this species are located outside of the Eastern Leases, in the north-east of Groote Eylandt and are not considered further in this MMPA.

Introduced Flora

Cumberland Ecology (2015) found that there were no declared weeds and that in general, very few weed species were present within the Eastern Leases. Weed management controls have been implemented during subsequent exploration activities however, there is the potential for weed species present in other areas of Groote Eylandt to become established in the Eastern Leases once construction and mining activities commence.

Section 5.6.3.7 provides further detail on the monitoring management of weeds by GEMCO. These measures will continue to be implemented for the Eastern Leases as the project moves into the construction and mining phases.

2.1.3.2 *Fauna*

A total of 25 native mammal species, 54 bird species, 31 reptile species and 6 amphibian species are known to occur within the Eastern Leases based on surveys conducted by Cumberland Ecology (2015). Of these, eight fauna species of conservation significance listed under the EPBC Act and/or the TPWC Act have been recorded within or adjacent to the Eastern Leases, with a further 27 fauna species of conservation significance identified as having the potential to occur. The species identified as having the potential to occur have not been recorded in recent or historical ecological surveys however they have been listed on the Commonwealth Protected Matters Database (DAWE, 2020) and/or identified by URS (2012) and Cumberland Ecology (2015) as having a possible presence within the Eastern Leases.

A summary of threatened species recorded in the Eastern Leases is provided in Table 2-3. Threatened species that have the potential to occur in the Eastern Leases are listed in Table 2-4. Further detail on the management of threatened species by GEMCO is provided in Section 5.6.3.5.

Table 2-5 provides a list of species that were formerly considered in threatened species assessments for Groote Eylandt but are no longer considered to be present on the island or have undergone a status change or are no longer listed under the EPBC Act or TPWC Act. There are previous records for these species on or near the Eastern Leases.

Table 2-3: Threatened fauna species recorded within GEMCO Eastern Leases

Species	EPBC Act Listing	TPWC Act Listing	Reference	Description of Location
Northern Hopping Mouse (*Notomys aquilo*)	Endangered	Vulnerable	Cumberland Ecology (2015, 2019)	Recorded north of the realigned Northern Eastern Lease haul road corridor.
Northern Quoll (*Dasyurus hallucatus*)	Endangered	Critically endangered	Cumberland Ecology (2015)	Recorded at numerous locations across the Eastern Leases and within the haul road corridor.
Mertens' Water Monitor (*Varanus mertensi*)	Not listed	Vulnerable	Cumberland Ecology (2015)	Recorded mainly in aquatic habitat in the Southern Eastern Lease, with only two recordings in the Northern Eastern Lease.
Northern Masked Owl (*Tyto novaehollandiae kimberli*)	Vulnerable	Vulnerable	Cumberland Ecology (2015)	Recorded in open eucalypt forest with low shrub or tussock grass understorey habitat in the Northern Eastern Lease and Southern Eastern Lease.
Ghost Bat *(Macroderma gigas)*	Vulnerable	Not Listed	EMS (2014)	Recorded foraging at several locations in *Eucalyptus tetrodonta/E. miniata open forest and Corymbia polycarpa/Melaleuca* open woodland communities within the Eastern Leases.
Brush-tailed Rabbit-rat (*Conilurus penicillatus*)	Vulnerable	Endangered	Cumberland Ecology (2015)	Recorded in the south-east portion of the Southern Eastern Lease.
Salt Water Crocodile (*Crocodylus porosus*)	Migratory	Not listed	Cumberland Ecology (2015)	Recorded in Amagula River within the Southern Eastern Leases.

Species	EPBC Act Listing	TPWC Act Listing	Reference	Description of Location
Rainbow Bee-eater (*Merops ornatus*)	Migratory	Not listed	Cumberland Ecology (2015)	Recorded in woodland and open forest, particularly those communities dominated by *Eucalyptus tetradonta* and *Eucalyptus miniata*.

Table 2-4: Threatened fauna species with the potential to occur within GEMCO Eastern Leases

Species	EPBC Act Status	TPWC Act Status	Likely Presence within GEMCO Eastern Leases
False Water Rat (*Xeromys myoides*)	Vulnerable	Not listed	Low. No suitable habitat within Eastern Leases and species has not been recorded on Groote Eylandt.
Gouldian Finch (*Chelobia gouldiae*)	Endangered	Vulnerable	Low. Not sighted on Groote Eylandt since a single report by Wilkins (1924).
Pale Field Rat (*Rattus tunneyi*)	Not listed	Vulnerable	Low. Limited habitat (tall grasslands) occurs within Eastern Leases and species has not been recorded within Eastern Leases.
Red Goshawk (*Erythrura radiatus*)	Vulnerable	Vulnerable	Low. Potential habitat present in Eastern Leases but species has not been recorded on Groote Eylandt.
Partridge Pigeon (*Geophaps smithii*)	Vulnerable	Vulnerable	Low. Potential habitat present and species recorded on Groote Eylandt outside of Eastern Leases.
Fork-tailed Swift (*Apus pacificus*)	Migratory	Not listed	Moderate. Potential habitat present and species recorded on Groote Eylandt outside of Eastern Leases.
Barn Swallow (*Hirundo rustica*)	Migratory	Not listed	Low. Potential habitat present in Eastern Leases but species has not been recorded on Groote Eylandt.
Rufous Faintail (*Rhipidura rufifrons*)	Migratory	Not listed	Moderate. Potential habitat present and species recorded on Groote Eylandt outside of Eastern Leases.
Eastern Great Egret (*Ardea modesta*)	Migratory	Not listed	Low. Prefers permanent wetland habitat not present within Eastern Leases.
Cattle Egret (*Ardea ibis*)	Migratory	Not listed	Low. Potential habitat present in Eastern Leases but species has not been recorded on Groote Eylandt.
Oriental Plover (*Charadrius veredus*)	Migratory	Not listed	Low. No suitable habitat within Eastern Leases and species has not been recorded on Groote Eylandt.
Oriental Pratincole (*Glareola maldivarum*)	Migratory	Not listed	Low. No suitable habitat within Eastern Leases and species has not been recorded on Groote Eylandt.

Species	EPBC Act Status	TPWC Act Status	Likely Presence within GEMCO Eastern Leases
Water Mouse (*Xeromys myoides*)	Vulnerable	Not listed	Low. No suitable habitat within Eastern Leases and species has not been recorded on Groote Eylandt.
Plains Death Adder (*Acanthopis hawkei*)	Vulnerable	Not listed	Low. No suitable habitat within Eastern Leases and species has not been recorded on Groote Eylandt.

Table 2-5: Threatened fauna species formerly considered to be of significance within or adjacent to GEMCO Eastern Leases

Species	EPBC Act Status	TPWC Act Status	Likely Presence within GEMCO's Eastern Leases
Carpentarian Antechinus (*Pseudantechinus mimulus*)	Not listed	Not listed	Moderate. Records for this species are associated with sandstone habitats adjacent to the Alyangula town lease. Formerly listed as Vulnerable under the EPBC Act but was delisted in 2019.
Floodplain / Yellow-spotted Monitor (*Varanus panoptes*)	Not Listed	Vulnerable	Low. Formerly reported to occur on Groote Eylandt (Mahney et al., 2009, Cumberland Ecology, 2015). Recent genetic sampling indicates that the only large non-rock dwelling goanna present on Groote is the common Gould's goanna (*Varanus gouldii*).

Introduced Terrestrial Vertebrates

There are five feral / pest animals currently known to be present on Groote Eylandt. These are the Domestic Dog (*Canis familiaris*), Asian Gecko (*Hemidactylus frenatus)*, House Mouse (*Mus musculus*), Rat (*Rattus sp.*) and Cat (*Felis catus*). The distribution of these species appears to be largely limited to areas in the vicinity of Angurugu, Umbakumba and Alyangula.

Cane Toads (*Rhinella marinus*) remain absent from the island due to a collaborative Quarantine and Biosecurity program led by GEMCO and the Anindilyakwa Land and Sea Rangers, despite all adjacent mainland areas now being affected by this invasive species. GEMCO Cane Toad management measures are described further in Section 5.6.3.6.

Aquatic Invertebrates

Aquatic invertebrates are good bio-indicators for the health status of aquatic ecosystems. The presence or absence of particular species, diversity, composition and abundance of communities provide general measures of health which can be used to assess impacts on aquatic systems.

In 2012, URS conducted a study that sampled freshwater aquatic macro invertebrates within the Angurugu and Emerald River systems. Taxa diversity for Groote Eylandt was comparable with unimpaired samples from southern Gulf of Carpentaria drainage basins, with 117 taxa sampled. No exotic macro invertebrates were recorded during the survey. A more recent study undertaken along the Emerald River (C&R Consulting, 2018) found a similar diversity of macro invertebrate taxa to the URS (2012) study (on a comparison of raw data).

In 2015, Cumberland Ecology completed a study that sampled freshwater aquatic macro invertebrates within the Amagula and Emerald River systems. The analysis indicated that the watercourses are in good to moderate condition for macroinvertebrates.

Ants

Surveys conducted by URS (2012) indicated that the ant fauna of Groote Eylandt is widely represented across the Top End, with 95% of the species recorded during the survey found across the region. A total of 103 native ant species were recorded, while 5 exotic species are known from the area: *Monomorium destructor*, *M. floricola, M. pharaonis, Paratrechina longicornis*, and *Tetramorium simillimum.*

2.2 Socio-Economic Environment

The Groote Eylandt Archipelago, which includes Groote Eylandt, Bickerton Island and a number of smaller, neighbouring islands, has a population of approximately 2,500 people (Australian Bureau of Statistics, 2017a). The Traditional Owners of the Groote Eylandt Archipelago have co-existed with GEMCO since the mine was established in the 1960s.

As the primary industry on Groote Eylandt, the GEMCO mine has played a significant role in the economic development of the island and in shaping the social fabric of the community. Royalties and a number of other related payments from the mine benefit the Traditional Owners of Groote Eylandt through investment in housing, infrastructure, services, and capacity development. Section 2.2.4 of the FY21-FY24 MMP describes the support GEMCO provides to the Groote Eylandt community in further detail.

2.2.1 *Current Land Use*

Groote Eylandt is declared as Aboriginal land under the *Aboriginal Land Rights (Northern Territory) Act 1976 (Cth)* (ALRA) and is managed by the ALC on behalf of the Traditional Owners. In accordance with the ALRA, a Mining Agreement was signed by GEMCO and the ALC in 2016 authorising GEMCO to undertake mining activities within the Eastern Leases. Section 3.2 provides further detail on GEMCO's obligations under this Mining Agreement. The majority of Groote Eylandt is not open to the general public however, the ALC has nominated a number of recreation areas that can be accessed by the public, subject to a permit system.

Key land uses on Groote Eylandt include the townships of Alyangula, Angurugu and Umbakumba, various satellite communities, mining and exploration activities (undertaken by GEMCO on Groote Eylandt and Winchelsea Mining Company Pty Ltd on Winchelsea Island), and traditional Aboriginal cultural practices such as hunting and gathering. There are also small-scale eco-tourism activities on Groote Eylandt, including a resort near Alyangula.

There are smaller outstations in close proximity to the Eastern Leases, namely Wurrumenbumanja and Yedikba (refer Figure 1-3). Both Wurrumenbumanja and Yedikba outstations are sporadically occupied by Aboriginal residents.

The Ajubukwajumanja recreation area (also known as the Leske Pools recreation area) is located directly to the south of the Southern Eastern Lease.

There are no declared National Parks, commercial farming or agricultural practices currently undertaken on Groote Eylandt, although the ALC have recently investigated the feasibility of aquaculture farming.

Currently, there is no permanent infrastructure within the Eastern Leases, although there are a number of unsealed access tracks (refer Figure 1-3). These include tracks developed by GEMCO as part of its exploration activities in the Eastern Leases. Access tracks within the Eastern Leases are also used by Aboriginal residents to access areas of cultural significance.

2.2.2 *Identified Stakeholders and Consultation*

GEMCO undertakes consultation with stakeholders utilising a range of methods at varied frequencies. Engagement with stakeholders is planned annually and considers the specific engagement needs of the individual stakeholder. Further detail on stakeholder engagement undertaken by GEMCO (including for the Eastern Leases) is provided in Section 2.2.2 of the FY21-FY24 MMP.

The ALC, as the representative body of the Traditional Owners of Groote Eylandt, is a high priority stakeholder. GEMCO's engagement strategy with the ALC is described in Section 2.2.2 of the FY21-FY24 MMP. The ALC provided their endorsement of this MMPA on 6 August 2021 (refer Appendix 9.3).

2.2.3 *Workforce Description and Demography*

A description of GEMCO workforce and demography is provided in Section 2.2.3 of the FY21-FY24 MMP. This existing workforce will be used during mining operations for the Eastern Leases.

A supplementary fly-in fly-out (FIFO) workforce of approximately 90 persons will be used for the Eastern Leases construction phase over a period of 24 – 48 months from FY22.

2.2.4 *Community Affairs*

South32's Community Standard (refer Appendix 9.9 of the FY21-FY24 MMP) outlines how operations understand their communities and develop appropriate plans to ensure that each operation can create shared benefit through its social and environmental leadership.

A description of planned GEMCO engagement with, and investment in, Groote Eylandt communities during the term of this MMPA is provided in Section 2.2.4 of the FY21-FY24 MMP.

3 STATUTORY AND NON-STATUTORY REQUIREMENTS

GEMCO's Eastern Leases operate in accordance with the following approvals:

- Land owner approval granted in the form of a Mining Agreement between GEMCO and the ALC pursuant to ALRA;
- Land owner approval granted in the form of an Access Authority under the ALRA;
- Regulatory approval granted in the form of Mineral Leases under the *Mineral Titles Act 2010* (NT);
- Regulatory approval granted from the Commonwealth under the EPBC Act (EPBC 2014_7228); and
- Authorisation under the MM Act, subject to DITT approval of this MMPA for Authorisation 0126-01.

The following sections provide a summary of these approvals, as well as other statutory and non-statutory requirements that GEMCO must adhere to.

3.1 Statutory Requirements

Table 3-1 outlines the key Commonwealth and Territory legislation applicable to the Eastern Leases.

Table 3-1: Relevant Commonwealth and Territory Legislation

Legislation	Administering Authority	Intent of Legislation	Relevance to the Eastern Leases
Mining			
Mineral Titles Act 2010 (NT)	DITT	The *Mineral Titles Act 2010* establishes a framework for granting and regulating mineral titles, including Mineral Leases (MLs), that authorise mining and associated activities.	The Mining Leases (MLs) associated with the Eastern Leases (refer Table 1-1) allow GEMCO to undertake mining and associated activities. A ML cannot be granted until a Mining Agreement under the ALRA is in place, and the grant of a ML is a precursor to the grant of Authorisation under the MM Act.
Mining Management Act 2001 (NT)	DITT	The MM Act aims to protect the environment by establishing a system whereby mining activities that will result in a substantial disturbance require an Authorisation. Operators of mines who require an Authorisation under the MM Act must submit an application to the NT DITT accompanied by an MMP.	GEMCO's Western Leases are currently authorised under the MM Act (0126-01). GEMCO is required by this legislation to operate in accordance with an approved MMP. This MMPA has been prepared to support an application to DITT to vary GEMCO's existing Authorisation 0126-01 for development of the Eastern Leases during the period FY21 – FY24. Construction and operational activities for the Eastern Leases cannot commence until Authorisation under the MM Act has been obtained.

Legislation	Administering Authority	Intent of Legislation	Relevance to the Eastern Leases
Environment			
Environment Protection and Biodiversity Conversation Act 1999 (Cth)	Commonwealth Department of Agriculture, Water and Environment (DAWE)	The EPBC Act provides a framework to protect and manage nationally and internationally important flora, fauna, ecological communities, heritage places and other matters, defined in the EPBC Act as matters of national environmental significance (MNES).	The Eastern Leases was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now DAWE) in May 2014 and was determined to be a 'controlled action' under the EPBC Act. Approval for the Eastern Leases under the EPBC Act was granted in June 2016 (EPBC 2014_7228). GEMCO sought a variation to EPBC 2014_7228 in June 2020 to realign a section of the Northern Eastern Lease access road. This realignment was proposed to avoid a known population of the Northern Hopping-mouse. The variation was approved in July 2020 and included the realignment of the access road and an extension to the time to substantially commence the Project by five years until June 2026.
Environmental Protection Act 2019 (NT) (EP Act)	NT Department of Environment, Parks and Water Security (DEPWS) - NT EPA	The EP Act aims to promote ecologically sustainable development by establishing a framework for assessing potential environmental impacts of development projects.	This MMPA supports an application to vary the Authorisation 0126-01, which was granted prior to the introduction of the EP Act. Therefore, approval under the EP Act is not required.
Territory Parks and Wildlife Conservation Act 1976 (NT) (TPWC Act)	NT Department of Tourism, Sport and Culture (DTSC) – Parks and Wildlife Commission	The TPWC Act provides for the declaration of land to be a sanctuary, park, reserve or protected area by the Administrator. The Act also provides for the protection of animals and plants and the preparation of management plans for parks and reserves.	No permits are required under the TPWC Act for disturbance associated with the Eastern Leases. However, GEMCO adheres to a range of internal management plans aimed to minimise the potential for impacts to threatened fauna and flora species listed under the TPWC Act (refer Section 5.6.3.5).
Bushfires Management Act 2016 (NT)	DEPWS – Bushfires NT	The *Bushfires Management Act 2016* provides a framework for the mitigation, management and suppression of bushfires in the NT and outlines when permits are required for the lighting of fires.	As the Eastern Leases are not located within a prescribed fire protection zone, fire breaks and permits to burn are not required under the *Bushfires Management Act 2016*. However, a fire danger period may be declared over parts of the NT. In the event of such a declaration applying to the Eastern Leases, GEMCO would ensure that a permit under the *Bushfires Management Act 2016* is obtained prior to conducting controlled burns. Despite there being no legal

Legislation	Administering Authority	Intent of Legislation	Relevance to the Eastern Leases
			requirement for a permit to burn, GEMCO manages burning in accordance with *GEM-PRO-4149 Permit to Clear and Burn Vegetation*, which involves an internal permitting process.
Marine Pollution Act 1999 (NT)	DEPWS	The purpose of the *Marine Protection Act 1999* is to protect the marine and coastal environment by minimising intentional and negligent discharges of ship-sourced pollutants into coastal waters. The *Marine Pollution Act 1999* applies to all vessels in NT waters.	Manganese concentrate from the Eastern Leases will be shipped via GEMCO's port facility under existing shipping arrangements, which are required to comply with the *Marine Pollution Act 1999.*
Waste Management and Pollution Control Act 1998 (NT)	DEPWS	The *Waste Management and Pollution Control Act 1998* provides for the protection of the environment through the encouragement of effective waste management, pollution prevention and control practices.	GEMCO operate a waste disposal facility in accordance with an Environmental Protection Licence (EPL 289) issued under the *Waste Management and Pollution Control Act 1998.* Waste associated with the Eastern Leases will be disposed of in accordance with GEMCO's existing practices and no changes to the existing Integrated Waste Management Facility are required for Eastern Leases operations.
Water Act 1992 (NT) (Water Act)	DEPWS – Water Resources Division	The Water Act provides the legislative framework for water planning and entitlements for most water resources in the NT. The Water Act also provides for the investigation, allocation, use, control, protection, management and administration of surface water and groundwater resources.	Recent amendments to the Water Act mean mining and petroleum activities are now controlled under the Act. As a result of these amendments, GEMCO submitted an application to DEPWS for an abstraction licence on 24 March 2020 for Western Leases. DEPWS approved this application and granted this licence in October 2020. GEMCO may apply to DEPWS for an abstraction licence for Eastern Leases extraction prior to the commencement of construction to ensure that predicted water extraction requirements are accounted for.
Weeds Management Act 2001 (NT) (WM Act)	DEPWS – Weed Management Branch	The WM Act aims to protect the NT from the adverse impacts of weeds and identifies the responsibilities of all landholders in relation to the management of declared weeds and	Weed management is undertaken in accordance with *GEM-STA-3091 Weed Management Plan*. GEM-STA-3091 is structured to address weed risks in accordance with their declared status and the statutory requirements of any relevant weed management plans

Legislation	Administering Authority	Intent of Legislation	Relevance to the Eastern Leases
		prevention of their spread.	(refer Section 5.6.3.7).
Biosecurity Act 2015 (Cth)	DAWE	The *Biosecurity Act 2015* provides a framework for managing biosecurity risks such as diseases and pests that may cause harm to human, animal or plant health.	GEMCO's quarantine and biosecurity measures are outlined in *GEM-STA-3091 Weed Management Plan*, *GEM-STA-3082 Cane Toad Management Plan* and *GEM-PLN-9009 Eastern Leases Biosecurity Management Plan*. These documents are structured to address the biosecurity requirements of applicable Statutory Weed Management Plans, the NT Biosecurity Strategy 2016 – 2026 and the Eastern Leases Mining Agreement (refer Sections 5.6.3.6 to Section 5.6.3.8).
Health and Safety			
Public and Environmental Health Act 2011 (NT)	NT Department of Health	The *Public and Environmental Health Act 2011* includes the objectives to monitor, assess and control environmental conditions, factors and agents, facilities and equipment and activities, services, and products that impact on or may impact on public and environmental health.	GEMCO has an extensive governance framework for managing the public and environmental health risks associated with its accommodation facilities (including food preparation and potable water sources). This framework is designed to assist GEMCO in meeting its objectives in relation to public and environment health and to ensure compliance with the *Public and Environmental Health Act 2011* and would be utilised for the Eastern Leases.
Work Health and Safety (National Uniform Legislation) Act 2011 (NT)	Department of the Attorney-General and Justice	The *Work Health and Safety (National Uniform Legislation) Act 2011* aims to promote health and safety in the workplace.	GEMCO has an extensive governance framework for managing health and safety risks associated with the operation of the Western Leases. This framework is designed to assist GEMCO with meeting its objectives in relation to health and safety and to ensure compliance with all applicable legislation and will be extended to include HSEC risks identified for the Eastern Leases.
Dangerous Goods Act 1998 (NT)	Department of the Attorney-General and Justice – NT WorkSafe Division	The *Dangerous Goods Act 1998* aims to provide for the safe handling of dangerous goods.	GEMCO manage the storage, transport and handling of hazardous materials in accordance with this legislation. *GEM-PRO-3177 Hazardous Materials Management* outlines how materials are to be managed to minimise the potential for hazardous materials to pose risk to health, safety and environment across site. In addition, the web-

Legislation	Administering Authority	Intent of Legislation	Relevance to the Eastern Leases
			based ChemAlert system is used to identify the location and volumes of dangerous goods. MSDS documentation is also kept on GEMCO's intranet with hard copies available at numerous locations across site. STA-3055 Crisis and Emergency Management outlines GEMCO's process for responding to emergencies involving bulk hazardous materials, such as hydrocarbon fuel fire.
Culture and Heritage			
Aboriginal Land Rights (Northern Territory) Act 1976 (Cth) (ALRA)	Commonwealth Minister for Indigenous Australians	The ALRA provides a comprehensive scheme for the claiming and granting of freehold title to traditional Aboriginal land in the Northern Territory. It provides Aboriginal landowners with legal title to traditional lands and establishes Land Councils to assist Aboriginal people in the management of their land. The ALRA also outlines a process for obtaining consent from the Traditional Owners for both exploration and mining activities on Aboriginal land.	Groote Eylandt, including GEMCO's Eastern Leases, is Aboriginal land under the ALRA and the ALC is the Land Council responsible for managing this land. Consent for mining is obtained in the form of a Mining Agreement with the ALC. Section 3.2.1 outlines GEMCO's obligations under the Mining Agreement in place for the Eastern Leases.
Northern Territory Aboriginal Sacred Sites Act 1989 (NT) (Sacred Sites Act)	NT Aboriginal Areas Protection Authority (AAPA)	The Sacred Sites Act provides a framework for protecting sacred Aboriginal sites. Sacred sites are places in the landscape that have a special significance under Aboriginal tradition. The Sacred Sites Act provides a mechanism for registering sacred sites and issuing Authority Certificates in relation to sacred sites.	An Authority Certificate provides conditions for any works undertaken on or near sacred sites. Although it is not a requirement to be in possession of an Authority Certificate, having an Authority Certificate (and undertaking the work in accordance with the requirements of the certificate) indemnifies the holder against prosecution under the Act for damage to sacred sites in the area of the Authority Certificate. AAPA issued Authority Certificate C2016-145 for the Eastern Leases on 29 November 2016. [redacted]
Heritage Act 2011 (NT) (Heritage Act)	DTSC - Heritage Branch	The Heritage Act provides protection for the following two classes of cultural	It is a requirement of the Heritage Act that a Work Approval be obtained from DTSC prior to any

Legislation	Administering Authority	Intent of Legislation	Relevance to the Eastern Leases
		heritage: • All places and objects formally assessed and added to the NT Heritage Register; and • All Aboriginal and Macassan places and objects (whether previously documented or not), as listed in the Aboriginal and Macassan Sites Database.	disturbance of a heritage place or object as declared or protected under this Act. Section 5.6.3.1 provides further details.

3.2 Non-Statutory Obligations

3.2.1 *Mining Agreement*

GEMCO's non-statutory obligations for the Eastern Leases are chiefly embodied in the Mining Agreement between GEMCO and the ALC dated 17 May 2016.

GEMCO's general environmental obligations under the Mining Agreement are as follows:

- Ensure the project is designed and conducted so as to:
    - Preserve and protect the environment and natural hydrological systems;
    - Disturb the least amount of soil and vegetation possible;
    - Prevent erosion and pollution;
    - Prevent the introduction of exotic fauna and flora to the Groote Eylandt Archipelago;
    - Restore mined quarry areas to a condition reasonably compatible with the surrounding environment;
    - Prevent disturbance to the residents of Aboriginal communities adjacent to the Mineral Tenements; and
    - Progressively rehabilitate disturbed areas using technically appropriate and environmentally sound rehabilitation practices.
- Take all necessary steps to avoid the occurrence of, or mitigate the results of, a breach under the Mining Agreement or any other incident that may pose a significant risk to the environment or human health; and
- Establish programs to monitor the effects of GEMCO's mining operations on biota, water, sediments, soils, air and other aspects of the environment.

Section 4 of this MMPA outlines GEMCO's operational activities while Section 5 and Section 6 describe GEMCO's environmental management structure. The processes described are designed

to ensure compliance with GEMCO's environmental obligations under the Mining Agreement, including the requirement to develop the following documents prior to the commencement of mining within the Eastern Leases:

- An Upper Catchment Area Monitoring and Management Plan (UCAMMP) for Emerald River Tributary 2 (*GEM-PRO-9008*). UCAMMP assessment and response programs are described in the Groundwater Dependent Ecosystem (GDE) Monitoring Program (GDEMP) and Water Management Plan sections of this MMPA (refer to Section 5.6.3.3 and Section 6, respectively);

- A Biosecurity Management Plan (*GEM-PRO-9009*). GEMCO management controls for key Eastern Leases biosecurity threats are summarised in Section 5.6.3.6 to Section 5.6.3.8 of this MMPA; and

- The GEMCO Mine Closure Plan, prepared in consultation with the ALC (refer Section 8).

GEMCO's general cultural obligations under the Mining Agreement are as follows:

- Ensure all personnel (including the additional construction workforce required for Eastern Leases) are familiar with Aboriginal tradition and culture. It is mandatory for all GEMCO employees and contractors to complete cross-cultural training within the first weeks of commencing work at GEMCO;

- Ensure all personnel comply with the Groote Eylandt Liquor Management Plan. GEMCO's mine site induction ensures all GEMCO employees and contractors are made aware of their obligations regarding the use of drugs and alcohol prior to commencing work at GEMCO; and

- Provide employment opportunities to Aboriginals or incorporated Aboriginal bodies. Section 2.2.2 of the FY21-FY24 MMP provides details on GEMCO's Indigenous Employment Plan.

Section 3.3.1 outlines GEMCO's obligations under the Mining Agreement with regards to Sacred Sites and cultural heritage objects and the processes in place to ensure compliance with these obligations.

3.2.2 *South32 Corporate Standards*

South32's Code of Business Conduct (the Code) sets the standards of conduct expected from its people, partners and suppliers across all its operations, including GEMCO. The Code, together with South32's values of care, trust, togetherness and excellence, is to guide every decision made by every individual across the business.

The required standards of conduct and GEMCO compliance with the Code are discussed in Section 3.2.2 of the FY21-FY24 MMP.

3.2.3 *International and National Guidelines*

GEMCO conducts operations in accordance with a number of guidelines, codes of practice and best practice initiatives, as directed by South32's Code of Business Conduct and supporting documentation (South32/GEMCO policies and standards) or other regulatory bodies.

These are detailed within the relevant sections of this MMPA and include guidelines relating to environmental management and monitoring, construction and closure planning.

3.3 Sacred, Archaeological and Heritage Sites

3.3.1 *Sacred Sites*

As outlined in Section 3.1, the Sacred Sites Act provides protection to all sacred sites in the Northern Territory and is administered by the AAPA. To enhance the protection of sacred sites, Traditional Owners can elect to register or record a sacred site with the AAPA. The Sacred Sites Act also provides a mechanism for project proponents to lodge an application for an Authority Certificate with the AAPA. An Authority Certificate provides conditions for any works undertaken on or near sacred sites. Although it is not a requirement to be in possession of an Authority Certificate, having an Authority Certificate (and undertaking the work in accordance with the requirements of the certificate) indemnifies the holder against prosecution under the Sacred Sites Act for damage to sacred sites in the area of the Authority Certificate.

Field surveys, in consultation with Traditional Custodians, were conducted by the ALC Staff Anthropologist throughout 2014 to identify the locations of any Sacred Sites in the Eastern Leases and haul road alignment. An Anthropology Report – the *Eastern Leases Project Instructions Report* (Bland, 2016) (Instructions Report) was developed, and supported an application for an Authority Certificate for Eastern Leases under the Sacred Sites Act.

Authority Certificate C2016/145 was issued in November 2016.

[redacted]

The Eastern Leases mine plan is designed to avoid identified sacred sites and their buffer zones. GEMCO's Permit to Clear process ensures both GEMCO and the ALC assess an area for cultural sites prior to disturbance. This is in addition to GEMCO's requirement to inform the ALC of the mine plan and associated works as part of the quarterly Mining Liaison Meetings. GEMCO acknowledges that these processes do not remove its obligations under the Sacred Sites Act should a site be damaged or entered upon without the consent of the Traditional Owners.

Table 3-2: Sacred Sites within the Eastern Leases

[redacted]

[redacted]

3.3.2 *Cultural Heritage and Archaeological Sites*

Several pieces of Commonwealth and NT legislation establish lists or registers which offer statutory protection to places and objects that are considered to have cultural values (refer Section 3.1).

The *Archaeological Report for the Eastern Leases Project* (SHIM Consulting, 2015) (Archaeological Report) was completed as part of the EIS. The assessment consisted of a desktop search of public registers and found:

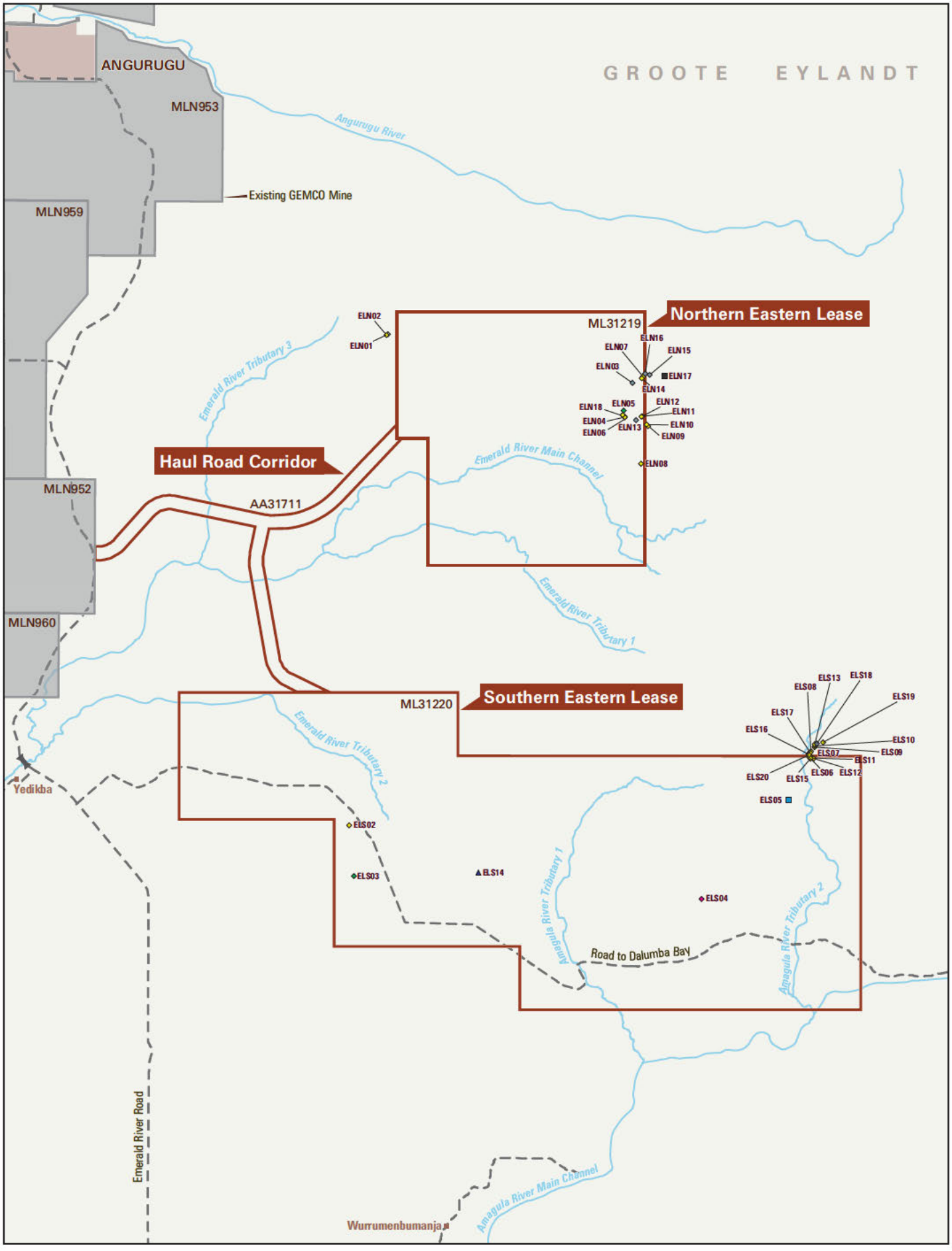
- The World Heritage Register, the (Australian) National Heritage Register and the Commonwealth Heritage Register (established under the *EPBC Act*) do not list any sites within or in close proximity to the Eastern Leases;
- No declarations under the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Cth) have been made for areas within or in close proximity to the Eastern Leases; and
- A number of sites under the NT Heritage (established under the *Heritage Act*) Register and the Aboriginal and Macassan Sites Database occur on Groote Eylandt, but none occur within the Eastern Leases.

