GMA Mining Australia

Mining Tenement M70/204 and M70/1330 Supporting Documentation for a Native Vegetation Clearing Permit Application

Contents

Abbreviations

Abbreviation	Definition
BAM Act	Biosecurity and Agricultural Management Act 2007
BoM	Bureau of Meteorology
DAWE	Department of Agriculture, Water and Envrionment
DBCA	Department of Biodiversity, Conservation and Attractions
DP	Declared Pest
DWER	Department of Water and Environmental Regulation
EP Act	*Environmental Protection Act 1986*
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
ESA	Environmentally Sensitive Area
NVCP	Native Vegetation Clearing Permit
PEC	Priority Ecological Community
RIWI Act	*Rights in Water and Irrigation Act 1914*
TEC	Threatened Ecological Community
BC Act	*Biodiversity and Conservation Act 2016*

1. Introduction

1.1 Background

GMA Garnet Pty Ltd (GMA) is a wholly-owned subsidiary of Garnet International Resources Pty Ltd. GMA owns and operates the garnet mineral sand mining, and processing operations in the Mid-West Region, Port Gregory, Western Australia. GMA operates two open cut alluvial garnet mines, the Hose Mine (tenements G70/171, M70/856, M70/926 and M70/927) and the Lynton Mine (tenements M70/204, M70/259, M70/968, M70/1330 and M70/1331). Mining is currently undertaken within M70/204 (Lynton north and south pit) and M70/926. All ore is processed at the wet separation plant (wet plant) located on M70/856.

The proposal covers mostly the existing mining void ("Old Dune Pit"), haul roads, the Lynton borefield water storage area and exploration drill lines. The overall purpose of this application is for the completion of mining and progressive rehabilitation of the old dune pit, upgrading and expansion of water storage facilities in the Lynton Borefield Water Storage area, exploration works and expansion of the Lynton North Pit. The application includes the following clearing activities

- Clearing of regrowth and remnant vegetation associated with the Old Dune Pit
- Clearing of regrowth and remnant vegetation for widening of the single lane haul road and Lynton Ramp Access Road
- Clearing of regrowth and remnant vegetation to facilitate upgrade works of the Lynton borefield water storage area.
- Clearing of native vegetation for exploration works as part of a Programme of Work (PoW) (pre-application stage).
- Clearing of native vegetation to facilitate expansion of the Lynton North Pit.
- Clearing of native vegetation for entrance realignment.
- Clearing of native vegetation to facilitate reinstatement of the former haul road.

The proposed clearing activities are shown in Figure 1.

A clearing permit is required under the *Environmental Protection (Clearing of Native Vegetation) Regulation 2004* and the *Environmental Protection Act 1986* (EP Act), which contains provisions that protect native vegetation while allowing the approved clearing activities.

1.2 Document Purpose

The purpose of this document is to provide the supporting information for a native vegetation clearing permit (NVCP) under Section 50E of Part V of the *Environmental Protection Act 1986*, to clear no more 58.96 hectares (ha) within the application area.

This document comprises the following:

- A description of the clearing details.
- Environmental Setting.
- Summary of rehabilitation undertaken within M70/204.
- Risk assessment and management.
- Assessment of the Ten Clearing Principles as defined in the Schedule 5 of the EP Act.

GMA commissioned GHD Pty Ltd (GHD, 2020a) to undertake a flora, vegetation and fauna survey, and a targeted flora survey (GHD, 2020b) of the application area. The information contained within the flora, vegetation and fauna survey informed the environmental assessment component of this report (Appendix A).

Both surveys supporting this NVCP application were previously submitted to the Index of Biodiversity Surveys for Assessments (IBSA). The submission details are summarised in Table 1.

Table 1 IBSA Submission Details

Report name	Submission number	IBSA number
GMA Garnet Pty Ltd Lynton Mine Expansion Biological Survey	IBSASUB-20201218-2A791C27	IBSA-2020-0538

2. Clearing description details

The clearing activities within the application area are outlined in the subsections below and mapped in Figure 1. Table 2, provides a summary of the various clearing activities within the application area.

Table 2 Clearing Activities within the Application Area

Activity	Ha
Completion of mining and progressively rehabilitating the Old Dune Pit and associated topsoil stockpiles	15.02
Single-lane haul road expansion	0.59
Lynton ramp access road	1.11
Lynton access road realignment	0.20
Upgrade works of the Lynton borefield water storage area.	1.14
Exploration works	27.54
Expansion of the Lynton north pit	13.01
Reinstate the former Lynton haul road	0.35
Application Area	**58.96**

2.1.1 Old Dune Pit

GMA proposes to clear native vegetation regrowth to expand the northern, eastern, and western portions of the existing mining pit, and complete mining of the Dune Pit. Once completed, the Dune Pit will be progressively rehabilitated and returned to native vegetation as per the Notice of Intent – Mining Lease M70/204 (NOI 3461) and Port Gregory Project – Revised Mine Closure Plan (Reg. ID: 85076) (Appendix B).

As part of rehabilitation, GMA requires to undertake clearing of native vegetation regrowth located west of the existing haul road to facilitate access to topsoil stockpiles. Topsoil will be progressively applied over the contour area within the Old Dune Pit.

The proposed clearing method will be a dozer with blades raised. Any vegetation matter will be stockpiled for future rehabilitation. The clearing extent is provided in Figure 1.

2.1.2 Single Lane Haul Road Expansion

A single lane haul road, located north of the Old Dune Pit requires widening to a standard haul road and to comply with the DMIRS' traffic management safety requirements. Clearing of a narrow tract of native vegetation on either of the existing single-lane haul road is required to facilitate. The haul road doubles as a firebreak as per the Shire of Northampton and *Bushfire Act 1954* requirements. The clearing extent is provided in Figure 1.

2.1.3 *Lynton Ramp Access Road*

Ore mined at Lynton is currently stockpiled in the middle portion of the existing North Pit Mining Void Ore and carted to the Hose wet plant via George Grey Drive in M70/856 by contract road haulage (Qube). A narrow tract of vegetation poses safety concerns to road users and requires clearing. The access road doubles as a firebreak as per the Shire of Northampton and *Bushfire Act 1954* requirements. The proposed disturbance footprint is covered mostly by cleared areas (current and historic). The clearing extent is provided in Figure 1.