The Archaeological Report describes the cultural setting and context and previous surveys that have been conducted over the Groote Eylandt Archipelago; and the survey conducted to support the EIS.

In total, 28 archaeological sites were identified during the Eastern Leases EIS survey (refer Table 3-3 and Figure 3-2). The survey found that the number and type of sites found within the Eastern Leases is significant. In particular, it was found that 25 of the 28 sites identified in the field survey for the EIS were rock shelters containing art. Many of these rock shelters also contained other archaeological features such as artefacts, deposit and grinding. Although this reflects the findings of other archaeological surveys undertaken in the Groote Eylandt archipelago, archaeological finds in Australia typically comprise stone scatters, while rock shelters with art have been relatively rare.

The Archaeological Report assessed the significance of the sites. Five sites (ELS03, ELS04, ELN05, ELN06 and ELN13) display a relatively higher significance in comparison to the other sites within the Eastern Leases. This is due to the wide range of cultural values noted at these sites.

GEMCO management of potential direct and indirect impacts from Eastern Leases to sites of cultural and/or archaeological significance are described in Section 5.6.3.1, Section 5.6.3.2 and Section 5.6.3.10.



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Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases
- Western Leases
- Township
- Sealed Public Roads
- Roads and Public Access Tracks
- Watercourse
- Bridge
- Outstation

Archaeological Sites

- Manuport
- Stone Artefact Scatter
- Sandstone Tor Rockshelter with Art
- Rockshelter with Art
- Rockshelter with Art, Artefacts and Deposit
- Rockshelter with Art and Grinding
- Rockshelter with Art and Deposit

SOUTH32

GEMCO Eastern Leases MMP

Figure 3-2
Archaeological Sites

Date: May 2021	Author: JBA	Plan No: Heritage and Archaeological Sites
Scale: See scale bar	Figure No: 3-2	

Table 3-3: Archaeological Sites within the Eastern Leases

Archaeological Site ID	Land System	Site Type
ELS01	Effington	Historic (geological survey)*
ELS02	Groote	Rock Shelter with Art
ELS03	Groote	Rock Shelter with Art, Artefacts and Deposit
ELS04	Groote	Rock Shelter with Art and Grinding
ELS05	Groote	Stone Artefact Scatter
ELS06	Groote	Rock Shelter with Art
ELS07	Groote	Rock Shelter with Art
ELS08	Groote	Rock Shelter with Art
ELS09	Groote	Rock Shelter with Art
ELS10	Groote	Rock Shelter with Art
ELS11	Groote	Rock Shelter with Art
ELS12	Groote	Rock Shelter with Art
ELS13	Groote	Rock Shelter with Art
ELS14	Yarrawirrie	Manuport
ELS15	Groote	Rock Shelter with Art
ELS16	Groote	Rock Shelter with Art
ELS17	Groote	Rock Shelter with Art
ELS18	Groote	Rock Shelter with Art and deposit
ELS19	Groote	Rock Shelter with Art
ELS20	Groote	Rock Shelter with Art
ELN01	Groote	Rock Shelter with Art and Deposit
ELN02	Groote	Rock Shelter with Art
ELN03	Groote	Rock Shelter with Art and Deposit
ELN04	Groote	Rock Shelter with Art
ELN05	Groote	Rock Shelter with Art, Artefacts and Deposit
ELN06	Groote	Rock Shelter with Art
ELN07	Groote	Rock Shelter with Art
ELN08	Groote	Rock Shelter with Art
ELN09	Groote	Rock Shelter with Art
ELN10	Groote	Rock Shelter with Art
ELN11	Groote	Rock Shelter with Art

Archaeological Site ID	Land System	Site Type
ELN12	Groote	Rock Shelter with Art
ELN13	Groote	Rock Shelter with Art and Deposit
ELN14	Groote	Rock Shelter with Art
ELN15	Groote	Rock Shelter with Art and Deposit
ELN16	Groote	Rock Shelter with Art and Deposit
ELN17	Groote	Sandstone Tor Rock Shelter with Art
ELN18	Groote	Rock Shelter with Art

** Note: Site ELS01 was not re-assessed following the EIS surveys as it is not considered to be of Aboriginal archaeological or cultural heritage significance.*

4 OPERATIONAL ACTIVITIES

GEMCO operations involve mining manganese ore by open cut mining methods, sizing and washing the ore in the concentrator and transporting the final product to the Milner Bay port facility for shipping.

Figure 4-1 provides a schematic of this production process. Ongoing exploration activities and sustaining capital project works are also undertaken to support the progression of mining activities. The activities associated with Eastern Leases operations are summarised in the following sections.

Table 4-1 provides a summary of the operational disturbance and rehabilitation progression during the term of this MMPA. This table forms the basis of financial security calculations. Given the nature of GEMCO's planning processes for Eastern Leases (as described within the respective sections below), the forecast security calculations are subject to change as mine plans are progressively refined (refer Section 4.1.2). GEMCO will report on its performance against this MMPA in annual Environmental Mining Reports (EMRs) (previously Operational Performance Reports (OPRs)) and provide updated forecast values for the remaining years of the MMPA period, if required.

Section 8.2 provides further detail on the costing of closure activities associated with the Eastern Leases for security purposes.

4.1 Mining Activities

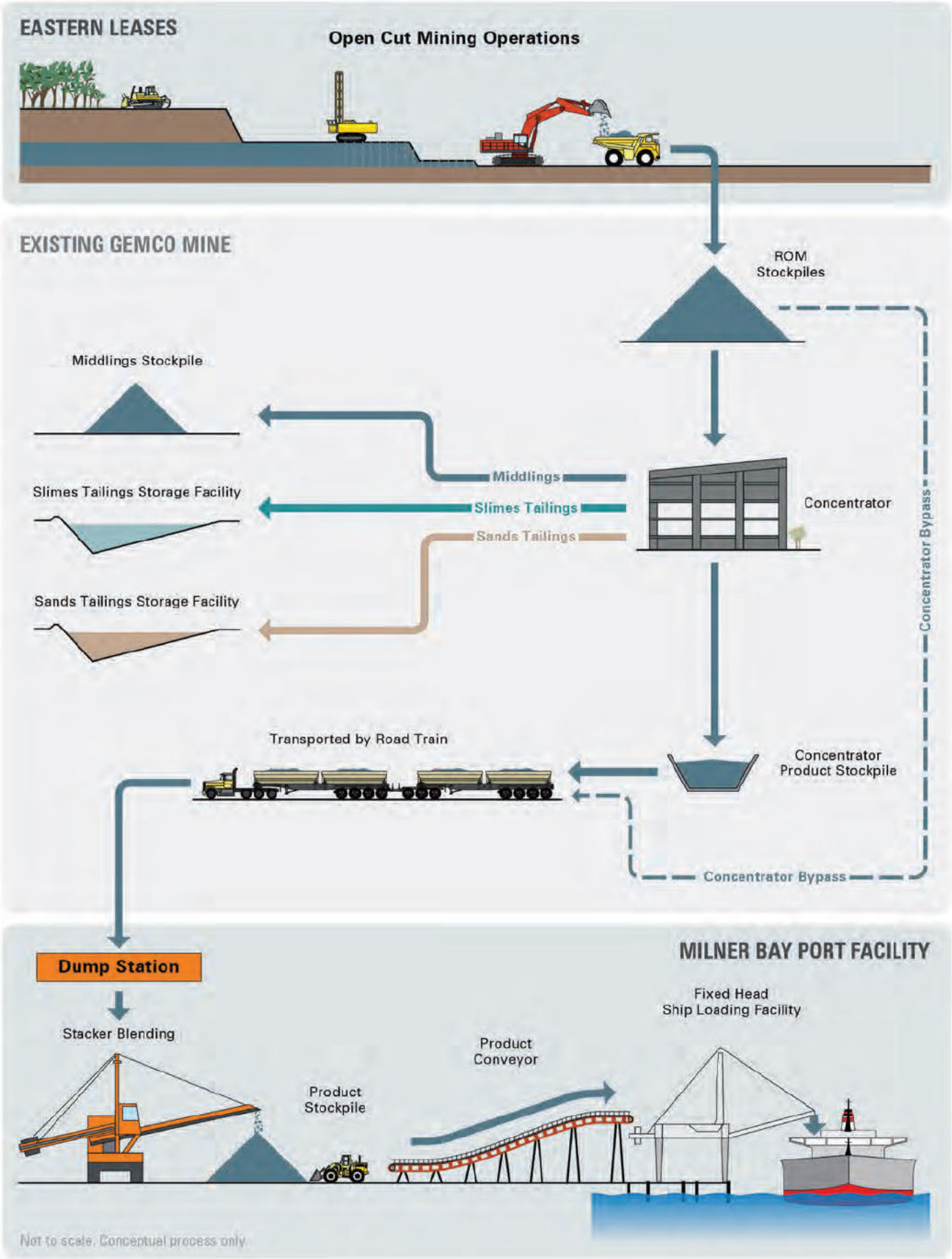
4.1.1 *Mining Process*

The mining process within the Eastern Leases will be undertaken generally as described in the EIS and in accordance with the existing GEMCO mining operations for the Western Leases (refer Figure 4-2). Further detail on the GEMCO mining process is included in Section 4.1 of the FY21-FY24 MMP.

Mining activities within the Eastern Leases will be undertaken using the existing GEMCO workforce and sharing of fixed and mobile plant and will supplement production from the Western Leases.

Table 4-1: Summary of GEMCO Eastern Leases Disturbance and Rehabilitation (ha)

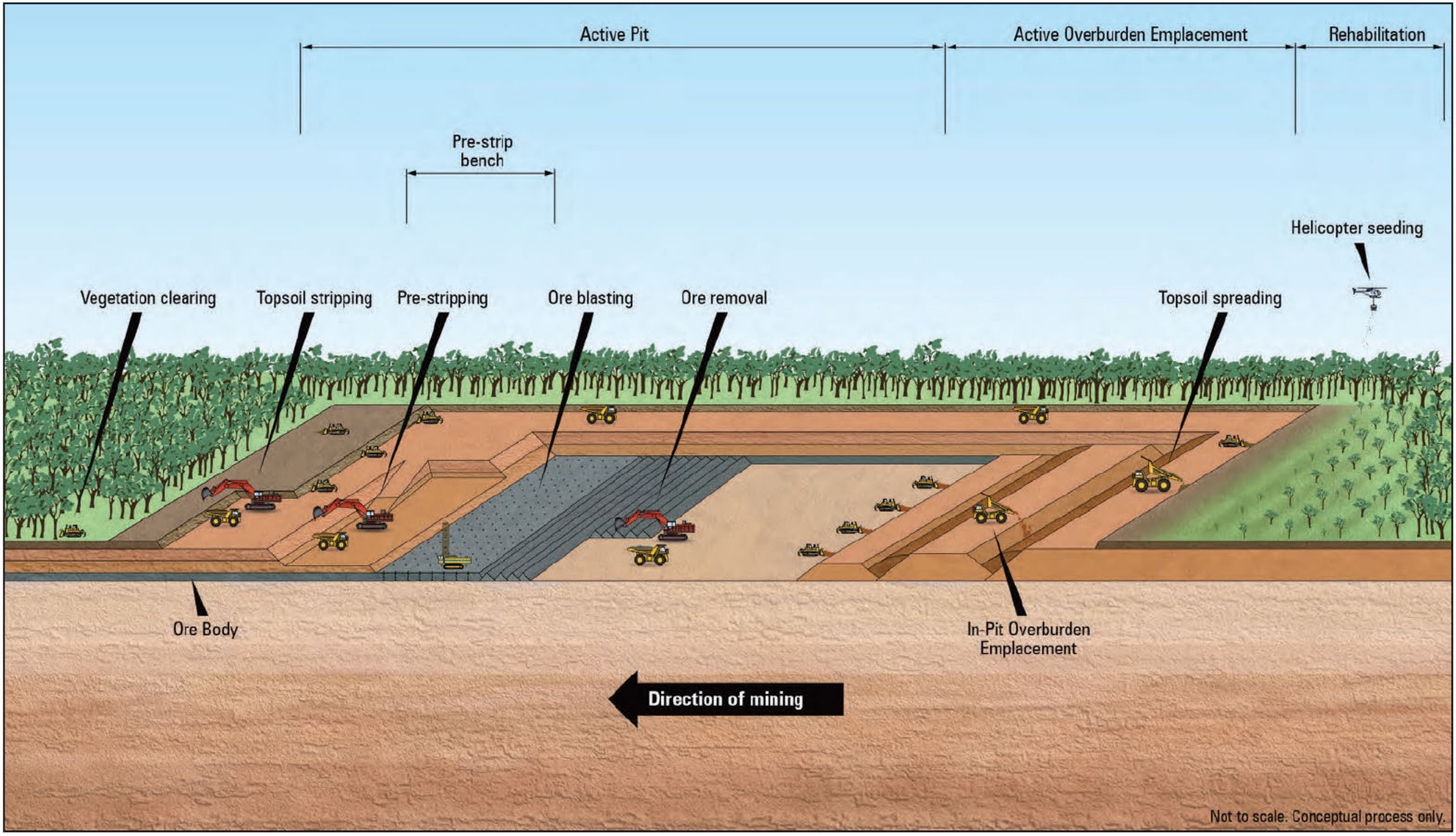
[redacted]



SOUTH32 GEMCO Eastern Leases MMP

Figure 4-1
Production Process

Date: May 2021	Author: JBA	Plan No: Production Process
Scale: See scale bar	Figure No: 4-1	



SOUTH32 GEMCO Eastern Leases MMP

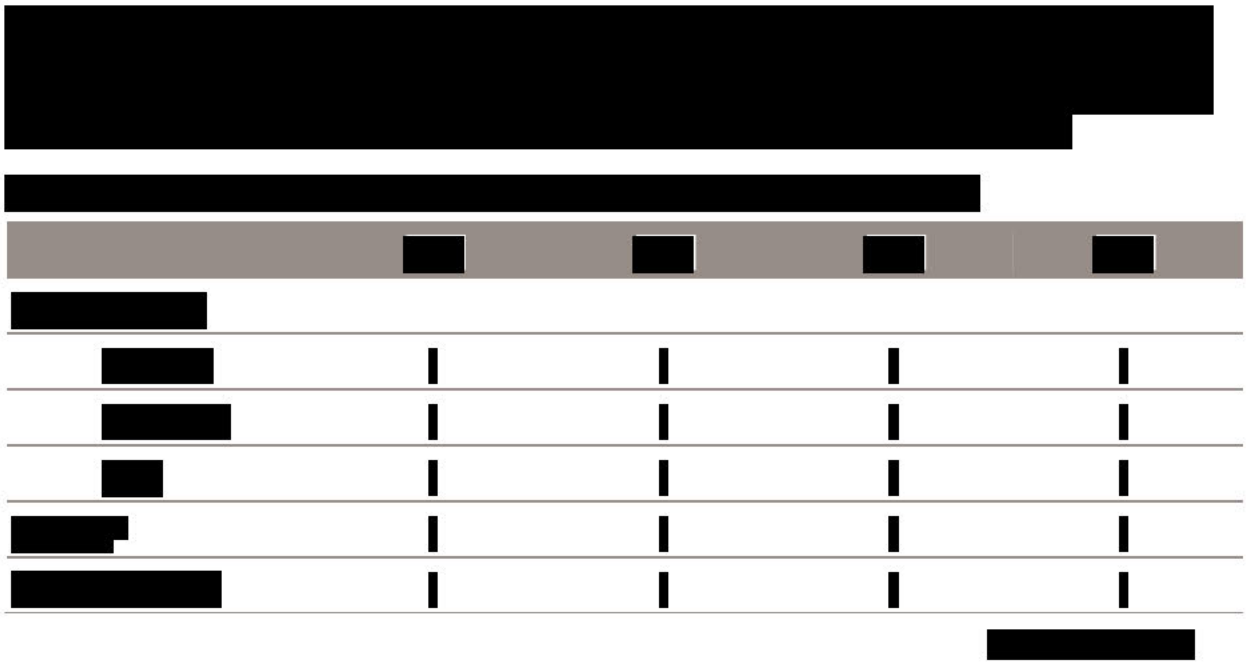
Figure 4-2
Open Cut Mining
Operations Schematic

Date: August 2020	Author: JBA	Plan No: Open Cut Mining Operations Schematic
	Figure No: 4-2	

4.1.2 *Mine Planning*

Mine planning at GEMCO is undertaken in an iterative and incremental manner whereby additional detail is progressively built into the mine schedule over time.

GEMCO's Life of Operations Plan (LoOP) is prepared by South32's Long Term Mine Planning team and is updated annually. The LoOP provides general direction for the areas to be mined for the remaining life of the mine and is developed as part of good business practises to ensure that current and future mining presents a viable option to GEMCO shareholders to determine predicted sales forecasts. It is also used to provide the basis for developing the Post Mining Surface (PMS) to inform closure cost estimates and environmental assessment. The Eastern Leases disturbance footprint shown on Figure 1-4 is derived from the current LoOP and encompasses an area of approximately 1,525 ha. While environmental constraints and future GEMCO exploration and mine planning activities may result in amendments to this footprint, the total area of native vegetation disturbance for Eastern Leases will not exceed this 1,525 ha area, as assessed in the EIS and approved under EPBC 2014_7228. Future mine planning changes that result in any amendments to the Eastern Leases disturbance footprint will be noted in the annual EMRs.



4.1.3 *Mine Design*

Mine designs for each mining strip are prepared by the GEMCO Production Planning team to enable execution of the mine schedule. This design process is described in Section 4.1.3 of the FY21-FY24 MMP and will continue to be used for the Eastern Leases.

Figure 4-3 illustrates a cross section of typical quarry designs for various stages in the GEMCO mining process.

4.1.3.1 *Water Requirements*

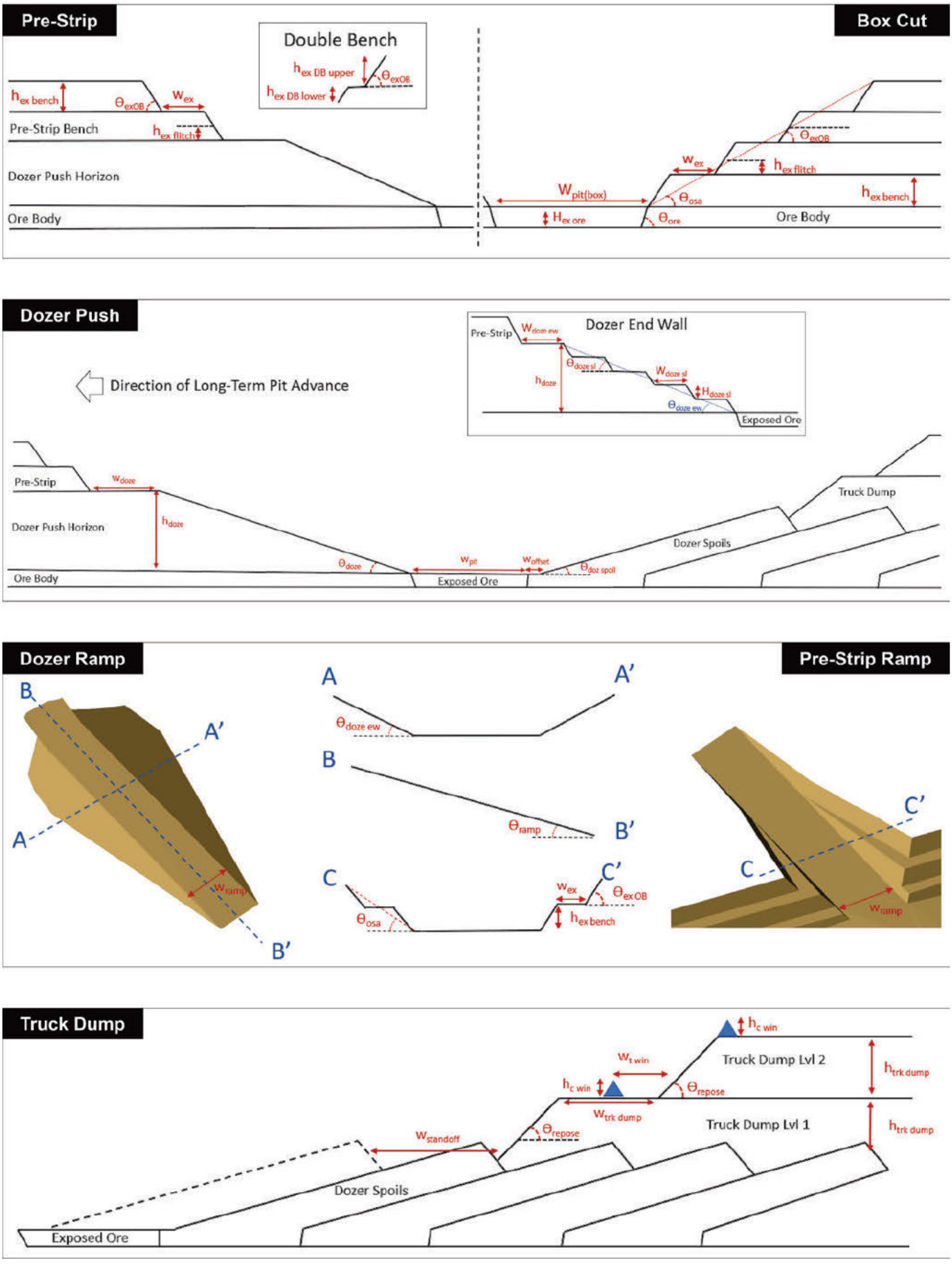
Most quarries at GEMCO intersect the water table during the mining process. For the Eastern Leases, water management requires the capture and management of inflows which are then utilised for dust suppression in site operations. As per the EIS, discharge of the collected water shall only occur during extreme weather events and are controlled based on known water quality constraints. Discharge of water may also be required during the early stages of construction for the Eastern Leases quarry water dams (refer Section 6.1.1.3) if volumes of water intersected cannot be captured and stored on site. Section 6 provides further detail on the Eastern Leases water management system.

4.1.3.2 *Ore and Product Stockpiles*

Ore from the Eastern Leases will be transported for processing via a network of dedicated haul roads to existing ore and product stockpiles located at the Western Leases. Ore from the Eastern Leases will be handled, processed and stockpiled generally in accordance with the process described in Section 4.1.3.2 of the FY21-FY24 MMP.

4.1.3.3 *Rehabilitation*

The progressive mine rehabilitation process implemented by GEMCO is summarised in Section 4.1.3.3 of the FY21-FY24 MMP. This process will continue to be implemented for Eastern Leases.



SOUTH32 GEMCO Eastern Leases MMP

Figure 4-3
Typical Quarry Designs

Date: August 2021	Author: JBA	Plan No: Typical Quarry Designs
Scale: See scale bar	Figure No: 4-3	

4.1.4 *Mining Reserves and Geology*

GEMCO's Mineral Resources and Ore Reserves are reported each financial year in accordance with ASX Listing Rule requirements. The South32 Annual Report 2020 can be accessed online via the South32 Investor Centre: https://www.south32.net/investors-media/investor-centre/annual-reporting-suite. The Eastern Leases ore quantities are not part of the South32 Annual Report 2020 as ore reserves are only reported after projects are formally approved for development within South32. The figures provided in this document are therefore supplied for the purposes of obtaining regulatory approvals.

It is noted that the Mineral Resources and Ore Reserves reported in the South32 Annual Report are expressed in dry metric tonnes, while most of the quantities in this MMPA are expressed in wet metric tonnes.

Section 2.1.2.2 provides a description of the mine geology.

4.1.5 *Mining Performance against MMP*

GEMCO report on annual mining performance in the annual EMR submitted to DITT for each financial year. The EMR will include a review of forecast and actual volumes of overburden and ore production for Eastern Leases following the commencement of mining.

4.2 Processing Activities

A summary of the forecast production profile for the Concentrator, SBP and Logistics for FY21-FY24 is provided in Section 4.2 of the FY21-FY24 MMP. GEMCO will report on its performance against this MMPA in annual EMRs and provide updated forecast values for the remaining years of this MMPA, as required.

4.2.1 *Treatment and Ore Processing Operations*

Manganese ore extracted from the Eastern Leases will be hauled to Western Lease ROM stockpiles prior to treatment at existing GEMCO processing facilities. This process is described in Section 4.2.1 of the FY21-FY24 MMP.

Geochemical testing undertaken to support the EIS identified small areas of PAF material in the north-western portion of the Southern Eastern Lease. GEMCO have developed a procedure for the monitoring, handling and emplacement of any PAF material encountered during Eastern Leases mining operations to ensure that potential risks are appropriately managed (refer Section 5.6.3.12). The procedure has also been developed to meet the PAF management commitments in the EIS and the associated recommendations of Assessment Report 77.

4.2.2 *Tailings Storage Facilities (TSFs)*

The processing of manganese ore from the Eastern Leases will result in the production of concentrate (manganese lump and fines) and waste materials (middlings and tailings). GEMCO procedures for the design, implementation, monitoring and management of waste in TSFs and forecast tailings production during FY21-FY24 are described in Section 4.2.2 of the FY21-FY24 MMP.

4.2.3 *Mine Water Dams*

Two mine (quarry) water dams will be constructed to manage quarry water during Eastern Leases mining operations:

- Dam ELNS, in the Northern Eastern Leases; and
- Dam ELSS, in the Southern Eastern Leases.

To ensure that additional storage capacity is available (i.e. during wet periods), the EL5C quarry void in the Southern Eastern Leases will also be retained for use as a temporary quarry water storage.

The maximum capacities of these storages are presented in Section 6.1.1.3.

4.2.4 *Processing Performance against MMP*

GEMCO report on annual mining performance in the EMR submitted to DITT for each financial year. The EMR will include a review of planned and actual ore processing and product transport for Eastern Leases following the commencement of mining.

4.3 Exploration Activities

GEMCO undertakes ongoing exploration drilling to improve the understanding of manganese mineralisation (depth, thickness, quality and continuity) across its lease areas. A description of this process is provided in Section 4.3 of the FY21-FY24 MMP.

As noted in Section 4.1.2, GEMCO are continuing the Eastern Leases exploration program to gain additional data on mineral resources and reserves. The results of the exploration program will inform future reviews of GEMCO's LoOP and the extent of mining within the Eastern Leases.

4.3.1 *Planned Exploration Activities*

Planning for exploration is conducted annually and is a sequential process whereby results from previous years are used to plan future drilling locations. Therefore, detailed drill plans are only available for FY22. The drill program scheduled for Eastern Leases in FY22 is shown in Figure 4-4 and includes:

- 22 geotechnical test pits;
- 52 diamond tipped drill holes (maximum depth 42 m); and
- 280 reverse circulation drill holes (maximum depth 42 m).

Figure 4-4 also identifies additional areas proposed for future exploration activities within the Eastern Leases. The location and extent of activities within these proposed areas will be refined by GEMCO pending the results of future exploration works and mine planning reviews (refer to Section 4.1.2).

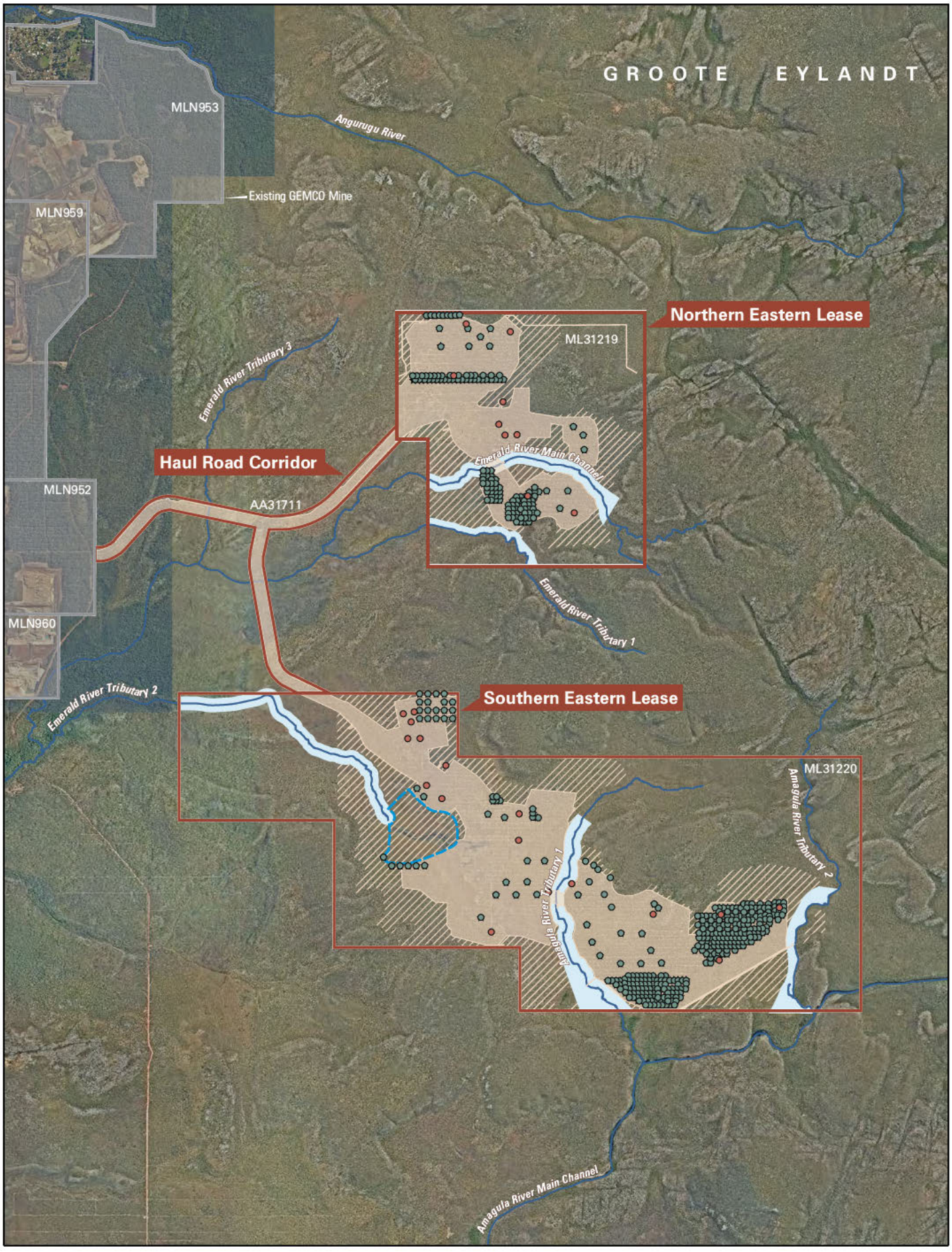
Clearing of access tracks and drill pads is required to undertake exploration drilling activities. Clearing is carried out using a scrub dozer in accordance with *GEM-PRO-4149 Permit to Clear and Burn Vegetation* and related documents. Tracks are nominally 3 m wide, and pads are typically a maximum 20 m by 20 m (including track width). Clearing is conducted using the "blade up" method, whereby the blade of the dozer is lifted to ensure topsoil is largely undisturbed and retains vegetative material (i.e. roots and tubers) and the soil seed bank. This facilitates natural regrowth of tracks and pads and therefore, no active rehabilitation is undertaken on the Eastern Leases. Exploration tracks and pads are left for vegetation to regenerate naturally and all holes are capped and filled immediately after drilling.

4.3.2 *Exploration Performance against MMP*

GEMCO report on annual exploration performance in the annual EMR submitted to DITT for each financial year. Eastern Leases exploration performance will be reported in the EMR for Authorisation 0126-01, should DITT approve this MMPA.

4.4 Projects

Major GEMCO capital projects planned for the FY21-FY24 period are described in Section 4.4 of the FY21-FY24 MMP.



N

0 2

Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases
- Western Leases
- Updated Project Disturbance Footprint (August 2021)
- Proposed Future Exploration
- Mine Planning Buffer
- Upper Catchment Area
- Watercourse
- Exploration Drill hole locations FY22
- Geotechnical Drill hole locations FY22

SOUTH32 GEMCO Eastern Leases MMP

Figure 4-4
FY22 Eastern Leases Drill Program

Date: September 2021	Author: JBA	Plan No: FY21 Drill Program
Scale: See scale bar	Figure No: 4-4	

5 ENVIRONMENTAL MANAGEMENT

5.1 Environmental Management Structure

Environmental management at GEMCO is undertaken by the Environment team, led by GEMCO's Manager Technical Services and supported by South32's global functions on an as-needed basis (refer to Section 1.1.1 of the FY21-FY24 MMP).

5.2 Sustainability Policy and Environment Standard

GEMCO is committed to operating in an environmentally sustainable manner as outlined in the South32 Sustainability Policy and the South32 Environment Standard. The South32 Environment Standard, included in Appendix 9.9 of the FY21-FY24 MMP, sets the minimum standard for South32 operations with regards to environmental management.

5.3 Environmental Commitments

GEMCO's existing environmental commitments are detailed within the FY21-FY24 MMP. This MMPA, sets out key environmental commitments for the Eastern Leases Project. These are largely based on commitments agreed to through the EIS approvals process, Eastern Leases Mining Agreement between GEMCO and the ALC and other commitments identified by GEMCO as being required to manage the environmental risks associated with the Eastern Leases Project.

5.3.1 *Commitments Contained in this MMPA*

Table 5-1 summarises the Eastern Leases environmental commitments for the term of this MMPA.

Table 5-1: Summary of Key Environmental Activities (FY21-FY24)

Commitment	Due Date	Section in MMP	Performance against Commitment
GEMCO SEP Update	July 2022	2.2	Consultation requirements for Eastern Leases approvals will be included in an update to the GEMCO SEP, prior to the commencement of construction. New or updated consultation actions will be communicated to relevant GEMCO and community personnel.
Eastern Leases Mining Agreement Plans	July 2022	3.2.1	GEMCO will implement the UCAMMP and Biosecurity Management Plan documents required under the Mining Agreement prior to the commencement of mining within Eastern Leases. GEMCO will not undertake mining or exploration within the 'Upper Catchment Area' (as defined in the Mining Agreement) without ALC approval of the UCAMMP.
Rock Art Heritage Site Condition Re-Assessment	July 2023	5.6.3.1	GEMCO will complete a re-assessment of the condition of Eastern Leases rock art sites prior to the commencement of mining to provide an updated baseline of rock art condition, in consultation with the ALC.
Rock Art Heritage Site Visual Inspections	July 2023	5.6.3.1	GEMCO will complete visual monitoring of specific rock art sites within five days of blast events that occur within 700m of a rock art site.

Commitment	Due Date	Section in MMP	Performance against Commitment
Manuport Heritage Site	January 2022	5.6.3.1	GEMCO will consult with the ALC and secure an agreement over a management approach for the manuport site (GEMCO Archaeological Site ID ELS14) and gain approval under the Heritage Act prior to any relocation of this site.
Rock Art Heritage Site Blast Monitoring	July 2023	5.6.3.2	GEMCO will establish monitoring site(s) to allow blast vibration levels representative of sensitive rock art sites to be recorded and assessed against impact criteria.
GDE Monitoring Program	July 2023	5.6.3.3	GEMCO will start monitoring of the sites identified within the GDEMP prior to the commencement of Eastern Leases mining to confirm baseline conditions.
Weed Survey	July 2022	5.6.3.7	GEMCO will complete a survey within the Eastern Leases to identify the presence of weed species that have become established since the Cumberland Ecology (2015) study completed for the EIS. A program to manage any identified outbreaks will be developed prior to the commencement of construction.
Rehabilitation Performance Trials	July 2023	5.6.3.9	GEMCO will complete trials within existing Western Leases rehabilitation areas to assess the value of: • Controlled burning; and • Use of salvaged timber resources (as fauna habitat).
Air Quality Monitoring Network	July 2022	5.6.3.10	An additional HVAS PM_{10} air quality monitoring site representative of Yedikba Outstation will be installed prior to the commencement of construction and added to the GEMCO monitoring network.
PAF Material Monitoring	As required	5.6.3.12	GEMCO will complete monitoring to identify potential PAF material when mining clay overburden at depths below 15 m that are within 500 m of boreholes EL-S-MB05 and EL-S-MB06 identified in the EIS.
Water Accounting Framework Reporting	July 2022	6.2.3	The existing GEMCO site water balance will be expanded to include Eastern Leases following commencement of the project, to fulfil internal reporting obligations and DITT's water reporting requirements through the EMR. Water accounting will be undertaken in accordance with the Minerals Council of Australia *User Guide, Water Accounting Framework for the Minerals Industry* (2014).
Water Monitoring Network	July 2022	6.5.2	GEMCO will resume monitoring within the Eastern Leases water monitoring network at the commencement of construction.

5.3.2 *Recommendations Resulting from Formal Environmental Assessment*

The NT EPA published Assessment Report 77 for the Eastern Leases in March 2016 and the Commonwealth provided EPBC Act approval 2014/7228 for the project in June 2016 (refer Section 3.1) which was updated in July 2020 to reflect a change to the haul road alignment. Both documents provide approval conditions and management recommendations. These obligations, and a summary of performance against each, are provided in Table 5-2.

Table 5-2: Eastern Leases Approvals Summary

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
NT EPA Assessment Report Recommendations		
1. The Proponent shall ensure that the GEMCO Eastern Leases Project is implemented in accordance with the environmental commitments and safeguards: • identified in the final Environmental Impact Statement for the GEMCO Eastern Leases Project (draft Environmental Impact Statement and Supplement to the draft Environmental Impact Statement) • recommended in this NT EPA Assessment Report 77. The Northern Territory Environment Protection Authority considers that all safeguards and mitigation measures outlined in the Environmental Impact Statement are commitments made by the Proponent.	**3 - 6**	Eastern Leases environmental monitoring and management programs and commitments are described in this MMPA. Performance against Eastern Leases approvals requirements will be reported annually in future GEMCO EMRs.
2. The Proponent shall advise the Northern Territory Environment Protection Authority and the responsible Minister of any alterations to the GEMCO Eastern Leases Project, in accordance with clause 14A of the Environmental Assessment Administrative Procedures.	-	No material alterations to the Eastern Leases Project have been made or are proposed in this MMPA.
3. A Weed Management Plan for the control and management of weeds shall be prepared. The Weed Management Plan must identify the species of weeds and their location in and around the GEMCO Eastern Leases Project and outline methods for eradicating/controlling existing infestations. It must identify actions to prevent introduction of new weed species from vehicles, machinery or any other method, and align with Statutory Weed Management Plans.	**5.6.3.7**	GEMCO have prepared an updated Weed Management Plan to reflect NT Statutory Weed Management Plans and consider management requirements for Eastern Leases. The updated document has also been prepared to address the requirements of EPBC 2014/7228 (the relevant conditions of EPBC 2014/7228 are reproduced below in this table).
4. The Proponent shall re-evaluate the risk assessment and management strategy for the cane toad. The amended assessment should be used to prepare a Cane Toad Management Plan, in consultation with experts in the management of cane toads.	**5.6.3.6**	The Cane Toad Management Plan, like all other GEMCO management plans, is a "live" document. GEMCO have updated the Cane Toad Management Plan since the issue of the final EIS to consider project risks and describe Eastern Leases requirements. GEMCO are in consultation with DAWE and other stakeholders over an update to the Cane Toad Management Plan as required

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
		under EPBC 2014/7228 (the relevant conditions of EPBC 2014/7228 are reproduced below in this table).
5. Should the Australian Government decide that offsets are required to compensate for the residual significant impacts to matters of national environmental significance, the Proponent shall submit an offset plan. The offset plan should clearly define the mitigation, management and compensatory measures that will be implemented on site. Any offset measures should be consistent with the Australian Government's Offset Policy and calculator.	**3.1**	The conditions of EPBC 2014/7228 require that GEMCO provide biodiversity offsets to compensate for residual impacts of the Eastern Leases. GEMCO are developing a Biodiversity Offset Strategy (BOS) and Biodiversity Offset Management Plan (BOMP) to address these requirements, in consultation with the ALC, NT regulatory agencies and DAWE.
6. In consideration of recommendation 5, the offsets plan should take into account the different ecological requirements and threats to each of the listed species considered to be at significant risk from the Project as identified in Assessment Report 77.	**3.1, 5.6.3.5**	The BOS and BOMP required under EPBC 2014/7228 will be prepared taking into account contemporary conservation advice and threats to listed species identified within the Eastern Leases. GEMCO have prepared an updated Threatened Species Management Plan (TSMP) to reflect contemporary regulatory requirements and conservation advice that includes management requirements for listed fauna species identified within the Eastern Leases.
7. The Proponent shall prepare and implement a Rehabilitation Plan for the GEMCO Eastern Leases Project. The Rehabilitation Plan should include objectives for the creation of threatened species habitat and recolonisation by threatened species populations, and identify explicit criteria for evaluation. The plan should include a sampling design and sampling methods for monitoring that will enable measurable evaluation of outcomes against identified criteria, in order to demonstrate the effectiveness of the Rehabilitation Plan for threatened species. The Rehabilitation Plan should be revised accordingly in response to the results of trials in prescribed burning of rehabilitated areas.	**5.6.3.9**	GEMCO have prepared an updated Rehabilitation Standard and Rehabilitation Monitoring and Evaluation Procedure that includes Eastern Leases requirements.
8. The Proponent shall prepare a Closure Plan for the GEMCO Eastern Leases Project that includes closure criteria that have been developed in consultation with relevant stakeholders and approved by the Department of Mines and Energy, including provisions for unplanned closure.	**8**	GEMCO are preparing an updated Mine Closure Plan that includes Eastern Leases requirements, in consultation with the ALC and DITT.

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
9. The Proponent shall develop and implement a Groundwater Monitoring Program to monitor groundwater level. The Program should be of an appropriate sampling density and frequency to detect water level variations resulting from dewatering for Project mining activities, accounting for seasonality. The numerical groundwater model used to predict drawdown levels should be validated at regular intervals against the results of the Groundwater Monitoring Program, and appropriate management measures developed if adverse impacts are detected.	**6**	The Eastern Leases Water Management Plan includes a groundwater monitoring and response program with a requirement for regular validation of the groundwater model.
10. The Proponent shall prepare a Groundwater Dependent Ecosystem Monitoring Plan that is consistent with the details provided in the Environmental Impact Statement. The Groundwater Dependent Ecosystem Monitoring Plan should include reporting requirements and appropriate protocols in the event that adverse impacts are identified.	**5.6.3.3, 6**	GEMCO have developed a GDEMP for Eastern Leases.
11. The Proponent shall not mine within any watercourse or any watercourse buffer.	**1.3**	The Eastern Leases mine plan avoids disturbance to local watercourses or watercourse buffers identified in the EIS and Mining Agreement (refer Figure 1-4).
12. The Proponent shall prepare a Water Management Plan that is consistent with the details provided in the Environmental Impact Statement. The Plan should include a suitable groundwater and surface water monitoring program, reporting requirements and appropriate protocols in the event that adverse impacts are identified, and emergency discharge protocols and limits. The Water Management Plan should contain a project water balance that includes water transfers, consumption and quarry water volumes; surface water quality monitoring and reporting; storage water quality monitoring and reporting; and discharge monitoring and reporting.	**6**	GEMCO have developed a Water Management Plan for Eastern Leases as a component of this MMPA.
13. The Proponent shall prepare an Erosion and Sediment Control Plan that is consistent with the details provided in the Environmental Impact Statement and includes the additional recommendations provided in this Report. The Erosion and Sediment Control Plan should be cross-referenced with the Rehabilitation Plan and other relevant sub-plans of the Mining Management Plan, and approved prior to the commencement of works.	**5.6.3.4**	GEMCO have developed an Erosion and Sediment Control Standard for the Eastern Leases as part of this MMPA.

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
14. The Proponent shall take all reasonable measures to avoid disturbing or excavating materials that are identified as potentially acid forming. If potentially acid forming material cannot be avoided, the Proponent shall prepare a management plan for the handling and storage of materials identified as potentially acid forming and/or capable of generating seepage that does not accord with water quality parameters. The plan should include details of the monitoring program to verify that the handling and storage of materials is effective.	**4.2.1**, **5.6.3.12**	GEMCO have developed a procedure for the monitoring and management of any PAF material that has the potential to be encountered during Eastern Leases operations.
15. The Proponent shall develop a communication strategy to ensure the public and surrounding community, including the persons likely to access Pelican's Nest or to use the unsealed track that comes off the Emerald River Road and provides access to Dalumba Bay, are informed about changes to site access and relocation/restricted access of roads/tracks.	**2.2**	GEMCO will continue to engage with community stakeholders using a range of measures described in the site Stakeholder Engagement Plan (SEP), which is reviewed on an annual basis (refer Section 2.2 of the FY21-FY24 MMP). New consultation requirements for Eastern Leases approvals will be included in the SEP prior to the commencement of construction and associated actions will be communicated to relevant GEMCO and community personnel.
16. The Proponent shall consult with the Anindilyakwa Land Council, the Heritage Branch of the Department of Lands, Planning and the Environment, and any other relevant stakeholder, in relation to a suitable management approach for the single archaeological site (i.e. the manuport), which is located within the Project disturbance footprint. Approvals in accordance with the Heritage Act shall be obtained by the Proponent prior to disturbing the site.	**5.6.3.9**	In consultation with the ALC, GEMCO have prepared a Cultural Heritage Management Plan (CHMP) for the management of archaeological sites within the Eastern Leases. GEMCO will secure an agreement with the ALC over the management approach for the manuport and gain approval under the Heritage Act prior to relocating this archaeological site.
17. The Proponent shall prepare a Cultural Heritage Management Plan for the protection of sites of archaeological significance. The Cultural Heritage Management Plan must include employee and contractor induction and awareness of the significance of site protection; methods to register and record monitoring; and obligations under the Heritage Act. The Cultural Heritage Management Plan should include provisions to monitor sites for impacts from dust, blasting and unauthorised access, and provisions for corrective actions in the event that adverse impacts are detected. The results of the additional surveys completed for two clustered sites (i.e. sites ELS06 to ELS13 and ELS15 in the Southern Eastern Lease, and ELN04 to ELN06	**5.6.3.1**, **5.6.3.2**	GEMCO have developed a CHMP for Eastern Leases, in consultation with the ALC. This plan includes measures for the monitoring and management of known archaeological and Sacred Sites.

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
and ELN08 to ELN13 in the Northern Eastern Lease) should be used to inform the Cultural Heritage Management Plan before the commencement of the Project.		
18. The Proponent shall prepare a Blast Management Plan that specifies ground vibration limits for the rock art sites, as well as periodic monitoring of rock shelters with art to confirm their integrity. The Blast Management Plan should align with the objectives and principles of the Cultural Heritage Management Plan and be prepared and revised in conjunction with the Cultural Heritage Management Plan.	**5.6.3.2**	GEMCO have prepared a Blast Management Plan for the Eastern Leases to provide management criteria for rock art sites identified in the EIS.
19. The Proponent taking the proposed action is wholly responsible for implementation of all conditions of approval and mitigation measures contained in the Environmental Management Plan and must ensure all staff and contractors comply with all requirements of conditions of approval and mitigation measures contained in the Environmental Management Plan. The Environmental Management Plan, and sub-plans, should form part of the Mining Management Plan. In preparing each plan, the Proponent shall include any additional measures for environmental protection and monitoring contained in this Assessment Report 77.	**5.1 - 5.5**	GEMCO induction and training procedures have been updated to consider Eastern Leases EIS and regulatory approval requirements described in this MMPA.
20. The Authorisation for the GEMCO Eastern Leases Project should include a condition requiring the Proponent to make and publish an Environmental Mining Report to satisfy the requirements of the Mining Management Act relevant to the Environmental Mining Report. The NT EPA recommends the Environmental Mining Report be made available to the public at 12 month intervals, for the duration of the life of the proposed action.	**3.1**	GEMCO will include reporting on Eastern Leases activities in future annual EMR documents.
EPBC 2014/7228 Conditions		
1. Within 5 business days after the commencement of the action, the approval holder must advise the Department [DAWE] in writing of the actual date of the commencement of the action.	**N/A**	Not triggered. GEMCO will notify DAWE on commencement of the action, as required under EPBC 2014/7228.

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
2. The approval holder must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits may be posted on the Department's website. The results of audits may also be publicised through the general media.	**N/A**	Not triggered. No requirements for information or audit have been raised by DAWE.
3. Within three months of every 12 month anniversary of the commencement of the action, or otherwise in accordance with an annual date that has been agreed to in writing by the [Commonwealth] Minister, the approval holder must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing proof of the date of publication must be provided to the Department at the same time as the compliance report is published. The reports must remain published on the website for the duration of the approval, or until otherwise agreed to by the Minister in writing. Following 12 months after the completion of the action and any requirements under these conditions, the approval holder may seek the Minister's written approval to cease annual reporting.	**N/A**	Not triggered. The action as defined under EPBC 2014/7228 has not commenced.
4. Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor and audit criteria must be approved by the Minister prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the Minister.	**N/A**	Not triggered. No requirements for audit have been raised by DAWE.
5. The approval holder may choose to revise the Environment Management Plan (EMP) approved by the Minister under condition 10 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised EMP would not be likely to have a new or increased impact. If the approval holder makes this choice they must…	**N/A**	Not triggered. EPBC 2014/7228 EMP has not been approved by DAWE.

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
…ii. subject to condition 5B, implement the revised EMP from the revised EMP implementation date.		
5A. The approval holder may revoke its choice under condition 5 at any time by notice to the Department. If the approval holder revokes the choice to implement a revised EMP, without approval under section 143A of the EPBC Act, the EMP approved by the Minister must be implemented.	**N/A**	Not triggered.
5B. If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the revised EMP would be likely to have a new or increased impact, then: i. Condition 5 does not apply, or ceases to apply, in relation to the revised EMP; and ii. The approval holder must implement the EMP approved by the Minister. To avoid any doubt, this condition does not affect any operation of conditions 5 and 5A in the 10 business day period before the day the notice is given. At the time of giving the notice the Minister may also notify that for a specified period of time that condition 5 does not apply to the EMP required under the approval.	**N/A**	Not triggered.
5C. Conditions 5, 5A and 5B are not intended to limit the operation of section 143A of the EPBC Act which allows the approval holder to submit a revised EMP to the Minister for approval.	**N/A**	Noted.
6. If, at any time after ten years from the date of this approval, the approval holder has not substantially commenced the action, then the approval holder must not undertake substantial commencement of the action without the written agreement of the Minister.	**N/A**	Not triggered.
7. Unless otherwise agreed to in writing by the Minister, the approval holder must publish all management plans and reports referred to in these conditions of approval on its website. Each management plan and report must be published on the website within 20 business days after being approved. The management plan and/or report must remain on the website for the period this approval has effect.	**N/A**	Not triggered. EPBC 2014/7228 management plans have not yet been approved. GEMCO are developing these documents in consultation with DAWE and will publish the plans once approved.

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
8. The approval holder must not clear more than 1525 ha of native vegetation for the purpose of the action.	**N/A**	Not triggered. GEMCO will monitor vegetation clearance for the Eastern Leases to ensure the 1,525 ha limit is not exceeded.
9. For the better protection of the impacted species, the approval holder must comply with recommendations 3, 4, 7 and 8 of Assessment Report 77 once those recommendations are included as conditions in a Mining Management Plan authorising the action under the Mining Management Act (NT).	**3.1**	See above for a summary of performance against NT EPA Assessment Report 77 conditions.
10. For the better protection of the impacted species, the approval holder must prepare and submit an Environment Management Plan (EMP) for approval by the Minister. The EMP must include, but is not limited to: a. A staff induction program that provides information to all employees and contractors on the impacted species and activities/actions that may result in a direct or indirect impact on these species. b. Measures to mitigate vehicle collisions with impacted species through installation of relevant signage on roads and entry points to the project site noting the presence of the impacted species. c. The prohibition of pets and firearms on the project site. d. Measures to control waste on the project site in order to avoid attracting and propagating vermin and feral cats. e. Demonstrate how the Weed Management Plan, prepared in accordance with recommendation 3 of Assessment Report 77, has considered, where relevant, the Threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses (Department of Sustainability, Environment, Water, Population and Communities, Canberra, 2012). f. Demonstrate how the Cane Toad Management Plan, prepared in accordance with recommendation 4 of Assessment Report 77, has considered, where relevant, the Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads. (Department of Sustainability, Environment, Water, Population and Communities, Canberra, 2011). g. A requirement for all employees and contractors to report all observations of feral cats, cane toads and the impacted species in the project site to the approval holder's environmental department. The approval holder must	**5.4, 5.5, 5.6**	Not triggered. The EMP required under EPBC 2014/7228 has not yet been approved by the Minister. GEMCO are developing the EMP in consultation with DAWE and will implement the document once approved (including the associated Eastern Leases Weed Management Plan and Cane Toad Management Plan).

Recommendation / Issue	Section(s) in MMP	Performance Against Commitment
report any incidents that result in death or injury to impacted species in the annual compliance report required by condition 3. The EMP must be submitted to the Minister for approval prior to the commencement of the action. Construction must not occur until the EMP has been approved by the Minister. The approved EMP must be implemented.		
11. The approval holder must prepare and submit a Biodiversity Offsets Strategy (BOS) for the Minister's approval. The BOS must outline and describe the strategy for providing offsets for the significant residual impacts of the action on impacted species. The approval holder must not commence the action unless the Minister has approved the BOS in writing. The BOS must… …If the Minister approves the BOS then the approved BOS must be implemented.	**N/A**	Not triggered. The EPBC 2014/7228 BOS has not yet been approved. GEMCO are developing the BOS in consultation with DAWE and other relevant stakeholders and will implement the strategy once approved.
12. The approval holder must prepare a Biodiversity Offset Management Plan (BOMP) to describe specific programs to implement the approved BOS described in condition 11. The approval holder must submit the BOMP to the Minister within 12 months of the commencement of the action. The action cannot continue for more than 24 months from the date of commencement of the action unless the Minister has approved the BOMP. The approved BOMP must be implemented. The BOMP must… … g. include a regime for: i. planning and setting a biennial (2 year) work program; ii. monitoring outcomes; iii. reporting outcomes against the work program; and iv. adaptive management.	**N/A**	Not triggered. The EPBC 2014/7228 BOMP has not yet been approved. GEMCO are developing the BOMP in consultation with DAWE and other relevant stakeholders and will implement the plan once approved.
13. The approval holder must implement the programs and/or actions included in the BOMP required by condition 12, in accordance with the requirements below…	**N/A**	Not triggered. The EPBC 2014/7228 BOMP has not yet been approved.

5.3.3 *Commitments and Recommendations Register*

The status of existing GEMCO management commitments and actions agreed with regulatory agencies are described in Section 5.3.3 of the FY21-FY24 MMP.

5.4 Environmental Training and Education

5.4.1 *Training and Inductions*

GEMCO is committed to educating its employees and contractors about their individual environmental responsibilities in order to facilitate effective environmental management. This is accomplished through the implementation of appropriate induction, training and education programs.

A summary of the general environmental inductions and training requirements for GEMCO personnel is provided in Section 5.4 of the FY21-FY24 MMP. Induction and training requirements have been revised to include additional material for construction and operational commitments described in the Eastern Leases EIS and regulatory approvals.

5.5 Environmental Emergency Preparedness and Response

Emergency preparedness and response procedures are an essential part of effective environmental management. GEMCO's Crisis and Emergency Management Plan provides a framework for responding to all crisis and emergency situations. By utilising the People, Environment, Assets, Reputation, Livelihood (PEARL) priorities system, incidents are managed to ensure any potential damage to the natural and social environment is minimised.

GEMCO procedures for responses to emergencies and material environmental risks are described in Section 5.5 of the FY21-FY24 MMP and these documents will be implemented for the Eastern Leases.

5.6 Implementation, Monitoring and Review

5.6.1 *Identification of Environmental Aspects and Impacts*

GEMCO has two primary types of risk registers which document all significant risks identified at the operation, including environmental risks. These include:

- **GEMCO's site-wide material risk register:** This register is maintained online in Global360. Global360 captures material and non-material risks for the operation, identifies risk and control owners accountable to manage the risks, documents how risks are controlled and schedules routine activities to ensure controls remain effective; and

- **Operational risk registers:** These registers cover relevant departmental risks, project risks and site strategic risks not currently managed within Global360.

Environmental risks were also assessed as a component of the EIS (2015), which considered the full range of operational activities proposed for the Eastern Leases (as described in Section 4) in relation to individual aspects of the environment. Key environmental risk aspects that were identified for the Eastern Leases include:

- Groundwater;
- Surface water (including erosion and sediment controls);
- Ecology (including biodiversity issues relating to flora and fauna, GDEs and rehabilitation); and
- Social (including social issues relating to air quality, noise, visual amenity, socio-economics and cultural heritage).

GEMCO have also developed an internal environmental commitments register for the Eastern Leases, which includes all recommendations, obligations and actions required under the Eastern Leases regulatory approvals (refer Section 3). This register is regularly reviewed to confirm that all commitments are allocated to appropriate GEMCO personnel and that required controls are being implemented.

5.6.2 *Risk Assessment*

Risk assessment and management is a key part of GEMCO's business and will continue to be undertaken in line with South32's Material Risk Management Standard. Procedures and tools for the assessment, review and management of material environmental risks for the Eastern Leases are described in Section 5.6.2 of the FY21-FY24 MMP.

5.6.3 *Environmental Management Plans (EMP)*

Environmental management at GEMCO is guided by a range of EMPs. These include the following documents for key environmental risks, which have been developed by GEMCO to consider the Eastern Leases approvals requirements and commitments:

- PLN-6501 Water Management Plan (see Section 6);
- PLN-6505 Cultural Heritage Management Plan (see Section 5.6.3.1);
- PRO-6506 Blast Management Plan (see Section 5.6.3.2);
- PLN-6503 GDE Monitoring Plan (see Section 5.6.3.3);
- PLN-6503 Erosion and Sediment Control Standard (see Section 5.6.3.4);
- STA-3056 Threatened Species Management Plan (see Section 5.6.3.5);
- STA-3082 Cane Toad Management Plan (see Section 5.6.3.6);
- STA-3091 Weed Management Plan (see Section 5.6.3.7);
- STA-3085 Land and Biodiversity Management Plan (see Section 5.6.3.8);
- STA-27700 Rehabilitation Standard (see Section 5.6.3.9);
- STA-3080 Air Emissions Management Plan (see Section 5.6.3.10).
- STA-3316 Waste Management Plan (see Section 5.6.3.11); and

- PRO-9007 PAF Material Monitoring and Management Procedure (see Section 5.6.3.12).

A summary of these EMPs and the additional monitoring and management commitments for Eastern Leases is provided in the following sections. These documents are provided as Appendix 9.7.

5.6.3.1 *Cultural Heritage Management Plan*

Objectives and Targets

The CHMP sets out the procedures for the management of Cultural Heritage sites within and adjacent to the Eastern Leases and Haul Road Corridor. The key objectives of the CHMP are to:

- Address all statutory requirements;
- Mitigate potential direct and indirect impacts to Archaeological and Sacred Sites (refer to Section 3.3 for sites identified during Eastern Leases assessments); and
- Monitor the potential direct and indirect impacts on Archaeological and Sacred Sites.

Management and Mitigation Strategies

The majority of known Archaeological and Sacred Sites fall outside the Eastern Leases limits of mining and will not be directly impacted. The exception to this is the Manuport, which is located within the disturbance boundary of the Southern Eastern Leases (refer site ELS14 on Figure 3-2). GEMCO will liaise with the ALC and gain approval under the Heritage Act to relocate the Manuport to an area outside the Eastern Leases limits of mining prior to the site being impacted.

Other GEMCO management actions under the CHMP include:

- Maintaining a database of known Archaeological and Sacred Sites within and external to the mining leases (refer Section 3.3). The database will include the buffer zones to be maintained around the Sacred Sites, as agreed with the ALC in the Eastern Leases Mining Agreement;
- Maintaining restrictions on the access to Archaeological sites by GEMCO personnel and contractors. The GEMCO site induction will include information on the restrictions in place to limit access to Aboriginal land and Archaeological and Sacred Sites listed in the CHMP;
- Continuing to implement the GEMCO 'Permit to Clear' process (*GEM-PRO-4149*) for Eastern Leases. This process ensures that all land related criteria, including areas of cultural or environmental significance, are assessed prior to any new disturbance;
- Management of dust impacts through implementation of the Air Emissions Management Plan (refer Section 5.6.3.10) and annual monitoring of rock art sites to document any changes in the colour and condition of the art;
- Implementation of the Blast Management Plan that will include blasting limits to protect archaeological rock shelter sites and controls for potentially sensitive cultural heritage or archaeological sites (refer Section 5.6.3.2);
- Procedures for the management of previously unrecorded Archaeological finds; and
- Site inductions for all personnel who conduct work within the Eastern Leases.

Monitoring and Measurement

Monitoring commitments under the CHMP include:

- Monitoring of dust impacts at rock art sites in accordance with the SHIM Consulting (2016) *Handbook for the Assessment of Rock Art Condition with the Eastern Leases*. A re-assessment of the condition of Eastern Leases rock art sites will be completed prior to the commencement of mining (scheduled for mid-2023). Follow-up monitoring of all sites will then be conducted annually for the duration of Eastern Leases operations. The ALC will be consulted prior to any monitoring events and will be invited to participate in the monitoring process;

- Regular inspections by GEMCO when mining in proximity of Easter Leases Sacred Sites, to ensure that the required buffer zones for each site are being maintained (refer Figure 3-1); and

- Visual monitoring of specific rock art sites will be completed by GEMCO within five days of every blast event that occurs within 700 m of a site. The Eastern Leases Blast Management Plan and associated monitoring and management commitments are described in Section 5.6.3.2.

Changes to Monitoring Program

Not applicable. GEMCO will report on any changes to the CHMP monitoring program in future EMRs.

Effectiveness of Management and Mitigation Strategies

GEMCO will review the effectiveness of CHMP management and mitigation strategies on an annual basis, or following any investigation of monitoring results.

Non-Conformance and Corrective Action

In addition to the general incident response process summarised in **Section 7**, GEMCO will:

- Report any incidents where monitoring indicates Eastern Leases activities have impacted Aboriginal Archaeological or Sacred Sites, in accordance with Section 29 of the MM Act and per *GEM-PRO-3151 Event Management Procedure*; and

- Report any Eastern Leases incidents involving Aboriginal Archaeological or Sacred Sites to the ALC, as required under the Eastern Leases Mining Agreement.

Any proposed changes to CHMP monitoring and mitigation strategies will be discussed with the ALC prior to updating the document.

5.6.3.2 *Blast Management Plan*

Objectives and Targets

The Blast Management Plan sets out the procedures for the management of blasting within the Eastern Leases. The key objectives of the Blast Management Plan are to:

1. Meet all statutory requirements for all blast related activities and events for the life of the Eastern Leases;

2. Prevent nuisance noise and vibration impacts on sensitive receptors for the life of the Eastern Leases;

3. Preserve the well-being of the local community in relation to blasting impacts; and

4. Preserve the cultural value of significant heritage sites by preventing blasting-related impacts.

Management and Mitigation Strategies

GEMCO has committed to minimising potential impacts from blasting activities associated with its operations. Additional blast management measures required for Eastern Leases have been developed to minimise potential impacts to the surrounding community and Archaeological rock art sites, as a result of blast vibration, overpressure, fly rock, fume and dust.

The Blast Management Plan outlines specific management measures and procedures for the Eastern Leases, including:

- Blast Design Limits: each blast will be specifically designed to minimise impacts and meet relevant criteria at all receptors and rock art sites. The design process will target limits to conservatively allow for some uncertainty in blast effects, with criteria for rock art sites developed following a geotechnical review of all sites by Red Earth Engineering (2021); and

- Blast Design Process: the design process will follow a staged review until a satisfactory design is developed that meets the target limits at all receptors and rock art sites. Ground vibration and overpressure calculations will be based on the recommended method in AS2187.2-2006 (or later revision of this Standard) or on an alternative method that can be shown to provide results of similar or better accuracy.

Monitoring and Measurement

Eastern Leases blast events will be monitored to confirm blasting impacts remain within the criteria described in the Blast Management Plan. Monitoring of blast impacts will occur at the nearest potentially-impacted receptor or location representative of the closest heritage site(s) identified in the blast design process. For heritage sites, the location(s) with the greatest potential to be impacted may be at a greater distance from a blast event where a site has a significantly lower ground vibration criterion. With the potentially most affected location correctly identified for each blast event, meeting the criteria at that location ensures the criteria would be met at all other sensitive locations.

As noted previously, visual monitoring of specific rock art sites will be conducted by GEMCO within five days following every blast event within 700 m of a site.

Changes to Monitoring Program

Not applicable. GEMCO will report on any changes to the blast monitoring program for Eastern Leases in future EMRs.

Effectiveness of Management and Mitigation Strategies

GEMCO is committed to a program to review the effectiveness of the blast design process for the Eastern Leases. Comparisons will be made between predicted blast impacts and results from the blast monitoring program. These comparisons will be completed on a regular basis to review the accuracy of the blast design process and will consider all blast events and locations for which blast

monitoring data is available. These comparison reviews will occur:

- Quarterly for the first 12 months following the commencement of blasting within the Eastern Leases;
- Annually after the first 12 months from the commencement of blasting within the Eastern Leases; and
- Within 48 hours following any measured exceedance of relevant criteria at any blast monitoring location or if visible fume is noted at a receptor or rock art site.

Results from the comparisons and design reviews, including a description of any revisions to the Eastern Leases blast design process or monitoring arrangements, will be reported in future GEMCO EMRs.

Non-Conformance and Corrective Action

In addition to the general incident response process summarised in Section 7, GEMCO will investigate any potential exceedance of blast impact criteria or significant impacts to rock structures associated with known archaeological heritage sites and if required, report to the ALC and regulatory agencies as an incident.