2.1.4 *Lynton Borefield Water Storage Upgrade Project*

The Lynton Borefield Water Storage area comprises of two water tanks, which supplies the watercart for the purposes of dust suppression. GMA requires to increase the current water capacity, to ensure adequate for supply for dust suppression. The project involves the removal of the existing infrastructure and the installation of two large water storage tanks at two separate locations. A new water pipeline will need to be installed to supply water at the new standpipe location at the Dune Pit clearing location.

Clearing of native vegetation regrowth is also require to improve line of sight to ensure safe access by Contractors and GMA personnel, during the upgrade works. The proposed clearing method will be a dozer with blades raised. The clearing extent is provided in Figure 1.

2.1.5 *Exploration Works*

Further resource definition is required necessitating exploration drilling as part of a Programme of Work (PoW) (pre-application stage). The proposed drill program will establishment of 73 drill line tracks to access the drill holes within M70/204 and M70/1330. Proposed drill tracks will run in an east-west direction parallel to one another located approximately 15m to 91m apart. Where existing connecting roads intersect tracks, they will be used for access; where there is no link with an existing road, tracks running north-south will be established for connection.

Vegetation within the proposed area was rated as good to completely degraded. The clearing practice will include blade up clearing to preserve topsoil. This clearing method involves fitting a loader with a scrub rake and pushing through the vegetation, avoiding digging into the topsoil. The pushed over scrub is pushed to the end of the line or into an already cleared area adjacent to the line. All tracks will be limited to the width of the scrub rake. If it is established that exploration works in any section the proposed area can be carried out without clearing (i.e., the loader and drill rig can drive around a tree/bush etc.), then clearing of a track will be avoided. The works will be completed as part of a PoW and drill lines will be rehabilitated following completion of works.

2.1.6 *M70/204 North Pit Expansion*

Mining within the current North Pit is anticipated to completed in mid-2022. The current north pit clearing area was approved under CPS 9172/1. GMA plans to progress mining northwards at an anticipate rate of 15 hectares of native vegetation clearing per annum. The mining voids to be progressively backfilled and rehabilitated at the trailing edge of the pit, while mining activities continue at the leading edge, progressing northwards.

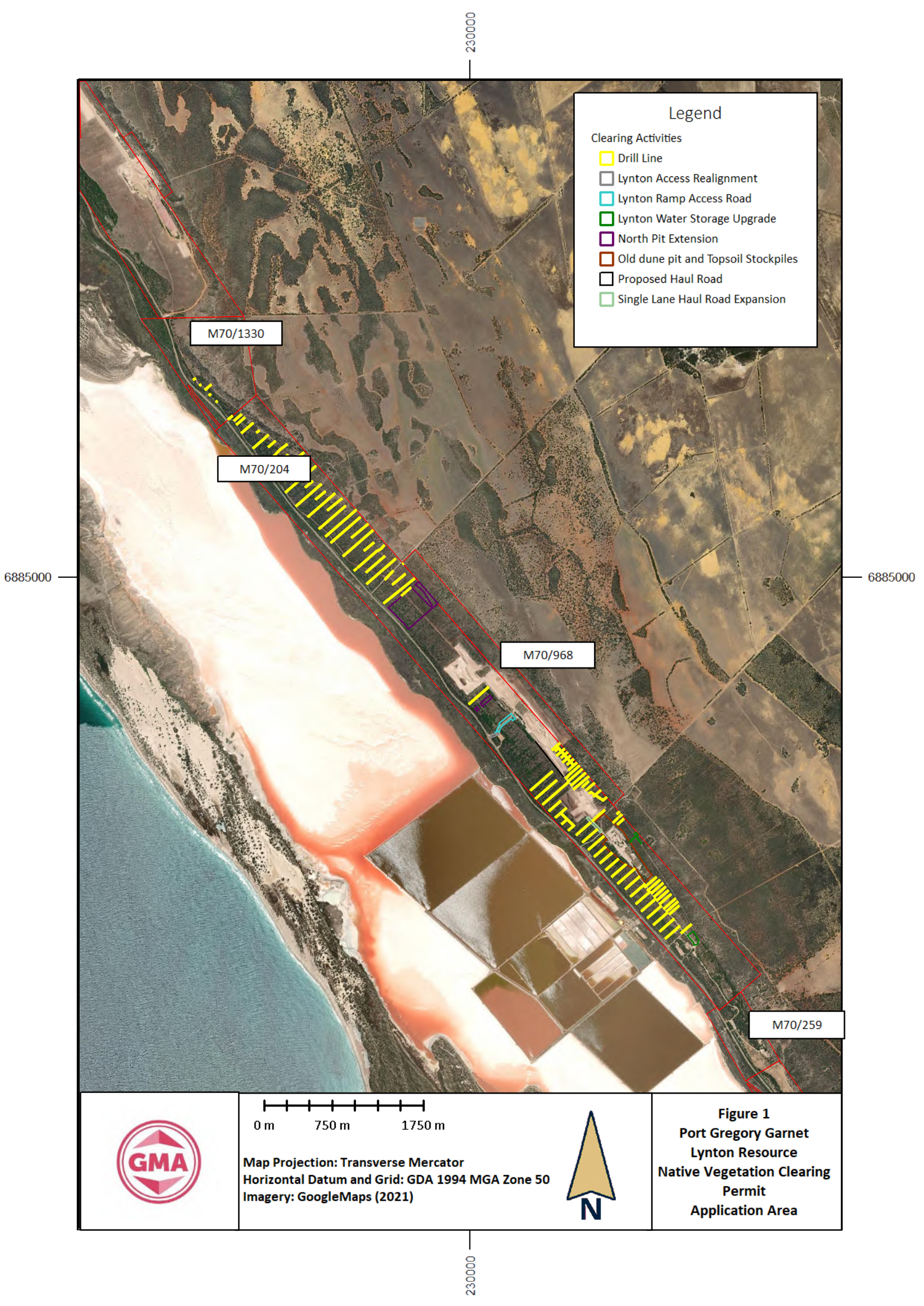
The mining area will be progressively rehabilitated and returned to native vegetation as per the Notice of Intent – Mining Lease M70/204 (NOI 3461) and Port Gregory Project – Revised Mine Closure Plan (Reg. ID: 85076).

GMA will continue to undertake rehabilitation works of the existing mining voids within Lynton. A summary of the current rehabilitation efforts undertaken is provided in section 4.2.5.

2.1.7 *Reinstate the former Lynton Haul Road*

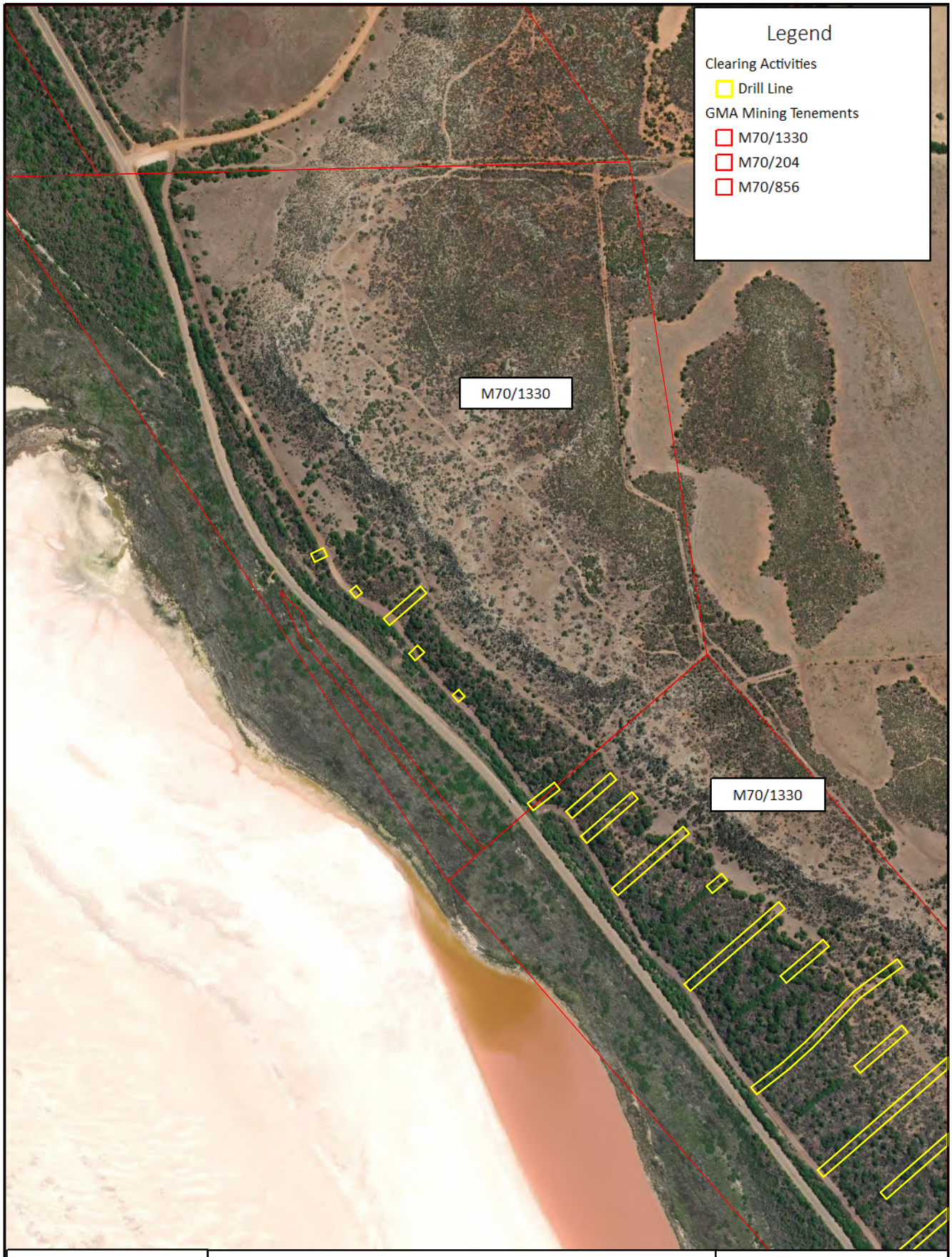
GMA are proposing to reinstate a previous haul road located within Lynton, M70/204. Native Vegetation Clearing Permit CPS91730/1 previously granted GMA to facilitate construction of the alignment; however, a review of the alignment was undertaken, which identified the alignment would meet the DMIRS'

requirements for operating a haul road. A further 0.35 hectares of native vegetation require clearing to facilitate the re-instatement of the form Lynton Haul Road.



Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Imagery: GoogleMaps (2021)

Figure 1
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Application Area



50 m 200 m 350 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Imagery: GoogleMaps (2021)

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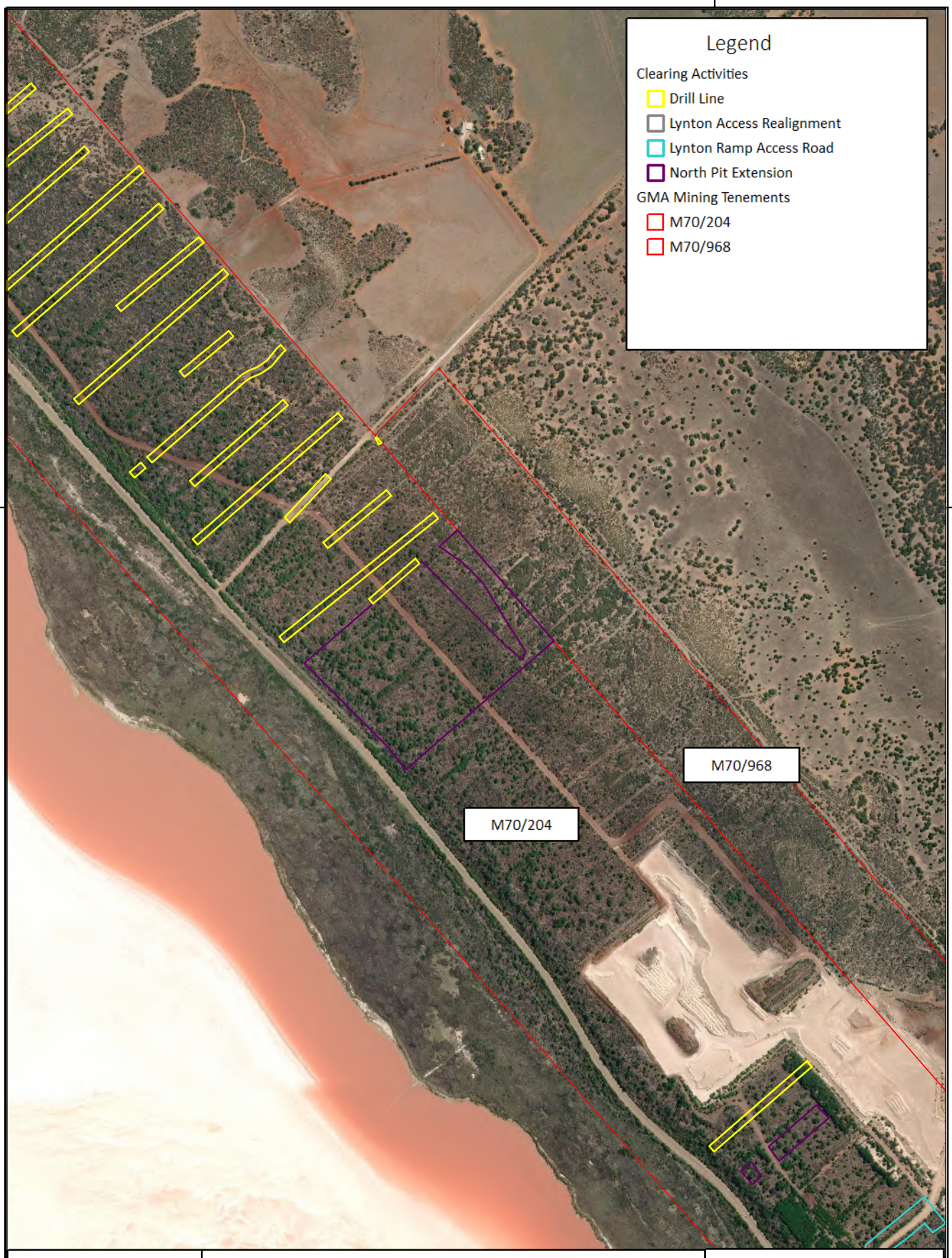
Figure 1
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Application Area