5.6.3.3 *GDE Monitoring Plan*

Objectives and Targets

The key objectives of the GDE Monitoring Program (GDEMP) for the Eastern Leases are to:

- Confirm the presence of GDEs and potential GDEs located within the Eastern Leases, based on a review of the EIS and contemporary vegetation mapping (DENR, 2018);
- Develop a monitoring program to be implemented by GEMCO for the review of GDEs during Eastern Leases mining operations;
- Provide a procedure for the review and investigation of data gathered within the Eastern Leases to confirm any potential impacts to GDEs.

Management and Mitigation Strategies

The EIS identified nine vegetation communities within the Eastern Leases as potential GDEs. These vegetation community Map Units (MU) were adapted from units defined by Webb (1992) and are listed in Table 5-3. Portions of these MUs within Eastern Leases assessed as potential GDEs under the GDEMP are shown on Figure 5-1.

Table 5-3: Mapping Units with the potential to be GDEs

Vegetation Mapping Units defined in the EIS (Webb, 1992)
MU3 - Dry sub-coastal (inland) monsoon vine forest
MU10a - *Melaleuca viridiflora/ Corymbia polycarpa* open forest with *Pandanus spiralis* and mixed tussock grassland understorey
MU10b - *Melaleuca viridiflora* open-forest and mixed tussock grassland understorey
MU11 - *Melaleuca leucadendra/ Dillenia alata* open forest with fern/ sedge understorey
MU15a - *Melaleuca cajuputi* low closed-forest/ *L*eptocarpus sedgeland/ closed sedgeland (permanent swamps/ sedgelands)
MU16 - *Eucalyptus tetrodonta* low open forest / woodland with low tree or *Sorghum interjectum* tussock grassland understorey
MU20 - *Melaleuca viridiflora / Corymbia polycarpa / Grevillea pteridifolia* woodland with *Asteromyrtus symphyocarpa* and *Veticeria elongata* tussock grassland
MU24 - *Eucalyptus tetrodonta/ Corymbia polycarpa/ Melaleuca viridiflora* low open-woodland with *Asteromyrtus symphyocarpa* shrubland
MU31 - *Eucalyptus tectifica* open woodland with mixed shrub/ tussock grass understorey

Monitoring and Measurement

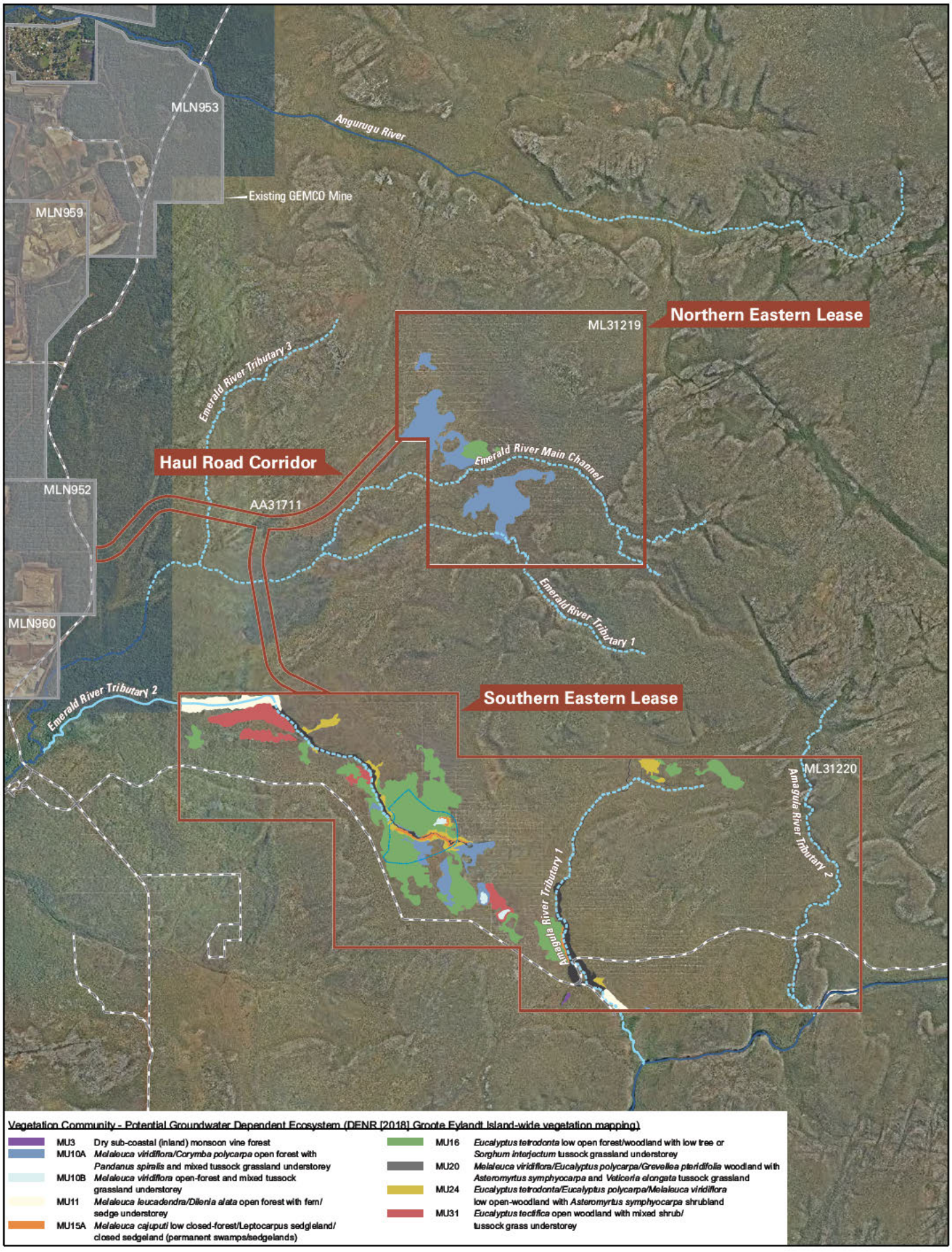
The GDEMP sites are shown on Figure 5-2 and summarised in Table 5-4. These include:

- Eight sites on the Amagula and Emerald Rivers located downstream of areas of predicted groundwater drawdown;
- Three sites located on the Emerald and Amagula River tributaries in areas where groundwater drawdown in predicted; and
- Five sites within wetland areas where groundwater drawdown is predicted.

Monitoring at each site will be completed:

- Prior to the commencement of mining (baseline);
- One year after mining commences;
- Every five years during mine operations;
- One year after closure; and
- A further four events following closure, each five years apart (i.e. up to 20 years after closure).

For each year in which monitoring takes place, monitoring should be completed in the late wet season (where access is available), or early in the dry season (May to June) and again in the late dry season (October to November).



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Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases
- Western Leases
- Public Roads and Access Tracks
- Upper Catchment Area

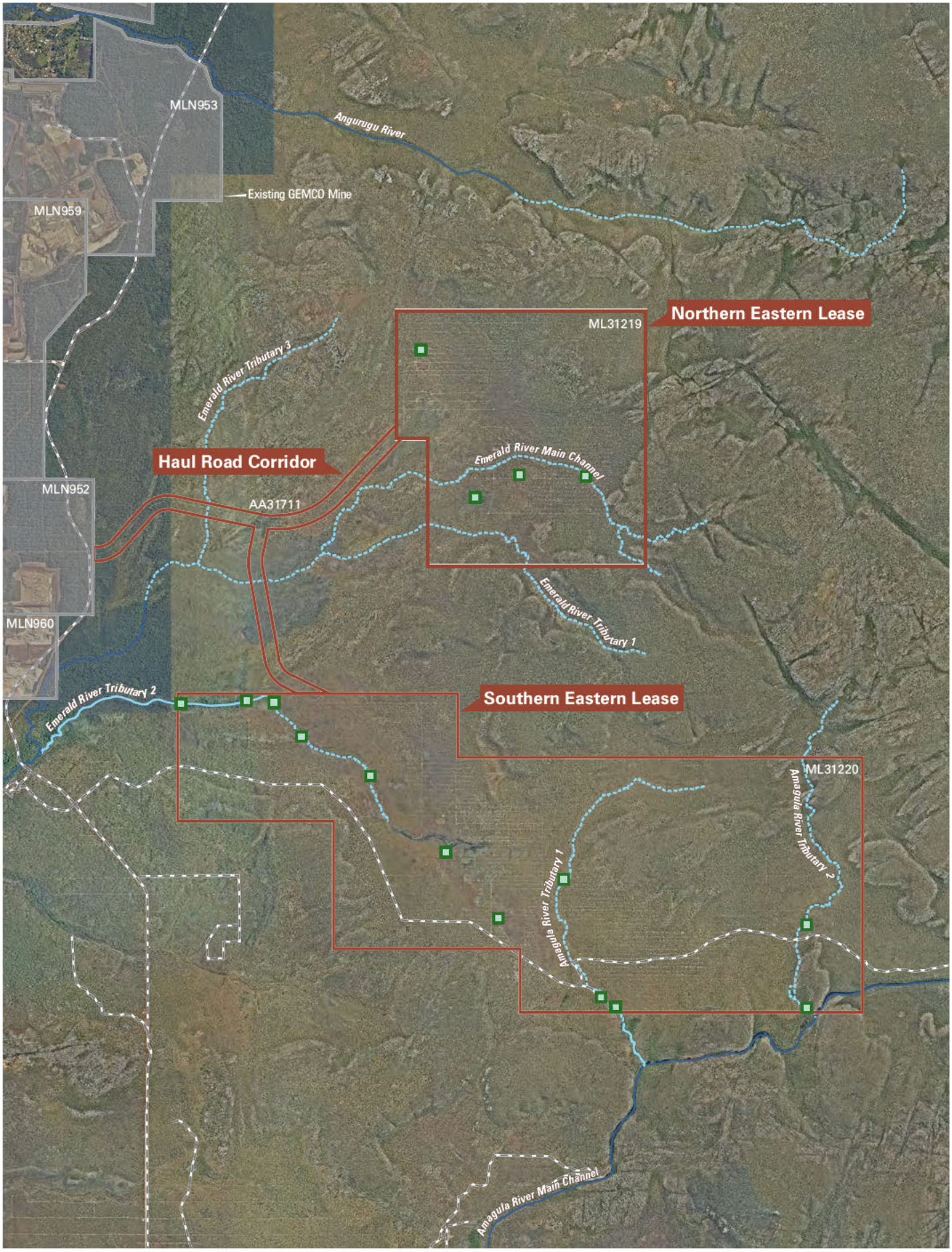
Watercourse

- Perennial Watercourse
- Perennial Watercourse (Location inferred)
- Perennial Watercourse (Minor)
- Ephemeral Watercourse

SOUTH32 GEMCO

Figure 5-1
Potential Groundwater Dependent Ecosystems

Date: August 2021	Author: JBA	Plan No: Potential GDEs (DENR)
Scale: See scale bar	Figure No: 5-1	



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0 2

Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases
- Western Leases
- Public Roads and Access Tracks

Watercourse

- Perennial Watercourse
- Perennial Watercourse (Location inferred)
- Perennial Watercourse (Minor)
- Ephemeral Watercourse

GDE Monitoring Site

SOUTH32 GEMCO

Figure 5-2
GDE Monitoring Sites

Date: May 2021	Author: JBA	Plan No: Proposed Monitoring Sites
Scale: See scale bar	Figure No: 5-2	

Information to be collected and analysed during each GDEMP monitoring event will include:

- General distribution of MUs identified as potential GDEs;
- Tropical Rapid Appraisal of Riparian Condition (TRARC) method data (Dixon et al. 2016), which includes an assessment of riparian condition (for riparian sites only) using 24 parameters. These parameters are used to calculate a Condition Rating and Pressure Index and will track the condition of potential GDE communities over time. The parameters include a review of vegetation structure, soils, dominant species, evidence of fauna activities, the presence of weeds and other disturbance;
- Floristic plots, which will include:
    - Flora species richness;
    - Height and percentage foliage cover of all stratum;
    - Basal area;
    - Composition of ground cover;
    - Other notes on vegetation condition, such as fire history, as required; and
    - Where surface water is present, aquatic flora species richness.
- Groundwater monitoring data for Eastern Leases (refer Section 6); and
- Reference photographs for each site.

Table 5-4: GDEMP Monitoring Sites

Site ID	GDE type	Site type	Existing site	Associated Watercourse (if relevant)	Monitoring type
GDE1	Permanent pool	Downstream	EIS aquatic	Amagula River Tributary 1	Flora plot, TRARC
GDE2	Perennial flow	Downstream	EIS aquatic	Amagula River Tributary 1	Flora plot, TRARC
GDE3	Above perennial flow	Impact	No	Amagula River Tributary 1	Flora plot, TRARC
GDE4	Wetland	Impact	No	Emerald River main channel	Flora plot
GDE5	Wetland	Impact	No	n/a	Flora plot
GDE6	Wetland	Impact	No	n/a	Flora plot
GDE7	Wetland	Impact	No	n/a	Flora plot
GDE8	Wetland	Impact	Cumberland Ecology (2019)	Emerald River Tributary 2	Flora plot, TRARC
GDE9	Perennial flow	Downstream	Cumberland Ecology	Emerald River Tributary 2	Flora plot, TRARC

Site ID	GDE type	Site type	Existing site	Associated Watercourse (if relevant)	Monitoring type
			(2019)/EIS aquatic		
GDE10	Perennial flow	Downstream	EIS aquatic	Emerald River Tributary 2	Flora plot, TRARC
GDE11	Above perennial flow	Downstream	Cumberland Ecology (2019)	Emerald River Tributary 2	Flora plot, TRARC
GDE12	Permanent pool	Downstream	Cumberland Ecology (2019)	Emerald River Tributary 2	Flora plot, TRARC
GDE13	Permanent pool	Downstream	EIS aquatic	Emerald River Tributary 2	Flora plot, TRARC
GDE 14	Wetland	Impact	No	n/a	Flora plot
GDE15	Permanent pool	Downstream	No	Emerald River Tributary 2	Flora plot, TRARC
GDE16	Above perennial flow	Impact	No	Emerald River Tributary 2	Flora plot, TRARC

Changes to Monitoring Program

Not applicable. GEMCO will report on any changes to the GDEMP in future EMRs.

Effectiveness of Management and Mitigation Strategies

Monitoring values that would indicate a possible impact of groundwater drawdown to GDEs that would trigger a GEMCO Trigger Action Response Plan (TARP) investigation are provided in Table 5-5. It is noted that these investigations would be undertaken to determine the cause of any potential impacts and appropriate management responses.

Non-Conformance and Corrective Action

Should a GDMEP TARP investigation of monitoring results identify any non-conformances or corrective actions, this will be recorded as an incident and responded to following the GEMCO procedures summarised in Section 7.

Table 5-5: GDE Monitoring Program Investigation TARP

Vegetation Mapping Units defined in the EIS (Webb, 1992)	
Vegetation mapping	Reduction in the distribution of a VMU that is a GDE or potential GDE (see Figure 5-1) of more than 1 ha between monitoring events.
Riparian Condition Rating	Significant reduction in riparian Condition Rating across multiple sites between monitoring events that is not explained by natural variations. A significant reduction would be a reduction in Condition Rating class such as from very good to good, or good to fair etc.

Vegetation Mapping Units defined in the EIS (Webb, 1992)	
Flora species richness	Significant reduction in species richness across multiple sites between monitoring events that is not explained by seasonal/rainfall patterns (as statistically determined by an ANOSIM and SIMPER tests).
Flora species composition	Significant changes in species composition (as statistically determined by ANOSIM and SIMPER tests) between monitoring events across multiple sites that is not explained by seasonal/rainfall patterns.
Canopy health	Significant loss of canopy cover due to dieback at multiple sites between monitoring events that is not explained by fire. A significant change would be one that changes the structural classification of the vegetation community (e.g., from rainforest to open forest or from woodland to open woodland etc.).

5.6.3.4 *Erosion & Sediment Control Standard*

Objectives and Targets

The objective of the Eastern Leases Erosion and Sediment Control (ESC) Standard is to provide strategies to manage soil erosion and sediment generation while minimising the potential for adverse impacts to downstream water quality. The ESC Standard also ensures that ESC measures are in place to adequately manage flood risks.

Specific design objectives for the management of ESC within the Eastern Leases are to:

- Maintain the beneficial uses of the Emerald River, Angurugu River and their receiving coastal waters;
- Include ESC controls for all Eastern Leases catchments to minimise the need for any release of sediment to downstream receiving waters; and
- Ensure that a risk-based approach is implemented by GEMCO during the Eastern Leases planning to ensure that ESC management structures are appropriately designed and sited.

Key targets for the ESC Standard are to:

- Integrate ESC measures into the planning phases of Eastern Leases construction and mining operations;
- Ensure catchments are managed by water type and that the movement of water within the site is appropriately managed;
- Minimise the duration and extent of topsoil/spoil exposure where possible;
- Stabilise disturbed areas where possible;

- Minimise the requirement for discharge of surface water from Eastern Leases and maximise the potential that any discharge water will achieve compliance with Eastern Leases water quality criteria (refer Section 6.3 and Section 6.4);

- Establish a monitoring program for ESC structures within the Eastern Leases; and

- Ensure that ESC measures are maintained in efficient working order at all times.

Management and Mitigation Strategies

The ESC Standard includes both proactive and reactive management and mitigation measures designed to minimise potential impacts of sediment on receiving waters. The primary management measure for ESC is the early planning and implementation of structures prior to and during ground disturbance within each catchment, and the timely rehabilitation of land, post-mining. Rehabilitation will be undertaken in accordance with GEMCO's Rehabilitation Standard and associated procedures (refer Section 5.6.3.3 of the FY21-FY24 MMP).

ESC measures will be considered during planning and established prior to disturbance to reduce the potential for sediment laden stormwater discharging to the receiving environment. ESC measures for catchments receiving quarry water (QW) from disturbed areas shall be designed and constructed by suitably qualified and experienced persons. The development of ESC management measures will also be documented in accordance with the GEMCO 'Permit to Clear' process (*GEM-PRO-4149*).

The following principles underpin the approach to ESC management for the Eastern Leases:

- Erosion control – prevention or minimisation of erosion caused by runoff on disturbed surfaces;

- Drainage control – a secondary erosion control, prevention or minimisation of erosion caused by concentrated flows. Appropriate management and separation of different water types through/around the area of concern; and

- Sediment control – trapping or retention of sediment generated from either overland flow or concentrated flow.

<u>Erosion Controls</u>

Erosion controls will include:

- Establishment of sediment basins as the primary control where Overburden Emplacement Areas (OEAs) are external to a quarry (and not draining back into a quarry) due to the rehabilitation timeframes required. External OEAs will be limited to the footprint of future mining areas (i.e. sediment basins will likely be temporary structures);

- Disturbed areas, excluding active quarry areas, will have a suitable ground cover established as soon as practicable (generally prior to the next wet season) to minimise wind and water erosion potential at the source. For example:

    - Areas available for permanent rehabilitation will be revegetated in accordance with the GEMCO Rehabilitation Standard (refer Section 5.6.3.9) and associated procedures;

    - Haul roads and hardstand areas will have a suitable road base to minimise erosion at the time of construction and will also include sediment traps;

- Externally draining embankment batters and haul road “roll-over” protection bunds will be reshaped and appropriate erosion controls applied at the time of construction; and

- Topsoil stockpiles will have appropriate erosion controls applied (vegetation cover preferred) as soon as possible after establishment.

Drainage Controls

Drainage is to be used to convey and separate diverted clean water, stormwater or QW. Drainage structures for the Eastern Leases will be classified as either permanent or operational (constructed on a temporary basis).

Permanent drainage refers to diversion channels that will be in place throughout the life of the Eastern Leases. These channels require a higher level of design to limit the potential maintenance liability for the period between when mining has ceased and final rehabilitation of GEMCO has been completed. Permanent drainage channels shall be designed by a suitably experience and qualified person and comply with the Water Act. For all permanent diversions, vegetation will be used as the primary method of stabilising channel bed and banks, benches and floodplain drainage paths.

Operational drainage controls shall be designed and constructed in accordance with the *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008) and the Eastern Leases Basis of Design document (whichever is more stringent). The NSW *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004 & NSWDECC, 2008) will also be used for further reference in the design and implementation of operational drainage controls.

Specific design standards are applied to operational drains that convey runoff to a sediment basin or QW dam, including:

- As a minimum, drains constructed in catchments with a disturbance duration risk rating of medium or higher (as per the ESC Standard) shall be topsoiled and seeded to minimise potential for channel erosion; and

- Drains constructed with a high slope (>1.8%) shall be lined with appropriate engineered armouring (liners, rock or similar), where possible.

Sediment Controls

The following sediment controls will be adopted at the Eastern Leases:

- Sediment control measures shall be designed and constructed in accordance with the *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008);

- Supplementary sediment control measures will be used as required to reduce the movement of sediment from the location that it was entrained and are considered an important component of best practice sediment control. Such measures may include excavated sediment traps, rock check dams or sediment fencing/bunds;

- Sediment basins will be designed to trap a proportion of entrained sediment. Designs implemented for sediment basis (including flow-through basins, wet basins and containment basins) will depend on operational function and risk rating assigned to each catchment area in accordance with the ESC Standard;

- The sediment storage volume will be de-silted on an annual basis (at a minimum); and

- All sediment basins shall be constructed with a spillway with appropriate drainage controls. An energy dissipator will be included downstream of the spillway where required. The spillway and downstream controls shall be designed and constructed in accordance with the *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008).

Monitoring and Measurement

Monitoring will be undertaken to confirm the success of the ESC and QW management structures and to identify any necessary remedial actions.

Monitoring will include routine inspections of structures identified on the ESC and QW inventory asset register for the Eastern Leases, with additional inspections triggered on a rain event basis. Details on the frequency of routine inspections and the triggers for event-based monitoring inspections are detailed in Table 5-6 and Table 5-7, respectively. These inspections will be undertaken in each catchment area within the Eastern Leases where ESC structures are in place, and will document:

- Water quality (field pH, EC and turbidity);

- Sediment storage volume;

- The condition of all ESC structures (i.e. record findings from the review of signs of erosion/scour, deterioration that requires maintenance);

- Occurrences of excessive sediment deposition (whether on lease or downstream of sediment basins) that require remedial action or maintenance; and

- Any failure of ESC structures, or where significant maintenance work is required.

To assist monitoring and maintenance, the sediment storage volume will be clearly marked on each permanent storage dam.

Maintenance responses that are identified during an inspection will be actioned in GEMCO's Global 360 system. Maintenance shall be undertaken prior to the next wet season, where feasible (i.e. start of November each calendar year).

Examples of deficiencies in ESC management measures that will trigger maintenance actions include, but are not limited to:

- Damage/scouring to ESC and QW structures;

- Sediment deposition in excess of the sediment storage volume;

- Damage/deterioration of access tracks or the ability to inspect/monitor, or maintain and/or operate area/infrastructure/equipment;

- Spill, contaminated or waste materials accumulated/deposited in ESC structures or their associated catchment areas; and

- Outlet controls of spillways and discharge points.

Changes to Monitoring Program

Not applicable. GEMCO will report on any changes to the ESC Standard in future EMRs.

Effectiveness of Management and Mitigation Strategies

GEMCO will review the effectiveness of the Eastern Leases ESC management and mitigation strategies on an annual basis or following any investigation of results from routine or event-based inspections.

Non-Conformance and Corrective Action

Should an ESC inspection or other investigation identify any significant non-conformances or corrective actions, this will be recorded as an incident and responded to following the GEMCO procedures summarised in Section 7.

Table 5-6: Routine ESC & QW Monitoring Frequency

Control Type	Monitoring Frequency
Erosion	Pre-wet season inspections (prior to start of November)
Drainage, Sediment and QW dams	Pre and post (prior to start of November and end of May) wet season inspections
Watercourse and drainage line crossings	Inspection frequency to be per the Haul Road Crossing Design Overview Report (Hansen Bailey, 2015b), i.e. bi-monthly during the wet season (November to end of May) and following rain events greater than 50% AEP.

Table 5-7: Event Based ESC and QW Monitoring Frequency

Catchment risk rating	Trigger for Inspection	
	Rainfall (mm)	Average Inspection Frequency
Low	70 mm over 5 days	6 times a year
Medium		
High		
Very High	105 mm over 24 hours	Once per year

5.6.3.5 *Threatened Species Management Plan*

A description of the TSMP is provided in Section 5.6.3.4 of the FY21-FY24 MMP. This document was revised by GEMCO in 2021 to consider the DEPWS (2019) *Groote Archipelago Threatened Species Management Plan 2019-2028* and threatened fauna species listed under NT and Commonwealth legislation (refer Section 3) that were identified in the EIS (2015) as present or have been identified as having the potential to occur within the Eastern Leases.

The management hierarchy developed by GEMCO was reviewed during the 2021 TSMP update to include Eastern Leases threatened species and is summarised below in Table 5-8. The TSMP management hierarchy will continue to be used by GEMCO to guide the implementation of

monitoring and management responses for threatened species identified on site.

Table 5-8: TSMP Management Hierarchy for Threatened Fauna Species on GEMCO Leases

5.6.3.6 *Cane Toad Management Plan*

The introduction of Cane Toads to Groote Eylandt as a result of GEMCO-related activities is a significant environmental risk for the business as the species is identified as a Key Threatening Process under the EPBC Act. To minimise these risks, GEMCO operates under a Cane Toad Management Plan and associated procedures, as described in Section 5.6.3.5 of the FY21-FY24 MMP.

The Cane Toad Management Plan is a "live" document and has been updated since the EIS (2015) was approved. GEMCO are currently developing an updated Cane Toad Management Plan to address the requirements of Condition 10(f) of EPBC 2014_7228 for Eastern Leases. This document is being prepared in consultation with the ALC, DEPWS and DAWE and will consolidate and update existing GEMCO procedures for:

- Identification of potential pathways for the introduction of Cane Toads to Groote Eylandt;
- Preventing Cane Toads being introduced to Groote Eylandt as a result of GEMCO related activities;
- Monitoring and detection of Cane Toads in the event they are introduced to Groote Eylandt; and

- Management responses should a Cane Toad introduction event take place.

Under the conditions of EPBC 2014_7228, the updated Cane Toad Management Plan must be implemented by GEMCO under the Commonwealth EMP prior to the commencement of construction for Eastern Leases.

5.6.3.7 *Weed Management Plan*

A description of the GEMCO Weed Management Plan is provided in Section 5.6.3.6 of the FY21-FY24 MMP. The Weed Management Plan has been updated in 2021 to reflect contemporary NT government advice on weed species and management measures required for Eastern Leases, including the requirements of Assessment Report 77 and Condition 10(e) of EPBC 2014_7228 for Eastern Leases. The Weed Management Plan will be implemented by GEMCO under the Commonwealth EMP prior to the commencement of construction for the Eastern Leases.

GEMCO will also complete a survey within the Eastern Leases to identify the presence of weed species that have become established since the Cumberland Ecology (2015) study for the EIS and develop a programme for the management of any outbreaks prior to construction occurring.

5.6.3.8 *Land and Biodiversity Management Plan*

A description of the GEMCO Land and Biodiversity Management Plan is provided in Section 5.6.3.2 of the FY21-FY24 MMP.

The plan includes a summary of the monitoring of invasive species by GEMCO. To address the EIS commitment regarding implementation of a mosquito monitoring program for Eastern Leases, the GEMCO Environment Team will continue to assist Northern Territory and Commonwealth regulatory agencies during their routine exotic mosquito surveillance visits to Groote Eylandt. This assistance will continue to be provided by GEMCO on request and may include:

- Notifying the community and GEMCO workforce of scheduled site visits via community and site wide engagement methods (refer Section 2.2 of the FY21-FY24 MMP); and

- Supporting sampling and co-ordinating mosquito collection activities by the Department of Medical Entomology (Top End Health Service) and DAWE at residential properties within the township of Alyangula and GEMCO lease areas, including Eastern Leases and the GEMCO port facility.

Other monitoring and management controls described in the GEMCO Land and Biodiversity Management Plan will not require any material changes for Eastern Leases activities during FY21-FY24.

5.6.3.9 *Rehabilitation Standard*

A description of the GEMCO Rehabilitation Standard is provided in Section 5.6.3.3 of the FY21-FY24 MMP. The management controls and development criteria described in the Rehabilitation Standard will be reviewed prior to the commencement of construction for Eastern Leases and updated, as required. No material changes to the existing GEMCO procedures for progressive rehabilitation of the site are anticipated for Eastern Leases activities scheduled during FY21-FY24.

To address rehabilitation commitments in the *Eastern Leases Project Supplement to the Draft EIS* (Hansen Bailey, 2016), GEMCO will complete the following programs during FY21-FY24:

- A trial within existing GEMCO rehabilitation areas to assess the value of using salvaged timber resources in promoting habitat values for fauna species (scheduled for FY23); and
- A trial to assess the use of controlled fires in GEMCO rehabilitation and the resilience of these areas to fire regimes (scheduled for FY22).

Where trial results identify positive outcomes for rehabilitation performance, GEMCO will revise the site Rehabilitation Standard to include additional monitoring and management requirements for controlled burning or the re-use of salvaged timber within Eastern Leases. The results of these rehabilitation trials will also be reported in the respective GEMCO EMRs.

5.6.3.10 *Air Emissions Management Plan*

A description of the Air Emissions Management Plan and controls to minimise emissions from GEMCO operations is provided in Section 5.6.3.7 of the FY21-FY24 MMP. In accordance with EIS commitments, the Air Emissions Management Plan has been reviewed for Eastern Leases and includes an additional High Volume Air Sampler (HVAS) site, to be installed at Yedikba Outstation (refer Figure 1-3) prior to the commencement of construction. This site will provide PM_{10} air emissions monitoring data representative of the community location closest to the Eastern Leases.

All other GEMCO monitoring and operational controls to minimise air quality impacts from the Eastern Leases will be implemented in accordance with the updated Air Emissions Management Plan.

5.6.3.11 *Waste Management Plan*

A description of the GEMCO Waste Management Plan is provided in Section 5.6.3.1 of the FY21-FY24 MMP. The management controls described in the Waste Management Plan will be implemented for Eastern Leases and will not require any material changes during FY21-FY24.

5.6.3.12 *PAF Materials Monitoring and Management Procedure*

As noted in Section 4.2, geochemical testing undertaken to support the EIS identified a small area of PAF material in the north-western portion of the Southern Eastern Leases. To address this potential risk and associated EIS commitment, GEMCO have developed a procedure that outlines the monitoring and management requirements for PAF material that may be encountered during mining within the Eastern Leases.

Monitoring to identify PAF material will be undertaken when mining clay overburden at depths below 15 m that are within 500 m of boreholes EL-S-MB05 and EL-S-MB06 identified in the EIS (refer Figure 5-3). Samples will be collected ahead of mining within these areas from the cuttings of selected drill holes in order to identify any PAF material. During mining operations, recently excavated and dumped material sourced from within 500 m of groundwater bores EL-S-MB05 and EL-S-MB06 will also be randomly sampled. Samples will be analysed using the Net Acid Generation. Test samples with a NAGpH of less than 4.5 will be considered PAF, while samples with a NAGpH of 4.5 or greater will be classified as NAF.

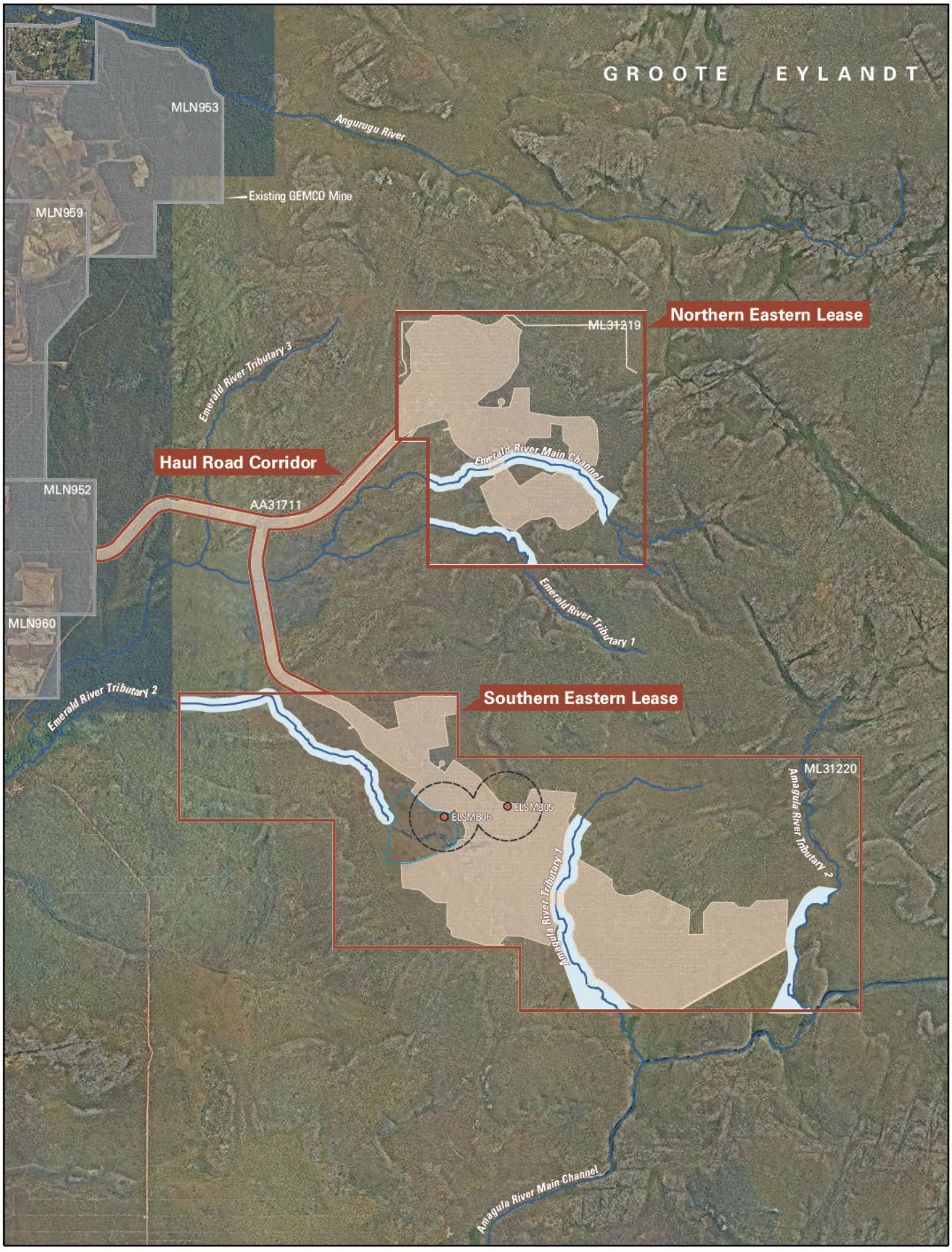
Any mining blocks identified as PAF will be selectively handled and emplaced with a cover of traffic-compacted, NAF overburden to limit the infiltration of air and water.