GMA

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GoogleMaps (2021)

Figure 1
Port Gregory Garnet
Lynton Resource
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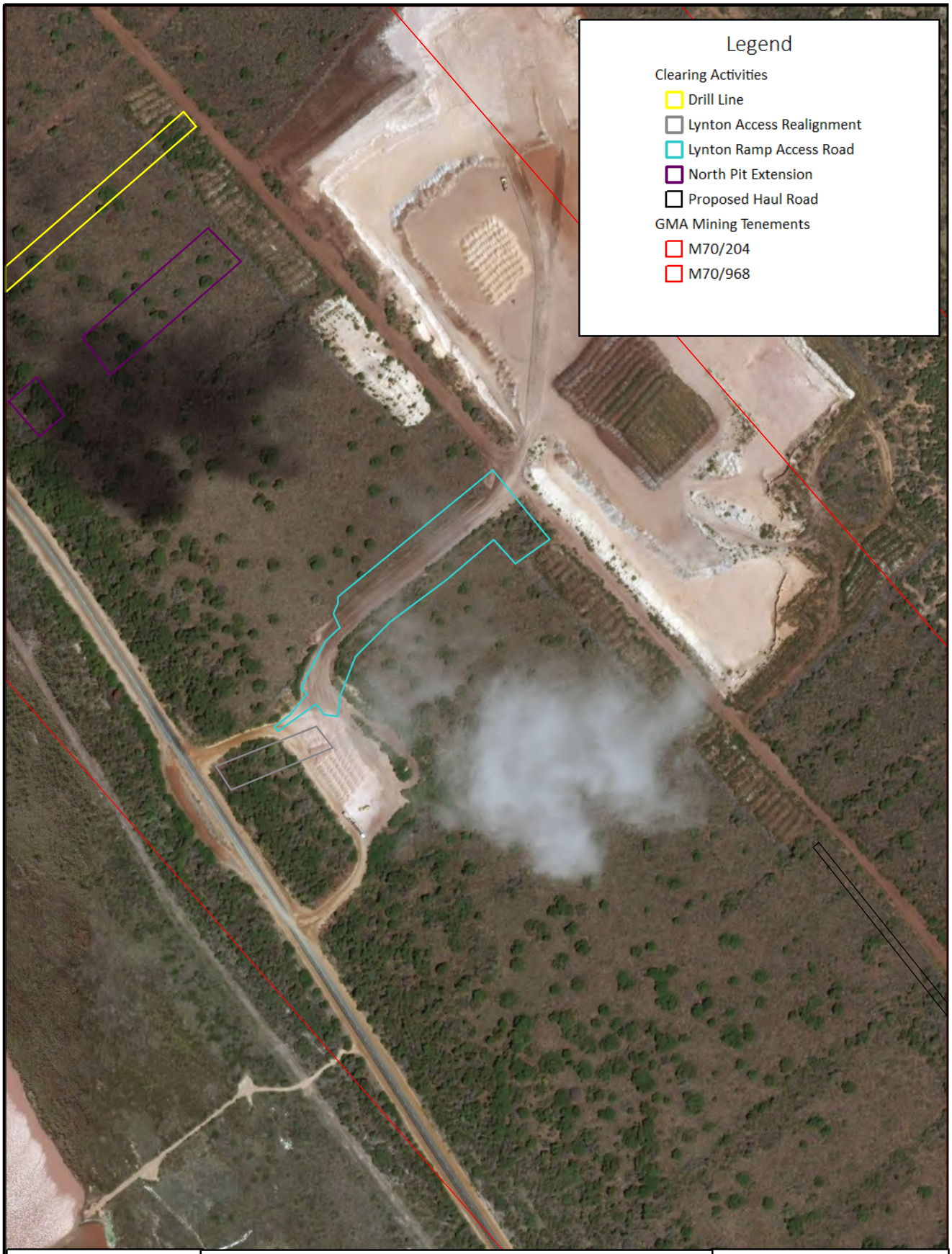
Application Area



GMA

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GoogleMaps(2021)

Figure 1
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Application Area

GMA

0 m 150 m 300 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Imagery: GoogleMaps (2021)

N

Figure 1
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Application Area

0 m 100 m 200 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Imagery: GoogleMaps (2021)

N

Figure 1
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Application Area

3. Environmental Setting

3.1 Climate

The application area is located within the Mid-West Region of Western Australia. The climate of Mid-West is considered warm semi-arid to Mediterranean climate with 400 to 500 mm of rainfall per annum (Desmond and Chant, 2002). The region experiences short mild, wet winter and the remainder of the year is warm to hot, dry to windy.

Annual Evaporation rate in the area is around 2,500 mm.