Surface run-off and groundwater seepage water downstream of Eastern Leases OEAs will be monitored on a quarterly basis during mining operations. Sample results outside of the relevant water quality trigger values in Eastern Leases Water Management Plan (refer Section 6) will be investigated to determine whether Acid Mine Drainage (AMD) is a contributing factor.

In the unlikely event that AMD is identified in surface runoff and groundwater seepage monitoring downgradient of OEA(s) where PAF material has been buried, GEMCO will investigate the source using additional overburden sampling and testing. Remediation options may include addition of agricultural limestone to identified PAF materials during placement and/or reducing the amount of time that any identified PAF material is exposed to weathering conditions prior to covering with NAF material.

5.7 Key Environmental Activities for the Oncoming Period

Eastern Leases activities scheduled during FY21-FY24 are described in Section 4, with key commitments for FY21-FY24 described in Section 5.3.1.



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Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases
- Western Leases
- Updated Project Disturbance Footprint (August 2021)
- Mine Planning Buffer
- Upper Catchment Area
- PAF Material Monitoring Area
- Watercourse
- EIS PAF Borehole

SOUTH32 GEMCO Eastern Leases MMP

Figure 5-3
PAF Material Monitoring Area

Date: August 2021	Author: JBA	Plan No: PAF Material Monitoring Area
Scale: See scale bar	Figure No: 5-3	

6 WATER MANAGEMENT PLAN

This section of the MMPA outlines the management of surface water and groundwater for GEMCO Eastern Leases.

6.1 Current Conditions

6.1.1 *Surface Water*

6.1.1.1 *Watercourses*

The Eastern Leases are located within the upper catchments of the Emerald, Amagula and Angurugu Rivers. The main perennial watercourses and their catchments are illustrated in Figure 6-1. The drainage lines within the Eastern Leases are predominantly ephemeral, although sections of perennial streams are present near the fringes of the Southern Eastern Lease.

The Emerald River drains towards the west and has three major tributaries (which are referred to as Tributary 1, Tributary 2 and Tributary 3). The Northern Eastern Lease is drained by the Emerald River, with the main channel and Tributary 1 passing through the lease.

Within the Eastern Leases, the main channel of the Emerald River is well defined, with the bedform and banks largely controlled by exposed rock. An alluvial fan develops where Emerald River – Tributary 1 enters the main channel downstream of the Northern Eastern Lease.

Emerald River – Tributary 2 enters the main channel approximately 4.7 km downstream of the Tributary 3 confluence. Tributary 2 drains the western extent of the Southern Eastern Lease, with the headwaters of Tributary 2 being located within the lease. The flow within Tributary 2 develops into a network of perennial pools near the western boundary of the Southern Eastern Lease.

Emerald River – Tributary 3 enters the main channel approximately 1.1 km downstream of the Tributary 1 confluence. Tributary 3 intersects the Eastern Leases Haul Road Corridor only.

The Emerald River becomes a 4th order stream at the confluence with Tributary 2. Upstream of this confluence, including within the Northern Eastern Lease, the Emerald River is a 2nd or 3rd order stream.

The Emerald River enters the Gulf of Carpentaria approximately 12.6 km downstream of the Northern Eastern Lease and 7 km downstream of the Southern Eastern Lease. The Amagula River and its two major tributaries (referred to as Tributary 1 and Tributary 2) drain the eastern portion of the Southern Eastern Lease. The main channel enters the Southern Eastern Lease from the east and exits towards the south. The main channel intersects the south-eastern corner of the Southern Eastern Lease for a short distance (approximately 0.8 km). The main channel is generally 40-50 m wide and located within a narrow floodplain (approximately 400 m wide). The main channel of the Amagula River has a perennial flow regime.

Amagula River – Tributary 1 flows north-south through the Southern Eastern Lease and enters the main channel approximately 900 m south of the lease boundary. Tributary 1 exhibits perennial flow near the confluence with the Amagula River main channel. Amagula River – Tributary 2 is an ephemeral stream that flows north-south through the Southern Eastern Lease. Tributary 2 enters the Amagula River main channel near the southern boundary of the Southern Eastern Lease.

Within the Southern Eastern Leases, the Amagula River is a 4th order stream. The Amagula River enters the Gulf of Carpentaria approximately 22 km downstream of the Southern Eastern Lease.

The Emerald and Amagula Rivers are considered to be environmentally and culturally sensitive features. To minimise potential impacts, buffers have been defined around the main channels of these watercourses (refer to Figure 1-4). The extent of the buffers is equivalent to the 1 in 100 year average recurrence interval (ARI) flood extents of these watercourses (as determined using a hydraulic model). All quarries will be sited outside of these buffers.

The Angurugu River is located 2 km to the north of the Northern Eastern Lease and flows westwards to the coast. A portion of the Northern Eastern Lease (approximately 181 ha) is located within the Angurugu River catchment. Runoff within this part of the catchment will continue to drain to the Angurugu River via minor drainage lines and overland sheet flow.

The Ajubukwajumanja recreation area (including Leske Pools) is located on the main channel of the Amagula River, approximately 2.4 km south of the Southern Eastern Lease (refer to Figure 1-3). This swimming hole is popular for day trips, overnight camping or camping over extended periods.

6.1.1.2 *Surface Water Quality*

The central region of Groote Eylandt is characterised by elevated rocky outcrops that form hills and escarpments. Vegetation and soil cover is limited within these rocky areas. The regional surface geology is naturally enriched in metals and depleted in minerals, and exhibits low soil erosion rates. This results in naturally low sediment loads and elevated metals in watercourses (Hansen Bailey, 2015b).

The baseline water quality of the Amagula and Emerald Rivers is similar, due to their similar geology and catchment conditions. The water within these streams is typically acidic and non-saline, with low turbidity and suspended sediment. These streams may experience naturally elevated concentrations of metals including aluminium, copper, manganese and zinc.

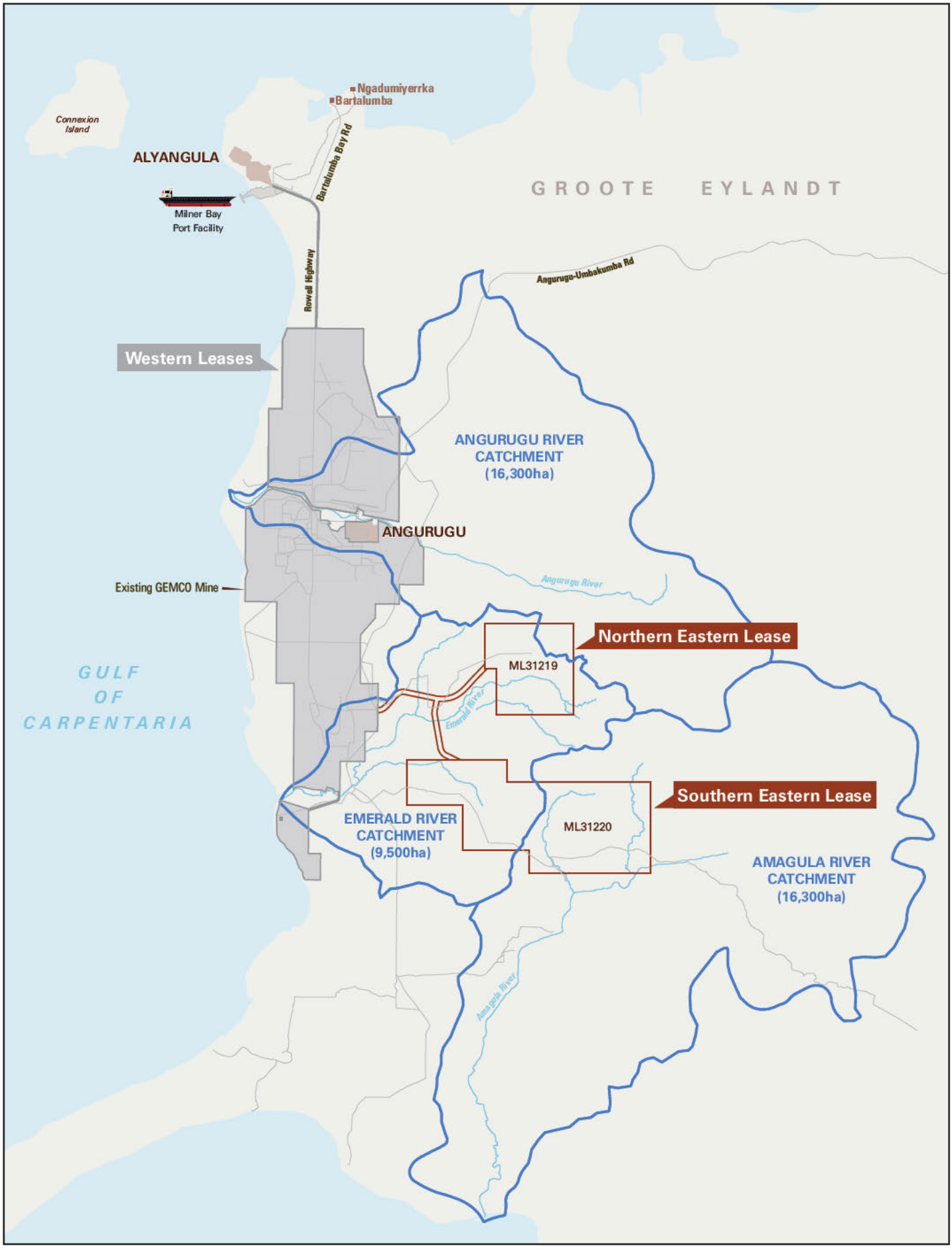
Baseline surface water quality monitoring for Eastern Leases was undertaken from January 2014 until December 2019. Monitoring was undertaken at eight locations within the Emerald River and Amagula River catchments (refer to Figure 6-2). The baseline water quality data for the Emerald and Amagula Rivers is summarised in Appendix 9.5.

RGS (2015) conducted a geochemical assessment of the overburden materials present within the Eastern Leases. Runoff from OEAs is generally expected to be non-saline and low in metals and metalloids (except for naturally elevated manganese levels). Therefore, runoff from OEAs is not expected to affect downstream water quality.

Runoff from OEAs and infrastructure areas may exhibit elevated sediment levels. Runoff from disturbed areas is managed in accordance with GEMCO PLN-6504 Eastern Leases Erosion and Sediment Control Standard (refer to Section 5.6.3.4). Given the benign geochemistry of runoff, passive release of water from sediment dams (i.e. following treatment) is not expected to adversely affect downstream water quality.

Discharge limits have been adopted to ensure that the water quality of the receiving watercourses does not exceed background variability. These discharge limits are presented in Table 6-8.

Only small volumes of hydrocarbons will be stored within the Eastern Leases. Appropriate spill management measures will be implemented to prevent any hydrocarbon spills (if they occur) from entering the receiving environment.



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Kilometres

Coordinate System: MGA Zone 53

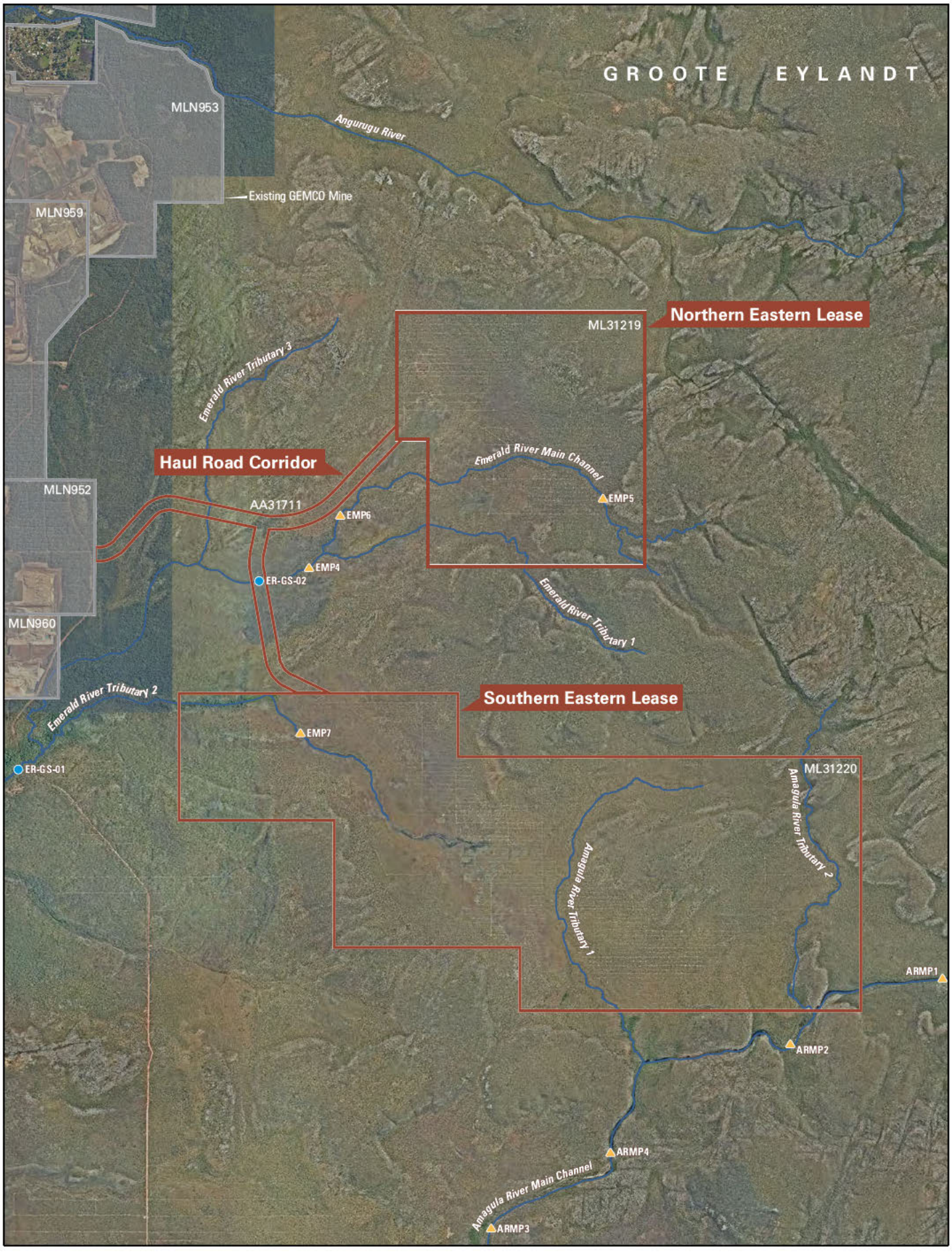
Legend

- Eastern Leases
- Western Leases
- Township
- Catchment Boundary
- Roads and Public Access Tracks
- Watercourse

SOUTH32 GEMCO Eastern Leases WMP

Figure 6-1
Catchments and Streams

Date: May 2021	Author: JBA	Plan No: Catchments and Streams
Scale: See scale bar	Figure No: 6-1	



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Kilometres

Coordinate System: MGA Zone 53

Legend

- Eastern Leases
- Western Leases
- Watercourse
- Gauging Station
- Surface Water Quality Monitoring Site

SOUTH32 GEMCO Eastern Leases WMP

Figure 6-2
Surface Water Monitoring Locations

Date: May 2021	Author: JBA	Plan No: Surface Water Monitoring Locations
Scale: See scale bar	Figure No: 6-2	

6.1.1.3 *Water Balance*

A water balance model (GoldSim) was used to determine the following:

- Quantities of quarry water that will be generated;
- Requirement for external water supplies; and
- Whether controlled discharges are needed during wet periods.

The water balance model uses historical climate records (132 years of data) to simulate the site water balance during the mining period. The water balance assessment was undertaken assuming there will be no water transfers between the northern and southern operations at the Eastern Leases.

The water balance was simulated for the seven financial years of mining operations. The modelled water balance under median conditions (50th percentile rainfall), wettest conditions (>99th percentile conditions) and driest conditions (<1st percentile conditions) is presented in Table 6-1, Table 6-2 and Table 6-3, respectively. It should be noted that quarrying operations occur for only part of the year during project year (financial year) 1 and project year (financial year) 7.

Given the planned quarry water storage volume at the Eastern Leases (consisting of the EL Northern Storage (ELNS), EL Southern Storage (ELSS) and the EL5C quarry void), discharges will not be required under normal operating conditions. The water balance model predicted the total maximum quarry water inventory (i.e. under the wettest climate simulation assessed) would be 1,848 ML, including 419 ML in the Northern Eastern Lease and 1,429 ML in the Southern Eastern Lease.

As indicated in Table 6-4, the quarry water dams and contingency void storage have sufficient capacity to contain all historically recorded storm events. The maximum operating volume for each storage has been set to retain a freeboard between the maximum operating volume and the spillway of at least the 1% AEP 120-hour storm volume (622 mm). As such, emergency discharges from the quarry water storages are not expected unless an unprecedented wet period occurs.

6.1.1.4 *Reduction in Catchment Area*

During mining, the proposed drainage arrangement will result in containment of up to approximately 76 ha of the Emerald River catchment (Eastern Leases project year 4) and 33 ha of the Amagula River catchment (Eastern Leases project year 6). This will result in minor decreases (0.97% and 0.29%) in the respective watercourse catchments at the historic gauging locations and any resultant change in watercourse flow or level would be imperceptible downstream of the Eastern Leases.

6.1.1.5 *Flooding*

The mine planning buffers adopted for the Eastern Leases (refer to Figure 1-4) serve the dual purpose of both protecting watercourses from direct mining impacts and protecting quarries from flooding. A 2-dimensional hydraulic model (TUFLOW) was used by WRM (2015) to confirm the effectiveness of the watercourse buffers. In summary, the model demonstrated that:

- Flows in the Emerald River (main channel) will remain unimpeded for all events up to a 1 in 100 year storm event;
- No quarries will be inundated by flooding of the Emerald River (main channel) for all events up to a 1 in 100 year storm event;

- Flows in Emerald River – Tributary 1 will largely remain unimpeded, although a small portion of one quarry in the Northern Eastern Lease may intercept floodwaters in a 1 in 100 year storm event;
- Flows in the Amagula River and its tributaries will remain unimpeded for all events up to a 1 in 100 year storm event; and
- No quarries will be inundated by flooding of the Amagula River and its tributaries for all events up to a 1 in 100 year storm event.

Table 6-1: Median Annual Water Balance

SOURCE	MEDIAN ANNUAL WATER BALANCE (ML/ANNUM)			
	PROJECT YEAR 1[3,5,6]	PROJECT YEAR 3[4,5]	PROJECT YEAR 5[4,5]	PROJECT YEAR 7[4,5,6]
Water Supplies				
Quarry Dewatering[1]	178	577	902	19
Quarry Water Storage	136	174	0[7]	797
External Water Supply	195	95	4	30
Water Demands				
Dust Suppression[2]	509	846	849	846
Controlled Release	0	0	0	0

1 Reported as total volume during the year
2 Assuming 1.5 ML/d demand for project year 1 and 2 and 2.5 ML/d thereafter (demand reduced on rain days)
3 In Project Year 1, only the Southern EL is operational
4 In Project Years 3, 5 and 7, both the Northern EL and Southern EL are operational
5 Project year 1 corresponds to 2024 financial year and project year 2-7 are the subsequent financial years
6 Quarrying operations occur for only part of project year 1 (9 months) and project year 7 (3 months)
7 Actual quarry water storage is -57 ML/annum (i.e. net gain in stored water inventory)

Table 6-2: Driest Scenario Annual Water Balance

SOURCE	DRIEST ANNUAL WATER BALANCE (ML/ANNUM)			
	PROJECT YEAR 1[3,5,6]	PROJECT YEAR 3[4,5]	PROJECT YEAR 5[4,5]	PROJECT YEAR 7[4,5,6]
Water Supplies				
Quarry Dewatering[1]	114	444	741	19
Quarry Water Storage	151	280	133	798
External Water Supply	274	171	24	78
Water Demands				
Dust Suppression[2]	539	895	898	895
Controlled Release	0	0	0	0

1 Reported as total volume during year
2 Assuming 1.5 ML/d demand for project year 1 and 2 and 2.5 ML/d thereafter (demand reduced on rain days)
3 In Project Year 1, only the Southern EL is operational
4 In Project Years 3, 5 and 7, both the Northern EL and Southern EL are operational
5 Project year 1 corresponds to 2024 financial year and project year 2-7 are the subsequent financial years
6 Quarrying operations occur for only part of project year 1 (9 months) and project year 7 (3 months)

Table 6-3: Wettest Scenario Annual Water Balance

SOURCE	WETTEST ANNUAL WATER BALANCE (ML/ANNUM)			
	PROJECT YEAR 1[3,5,6]	PROJECT YEAR 3[4,5]	PROJECT YEAR 5[4,5]	PROJECT YEAR 7[4,5,6]
Water Supplies				
Quarry Dewatering[1]	292	835	1,219	19
Quarry Water Storage	22	0[7]	0[8]	760
External Water Supply	186	135	23	52
Water Demands				
Dust Suppression[2]	500	831	834	831
Controlled Release	0	0	0	0

1 Reported as total volume during the year
2 Assuming 1.5 ML/d demand for project year 1 and 2 and 2.5 ML/d thereafter (demand reduced on rain days)
3 In Project Year 1, only the Southern EL is operational
4 In Project Years 3, 5 and 7, both the Northern EL and Southern EL are operational
5 Project year 1 corresponds to 2024 financial year and project year 2-7 are the subsequent financial years
6 Quarrying operations occur for only part of project year 1 (9 months) and project year 7 (3 months)
7 Actual quarry water storage is -139 ML/annum (i.e. net gain in stored water inventory)
8 Actual quarry water storage is -408 ML/annum (i.e. net gain in stored water inventory)

Table 6-4: Quarry Water Dam Storage Capacities

STORAGE DAM	MAXIMUM OPERATING CAPACITY[1] (ML)	FULL STORAGE VOLUME[2] (ML)	FREEBOARD (TO SPILLWAY) (M)
Northern Eastern Lease			
Quarry Water Dam (ELNS)	446	512	0.7
Southern Eastern Lease			
Quarry Water Dam (ELSS)	647	740	0.66
Contingency Storage (EL5C Void)	665	752	0.63

1 Maximum operating capacity set at least 0.62 m below the spillway level to provide capacity for the 1% AEP 120 hour storm
2 Volume to dam spillway / void overflow level

6.1.1.6 *Watercourse Crossings*

The approved project includes haul road crossings over the following watercourses (as shown in Figure 1-4):

- Emerald River main channel, at one location within the Northern Eastern Lease and one location within the haul road corridor;
- Emerald River – Tributary 3, at one location within the Haul Road Corridor; and
- Amagula River – Tributary 1, at one location within the Southern Eastern Lease.

All haul road crossings are located within the ephemeral reaches of these watercourses.

Haul road crossings will be installed with low flow drainage culverts designed to convey up to the 1 in 2 year ARI flood flow. Floods larger than the design event will flow over the culvert. Accordingly, there will be no retention of water within these watercourses due the construction of Eastern Leases haul road crossings.

Haul road crossing locations will be inspected prior to commissioning to ensure that external bank slopes are stable and have been revegetated.

Watercourse crossings will be constructed progressively as the mining operations expand. These crossings will be retained for the life of the mine and removed after completion of mining (subject to consultation with the ALC and Traditional Owners).

6.1.2 *Groundwater*

6.1.2.1 *Aquifers*

The stratigraphic sequence at the site consists of geological units ranging in age from Quaternary to Proterozoic. The Proterozoic basement is a strongly jointed quartzite. The rugged and sparsely vegetated hills and escarpments at Groote Eylandt are formed by outcropping of the quartzite. Outside of these outcrops, the Proterozoic basement is overlain by a sequence of later sedimentary deposits. Table 6-5 identifies the water bearing units present within the Eastern Leases.

The primary groundwater bearing units are the shallow laterite and the deeper marine sandstone and reworked basement. The lithology of the reworked basement is quartz sandstone derived from weathering of the underlying quartzite. The two deeper sandstone units act as a single aquifer and are collectively referred to as the Cretaceous sandstone. The shallow laterite and the deeper Cretaceous sandstone are separated by claystone units, which are aquitards.

Baseline water level monitoring indicates that groundwater head is greater in the shallow laterite than the deeper sandstone. This indicates that the hydraulic gradient is downwards (AGE, 2015). However, downward seepage is constrained by the low hydraulic conductivity of the claystone units. As a result, the groundwater regime consists of an unconfined shallow water table in the laterite and a deeper confined aquifer.

Water levels in the shallow laterite aquifer exhibit a strong correlation with rainfall, which indicates that this aquifer is rapidly recharged. Groundwater flow is strongly influenced by local geomorphology. Within the Emerald River and Amagula River catchments, the direction of flow is towards the main channels (AGE, 2015). As such, the shallow aquifer provides baseflow to the Emerald and Amagula rivers. The hydraulic conductivity of the laterite can be highly variable. Cemented materials have low conductivity, whereas minor granular layers exhibit higher hydraulic conductivity.

The Cretaceous sandstone exhibits good hydraulic conductivity and is therefore a productive aquifer (where saturated) (AGE, 2015). Groundwater flow in the deeper aquifers is less influenced by topography. Measured water levels in the deeper bores indicate that the flow direction in the deeper aquifers is towards the west coast of Groote Eylandt.

The Quaternary sediments are highly permeable but are generally less than 3 m thick. This unit is generally unsaturated, although a shallow water table may form at the base of this unit during the wet season. This is a not a productive aquifer due to short residence time for water in this unit (AGE, 2015).

Baseline groundwater level data was collected from June 2014 until October 2019. Measured water levels at the 10 groundwater monitoring locations within the Eastern Leases (refer to Figure 6-3) are presented in Appendix 9.6.

Table 6-5: **Groundwater Regime**

Age	Unit	Water Bearing Status
Quaternary	Quaternary sediments	Ephemeral groundwater present
Tertiary	Laterite	Unconfined aquifer
	Lateritic claystone	Aquitard (confining unit)
Cretaceous	Marine claystone	Aquitard (confining unit)
	Marine sandstone	Confined aquifer
	Reworked basement	Confined aquifer
Proterozoic	Proterozoic basement	Aquitard

6.1.2.2 *Groundwater Quality*

Groundwater within the Cretaceous sandstone exhibits low salinity, low concentrations of dissolved minerals and moderately acidic to neutral pH (5.1 to 6.9). Although this groundwater is classified as fresh water, it does not meet the *Australian Drinking Water Guidelines* (NHMRC and NRMMC, 2011) due to its acidity and concentrations of metals (AGE, 2015).

Groundwater within the shallow laterite is fresh and slightly to moderately acidic (pH 4.8 to 6.5). This groundwater generally meets drinking water standards, although there may be isolated exceedances of metals and metalloids. Consistent with the other aquifers, the laterite exhibits low concentrations of dissolved minerals (AGE, 2015).

There are no intensive agricultural activities in the vicinity of the Eastern Leases. As such, water quality standards for agriculture are not relevant to the project.

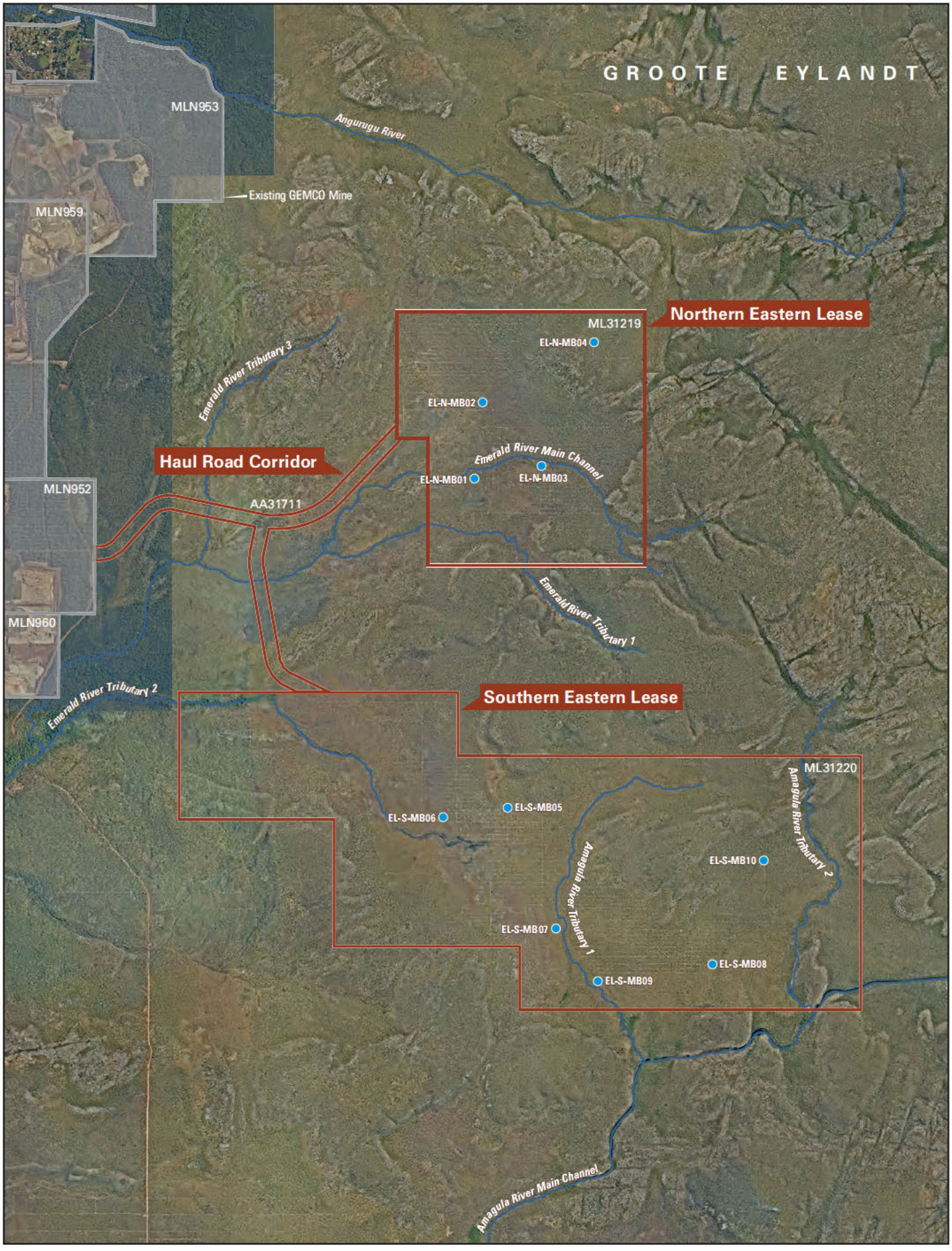
Baseline groundwater quality data was collected from January 2014 until February 2020. The results of baseline groundwater quality monitoring are presented in Appendix 9.5.

During mining, leachate generated from OEAs will migrate via the aquifer towards the quarries (which act as groundwater sinks) and be managed along with other groundwater inflows. The quarries will continue to act as groundwater sinks for a period after mining. Overburden leachate will not migrate into the surrounding environment until groundwater levels within the backfilled quarries have recovered to pre-mining levels.

Geochemical testing by RGS (2015) has determined that leachate generated by the overburden materials will exhibit the following properties:

- Low salinity;
- Low acidity; and
- Low concentrations of minerals and metals (other than elevated concentrations of manganese).

Except for the limited PAF overburden material identified in the EIS as requiring additional monitoring (refer to Section 5.6.3.12), the water quality of the overburden leachate is expected to be similar to the existing groundwater quality (RGS, 2015). Accordingly, migration of overburden leachate into the surrounding environment (upon full recovery of groundwater levels) is not expected to have a detrimental impact on groundwater quality.



Legend

- Eastern Leases
- Western Leases
- Watercourse
- Groundwater Monitoring Location

N

0 2

Kilometres

Coordinate System: MGA Zone 53

SOUTH32 GEMCO Eastern Leases WMP

Figure 6-3
Groundwater Monitoring Locations

Date: May 2021	Author: JBA	Plan No: Groundwater Monitoring Locations
Scale: See scale bar	Figure No: 6-3	

6.1.2.3 *Water Users*

Two private water supply bores are located within 5 km downstream of the Eastern Leases:

- One bore at Yedikba Outstation, approximately 2.2 km west of the Southern Eastern Lease; and
- One bore at Wurrumenbumanja Outstation, approximately 3.5 km south of the Southern Eastern Lease.

Both bores draw water from the Cretaceous sandstone aquifer, however only the Yedikba Outstation bore is currently used as a water source. Drinking water at Wurrumenbumanja Outstation (refer Figure 1-3) is sourced from the adjacent watercourses.

6.1.2.4 *Groundwater Inflows*

Potential impacts to groundwater systems were assessed by Australasian Groundwater and Environmental Consultants (AGE) using a numerical groundwater model (MODFLOW SURFACT). The groundwater model predicts the following volumes of inflows to the quarries:

- Maximum of 217 ML/year into the quarries in the Northern Eastern Lease quarries in FY 2026-27; and
- Maximum of 575 ML/year into the quarries in the Southern Eastern Lease quarries in FY 2027-28.

The maximum annual inflows for the Northern Eastern Lease and Southern Eastern Lease do not occur in the same year. The maximum annual inflow for the two leases is predicted to be 788 ML/year in FY 2026-27.

Groundwater inflows are sourced predominantly from the laterite aquifer, with smaller contributions from the Quaternary sediments, manganese orebody and laterite clays.

6.1.2.5 *Groundwater Depressurisation*

Open cut mining will result in a zone of depressurisation around the quarries. The zone of depressurisation is defined as the area where the potentiometric surface is lowered by more than 1 m. The zone of depressurisation will be greatest at the end of mining.

The maximum depressurisation occurs in the Southern Eastern Lease due to these quarries being the deepest. The groundwater model predicts that the laterite aquifer will experience up to 19 m of depressurisation. The zone of depressurisation is predicted to be limited to within 1 km of quarries.

The marine claystone underlies the manganese ore body and therefore forms the base of the quarries. Due to the low hydraulic conductivity of the claystone, depressurisation of the deeper Cretaceous sandstone is predicted to be negligible.

After completion of mining, the backfilled quarries will gradually fill with water, thereby reducing the hydraulic gradients towards the quarries. The groundwater model predicts that pressures within the laterite aquifer will recover by 80% within 5 years and recovery to within 1m of the pre-mining water level within 100 years after completion of mining.

The zones of depressurisation that will be generated by the Eastern Leases will not intersect the zones of depressurisation created by the existing GEMCO mining operations within the Western Leases. As such, there will be no cumulative impacts between the Eastern Leases and the Western Leases.

The two private water supply bores located downstream of the Eastern Leases are both outside of the predicted zone of depressurisation. As such, the potential yields of these bores will not be affected by mining.

6.1.2.6 *Impacts on Stream Flow*

Sections of the Emerald, Amagula and Angurugu Rivers receive baseflow from the laterite and Cretaceous sandstone aquifers. Mining induced drawdown may impact upon stream flow via the following mechanisms:

- Decrease in baseflow due to depressurisation of the underlying aquifers; and
- Increase in seepage from the stream to the groundwater system.

The maximum stream flow losses predicted by the groundwater model are presented in Table 6-6. These effects on stream flow will gradually decrease as groundwater pressures recover post-mining.

Table 6-6: Impacts of Groundwater Depressurisation on Stream Flow

Stream	Predicted Reduction in Baseflow (ML/year)	Predicted seepage to groundwater (ML/year)
Emerald River	34.5	< 1
Amagula River	11.0	8.1
Angurugu River	9.9	< 1

6.2 Information/Knowledge Gaps

6.2.1 *Identification of Information/Knowledge Gaps*

Baseline surface water quality monitoring was conducted from January 2014 to December 2019. Similarly, baseline groundwater quality was monitored from January 2014 to February 2020. Data collected during this period was used to define background variability and formulate triggers for further management measures.

Baseline monitoring undertaken at the Eastern Leases has generally provided good sample sizes for most water quality parameters. The sample size for EC at surface water monitoring sites is relatively small; however, the available data indicates that background EC levels are well within the typical ranges for freshwater.

Where there is limited baseline data for a particular monitoring site or parameter, limits and/or trigger values have been sourced from the relevant water quality guidelines (refer to Table 6-8 and Table 6-13).

6.2.2 *Filling Information/Knowledge Gaps*

There are no information gaps in this Water Management Plan.

6.2.3 *Water Accounting*

Given that construction and mining operations have not commenced, GEMCO currently does not undertake any water accounting within the Eastern Leases. . GEMCO's existing water balance will be expanded to cover the Eastern Leases to fulfil corporate reporting obligations and reporting to DITT through annual EMRs and MMPs. Water accounting will be undertaken in line with the Minerals Council of Australia (2014) *User Guide, Water Accounting Framework for the Minerals Industry*.

6.3 Risk Management

6.3.1 *Identify Hazards and Rank Risks*

GEMCO's risk assessment framework is outlined in Section 5.6.1 and Section 5.6.2.

GEMCO Environment Department personnel are included in project and operational risk reviews (where relevant) to ensure all environmental risks related to water are considered. A summary of GEMCO's key risks related to water have been provided in Table 6-7. These risks are described within the Operational Risk Register of the respective Department.

This risk assessment will be reviewed annually to determine if the adopted controls have been effective at minimising the identified risks.

Table 6-7: GEMCO's Key Risks Related to Water

Risk			Controls	
Risk Event	**Department**	**Direct Causes**	**Preventative**	**Mitigating**
Controlled discharge of mine water	Environment	Extreme rainfall event	Mine water management strategy implemented to ensure with sufficient capacity to contain rainfall events	Discharge water quality limits
Impacts to water quality of receiving watercourses	Environment	Runoff from disturbed areas (OEAs and infrastructure areas)	Defined watercourse buffers Clean water diversion bunds	Erosion and Sediment Control Plan Progressive rehabilitation
Reduction in catchment yield	Environment	Rainfall runoff intercepted by quarries	Creation of a free-draining final landform (post-mining)	Diversion of clean runoff around quarries as much as practicable (during mining)
Inundation of quarries during flood events	Environment	Extreme rainfall event	Buffers around the key watercourses in the Eastern Leases	N/A
Impediment of stream flow	Environment	Haul road crossings of watercourses	N/A	Culverts designed to convey up to 1 in 2 year ARI flood event
Groundwater depressurisation and reduction in baseflow	Environment	Mining operations	N/A	Groundwater monitoring program
Water contamination	Environment	Spills of hydrocarbons or other hazardous materials	Hazardous material handling protocols	Spill kits and response training

6.3.2 *Actions and Strategies in Response to Identified Risks*

Prevention and mitigation measures for the key risks to water resources are summarised in Table 6-7.

6.3.2.1 *Surface Water Management Strategy*

The key principles of the surface water management strategy for Eastern Leases are:

- Where possible, divert clean runoff around areas disturbed by mining activities;
- Control sediment-affected water in accordance with PLN-6504 Eastern Leases Erosion and Sediment Control Plan, which will involve capturing and treating sediment-affected water in appropriate sediment control structures; and
- Contain quarry water in on-site water storages and reuse of quarry water to meet operational demands (mine water supply).

Diversion drains will be established to direct clean water (i.e. runoff from undisturbed areas) away from quarries and other disturbed areas. Exact sizes of drains will depend on the area of the contributing catchment and will be determined during detailed design and implemented in accordance with the principles described in *GEM-PLN-6504 Eastern Leases Erosion and Sediment Control Plan*.

Quarry water is obtained through groundwater inflows to the quarries and runoff from the surrounding catchment. Quarry water will be captured in sumps constructed in the floors of quarries. The collected water is pumped from these sumps to on-site quarry water dams or available quarry voids. The capacities of the proposed quarry water dams are shown in Table 6-4. If necessary during extremely wet periods, water can be pumped from quarry water dams back to quarries to maintain sufficient freeboard. Water can be extracted from storage dams as required to meet operational demands (e.g. dust suppression).

Runoff from the following areas may contain elevated levels of suspended sediment:

- OEAs;
- Haul roads; and
- Mine infrastructure such as staff facilities (crib huts), parking areas and dams.

Runoff from OEAs and infrastructure areas will be collected and treated in sediment dams and traps. Smaller sediment traps facilitate the removal of coarse sediments close to the source before the water is directed to larger sediment dams for settling of finer sediments. The quantity and location of sediment traps will vary depending on the progression of overburden emplacement. All sediment control structures will be designed in accordance with the principles of the International Erosion Control Association (2008) *Best Practice Erosion and Sediment Control Guidelines*. Sediment dams and traps will be routinely desilted to maintain storage capacity.

Further details on management of sediment-affected water are provided in *GEM-PLN-6504 Eastern Leases Erosion and Sediment Control Standard* (refer Section 5.6.3.4).

6.3.2.2 *Discharge Limits*

It is not expected that controlled discharges will be required for the Eastern Leases. Nevertheless, discharge limits have been formulated in the event that emergency discharge is required during extreme wet conditions. If required, excess water will be discharged to bushland in accordance with the existing practices at the Western Leases. Discharge locations will be strategically selected to minimise the risk of the water seeping into watercourses.

Discharge limits have been developed in accordance with the principles of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) (Water Quality Guidelines). The receiving environment is classified as a high conservation or ecological value system. The Water Quality Guidelines recommend that high conservation or ecological value system should be afforded the following level of protection:

- No change in physical or chemical stressors beyond natural variability; and
- No increase in toxicant concentrations beyond background values.

Accordingly, the management goal for water discharges is to maintain the background water quality. Baseline water quality in the Emerald and Amagula Rivers was monitored from January 2014 to December 2019. The maximum concentrations recorded during this period have been adopted as the discharge limits (refer Table 6-8).

Discharge limits for the Emerald River were formulated using baseline data for location EMP4, which is downstream of the confluence between the main channel and Tributary 1. Similarly, discharge limits for the Amagula River were formulated using baseline water quality at ARMP4, which is downstream of the main channel and Tributary 1. The locations of EMP4 and ARMP4 are shown on Figure 6-2. The water quality parameters that are generally below the limit of reporting have not been included as discharge limits.

The background EC in both the Emerald and Amagula Rivers is very low. These background values have not been adopted as discharge limits, as these very low thresholds may unnecessarily constrain the ability to discharge (when needed). *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMANZ, 2000) recommended that the EC for freshwater should not be increased above 1,500 µS/cm. This value has been adopted as the EC discharge limit for Eastern Leases.

Table 6-8: Discharge Water Quality Limits

Parameter	Units	Discharge Limits	
		Amagula River	Emerald River
Physical and Chemical Parameters			
Suspended Solids	mg/L	70	18
pH	pH unit	4.5 (lower limit), 6.5 (upper limit)	5.0 (lower limit); 7.9 (upper limit)
Redox Potential	mV	305	433
Electrical Conductivity (EC)	µS/cm	1,500^	1,500^
Dissolved Oxygen	% sat	74 (lower limit)	75 (lower limit)
Turbidity	NTU	6.8	7.4
Total Hardness*	mg/L	-	26

Parameter	Units	Discharge Limits	
		Amagula River	Emerald River
Total Alkalinity	mg/L	7	35
Dissolved Metals and Metalloids			
Aluminium	mg/L	0.46	0.16
Barium	mg/L	0.006	0.012
Copper	mg/L	0.003	0.003
Iron	mg/L	0.26	0.47
Manganese	mg/L	0.104	0.843

^ ANZECC (2000) guidelines recommend that the EC for fresh water should not be increased above this value.

6.4 Water Monitoring

6.4.1 *Surface Water Monitoring*

6.4.1.1 *Stream Flow Gauging*

GEMCO operates two stream flow gauging stations located on the main channel of Emerald River (refer to Figure 6-2):

- Station ER-GS-02 located downstream of the confluence with Emerald River Tributary 1; and
- Station ER-GS-01 located downstream of the confluence with Emerald River Tributary 2.

Station ER-GS-01 is located downstream of the Southern Eastern Lease whereas Station ER-GS-02 is downstream of the Northern Eastern Lease. These locations are suitable for monitoring potential impacts of mining operations on streamflow in the Emerald River.

6.4.1.2 *Receiving Environment Surface Water Quality Monitoring*

The surface water monitoring network for the Eastern Leases was established in January 2014 to collect baseline water quality data. The Eastern Leases monitoring network includes the following monitoring locations:

- Four sites in the Emerald River catchment (EMP4 to EMP7); and
- Four sites in the Amagula River catchment (ARMP1 to ARMP4).

The Eastern Leases monitoring program is in addition to the monitoring program undertaken for the Western Leases, which includes three monitoring sites in the lower reaches of the Emerald River (EMP1 to EMP3). Therefore, the consolidated monitoring program for the GEMCO mine includes seven sites in the Emerald River catchment and four sites in the Amagula River catchment. The locations of the Eastern Leases surface water monitoring sites are shown in Figure 6-2.

The water quality data collected from January 2014 to December 2019 represents the baseline water quality prior to mining operations. Data collected from the Western Leases monitoring sites (i.e. EMP1, EMP2 and EMP3) are not considered to be representative of baseline conditions for the

Eastern Leases as these sites are located a significant distance downstream (refer to Section 6 of the FY21-FY24 MMP).

The surface water monitoring network includes sites located upstream, within and downstream of the Eastern Leases. The upstream monitoring sites will not be impacted by mining activities and are therefore suitable reference sites. Changes in water quality from the reference sites to the downstream sites may indicate an impact due to mining operations.

During construction and mining operations, water quality monitoring will be conducted on a quarterly basis. In the unlikely event that controlled discharge is required, additional monitoring events will be undertaken before and after the discharge event. Table 6-9 lists the water quality parameters that will be measured.

Baseline water quality monitoring identified several metals that are generally below the level of detection. Such parameters are not included in quarterly monitoring but will be monitored annually to confirm that concentrations of these metals have not increased from baseline levels. The parameters that are only monitored on an annual basis are listed in Table 6-9.

The results of water quality monitoring will be compared to the trigger values in Table 6-13.

6.4.1.3 *Inspections of Water Management Structures*

Storage volumes in quarry water dams are monitored on a monthly basis to ensure that dams are within design limits.

Haul road stream crossings are inspected monthly during the wet season (November to April) to confirm that the culverts are operating effectively. The inspections will also identify if there are any signs of increased erosion or sedimentation caused by culvert structures that may require remediation.

Erosion and sediment control structures (i.e. sediment dams, haul road culverts, diversion drains) are inspected monthly. These inspections are undertaken to identify maintenance issues that may affect the efficiency of the controls, such as structural damage or accumulation of residue.

Erosion and sediment control management measures for Eastern Leases are described in Section 5.6.3.4.

Table 6-9: Receiving Environment Water Quality Monitoring Parameters

Monitoring Frequency	Parameter
Quarterly	**Physico-chemical parameters – Field** pH, Redox Potential (ORP), EC, Turbidity, Temperature, Dissolved Oxygen **Physico-chemical parameters – Laboratory** Total suspended solids (TSS), total hardness as $CaCO_3$, Bicarbonate Alkalinity as $CaCO_3$, Carbonate Alkalinity as $CaCO_3$, Hydroxide Alkalinity as $CaCO_3$ and Total Alkalinity as $CaCO_3$ **Ions** Sulphate as SO_4, Chloride, Calcium, Magnesium, Potassium, Sodium, Ionic balance, total anions, total cations **Nutrients** Total Nitrogen, Nitrate and Nitrite, Total Kjeldahl Nitrogen (KN), total Phosphorus **Metals and Metalloids** Aluminium, Barium, Iron, Manganese, Zinc

Monitoring Frequency	Parameter
Annual (in addition to quarterly monitoring parameters)	**Metals and Metalloids** Arsenic, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Mercury, Lead, Nickel, Selenium, Uranium, Vanadium

6.4.2 *Groundwater*

6.4.2.1 *Groundwater Quality Monitoring*

The groundwater monitoring network for the Eastern Leases was established in January 2014 and consists of 19 monitoring bores across ten locations. When bores are intercepted by mining, replacement bores will be established at suitable alternative locations, if required. The current locations of groundwater monitoring bores are presented in Table 6-10 and illustrated in Figure 6-3.

Low flow sampling groundwater bores will be undertaken bi-annually. Table 6-11 lists the parameters that will be monitoring during construction and operations. The results of groundwater quality monitoring will be compared to the trigger values in Table 6-13.

6.4.2.2 *Water Level Monitoring*

The water level data collected from June 2014 to October 2019 represents the baseline groundwater levels. During the construction and operational phase, water levels in the Eastern Leases groundwater monitoring bores (refer to Table 6-10) will be monitored using electronic loggers. Water levels will also be measured manually during bi-annual sampling of groundwater quality (refer Table 6-11). Measured groundwater levels will be compared to the trigger values in Table 6-12.

6.4.3 *Data Review and Interpretation*

GEMCO will prepare an EMR on an annual basis. The EMR will present all surface water and groundwater compliance monitoring data collected during that reporting period. The report will also include analyses of long-term trends and comparison against the predictions of the groundwater model.

Table 6-10: Groundwater Monitoring Bores

Lease	Location	Bore	Easting (GDA94)	Northing (GDA94)	Geological Unit
Northern Eastern Lease	EL-N-MB01	MB01S	664017	8447502	Laterite / Lateritic Clay
		MB01D	664017	8447502	Reworked Basement / Marine Sandstone
	EL-N-MB02	MB02S	664120	8448622	Laterite / Manganese Ore / Marine Claystone
		MB02D	664120	8448622	Marine Sandstone
	EL-N-MB03	MB03S	664986	8447701	Laterite / Manganese Ore / Marine Claystone
		MB03D	664986	8447701	Reworked Basement
	EL-N-MB04	MB04S	665744	8449493	Lateritic Clay

Lease	Location	Bore	Easting (GDA94)	Northing (GDA94)	Geological Unit
		MB04D	665744	8449493	Reworked Basement
Southern Eastern Lease	EL-S-MB05	MB05	664495	8442763	Marine Claystone
	EL-S-MB06	MB06S	663563	8442620	Quaternary Sediments / Laterite
		MB06D	663563	8442620	Reworked Basement
	EL-S-MB07	MB07S	665215	8441005	Laterite / Manganese Ore
		MB07D	665215	8441005	Reworked Basement / Marine Sandstone
	EL-S-MB08	MB08S	667488	8440496	Laterite / Lateritic Clay
		MB08D	667488	8440496	Marine Claystone
	EL-S-MB09	MB09S	665875	8440131	Marine Claystone / Manganese Ore
		MB09D	665875	8440131	Reworked Basement
	EL-S-MB10	MB10S	668233	8441997	Laterite / Lateritic Clay
		MB10D	668233	8441997	Marine Claystone

Table 6-11: Groundwater Quality Monitoring Parameters

Monitoring Frequency	Parameter
Bi-annual	**Physico-chemical parameters – Field** pH, EC, TDS, Temperature, Dissolved Oxygen **Physico-chemical parameters – Laboratory** Total hardness as $CaCO_3$, Bicarbonate Alkalinity as $CaCO_3$, Carbonate Alkalinity as $CaCO_3$, Hydroxide Alkalinity as $CaCO_3$ and Total Alkalinity as $CaCO_3$ **Ions** Major anions (CO_3, HCO_3, Cl, SO_4), major cations (Ca, Mg, Na, K) **Nutrients** Total Nitrogen, Nitrate and Nitrite, Ammonium, total Phosphorus **Metals and Metalloids** Aluminium, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Manganese, Mercury, Nickel, Lead, Selenium, Uranium, Vanadium, Zinc **Hydrocarbons** Total petroleum hydrocarbons, total recoverable hydrocarbons

6.5 Management

6.5.1 *Remedial or Corrective Management Actions*

A surface water and groundwater response plan has been developed to address any impacts to water levels or water quality that are greater than predicted.

Baseline groundwater levels were monitored from June 2014 to October 2019 using both automatic loggers and manual readings. The groundwater model predicted the maximum drawdown at each monitoring location during mining. The predicted drawdowns were applied to the baseline water levels to derive water level triggers for each monitoring bore (refer to Table 6-12).

Baseline water quality in the Emerald and Amagula Rivers was monitored from January 2014 until December 2019. In addition, baseline groundwater quality was monitored from January 2014 to February 2020. The baseline water quality data indicates that most of the monitored parameters are generally below the limit of detection. Water quality triggers have only been defined for the metals that regularly occur in measurable quantities, namely Aluminium, Copper, Iron, Manganese and Zinc.

In accordance with the *Water Quality Guidelines* (Australian Government, 2018), the management goal is to maintain the background water quality. As such, water quality triggers (presented in Table 6-13) are generally based on the maximum concentration recorded during baseline monitoring (i.e. the upper bound of background variability). The *Water Quality Guidelines* also recommend Default Guideline Values (DGVs) for certain toxicants, including Aluminium, Copper, Manganese and Zinc.

The DGV has been adopted as the trigger value in the following instances:

- Where the background concentration of manganese is substantially lower than the DGV for 99% level of species protection, the DGV of 1.2 mg/L has been adopted;
- Where a groundwater bore has not recorded any measurable concentrations of copper, the DGV for 99% level of species protection (0.001 mg/L) has been adopted; and
- Where a groundwater bore has not recorded any measurable concentrations of zinc, the DGV for 95% level of species protection (0.008 mg/L) has been adopted [note that the DGV for 99% level of species protection is below the level of detection].

Table 6-12: Groundwater Level Triggers

Bore	Baseline Water Levels (mAHD)	Predicted Maximum Drawdown (m)	Trigger Value (mAHD)
EL-N-MB01D	22.0 – 27.0	0.5	21.5
EL-N-MB01S	32.0 – 39.5	0.5	31.5
EL-N-MB03D	23.5 – 29.5	0.5	23.0
EL-N-MB03S	42.5 – 47.0	0.5	42.0
EL-N-MB04D	26.5 – 42.0	< 0.5	26.5
EL-S-MB05D	19.5 – 22.5	0.5	19.0
EL-S-MB06D	17.5 – 20.0	< 0.5	17.5
EL-S-MB06S	28.5 – 33.5	0.5	28.0
EL-S-MB07D	19.5 – 23.0	1.5	18.0
EL-S-MB07S	29.5 – 35.0	1.5	28.0
EL-S-MB08D	29.0 – 40.0	6.0	23.0
EL-S-MB08S	35.0 – 42.0	6.0	29.0

Bore	Baseline Water Levels (mAHD)	Predicted Maximum Drawdown (m)	Trigger Value (mAHD)
EL-S-MB09D	19.0 – 22.5	1.5	17.5
EL-S-MB09S	22.5 – 28.0	1.5	21.0
EL-S-MB10D	33.5 – 40.5	< 0.5	33.5
EL-S-MB10S	52.5 – 54.5	< 0.5	52.5

** All values rounded to the nearest 0.5m*

Table 6-13: Water Quality Triggers

Monitoring Site	pH (lower)	pH (upper)	Suspended Solids (mg/L)	Aluminium (mg/L)	Copper (mg/L)	Iron (mg/L)	Manganese (mg/L)	Zinc (mg/L)
Groundwater Monitoring Locations								
EL-N-MB01D	4.3	5.0	N/A	0.18	0.02	0.08	1.2^	0.03
EL-N-MB01S	5.0	6.4	N/A	0.85	0.17	3.43	2.15	0.06
EL-N-MB03D	4.0	4.8	N/A	0.02	0.05	-	1.2^	0.03
EL-N-MB03S	4.5	5.1	N/A	0.26	0.31	-	1.2^	0.03
EL-N-MB04D	4.2	5.1	N/A	0.02	0.03	0.06	5.8	0.02
EL-S-MB05D	5.1	5.9	N/A	0.04	0.01	-	1.2^	0.03
EL-S-MB06D	4.1	4.7	N/A	0.05	0.17	-	1.2	0.42
EL-S-MB06S	4.6	6.0	N/A	0.2	0.12	0.46	1.2^	0.89
EL-S-MB07D	4.2	5.2	N/A	0.04	0.06	0.91	5.0	0.05
EL-S-MB07S	4.3	5.3	N/A	0.05	0.12	-	1.31	0.02
EL-S-MB08D	4.3	5.5	N/A	0.02	0.17	0.33	6.01	0.07
EL-S-MB08S	4.2	5.0	N/A	0.15	0.09	11.0	15.3	0.03
EL-S-MB09D	3.7	4.9	N/A	0.02	0.03	-	1.2^	0.03
EL-S-MB09S	3.7	5.0	N/A	0.23	0.85	0.11	2.95	0.2
EL-S-MB10D	4.6	5.9	N/A	0.57	0.02	0.38	5.0	0.06
EL-S-MB10S	4.8	5.2	N/A	0.13	0.001^	0.42	1.83	0.02
Surface Water Monitoring Locations								
ARMP1	4.4	5.3	20	0.51	0.004	0.72	1.2^	0.006
ARMP2	4.3	7.3	67	0.14	0.004	0.22	1.2^	0.008
ARMP3	4.2	5.8	32	0.12	0.003	0.14	1.2^	0.008^
ARMP4	4.5	6.5	70	0.46	0.003	0.26	1.2^	0.015
EMP4/4A	5.0	7.9	18	0.16	0.003	0.47	1.2^	0.008^
EMP5	4.0	5.2	-	0.03	0.001^	-	1.2^	0.008^
EMP6/6A	5.1	6.5	28	0.20	0.002	1.62	5.72	0.008^
EMP7	4.4	6.2	17	0.13	0.002	1.19	4.08	0.008^

Table 6-14 outlines the management responses that will be implemented if the trigger values are exceeded.

Table 6-14: Groundwater Monitoring Triggers and Response Plan

Aspect	Monitoring	Trigger	Response
Surface water quality	Quarterly water quality monitoring at eight locations	Trigger values in Table 6-13 are exceeded on two consecutive monitoring rounds.	Investigate the cause of the trigger exceedance. If Eastern Leases operations are determined to be a cause of the exceedance, the exceedance will be recorded as an incident in GEMCO's event management system and reported to DITT (see Section 7). GEMCO will also review the need for additional controls (which many include modification of mining activities or the surface water monitoring program). Any remediation and mitigation measures implemented as a result of the exceedance and any GEMCO incident investigations will be reported to regulatory agencies including DITT.
Mine water storage	Monthly monitoring of dam storage volumes	Storage volume in a mine water dam is within 10% of its maximum design capacity (see Table 6-4).	Consider whether there is sufficient storage capacity available in other dams or quarries. If transferring water to other storages within Eastern Leases is not feasible, consider whether discharge may be required (having regard to prevailing and forecast weather conditions). If it is likely that discharge will be required, schedule an additional round of water quality monitoring as soon as practicable. This will enable compliance with discharge limits to be determined prior to a discharge event.
Groundwater quality	Bi-annual water quality monitoring at ten locations.	Trigger values in Table 6-13 are exceeded for two consecutive monitoring rounds.	Investigate the cause of the trigger exceedance. If Eastern Leases operations are determined to be a cause of the exceedance, the exceedance will be recorded as an incident in GEMCO's event management system and reported to DITT (see Section 7). GEMCO will also review the need for additional controls (which many include modification of mining activities or the groundwater monitoring program).

Aspect	Monitoring	Trigger	Response
			Any remediation and mitigation measures implemented as a result of the exceedance and any GEMCO incident investigations will be reported to regulatory agencies including DITT.
Groundwater levels	Automated monitoring of groundwater levels at ten locations.	Recorded water level is below trigger value in Table 6-12.	Engage an expert to investigate the cause of the greater than anticipated drawdown. If Eastern Leases operations are determined to be a cause of the exceedance, the exceedance will be recorded as an incident in GEMCO's event management system and reported to DITT (see Section 7). GEMCO will also review the need for additional controls (which many include modification of mining activities or the groundwater monitoring program). Any remediation and mitigation measures implemented as a result of the exceedance and GEMCO incident investigations will be reported to regulatory agencies including DITT and NT EPA.

6.5.2 *Actions Proposed Over the Reporting Period*

As noted above, GEMCO will resume water quality monitoring within Eastern Leases at the commencement of construction. Any material changes to the Eastern Leases water management system or monitoring network other than those described above in Section 6 during the term of this MMPA will be reported via the GEMCO EMR.

7 INCIDENT REPORTING

Environmental incident reporting is carried out in accordance with GEMCO's Event Management Procedure (*GEM-PRO-3151 Event Management Procedure*). The severity of each environmental incident is assessed against the DITT Guideline on Environmental Incident Reporting and all Severity Class 2 and above incidents are reported to DITT under Section 29 of the *Mining Management Act 2001* (NT). Any relevant incidents that occur off-lease are reported to the NT EPA.

GEMCO will also provide environmental incident notifications and reports to the ALC, in accordance with the *GEM-PRO-3014 External Reporting Obligations* and the requirements of Clause 7.2 of the Eastern Leases Mining Agreement.

No environmental incidents occurred within the Eastern Leases during the 2019/20 reporting period.

8 CLOSURE PLANNING

The South32 Closure Standard, GEMCO Closure Plan and commitments for unplanned closure are described in Section 8 of the FY21-FY24 MMP.

The GEMCO Closure Plan is scheduled for an update which will occur late 2021 / early 2022. This review will be undertaken in consultation with the ALC and an updated Closure Plan will be issued to DITT in 2022. The updated plan will consider Eastern Leases closure and security requirements, EIS commitments and the activities scheduled for Eastern Leases in FY21-FY24, as described in this MMPA. Key environmental aspects for Eastern Leases closure planning include:

- Backfilling quarries with overburden:
    - To create a free draining landform that broadly replicates the pre-mining topography;
    - So there will be no elevated ex-pit overburden storage areas or final voids (defined as deep quarries that accumulate water) at the end of the mine life;
- Maintaining Traditional Owner access;
- Progressive rehabilitation;
- Reviewing and updating completion criteria including criteria for fauna;
- Identification and appropriate management of PAF material;
- Conducting controlled burn trials in rehabilitation areas;
- Management of pests and weeds;
- Management of water and erosion post-closure;
- Community development and Indigenous employment;
- Protection of archaeological and sacred sites; and
- Development of closure and rehabilitation plans.

8.1 Life of Operation Plan – Unplanned Closure

The GEMCO Closure Plan continues to be integrated with the GEMCO Life of Operations Plan (LoOP), which currently forecasts mine operations. As the LoOP is updated and reforecast annually, unplanned closure of Eastern Leases during the term of this MMPA is considered unlikely.

GEMCO response procedures to be implemented in the event of unplanned closure of the site are described in Section 8.1 of the FY21-FY24 MMP and in Section 9.11 of the GEMCO Closure Plan. GEMCO will develop appropriate governance arrangements for the continued implementation of these procedures and any corrective action programs required for Eastern Leases if unplanned closure should occur, in consultation with key stakeholders.

8.2 Background for Costing of Closure Activities

Table 8-1 summarises the mining disturbance across the Eastern Leases used for the security estimate in Section 8.3 (no mining disturbance is proposed during the period FY21 – FY24). The information in Table 8-1 is accurate as at August 2021. Disturbance tracking for Eastern Leases will be conducted on a quarterly basis, taking into consideration progressive rehabilitation as well as new or expanded activities.

[redacted]

Closure costing has been developed in line with the NT DPIR (2016) *Security Calculation Procedure*. Where applicable, costs per unit (i.e. $/Ha, $/m^3) and individual items costs have been developed using GEMCO rates or a third-party estimate. The total number of units and material quantities requiring rehabilitation is based on the disturbance data above.

8.3 Security Estimate

[redacted]

9 APPENDICES

9.1 Abbreviations and units

Table 9-1: Abbreviations

Abbreviation	Description
AA	Access Authority
AAPA	Aboriginal Areas Protection Authority
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ALARP	As low as reasonably practicable
ALC	Anindilyakwa Land Council
ALRA	*Aboriginal Land Rights (Northern Territory) Act 1976* (Cth)
AMD	Acid Mine Drainage
ANCOLD	Australian National Committee on Large Dams
ANZECC	Australian and New Zealand Environment Conservation Council (2000)
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASX	Australian Securities Exchange
BoM	Bureau of Meteorology
CRD	Cumulative Rainfall Departure
DAWE	Commonwealth Department of Agriculture, Water and Environment
DEPWS	NT Department of Environment, Parks and Water Security
DGV	Default Guideline Values
DITT	NT Department of Industry, Tourism and Trade
DTSC	NT Department of Tourism, Sport and Culture
EIS	Environmental Impact Study
EMP	Environment Management Plan
EMR	Environmental Mining Report
EP Act	*Environmental Protection Act 2019* (NT)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPL	Environment Protection Licence
ESC	Erosion and Sediment Control

Abbreviation	Description
FY	Financial Year
GEMCO	Groote Eylandt Mining Company Pty Ltd
GDE	Groundwater Dependent Ecosystem
GDEMP	Groundwater Dependent Ecosystem Monitoring Program
GIS	Geographical Information System
HVAS	High Volume Air Sampler
IECA	International Erosion Control Association
LoOP	Life of Operations Plan
MLs	Mining Leases
MMP	Mining Management Plan
MMPA	Mining Management Plan Amendment
MNES	Matters of National Environmental Significance
NAF	Non Acid-Forming
NT EPA	Northern Territory Environment Protection Authority
OEA	Overburden Emplacement Area
OPR	Operational Performance Report (now EMRs)
PCS	Primary Crushing Station
PEARL	People, Environment, Assets, Reputation, Livelihood
PMS	Post Mining Surface
RMSL	Rehabilitation, Mine Services and Legacy
QW	Quarry Water
ROM	Run of Mine
SEP	Stakeholder Engagement Plan
SBP	Sand Beneficiation Plant
SPL	Special Purpose Lease
TPWC Act	*Territory Parks and Wildlife Conservation Act 1976* (NT)
TRARC	Tropical Rapid Appraisal of Riparian Condition
TSMP	Threatened Species Management Plan
TSF	Tailings Storage Facility

Abbreviation	Description
Water Act	*Water Act 1992* (NT)
WM Act	*Weeds Management Act 2001* (NT)

Table 9-2: Units

Unit	Description
%	Percent
cm	Centimetre
ha	Hectare
kt	Kilograms per tonne
km	Kilometres
km/hr	Kilometres per hour
km^2	Square kilometres
mm	Millimetres
mm^3	Cubic millimetre
mm/day	Millimetres per day
m	Metres
m^3	Cubic metres
ML	Million litres
Mt	Million tonnes
Mtpa	Million tonnes per annum
MWh	Megawatt hour
PM_{10}	Particulate matter 10 micrometres or less in diameter
PM_4	Particulate matter 4 micrometres or less in diameter
$\mu g/m^3$	Micrograms per cubic metre

9.2 Mining Management Plan Checklist

Y / N	Page/s	Requirement	Department's Comment
Y	Title Page	Has the plan been endorsed by a senior representative of the company?	
Y	1	**Introduction:** Have Operator details been included?	
Y	1	Is the company structure described?	
Y	1	Are title details included?	
Y	4-7	Is there a project summary and description improvements?	
Y	8-21	**Site Conditions:** Have all the physical environment conditions for the site and surrounds been identified?	
Y	20-21	Have the current land uses and users and stakeholders been identified?	
Y	21	Have Community Affairs been described?	
Y	22-34	**Statutory and Non-Statutory Requirements:** Has all legislation relevant to the operation and associated permits and approvals been identified? Have all non-statutory obligations been identified and included?	
Y	29-34	Have Aboriginal and heritage sites been identified?	
Y	35-44	**Operational Activities:** Have all operational activities relating to mining, processing, exploration and any related activities for the site been addressed in the MMP?	
N	N/A	**Waste Rock Characterisation:** Have results of waste rock characterisation been included and discussed? Has a waste characterisation report been included? Does the MMP include a waste rock management plan?	