The nearest Bureau of Meteorological (BoM) station that provides reliable wind data is the Geraldton Airport (Site No. 8051). The BoM's Geraldton Airport 2007 meteorological file indicates dominant wind blows from the south and south-east direction, with a secondary prevailing wind from the north-east direction (Chart 1). Wind speeds between 2 and 6 m/s are most often observed, with wind speed reaching 8 m/s from the south-east direction.

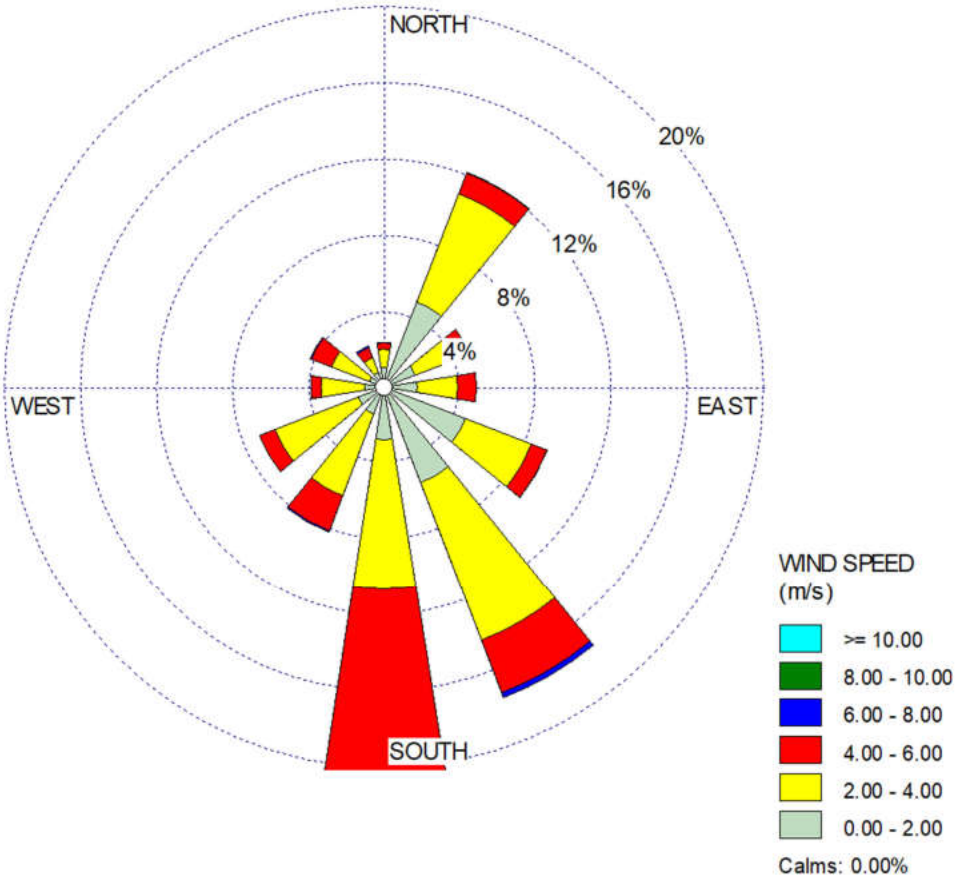


Chart 1 Wind rose (9 am and 3 pm) BoM 2007

3.2 Land use

3.2.1 Reserves

A search of the *NatureMap* database identified one DBCA listed reserve – Utcha Well Nature Reserve within 10 km of the application area (GHD, 2020a).

3.3 Landforms, geology and soils

The application area is covered by two soil-landscape mapping systems as described:

- The Grey System – Riverbeds, terraces and alluvial flats, includes dissected margins of relic alluvial plains
- Tamala North System – Low hills with relict dunes and some limestone outcrop. Forms a coastal band 3 to 7 km wide.

The application area is located within the Tumblagooda Sandstone, which is characterised by sandstone, with minor siltstone and granulate to pebble conglomerate. Most of the survey area is located on the Tamala North Land System, described as low hills with relict dunes and some limestone outcrop, which forms a coastal band 3 to 7 km wide. Parts of the western boundary of the survey area is located within the Grey Land System, described as riverbeds, terraces and alluvial flats, includes dissected margins of relic alluvial plains (GHD 2020a).

The topography of the application area ranged from 4 metres to 40 metres above sea level (Figure 2).

Soils within M70/204 were brown to orange sands (GHD, 2020a).

The average topsoil depth observed across the Lynton deposit through mining and exploration drilling is relatively shallow at between 0.2m to 0.4m. The soil depth varies from a few centimetres above limestone cap rock up in the east, to potentially 1m in areas towards the west. The soil is sandy and porous with a similar texture to the underlying paleo-dune sand and in profile the darker brown/orange soil colour grades into the lighter yellow/light brown/beige of the underlying sand.

Beneath the topsoil, a weathering profile extends to a depth generally between 0.5m to 2.0m. This zone characterised by an increase in fine calcareous material and contains nodules of calcium carbonate cemented sand. The base of the weathering zone varies from 0.5m to 2m and defined by a calcium carbonate nodule rich horizon. In some instances, this horizon has cemented into a discontinuous lens/pod of limestone up to 0.5m thick. The paleo-dunes are shell fragment rich, and it is weathering/dissolution of the shell fragments that provide calcium carbonate for precipitation into secondary nodules and limestone layers.

A characteristic of the local soil is the relatively high concentration of garnet mineral sand. The garnet is concentrated in the soil profile by weathering effects. Lighter minerals are blown or washed away over time whereas the heavy garnet mineral is left behind.

3.4 Hydrogeology and Hydrology

3.4.1 Surface water

The clearing application area is not located within a proclaimed surface water catchment area and has a low average annual rainfall (400 mm/year), however is subject to cyclonic events. The project is located on sandplains and have very little drainage lines because of the porous nature of the sandplain and underlying carbonate sedimentary to groundwater. URS (2013) identified that a small proportion of groundwater recharge originates from rainfall that infiltrates during the winter months and from episodic large rainfall events associated with cyclones (URS, 2013). GHD (2020a) did not record drainage lines within the clearing application area.

The sandplain is bounded to the east by a low limestone escarpment (Tamala Limestone). The Tamala Limestone consists of unconsolidated sands, limestone lenses/layers and patchy zones of carbonate cementation. Minor drainage lines occur on the slope of the Tamala Limestone escarpment.; however due to the porous nature of the underlying geology any rainfall will likely infiltrate to groundwater (URS, 2013).

The nearest surface water is the Hutt Lagoon is located approximately 100 metres west of the project and is approximately 15 km long and up to 2.5 km wide (Figure 4c). The Lagoon is listed as a wetland of national importance on the Directory of Important Wetlands in Australia (DIWA) and Environmentally Sensitive Area (DBCA, 2009). Water supply for the Hutt Lagoon derives from direct precipitation, surface inform from several minor creeks and seepage of groundwater (DEE 2019).

The Hutt Lagoon, which is located 200 m west of the application area, is listed as a wetland of national importance on the Directory of Important Wetlands in Australia (DIWA) (DEC 2009). Hutt Lagoon is a macroscale elongate sumpland aligned northwest to south-east, parallel to the coast. The Lagoon is usually partly filled with hypersaline water during winter for the remainder of the year, the Lagoon is usually dry. The Lagoon contains the world's largest microalgae production plan, a 250 hectares series of artificial ponds used to produce beta-carotene. During summer and in dry seasons, the Lagoon is mostly empty except the artificial ponds used for algal cultivation (URS, 2013). The Hutt Lagoon neighbours a macroscale elongate floodplain (to the north-west and the south-east) that include more than twenty microscale elongate sumplands such as Utcha Swamp (Jaensch 1992). Water supply for the Hutt Lagoon derives from direct precipitation, surface inform from several minor creeks and seepage of groundwater (DEC, 2009).

3.4.2 Groundwater

The Department of Water and Environmental Regulation (DWER) Perth Groundwater Map indicates the survey area is in within the Gascoyne Groundwater Area.

A superficial aquifer underlies the Application Area with superficial formation present are up to 15 m thick and become progressively thinner to the east. Sub-surface flows are from east to west and discharge into the Hutt Lagoon. The flows discharge over a hypersaline saltwater wedge extending from the eastern portion of the Hutt Lagoon. Groundwater salinity within the application area varies from 800 mg/L to 1,500 mg/L. Groundwater salinities are higher toward the Utcha Swamp (up to 30,000 mg/L) and the Hutt Lagoon perimeter (up to 150,000 mg/L). Groundwater standing levels vary of 15 m below ground levels (m bgl) towards the western boundary of the tenement to 35 m bgl (URS, 2013).

3.4.3 Public drinking water source areas

The are no public drinking water sources areas within 10 km of the application area. The nearest public drinking water source is 60 km north of the application area – Kalbarri Water Reserve (Department of Water and Environmental Regulation, 2020).

3.5 Flora and vegetation

3.5.1 Broad vegetation mapping and extents

Broadscale mapping (1:1,000,000) pre-European vegetation mapping (Beard, 1976) indicates two Beard Vegetation Associations (BVA) were mapped within the application area including:

- BVA 371 - Low forest.
- BVA 17 – Thicket.

The pre-European mapping has been adapted and digitised by Shephard et. al. (2002). The extent of vegetation associations has been determined by the State-Wide vegetation extents calculations maintained by the DBCA (current as of March 2019 – GoWA, 2019).

As shown in Table 2, the current extent of BVA 371 is below the 30% retention target of the pre-clearing size at all levels except LGA shown in the table below.

Table 3 Pre-European Vegetation Extent Association (GoWA, 2019)

Pre-European Vegetation Extent Association	Pre-European (ha)	Current extent (ha)	Remaining pre-European extent (%)
Greenough_371			
State	32,816.04	3,499.60	10.66
IBRA Bioregion: Geraldton Sandplains	32,807.53	3.499.10	10.67
Sub-IBRA: Geraldton Hills	32,807.53	3,499.10	10.67

Pre-European Vegetation Extent Association	Pre-European (ha)	Current extent (ha)	Remaining pre-European extent (%)
LGA: Shire of Northampton	5,749.92	2,142.08	36.94

3.5.2 Mapped vegetation types and conditions

GHD (2020a) mapped two vegetation types within the application area including:

- Vegetation type 1: *Acacia rostellifera* open woodland to woodland.
- Vegetation type 2: *Melaleuca cardiophylla* shrubland to open shrubland.

There are areas within the application area that were previously cleared, rehabilitated, or comprise of previously cleared regrowth (GHD, 2020a). The vegetation types mapped within the application area are shown in Figure 3.

The vegetation condition within the application area ranged from good to completely degraded (GHD 2020a). The application area has been subject to historical grazing and clearing. The vegetation conditions mapped within the application area are shown in Figure 4.

GHD (2020a) undertook a comparison of mapped BVA with the vegetation types recorded within the applications area and concluded the following:

- Two vegetation types were mapped within the application area – *Acacia rostellifera* open woodland to woodland with brown to orange sands and Shrublands on seasonally wet brackish drainage flats. The vegetation type mapped in low-lying and middle to upper slopes of the survey area and aligns with BVA 17 (*Acacia rostellifera* dense thicket at 6 m in height, principal species comprise of *Alyogyne cuneiformis, Pimelea floribunda* and *Melaleuca cardiophylla*).
- BVA 371 (*Acacia* low forest) located on some flats north of the Hutt River and is a taller version of the A. *rostellifera* thicket exceeding 10 metres in height, and it is very dense. The Acacia *rostellifera* seems to be a pure stand of that species (Beard and Burns 1976).

Table 4 provides a summary of the GHD (2020) vegetation types mapped in each clearing activity.

Table 4 Mapped Vegetation Types in each Clearing Activity

Clearing Activity	Mapped vegetation type	Comment
Old Dune Pit and topsoil stockpiles	VT01, Rehabilitated, Cleared	-
Single land haul road expansion	VT01, Cleared	-
Lynton ramp access road	VT01, Cleared	-
Upgrade works of Lynton Borefield water storage area	VT01, Cleared	Part of the area has not been previously mapped, the extrapolated vegetation type is vegetation type 1, and is consistent with the vegetation type mapped north and west of the proposed clearing area.
Exploration Works	VT01, VT02, Rehabilitated, Cleared.	-
Reinstate former Lynton haul road	VT01	-

3.5.3 *Ecological Communities*

GHD (2020a) desktop searches did not identify Threatened Ecological Communities within 10 km of the application area. Two Priority Ecological Communities PECs were identified within 10 km of the application, and these include:

- *The Kalbarri Ironstone Community* (P1) – 8 km east of the application area.
- *Shrubland of the Northampton Area, dominated by Melaleuca species over exposed Kockatea shale* (Priority 1 – PEC) – 5 km south-east of the application area.