Y / N	Page/s	Requirement	Department's Comment
Y	1, 45	**Environmental Management:** Has the Environmental Management structure and responsibilities been outlined?	
Y	45-56	Has the Environmental Policy been included? Has a register of environmental commitments been included? Has a summary of all recommendations from the Environmental Impact Assessment been included and addressed if the project has been formally assessed?	
Y	56	Has training and induction been addressed?	
Y	56	Is there an Environmental Emergency and response plan?	
Y	56-57	Have all environmental aspects and potential impacts been identified? Has a risk assessment been carried out?	
Y	56-99 (summary included)	Have Environmental Management Plans (EMP's) for identified risks been developed and included?	
Y	56-99	**EMPs:** Do all EMP's include: • objectives and targets • management and mitigation strategies • monitoring and measurement • discussion and analysis of results • non-conformances and corrective actions?	
Y	77-84	**Water Management:** Has a comprehensive description of surface water conditions been included?	
Y	84-88	Has a comprehensive groundwater model been described?	
N	88	Have information or knowledge gaps been identified and described for water management?	

Y / N	Page/s	Requirement	Department's Comment
N	N/A	Are there comprehensive details (including scopes of work) on actions proposed to be taken to respond to any identified information or knowledge gaps?	
Y	89-92	Have hazards been identified that could result from activities related to the operation and rank the associated risks of impacts to both surface and groundwater?	
Y	90-92	Are all strategies and actions that will be undertaken to manage any risks identified included?	
Y	92-99	Has the water monitoring program been detailed?	
Y	92-95, 116-157	Has all monitoring data been included?	
Y	94	Has an interpretation of data by a suitably qualified person been included?	
Y	94	Has a discussion of trends over time been detailed?	
Y	95-99	Have details of remedial/corrective strategies and scopes of work been included?	
Y	99	Have proposed actions been detailed?	
Y	100	**Incident Reporting:** Has a table of all incidents recorded on site been included and discussed?	
Y	101-103 (summary included) Note: GEMCO's Closure Plan previously submitted to DITT.	**Closure Planning:** Has a Life of Operation Plan – Unplanned Closure plan been included? Are all disturbances described? Are remediation activities that would be required in the event of unplanned closure described? Are activities required to achieve end land use objectives, described?	
Y	102-103, Security Calculation Tool	Does the MMP include a detailed costing of closure activities for the life of plan? Have all past disturbances and those proposed for the next reporting period been identified and included?	

Y / N	Page/s	Requirement	Department's Comment
Y	Various	**Maps and Plans:** Maps and plans have scale, scale bar, legend and north point? Datums used are MGA94 or GDA 94 (expressed in decimal degrees) with elevations based on AHD?	

9.3 ALC Letter of Endorsement

Anindilyakwa Land Council

6 August 2021

Delivered by email

Mr Mark Filtness
Vice President Operations
GEMCO
ALYANGULA NT 0885

Via Email: Mark.Filtness@south32.net
John Hansen John.E.Hansen@south32.net

Dear Mark,

Re: In Principle Support for GEMCO's Eastern Leases MMPA

Thank you for the opportunity to consider this MMPA undertaken by GEMCO for the Eastern Leases.

The Anindilyakwa Land Council (ALC) have considered GEMCO's Mine Management Plan Amendment for the Eastern leases and met with GEMCO personnel to discuss the amendments. The ALC is satisfied with the plan and can provide In Principle Support for this document.

It is acknowledged by the Land Council that the Closure Plan for the Eastern Leases is currently being reviewed and redeveloped and will be provided to the ALC for our review and consultations during 2022.

If you require further clarification around this letter, please contact Ross McDonald Mining & Environment Manager 08 8987 4008 rmcdonald@alcnt.com.au.

Yours Sincerely,

Ross McDonald
Mining & Environment Manager
Anindilyakwa Land Council

30 Bougainvillea Drive, Alyangula NT | PO Box 172, Alyangula NT 0885
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9.4 Risk Assessment Matrix

The South32 impact and likelihood tables are presented in Figure 9-1 and Figure 9-2. These are used to assess and mitigate risks in line with legal and company risk assessment frameworks.

Figure 9-1: Risk Impact

Impact Level	Impact Types						Impact Factor
	Health[1] and safety	Environment	Community	Reputation	Legal	Financial[2]	
7	>50 fatalities. Permanent impairment >30% of body to more than 500 persons.	Permanent severe impact/s to land, biodiversity, ecosystem services, water resources or air.	Severe, widespread community health, safety or security impacts (>1000 households) or human rights violations; complete destruction of >1000 houses or community infrastructure; complete irreversible desecration of multiple structures/objects/places of global significance.	Crisis event or publication of highly confidential material information resulting in international media, government, regulator, NGO campaigning and employee condemnation of the company (>6 months). Long term damage to company reputation.	Bankruptcy, closure / nationalisation of operations on multiple sites.	≥ US$1 billion	1000
6	>20 fatalities. Permanent impairment >30% of body to more than100 persons.	Severe impact/s (>20years) to land, biodiversity, ecosystem services, water resources or air.	Extensive community health, safety or security impacts (>200 households) or human rights violations; extended serious disruption to people's lives (>1000 households); extensive damage to >1000 houses or community infrastructure or structures/ objects/places of global cultural significance.	Crisis event or publication of confidential material information resulting in international media, government, regulator, NGO campaigning and employee condemnation of the company (< 6 months). Ongoing condemnation results in damage of the reputation of the company.	Lack of valid operating title, forced closure of an operation, competition , anti-corruption , international trade law or tax breach; Major personal injury class actions. Nationalisation of Operation by host government.	≥ US$250 million to <US$1 billion	300
5	2-20 fatalities Permanent impairment >30% of body more than 10 persons.	Serious or extensive impact/s (<20 years) to land, biodiversity, ecosystem services, water resources or air.	Serious community health, safety or security impacts (>50 households) or human rights violations; extended disruption to people's lives (>200 households), extensive damage to >200 houses or structures/ objects/places of national cultural significance.	Serious national and international negative media attention. General public and NGO adverse reaction with interest from regulators (< 3 months). Structured campaigning from employees, NGOs or communities having a major impact on the company / Operations reputation.	Prosecutions for criminal breaches resulting in jail terms for employees or agents or defendant to major civil litigation.	≥ US$100 million to < US$250 million	100
4	Single Fatality. Permanent impairment >30% of body to one or more persons.	Major impact/s (<5 years) to land, biodiversity, ecosystem services, water resources or air.	Serious community health, safety or security impacts (<50 households). Multiple allegations of human rights violations; extended disruption to people's lives (>50 households); extensive damage to >50 houses; moderate irreversible damage to structures/ objects/places of national cultural significance.	Adverse national media attention. General public and NGO adverse reaction with interest from regulators with no material outcome. Structured campaigning from employees, NGOs or communities having a major impact on the company / Operations reputation.	Significant civil litigation.	≥ US$25 million to <US$100 million	30

Impact Level	Impact Types						Impact Factor
	Health[1] and safety	Environment	Community	Reputation	Legal	Financial[2]	
3	Permanent impairment <30% of body to one or more persons. Restricted or lost days due to injury or illness.	Moderate impact/s (<1 year) to land, biodiversity, ecosystem services, water resources or air.	Moderate community health, safety or security impacts (<50 households). Single allegation of human rights violations; moderate disruption to people's lives (<50 households); extensive damage to <50 houses; moderate reversible damage to structures/objects/ places of national cultural significance.	Attention from media and/or heightened concern by local community. Criticism by community, NGOs or activists. Operations reputation adversely affected.	Breach of regulation. Lack of valid exploration title.	≥ US$5 million to < US$25 million	10
2	Objective but reversible impairment. Medical treatment injury or illness.	Minor impact/s (<3 months) to land, biodiversity, ecosystem services, water resources or air.	Minor community health, safety or security impacts (<10 households) or human rights infringements; inconvenience to livelihoods <6 months; moderate damage to <50 houses or community infrastructure; minor, reversible damage to structures/ objects/places of regional cultural significance.	Adverse local public or media attention and complaints. Heightened scrutiny from regulator. Operations reputation is adversely affected with a small number of people.	Minor legal issues and non-compliances with commitments.	≥US$500,000 to <US$5 million	3
1	Low-level short-term subjective symptoms or inconvenience. No medical treatment.	Low-level impact/s to land, biodiversity, ecosystem services, water resources or air.	Single low level community health, safety or security impact; low-level inconvenience <2 weeks; minor, reversible, low-level disturbance or minor damage to a single house or structure/object/place of regional cultural significance.	Public concern restricted to local complaints. Low-level interest from local media and/or regulator.	Low-level legal issue.	<US$500,000	1

Figure 9-2: Risk Likelihood

Uncertainty	Business	Projects	Likelihood Factor
	Based on South32 and industry experience and expected future conditions, the risk event:	Based on South32 and industry experience and expected future conditions, with similar studies or projects, the risk event:	
Almost certain	Could be incurred more than once in a year.	Could be expected to occur more than once during the study or project delivery.	10
Likely	Could be incurred over a 1 - 2 year budget period.	Could easily be incurred and has generally occurred in similar studies or projects.	3
Possible	Could be incurred within a 5 year strategic planning period.	Incurred in a minority of similar studies or projects.	1
Unlikely	Could be incurred within a 5 - 20 year time frame.	Known to happen, but only rarely.	0.3
Rare	Could be incurred in a 20 - 50 year timeframe.	Has not occurred in similar studies or projects, but could.	0.1
Very rare	For a system failure: This consequence has not happened in the industry in the last 50 years. For a natural hazard: The predicted return period for a risk of this strength/ magnitude is one in 100 years or longer.	Conceivable, but only in extreme circumstances.	0.03

9.5 Surface Water Monitoring Results Summary

Note: Refer to Figure 6-2 for the location of surface water monitoring sites

EMP4/4A – Emerald River main channel (downstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	18
pH	pH unit	0.1	5.0	5.3	7.9
Redox potential	mV	1	163	207	433
Electrical conductivity	µS/cm	1	-	-	-
Dissolved oxygen	% sat	0.1	75.1	93.6	106.4
Turbidity	NTU	1	-8.8	2.5	7.4
Total hardness	mg/L	1	< 1	< 1	26
Bicarbonate alkalinity	mg/L	1	< 1	8	35
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	8	35
Major Ions					
Total anions	meq/L	0.01	0.33	0.40	0.59
Total cations	meq/L	0.01	0.26	0.30	0.56
Sulphate	mg/L	1	< 1	< 1	16
Chloride	mg/L	1	8	9	21
Calcium	mg/L	1	< 1	< 1	4
Magnesium	mg/L	1	< 1	< 1	4
Potassium	mg/L	1	< 1	< 1	4
Sodium	mg/L	1	6	7	17
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.01	0.16

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	< 0.001	0.006	0.012
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.003
Iron	mg/L	0.05	< 0.05	0.11	0.47
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.003	0.183	0.843
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.002
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	< 0.005

EMP5 – Emerald River main channel (upstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	< 5
pH	pH unit	0.1	4.0	4.3	5.2
Redox potential	mV	1	285	299	313
Electrical conductivity	µS/cm	1	38	38	38
Dissolved oxygen	% sat	0.1	72.6	75.3	78.0
Turbidity	NTU	1	0.3	3.1	4.8
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	< 1	3.5	4
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	3.5	4
Major Ions					
Total anions	meq/L	0.01	0.28	0.31	0.38
Total cations	meq/L	0.01	0.17	0.20	0.30
Sulphate	mg/L	1	< 1	< 1	2
Chloride	mg/L	1	8	8	12
Calcium	mg/L	1	< 1	< 1	< 1
Magnesium	mg/L	1	< 1	< 1	< 1
Potassium	mg/L	1	< 1	< 1	< 1
Sodium	mg/L	1	4	4.5	7
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.02	0.03
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.002	0.002	0.004
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	< 0.001
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	< 0.001	0.001	0.003
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	< 0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	< 0.005

EMP6/6A – Emerald River main channel (downstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	28
pH	pH unit	0.1	5.1	5.3	6.5
Redox potential	mV	1	197	236	510
Electrical conductivity	µS/cm	1	42	42	42
Dissolved oxygen	% sat	0.1	61.5	85.4	94.6
Turbidity	NTU	1	-0.3	2.5	8.1
Total hardness	mg/L	1	< 1	< 1	31
Bicarbonate alkalinity	mg/L	1	5	11	38
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	5	11	38
Major Ions					
Total anions	meq/L	0.01	0.37	0.52	0.75
Total cations	meq/L	0.01	0.26	0.37	0.61
Sulphate	mg/L	1	< 1	< 1	4
Chloride	mg/L	1	8	13	20
Calcium	mg/L	1	< 1	< 1	6
Magnesium	mg/L	1	< 1	< 1	4
Potassium	mg/L	1	< 1	< 1	4
Sodium	mg/L	1	6	11	16
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.02	0.20
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.004	0.024	0.083
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	0.11
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	0.002
Copper	mg/L	0.001	< 0.001	< 0.001	0.002
Iron	mg/L	0.05	< 0.05	0.15	1.62
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.058	0.905	5.720
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	< 0.005

EMP7 – Emerald River tributary 2

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	17
pH	pH unit	0.1	4.4	5.6	6.2
Redox potential	mV	1	106	210	269
Electrical conductivity	µS/cm	1	50	51	68
Dissolved oxygen	% sat	0.1	46.7	70.1	108.2
Turbidity	NTU	1	-0.4	1.3	9.5
Total hardness	mg/L	1	< 1	< 1	4
Bicarbonate alkalinity	mg/L	1	3	7	16
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	3	7	16
Major Ions					
Total anions	meq/L	0.01	0.26	0.42	0.68
Total cations	meq/L	0.01	0.22	0.30	0.62
Sulphate	mg/L	1	< 1	< 1	12
Chloride	mg/L	1	7	10	15
Calcium	mg/L	1	< 1	< 1	< 1
Magnesium	mg/L	1	< 1	< 1	1
Potassium	mg/L	1	< 1	< 1	10
Sodium	mg/L	1	5	7	12
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.13
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.002	0.008	0.044
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	0.08
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	0.003
Copper	mg/L	0.001	< 0.001	< 0.001	0.002
Iron	mg/L	0.05	< 0.05	0.16	1.19
Lead	mg/L	0.001	< 0.001	< 0.001	0.001
Manganese	mg/L	0.001	0.048	0.487	4.08
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	< 0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	< 0.005

ARMP1 – Amagula River main channel (upstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	20
pH	pH unit	0.1	4.4	4.7	5.3
Redox potential	mV	1	161	247	313
Electrical conductivity	µS/cm	1	50	51	51
Dissolved oxygen	% sat	0.1	68.2	81.3	96.9
Turbidity	NTU	1	0	3.6	20.7
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	< 1	4	8
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	4	8
Major Ions					
Total anions	meq/L	0.01	0.25	0.40	9.22
Total cations	meq/L	0.01	0.17	0.30	0.35
Sulphate	mg/L	1	< 1	< 1	428
Chloride	mg/L	1	6	11	14
Calcium	mg/L	1	< 1	< 1	< 1
Magnesium	mg/L	1	< 1	< 1	< 1
Potassium	mg/L	1	< 1	< 1	< 1
Sodium	mg/L	1	4	7	8
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.01	0.51
Arsenic	mg/L	0.001	< 0.001	< 0.001	0.005
Barium	mg/L	0.001	< 0.001	0.004	0.005
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.004
Iron	mg/L	0.05	< 0.05	0.08	0.72
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.001	0.003	0.039
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	0.006

ARMP2 – Amagula River main channel (downstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	67
pH	pH unit	0.1	4.3	5.4	7.3
Redox potential	mV	1	146	212	314
Electrical conductivity	µS/cm	1	48	50	51
Dissolved oxygen	% sat	0.1	68.0	83.9	101.7
Turbidity	NTU	1	-7.6	2.1	6.6
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	< 1	4	8
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	4	8
Major Ions					
Total anions	meq/L	0.01	0.25	0.39	0.49
Total cations	meq/L	0.01	0.17	0.30	0.39
Sulphate	mg/L	1	< 1	< 1	2
Chloride	mg/L	1	9	12	14
Calcium	mg/L	1	< 1	< 1	< 1
Magnesium	mg/L	1	< 1	< 1	< 1
Potassium	mg/L	1	< 1	< 1	2
Sodium	mg/L	1	4	7	9
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.14
Arsenic	mg/L	0.001	< 0.001	< 0.001	0.005
Barium	mg/L	0.001	< 0.001	0.004	0.006
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.004
Iron	mg/L	0.05	< 0.05	0.10	0.22
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.004	0.010	0.023
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	0.008

ARMP3 – Amagula River main channel (downstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	32
pH	pH unit	0.1	4.2	4.8	5.8
Redox potential	mV	1	115	277	320
Electrical conductivity	µS/cm	1	48	48	48
Dissolved oxygen	% sat	0.1	24.8	73.0	100.7
Turbidity	NTU	1	-0.2	1.7	10.3
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	< 1	3	8
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	3	8
Major Ions					
Total anions	meq/L	0.01	0.29	0.36	0.44
Total cations	meq/L	0.01	0.26	0.26	0.35
Sulphate	mg/L	1	< 1	1	2
Chloride	mg/L	1	9	10	12
Calcium	mg/L	1	< 1	< 1	< 1
Magnesium	mg/L	1	< 1	< 1	< 1
Potassium	mg/L	1	< 1	< 1	< 1
Sodium	mg/L	1	6	6	8
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.02	0.12
Arsenic	mg/L	0.001	< 0.001	< 0.001	0.004
Barium	mg/L	0.001	< 0.001	0.004	0.007
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	0.002
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.003
Iron	mg/L	0.05	< 0.05	< 0.05	0.14
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.008	0.013	0.088
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	< 0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	< 0.005

ARMP4 – Amagula River main channel (downstream)

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
Suspended solids	mg/L	5	< 5	< 5	70
pH	pH unit	0.1	4.5	5.5	6.5
Redox potential	mV	1	57	228	305
Electrical conductivity	µS/cm	1	48	50	51
Dissolved oxygen	% sat	0.1	74.4*	85.3	107.5
Turbidity	NTU	1	-2.4	1.5	6.8
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	< 1	3	7
Carbonate a kalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	1	7
Major Ions					
Total anions	meq/L	0.01	0.29	0.39	0.49
Total cations	meq/L	0.01	0.22	0.30	0.39
Sulphate	mg/L	1	< 1	< 1	3
Chloride	mg/L	1	8	11	14
Calcium	mg/L	1	< 1	< 1	< 1
Magnesium	mg/L	1	< 1	< 1	< 1
Potassium	mg/L	1	< 1	< 1	< 1
Sodium	mg/L	1	5	7	9
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.46
Arsenic	mg/L	0.001	< 0.001	< 0.001	0.004
Barium	mg/L	0.001	< 0.001	0.004	0.006
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001

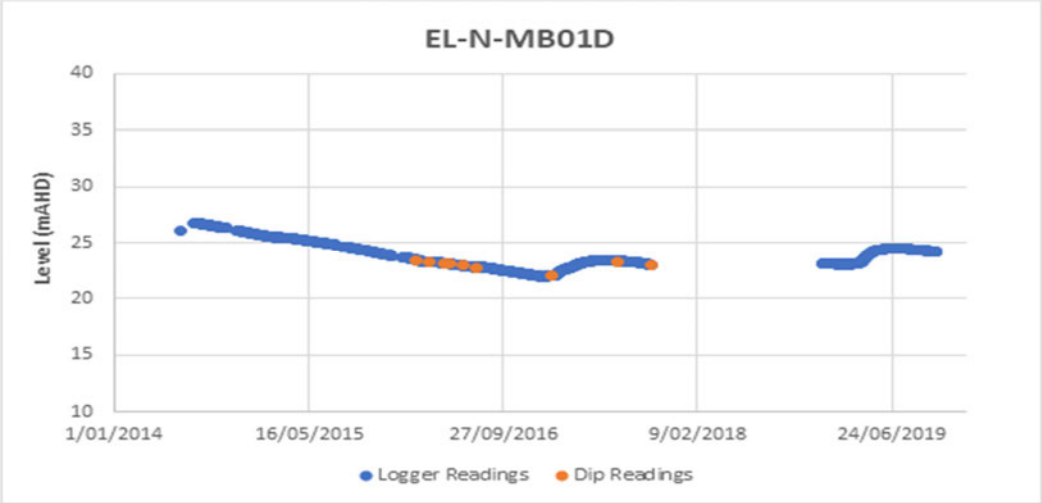
Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.003
Iron	mg/L	0.05	< 0.05	0.09	0.26
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.007	0.020	0.104
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	< 0.001
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	< 0.005	0.015

** Excluding outliers*

9.6 Groundwater Monitoring Results Summary

Note: Refer to Figure 6-3 for the location of groundwater monitoring sites

Bore EL-N-MB01D – Water Levels



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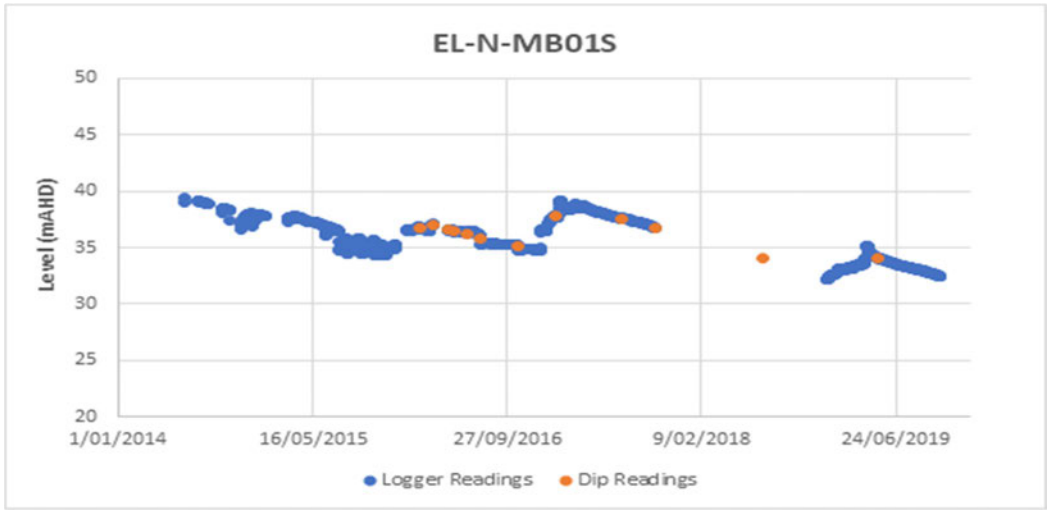

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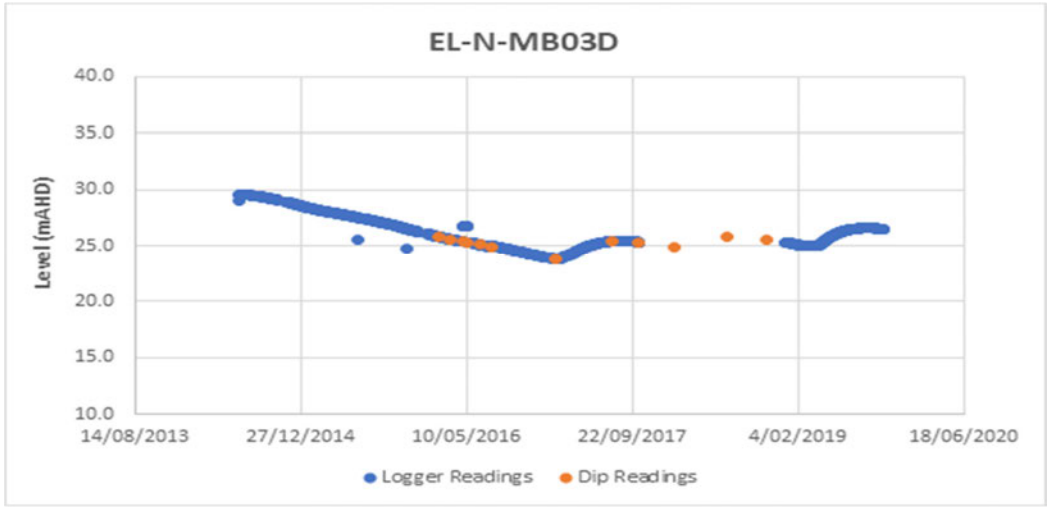

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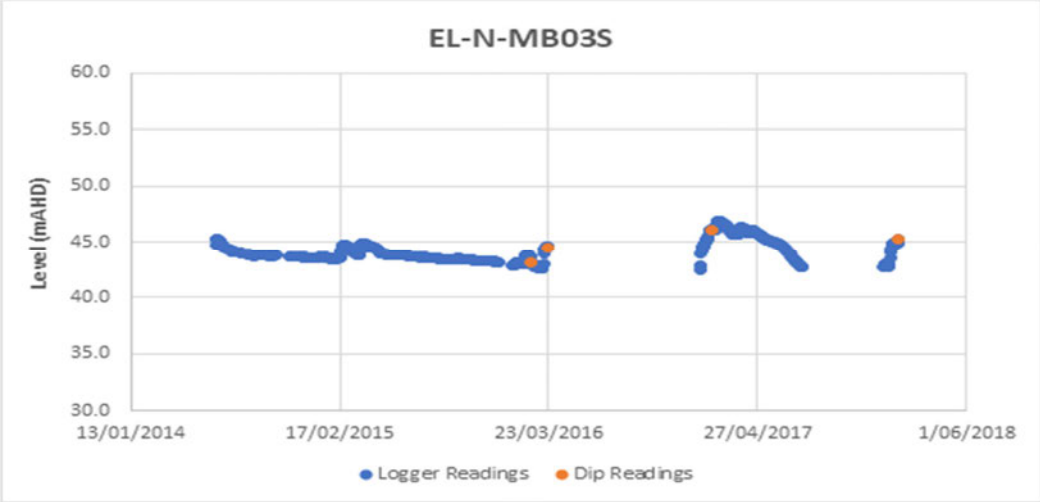

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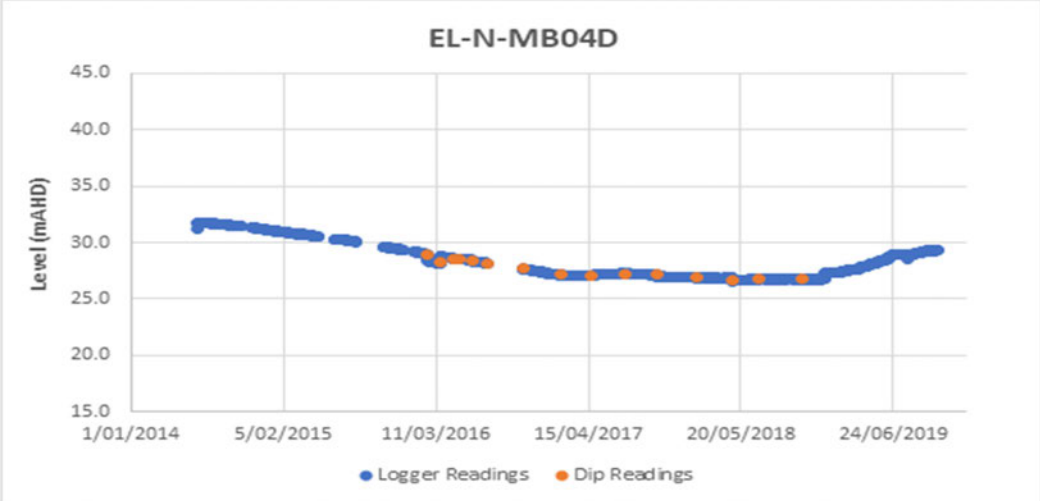
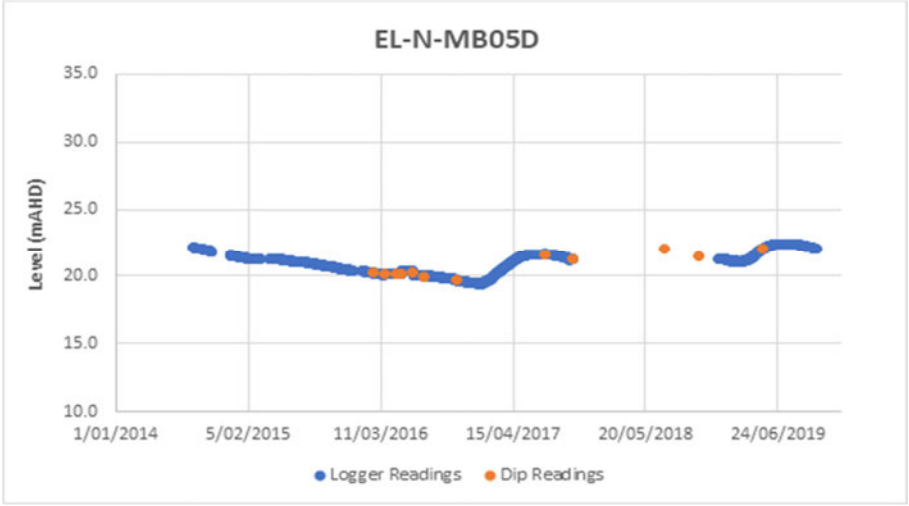
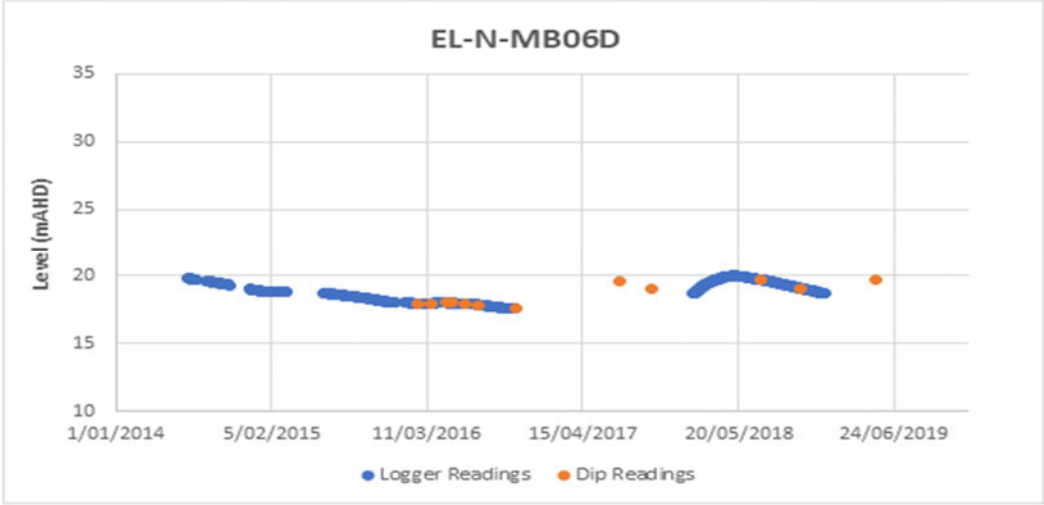