No PEC or TECs were delineated from the application area (GHD, 2020a).

3.5.4 *Flora Diversity*

Sixty-four flora taxa (including subspecies and varieties) representing 26 families and 50 genera were recorded from the survey area during the field survey (GHD, 2020a).

3.5.5 *Conservation significant flora*

A review of the *NatureMap,* EPBC PMST and purchase DBCA database indicate the potential presence of 48 conservation significant flora occurring within 10 km of the application area (GHD 2020a).

No Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) or Biodiversity Conservation Act 2016 (BC Act) or Department of Biodiversity Conservation and Attraction listed flora were recorded within the survey area.

The likelihood of occurrence assessment post-field survey concluded three species considered possible to occur, five species unlikely to occur, and 40 species highly unlikely to occur in the survey area. The species considered possible to occur within the mapped vegetation type of the application area included *Anthocercis intricata* (P3) and *Balladonia aervoides* (P3) (GHD 2020a).

3.5.5.1 Targeted Survey

GHD (2020b) completed a targeted flora survey for *Caladenia bryceana* subsp. *cracens* (the orchid). The survey targeted potential habitat for the orchid identified during the GHD (2020a) Lynton Mine Expansion Biological Survey.

Caladenia bryceana subsp. *cracens* is listed Vulnerable under the *Environmental Protection Biodiversity and Conservation Act 1999* (EPBC Act) and declared rare under the *Biodiversity Conservation Act 2016* (BC Act). The orchid is endemic to the mid-west of Western Australia, with 15 known populations occurring between Northampton and Kalbarri. The orchid was previously recorded within mining tenement M70/1380. The Orchid is known to flower in August 2020.

Prior to the commencement of the targeted survey the Department of Biodiversity, Conservation and Attractions (DBCA) Conservation Officer – Ms Alanna Chant, conducted a site visit on 10 August 2020 to confirm some of the known populations of the orchid and assess the habitat type within M70/1380. During the site visit the orchid was recorded flowering and was considered optimal survey timing for the orchid.

Methodology

The targeted survey was undertaken with reference to the EPA (2016) Technical Guidance – Flora and Vegetation Survey for Environmental Impact Assessment and the Commonwealth of Australia (2013) Survey Guidelines for Australia's Threatened Orchids.

The survey was undertaken between 11 and 14 August 2020. GHD also visited known populations within M70/1380 to confirm the flowering time.

The survey method was systematic spaced 10 metre transects within a potentially suitable habitat described by GHD (2020a) – *Melaleuca cardiophylla* shrubland.

Results

GHD (2020a) did not record *Caladenia bryceana* subsp. *cracens* from the survey area as the habitat was considered too degraded with evidence of weeds and significant wild pig grazing. Also, the habitat type was not consistent with the orchid habitat recorded within M70/1380.

3.5.6 Environmentally Sensitive Area

One Environmentally Sensitive Area (ESA) was identified 200 metres west of the application area (GHD 2020a).

3.6 Fauna

GHD (2020a) completed a Level 1 Fauna assessment of the survey area. A summary of the results is provided in the sections below and further detail is documented within the GHD (2020a) GMA Garnet Pty Ltd Lynton Mine Expansion Biological Survey Report.

3.6.1 Fauna Diversity

GHD (2020) recorded thirty-one fauna species during the biological survey, including 21 bird, eight mammal and two reptile species. Of these, 24 are native and seven introduced/feral.

Conservation Significant Fauna

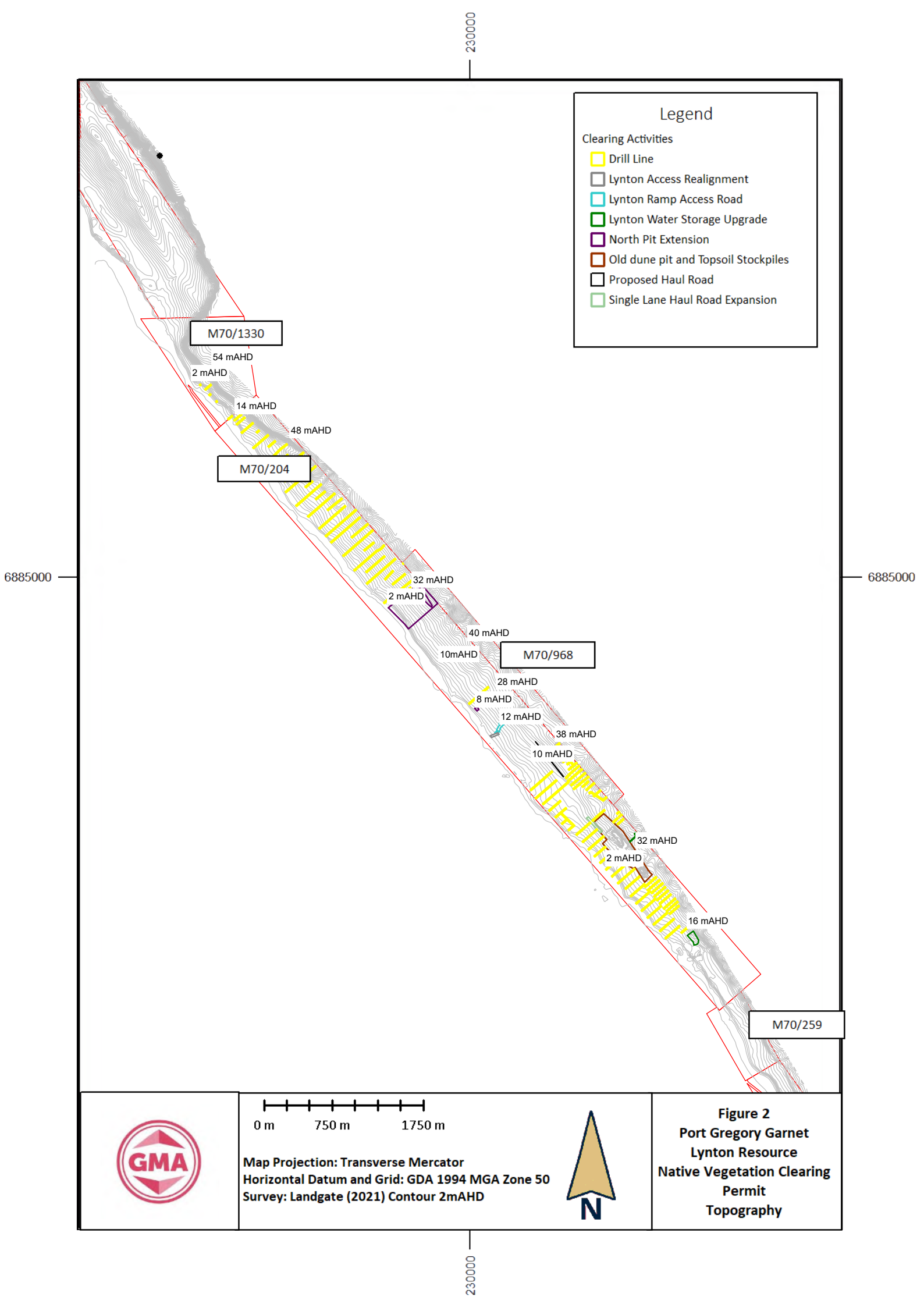
A review of the *NatureMap*, EPBC PMST and purchase DBCA database indicate the potential presence of 35 conservation significant fauna occurring within 10 km of the application area (GHD 2020a).