Bore EL-S-MB05D – Water Levels



Bore EL-S-MB06D – Water Levels



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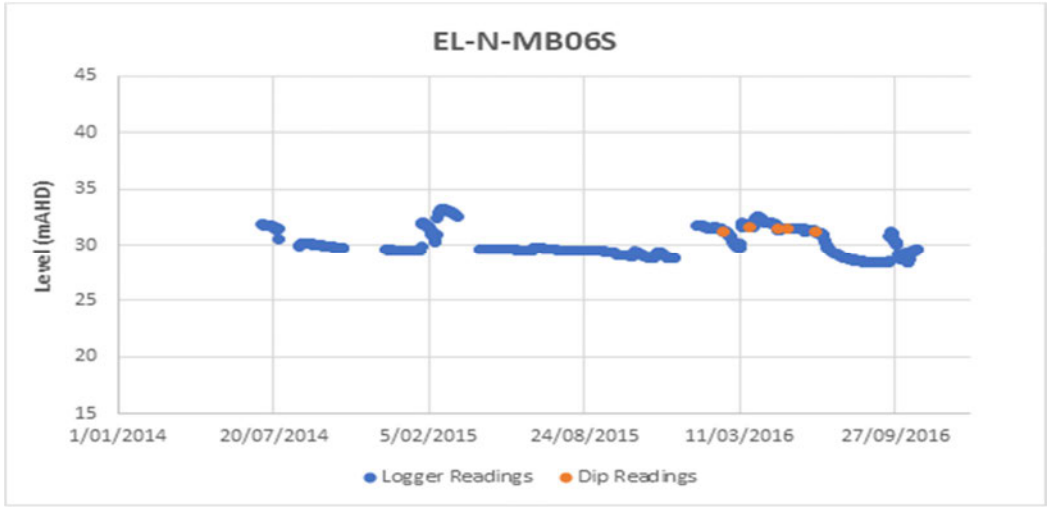
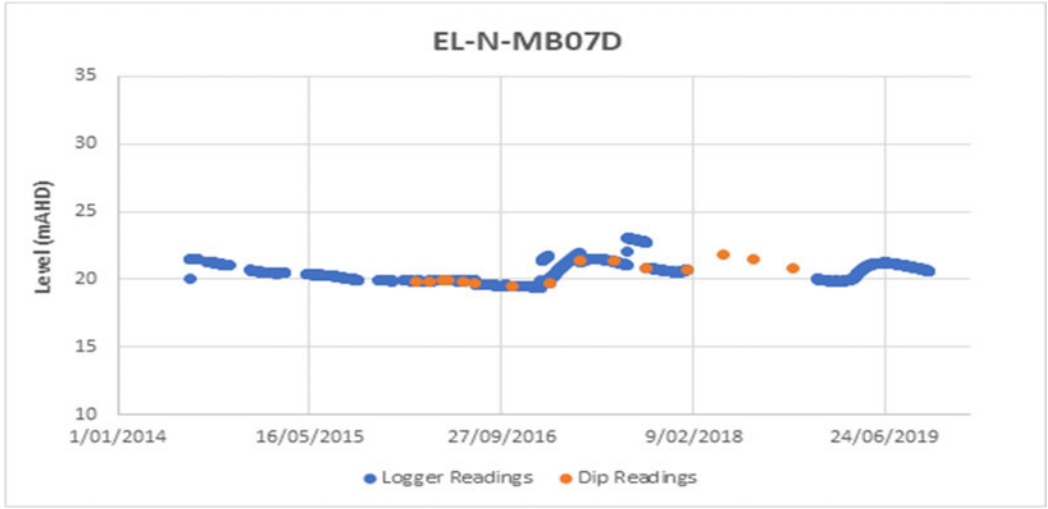
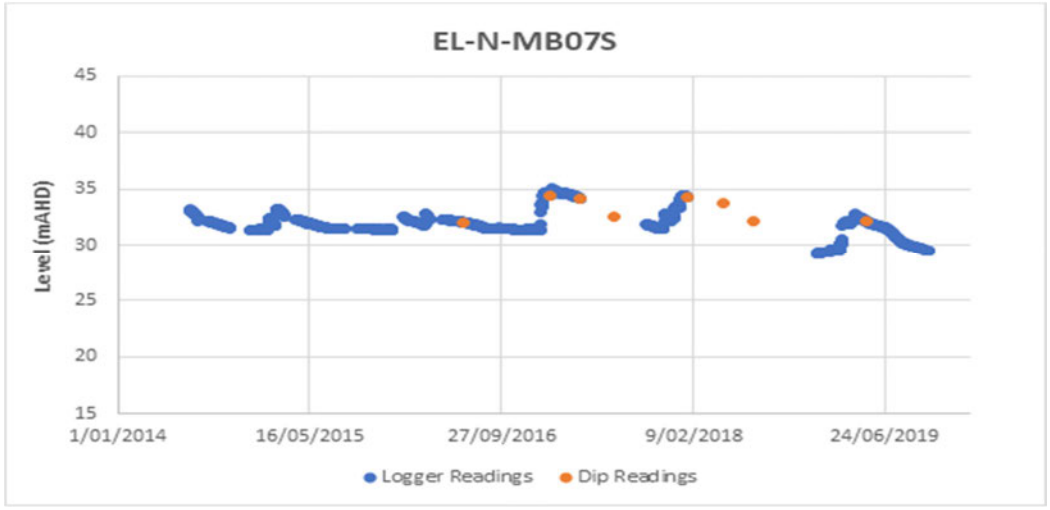


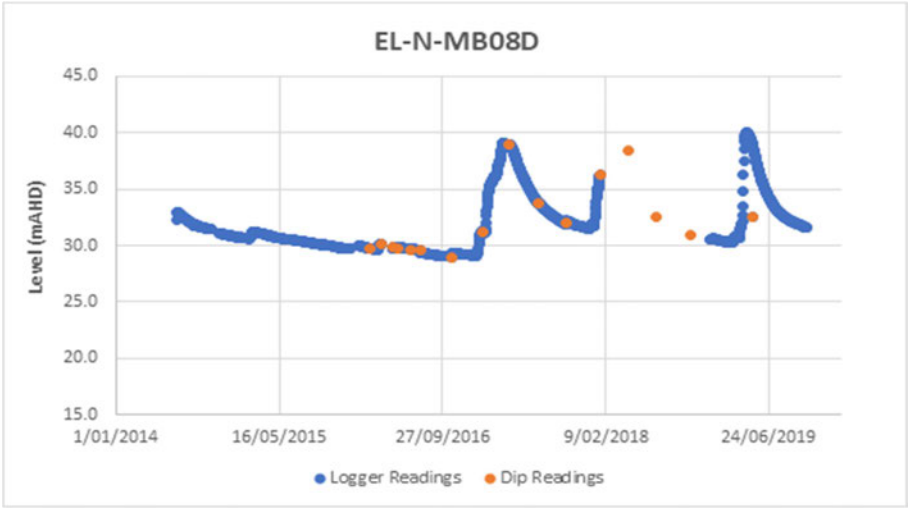
Bore EL-S-MB07D – Water Levels



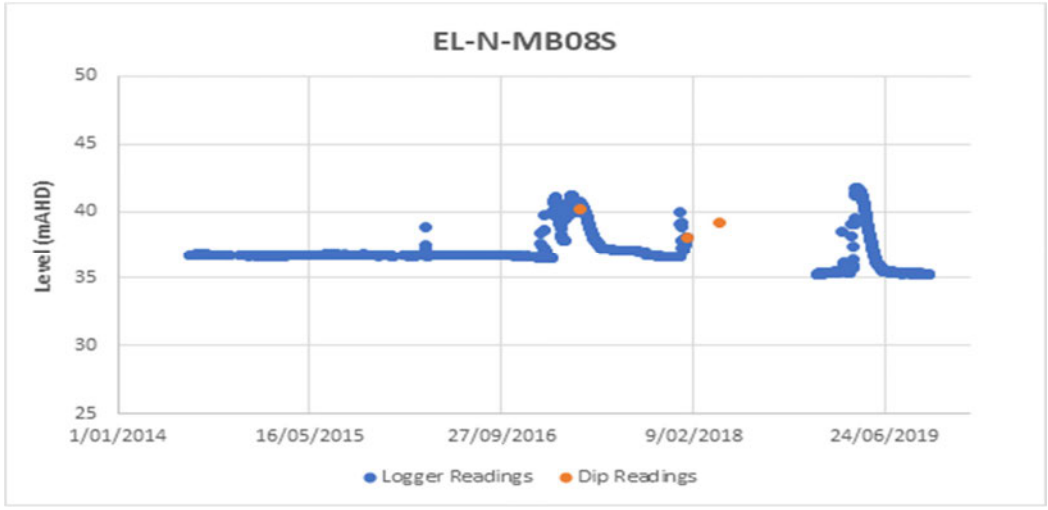
Bore EL-S-MB07S – Water Levels



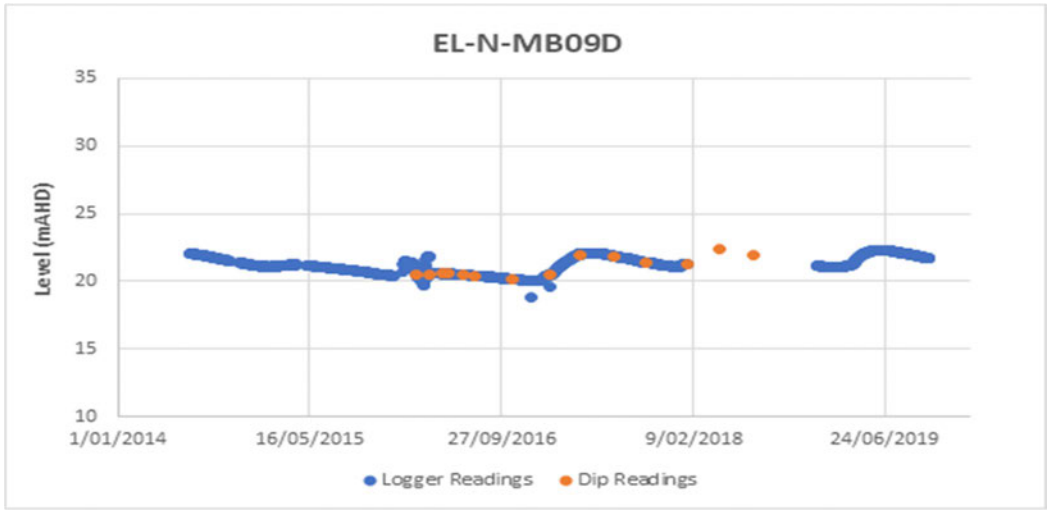
Bore EL-S-MB08D – Water Levels



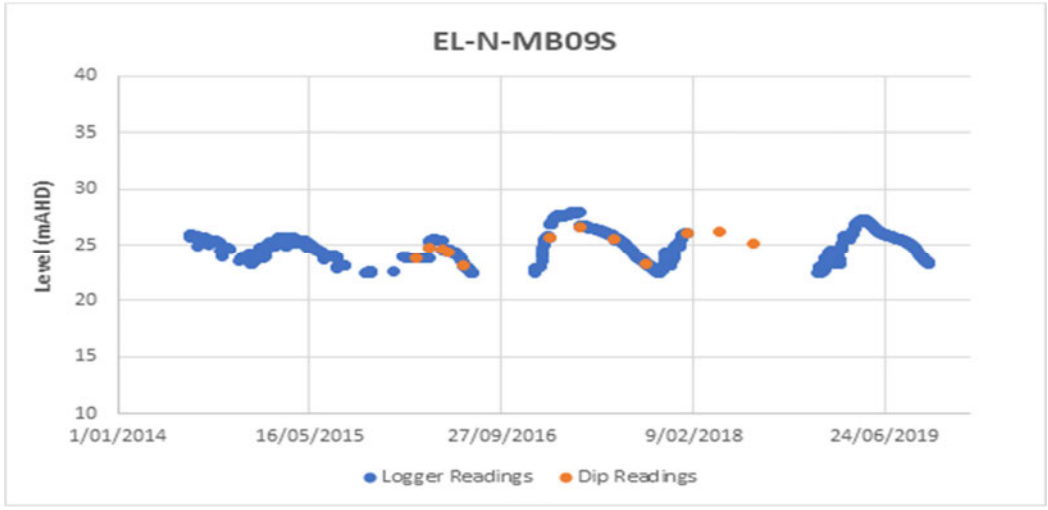
Bore EL-S-MB08S – Water Levels



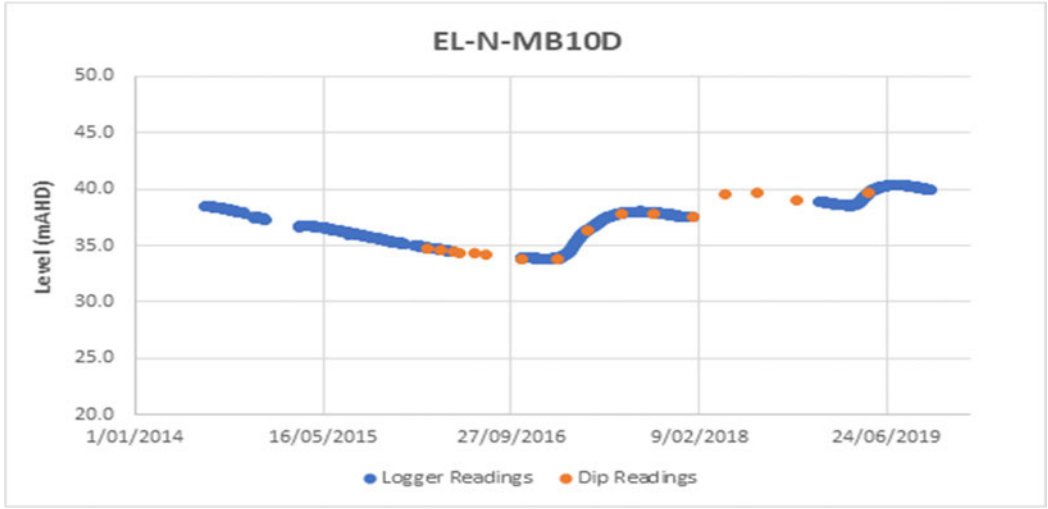
Bore EL-S-MB09D – Water Levels



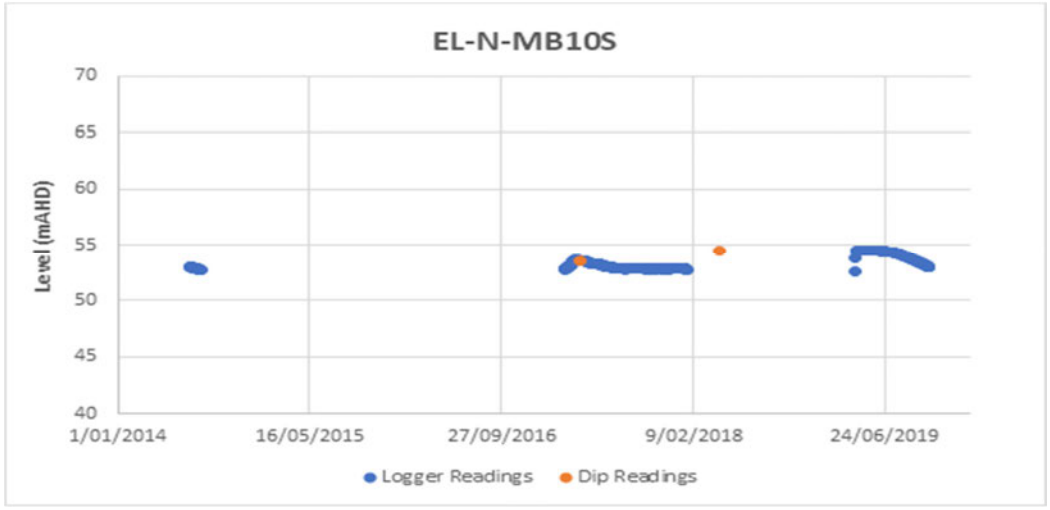
Bore EL-S-MB09S – Water Levels



Bore EL-S-MB10D – Water Levels



Bore EL-S-MB10S – Water Levels


EL-N-MB10S
70
65
60
55
50
45
40
Level (mAHD)
1/01/2014
16/05/2015
27/09/2016
9/02/2018
24/06/2019
Logger Readings
Dip Readings

Bore EL-N-MB01D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.3	4.7	5.0
Electrical conductivity	µS/cm	1	40	64	86
Dissolved oxygen	mg/L		4.9	5.8	6.9
Temperature	°C		27.9	29.6	32.6
Total hardness	mg/L	1	< 1	< 1	7
Bicarbonate alkalinity	mg/L	1	2	4	13
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	2	4	13
Major Ions					
Total anions	meq/L	0.01	0.32	0.40	0.56
Total cations	meq/L	0.01	0.22	0.30	0.48
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.18
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.02	0.03
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.01	0.02
Iron	mg/L	0.05	< 0.05	< 0.05	0.08
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.02	0.03	0.15
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.06
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.03
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.7
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.7
Ammonium	mg/L	0.01	0.03	0.24	0.44
Total Phosphorous	mg/L	0.01	< 0.01	0.01	0.22

Bore EL-N-MB01S – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	5.0	6.1	6.4
Electrical conductivity	µS/cm	1	133	319	903
Dissolved oxygen	mg/L		1.1	5.6	6.8
Temperature	°C		28.3	30.2	31.8
Total hardness	mg/L	1	4	14	106
Bicarbonate alkalinity	mg/L	1	22	47	130
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	22	47	130
Major Ions					
Total anions	meq/L	0.01	2.1	4.55	17.2
Total cations	meq/L	0.01	2.08	4.47	15.1
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.09	0.85
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.05	0.16
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	0.06	0.18
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.02	0.17
Iron	mg/L	0.05	< 0.05	< 0.05	3.43
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.18	0.47	2.15
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.07
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.06
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	0.3	2.8
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	0.2	2.8
Ammonium	mg/L	0.01	0.01	0.05	0.08
Total Phosphorous	mg/L	0.01	0.02	0.12	2.62

Bore EL-N-MB01S – Water Quality

Parameter	Units	Limit of Reporting	Minimum*	Median*	Maximum*
Physical and Chemical Parameters					
pH	pH unit	0.1			
Electrical conductivity	µS/cm	1			
Dissolved oxygen	mg/L				
Temperature	°C				
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	33	33	33
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	33	33	33
Major Ions					
Total anions	meq/L	0.01	1.15	1.15	1.15
Total cations	meq/L	0.01	1.09	1.09	1.09
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	13.4	13.4	13.4
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.34	0.34	0.34
Beryllium	mg/L	0.001	0.01	0.01	0.01
Boron	mg/L	0.05	0.07	0.07	0.07
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	0.01	0.01	0.01
Cobalt	mg/L	0.001	0.01	0.01	0.01
Copper	mg/L	0.001	0.02	0.02	0.02
Iron	mg/L	0.05	13.6	13.6	13.6
Lead	mg/L	0.001	0.04	0.04	0.04
Manganese	mg/L	0.001	0.51	0.51	0.51
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	0.01	0.01	0.01
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	0.02	0.02	0.02
Vanadium	mg/L	0.01	0.02	0.02	0.02
Zinc	mg/L	0.005	0.06	0.06	0.06
Nutrients					
Total Nitrogen	mg/L	0.1	0.2	0.2	0.2
Nitrate and Nitrite	mg/L	0.01			
Total Kjeldahn Nitrogen	mg/L	0.1	0.2	0.2	0.2
Ammonium	mg/L	0.01			
Total Phosphorous	mg/L	0.01	0.29	0.29	0.29

** Only one result measured at this bore*

Bore EL-N-MB03D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.0	4.4	4.8
Electrical conductivity	µS/cm	1	42	60	83
Dissolved oxygen	mg/L		3.4	5.8	6.5
Temperature	°C		29.0	29.8	30.5
Total hardness	mg/L	1	< 1	< 1	< 1
Bicarbonate alkalinity	mg/L	1	2	3	8
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	22=	3	8
Major Ions					
Total anions	meq/L	0.01	0.31	0.39	0.52
Total cations	meq/L	0.01	0.26	0.30	0.43
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.02
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	< 0.01	0.03	0.05
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.03	0.05
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	0.01
Manganese	mg/L	0.001	< 0.001	0.05	0.39
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.05
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.03
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	3.0
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	3.0
Ammonium	mg/L	0.01	< 0.01	0.03	0.04
Total Phosphorous	mg/L	0.01	< 0.01	< 0.01	0.14

Bore EL-N-MB03S – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.5	4.7	5.1
Electrical conductivity	µS/cm	1	53	69	96
Dissolved oxygen	mg/L		4.3	5.8	6.4
Temperature	°C		28.6	30.3	31.2
Total hardness	mg/L	1	< 1	< 1	7
Bicarbonate alkalinity	mg/L	1	8	12	26
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	8	12	26
Major Ions					
Total anions	meq/L	0.01	0.38	0.46	0.96
Total cations	meq/L	0.01	0.26	0.39	0.92
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.06	0.26
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.03	0.06
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	0.06
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.02	0.31
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.02	0.04	0.10
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.06
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.03
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	0.2	2.0
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.3
Ammonium	mg/L	0.01	0.02	0.02	0.02
Total Phosphorous	mg/L	0.01	< 0.01	< 0.01	0.03

Bore EL-N-MB04D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.2	4.7	5.1
Electrical conductivity	µS/cm	1	8	37	52
Dissolved oxygen	mg/L		4.7	6.1	8.3
Temperature	°C		27.7	30.4	33.5
Total hardness	mg/L	1	< 1	< 1	13
Bicarbonate alkalinity	mg/L	1	< 1	4	26
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	4	26
Major Ions					
Total anions	meq/L	0.01	0.18	0.26	0.96
Total cations	meq/L	0.01	0.13	0.17	0.53
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.02
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.02	0.04
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.01	0.03
Iron	mg/L	0.05	< 0.05	< 0.05	0.06
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.02	0.08	5.8
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.05
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.02
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.6
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.6
Ammonium	mg/L	0.01	0.02	0.05	0.12
Total Phosphorous	mg/L	0.01	< 0.01	0.01	0.80

Bore EL-N-MB05D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	5.1	5.4	5.9
Electrical conductivity	µS/cm	1	84	123	196
Dissolved oxygen	mg/L		0.7	4.1	6.3
Temperature	°C		28.4	30.2	34.7
Total hardness	mg/L	1	< 1	< 1	4
Bicarbonate alkalinity	mg/L	1	26	30	38
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	26	30	38
Major Ions					
Total anions	meq/L	0.01	0.93	1.07	1.17
Total cations	meq/L	0.01	0.83	0.94	1.11
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.01	0.04
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	< 0.01	< 0.01	0.01
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	-	-	-
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.01
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	< 0.001	0.01	0.07
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.03
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.03
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	0.1	0.3
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.2
Ammonium	mg/L	0.01	< 0.01	0.03	0.07
Total Phosphorous	mg/L	0.01	0.09	0.22	0.55

Bore EL-S-MB06D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.1	4.7	5.7
Electrical conductivity	µS/cm	1	41	49	89
Dissolved oxygen	mg/L		4.8	5.9	7.1
Temperature	°C		28.4	29.0	31.4
Total hardness	mg/L	1	< 1	< 1	22
Bicarbonate alkalinity	mg/L	1	< 1	3	28
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	3	28
Major Ions					
Total anions	meq/L	0.01	0.32	0.38	1.14
Total cations	meq/L	0.01	0.22	0.26	0.97
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.05
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.02	0.04
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	0.0004
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.04	0.17
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	0.02
Manganese	mg/L	0.001	0.023	0.036	1.2
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.05
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.42
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.7
Nitrate and Nitrite	mg/L	0.01	< 0.01	0.02	0.03
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.7
Ammonium	mg/L	0.01	< 0.01	0.02	0.03
Total Phosphorous	mg/L	0.01	< 0.01	< 0.01	0.19

Bore EL-S-MB06S – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.6	5.5	6.0
Electrical conductivity	µS/cm	1	41	55	83
Dissolved oxygen	mg/L		1.2	4.2	6.1
Temperature	°C		28.7	29.8	30.8
Total hardness	mg/L	1	< 1	< 1	22
Bicarbonate alkalinity	mg/L	1	3	5	36
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	3	5	36
Major Ions					
Total anions	meq/L	0.01	0.32	0.44	1.09
Total cations	meq/L	0.01	0.22	0.35	0.92
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.03	0.2
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.02	0.07
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	0.0015
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.01	0.12
Iron	mg/L	0.05	< 0.05	0.06	0.46
Lead	mg/L	0.001	< 0.001	< 0.001	0.01
Manganese	mg/L	0.001	0.03	0.093	0.252
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	< 0.001	0.05
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.009	0.886
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.7
Nitrate and Nitrite	mg/L	0.01	< 0.01	0.04	0.5
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.3
Ammonium	mg/L	0.01			
Total Phosphorous	mg/L	0.01	< 0.01	0.01	0.12

Bore EL-N-MB07D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.2	4.7	5.2
Electrical conductivity	µS/cm	1	36	63	87
Dissolved oxygen	mg/L		2.3	5.8	6.6
Temperature	°C		28.7	29.4	31.2
Total hardness	mg/L	1	< 1	< 1	67
Bicarbonate alkalinity	mg/L	1	2	7	136
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	2	7	136
Major Ions					
Total anions	meq/L	0.01	0.36	0.42	4.21
Total cations	meq/L	0.01	0.26	0.30	4.37
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.04
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.03	0.05	0.1
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	0.01
Copper	mg/L	0.001	< 0.001	0.01	0.06
Iron	mg/L	0.05	< 0.05	< 0.05	0.91
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.11	0.29	5.0
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	0.01	0.01	0.06
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.05
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	1.5
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	1.5
Ammonium	mg/L	0.01	0.02	0.03	0.07
Total Phosphorous	mg/L	0.01	< 0.01	0.02	0.71

Bore EL-N-MB07S – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.3	4.3	5.3
Electrical conductivity	µS/cm	1	27	44	55
Dissolved oxygen	mg/L		0.7	6.1	6.9
Temperature	°C		28.0	29.2	30.5
Total hardness	mg/L	1	< 1	< 1	4
Bicarbonate alkalinity	mg/L	1	3	6	11
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	3	6	11
Major Ions					
Total anions	meq/L	0.01	0.28	0.34	0.49
Total cations	meq/L	0.01	0.09	0.26	0.34
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.02	0.05
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	< 0.001	0.01	0.08
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.01	0.12
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.03	0.10	1.31
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.05
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.05
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.4
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.2
Ammonium	mg/L	0.01	< 0.01	0.01	0.05
Total Phosphorous	mg/L	0.01	< 0.01	< 0.01	0.05

Bore EL-N-MB08D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					
pH	pH unit	0.1	4.3	4.7	5.5
Electrical conductivity	µS/cm	1	53	84	118
Dissolved oxygen	mg/L		-0.2	6.1	7.7
Temperature	°C		28.8	29.1	30.2
Total hardness	mg/L	1	< 1	< 1	26
Bicarbonate alkalinity	mg/L	1	4	9	50
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	4	9	50
Major Ions					
Total anions	meq/L	0.01	0.43	0.59	1.74
Total cations	meq/L	0.01	0.26	0.43	1.71
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.01	0.02
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.02	0.04	0.11
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	0.01
Copper	mg/L	0.001	< 0.001	0.01	0.17
Iron	mg/L	0.05	< 0.05	0.14	0.33
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.75	1.38	6.01
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.04
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.07
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.5
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.2
Ammonium	mg/L	0.01	0.02	0.05	0.15
Total Phosphorous	mg/L	0.01	< 0.01	0.01	0.15

Bore EL-N-MB08S – Water Quality

Parameter	Units	Limit of Reporting	Minimum*	Median*	Maximum*
Physical and Chemical Parameters					
pH	pH unit	0.1	4.2	4.7	5.0
Electrical conductivity	µS/cm	1	65	87	163
Dissolved oxygen	mg/L		3.5	6.2	6.5
Temperature	°C		29.1	29.2	30.6
Total hardness	mg/L	1	< 1	< 1	26
Bicarbonate alkalinity	mg/L	1	8	29	216
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	8	29	216
Major Ions					
Total anions	meq/L	0.01	0.60	1.36	10.6
Total cations	meq/L	0.01	0.48	1.12	10.0
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	0.05	0.08	0.15
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.05	0.08	1.01
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	0.09
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	0.01
Copper	mg/L	0.001	< 0.001	0.05	0.09
Iron	mg/L	0.05	< 0.05	0.52	11.0
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.28	0.87	15.3
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	0.01	0.01	0.04
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	0.01	0.03	0.03
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	0.2	1.2
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	0.2	1.2
Ammonium	mg/L	0.01	< 0.01	0.02	0.06
Total Phosphorous	mg/L	0.01	0.01	0.02	0.17

** Limited sample size for this bore*

Bore EL-N-MB09D – Water Quality

Parameter	Units	Limit of Reporting	Minimum*	Median*	Maximum*
Physical and Chemical Parameters					
pH	pH unit	0.1	3.7	4.5	4.9
Electrical conductivity	µS/cm	1	29	71	98
Dissolved oxygen	mg/L		3.5	5.8	6.7
Temperature	°C		28.6	30.1	31.8
Total hardness	mg/L	1	< 1	< 1	2
Bicarbonate alkalinity	mg/L	1	< 1	3	10
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	3	10
Major Ions					
Total anions	meq/L	0.01	0.36	0.42	0.52
Total cations	meq/L	0.01	0.26	0.30	0.35
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.02
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.02	0.03	0.03
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.01	0.03
Iron	mg/L	0.05	< 0.05	< 0.05	< 0.05
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.03	0.04	0.15
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.04
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.03
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.2
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.2
Ammonium	mg/L	0.01	< 0.01	0.04	0.07
Total Phosphorous	mg/L	0.01	< 0.01	0.02	0.4

Bore EL-N-MB09S – Water Quality

Parameter	Units	Limit of Reporting	Minimum*	Median*	Maximum*
Physical and Chemical Parameters					
pH	pH unit	0.1	3.7	4.5	5.0
Electrical conductivity	µS/cm	1	33	182	280
Dissolved oxygen	mg/L		1.6	5.7	6.5
Temperature	°C		29.1	30.1	31.8
Total hardness	mg/L	1	8	21	79
Bicarbonate alkalinity	mg/L	1	2	8	20
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	2	8	20
Major Ions					
Total anions	meq/L	0.01	0.92	1.47	3.94
Total cations	meq/L	0.01	0.86	1.50	3.87
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	0.07	0.23
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.05	0.10	0.17
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	0.08
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	0.03	0.85
Iron	mg/L	0.05	< 0.05	< 0.05	0.11
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.48	1.23	2.95
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	0.01	0.01	0.08
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	0.01	0.01	0.2
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	0.2	0.4
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.3
Ammonium	mg/L	0.01	< 0.01	0.01	0.05
Total Phosphorous	mg/L	0.01	< 0.01	0.03	0.69

Bore EL-N-MB10D – Water Quality

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
Physical and Chemical Parameters					

Parameter	Units	Limit of Reporting	Minimum	Median	Maximum
pH	pH unit	0.1	4.6	5.3	5.9
Electrical conductivity	µS/cm	1	92	127	217
Dissolved oxygen	mg/L		0.8	6.1	8.9
Temperature	°C		28.5	29.4	30.4
Total hardness	mg/L	1	11	11	36
Bicarbonate alkalinity	mg/L	1	< 1	22	59
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	< 1	22	59
Major Ions					
Total anions	meq/L	0.01	0.88	1.15	2.33
Total cations	meq/L	0.01	0.82	1.00	2.37
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	< 0.01	< 0.01	0.57
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.01	0.02	0.04
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	0.06
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	0.02
Iron	mg/L	0.05	< 0.05	< 0.05	0.38
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	2	2	5
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.03
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	< 0.005	0.01	0.06
Nutrients					
Total Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.6
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	< 0.1	< 0.1	0.5
Ammonium	mg/L	0.01	< 0.01	0.01	0.08
Total Phosphorous	mg/L	0.01	< 0.01	0.02	0.42

** Excluding outliers*

Bore EL-N-MB10S – Water Quality

Parameter	Units	Limit of Reporting	Minimum*	Median*	Maximum*
Physical and Chemical Parameters					
pH	pH unit	0.1	4.8	5.0	5.2
Electrical conductivity	µS/cm	1	68	116	164
Dissolved oxygen	mg/L		2.7	4.5	6.3
Temperature	°C		29.6	29.8	30.1
Total hardness	mg/L	1	81	81	81
Bicarbonate alkalinity	mg/L	1	4	16.5	116
Carbonate alkalinity	mg/L	1	< 1	< 1	< 1
Hydroxide alkalinity	mg/L	1	< 1	< 1	< 1
Total alkalinity	mg/L	1	4	16.5	116
Major Ions					
Total anions	meq/L	0.01	0.83	1.01	3.19
Total cations	meq/L	0.01	0.80	1.05	3.29
Dissolved Metals and Metalloids					
Aluminium	mg/L	0.01	0.03	0.05	0.13
Arsenic	mg/L	0.001	< 0.001	< 0.001	< 0.001
Barium	mg/L	0.001	0.05	0.06	0.12
Beryllium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Boron	mg/L	0.05	< 0.05	< 0.05	0.07
Cadmium	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001
Copper	mg/L	0.001	< 0.001	< 0.001	< 0.001
Iron	mg/L	0.05	< 0.05	0.08	0.42
Lead	mg/L	0.001	< 0.001	< 0.001	< 0.001
Manganese	mg/L	0.001	0.28	0.35	1.83
Mercury	mg/L	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel	mg/L	0.001	< 0.001	0.01	0.01
Selenium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Uranium	mg/L	0.001	< 0.001	< 0.001	< 0.001
Vanadium	mg/L	0.01	< 0.01	< 0.01	< 0.01
Zinc	mg/L	0.005	0.01	0.02	0.02
Nutrients					
Total Nitrogen	mg/L	0.1	0.2	0.4	0.5
Nitrate and Nitrite	mg/L	0.01	< 0.01	< 0.01	< 0.01
Total Kjeldahn Nitrogen	mg/L	0.1	0.1	0.4	0.5
Ammonium	mg/L	0.01	< 0.01	0.03	0.21
Total Phosphorous	mg/L	0.01	0.01	0.04	0.06

** Limited sample size for this bore*

9.7 Eastern Leases Environmental Management Plans

Note: Environmental Management Plans provided separately due to file size

9.8 References

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