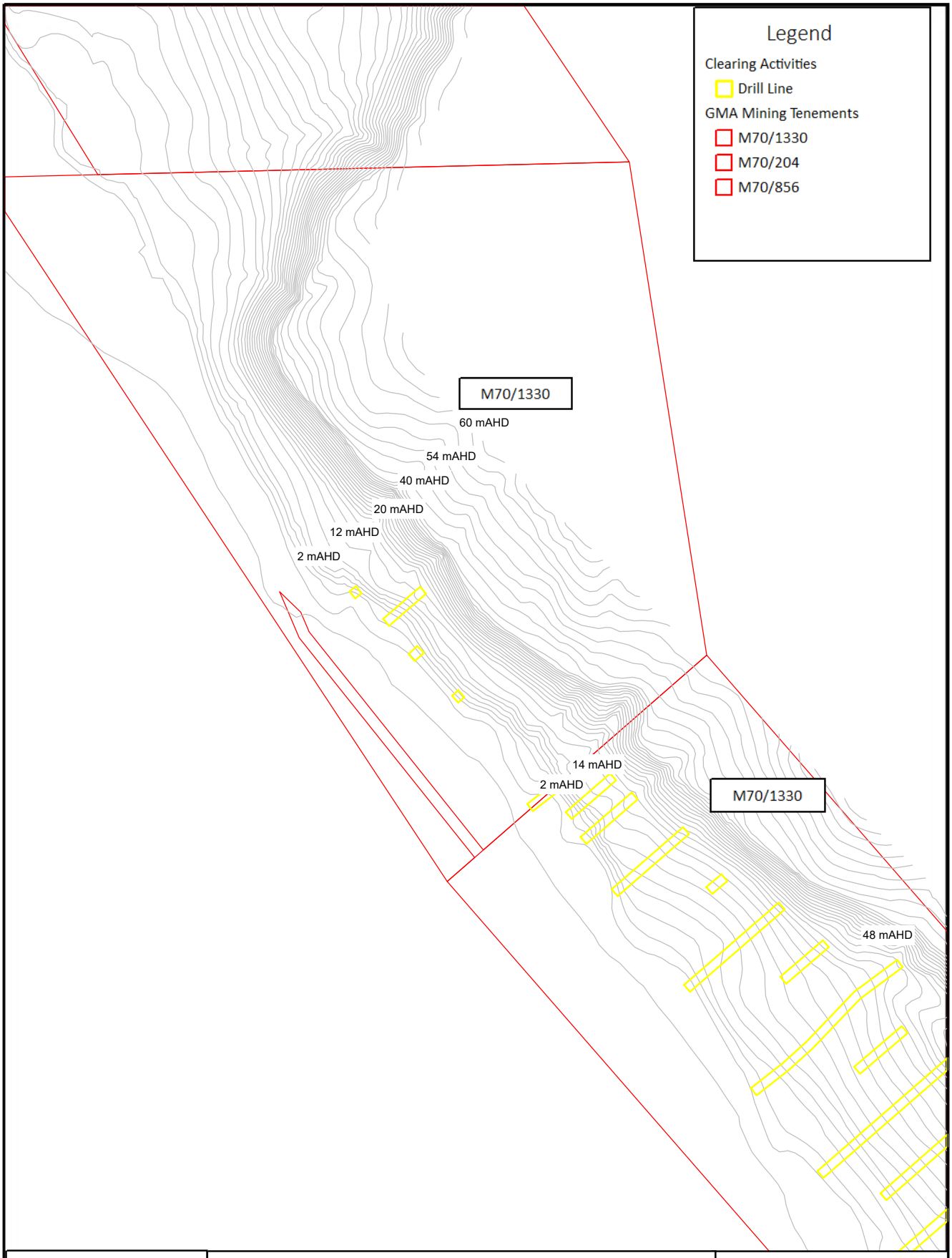
No Threatened fauna listed under the EPBC Act and/or BC Act or Priority fauna species listed by the DBCA were recorded during the survey. The Eastern Osprey (*Pandion cristatus*) listed as Migratory and Marine under the EPBC Act and International Agreement under the BC Act were recorded during the survey but outside the application area.

Of the 35-conservation significant fauna identified in the desktop searches:

- One species was present (*Pandion cristratus* (Osprey) – Migratory and Marine listed))
- Two considered likely to occur.
- The remaining species are considered unlikely or highly unlikely to occur.

An Osprey nesting site was recorded outside the application area and in the south-western portion of M70/204. A 100 m buffer was applied to the nesting site by GMA (Figure 5).


230000
6885000
6885000
230000
Legend
Clearing Activities
Drill Line
Lynton Access Realignment
Lynton Ramp Access Road
Lynton Water Storage Upgrade
North Pit Extension
Old dune pit and Topsoil Stockpiles
Proposed Haul Road
Single Lane Haul Road Expansion
M70/1330
54 mAHD
2 mAHD
14 mAHD
48 mAHD
M70/204
32 mAHD
2 mAHD
40 mAHD
10mAHD
M70/968
28 mAHD
8 mAHD
12 mAHD
38 mAHD
10 mAHD
32 mAHD
2 mAHD
16 mAHD
M70/259
0 m
750 m
1750 m
N
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: Landgate (2021) Contour 2mAHD
Figure 2
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Topography



50 m 200 m 350 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: Landgate (2021) Contour 2mAHD

N

Figure 2
Port Gregory Garnet
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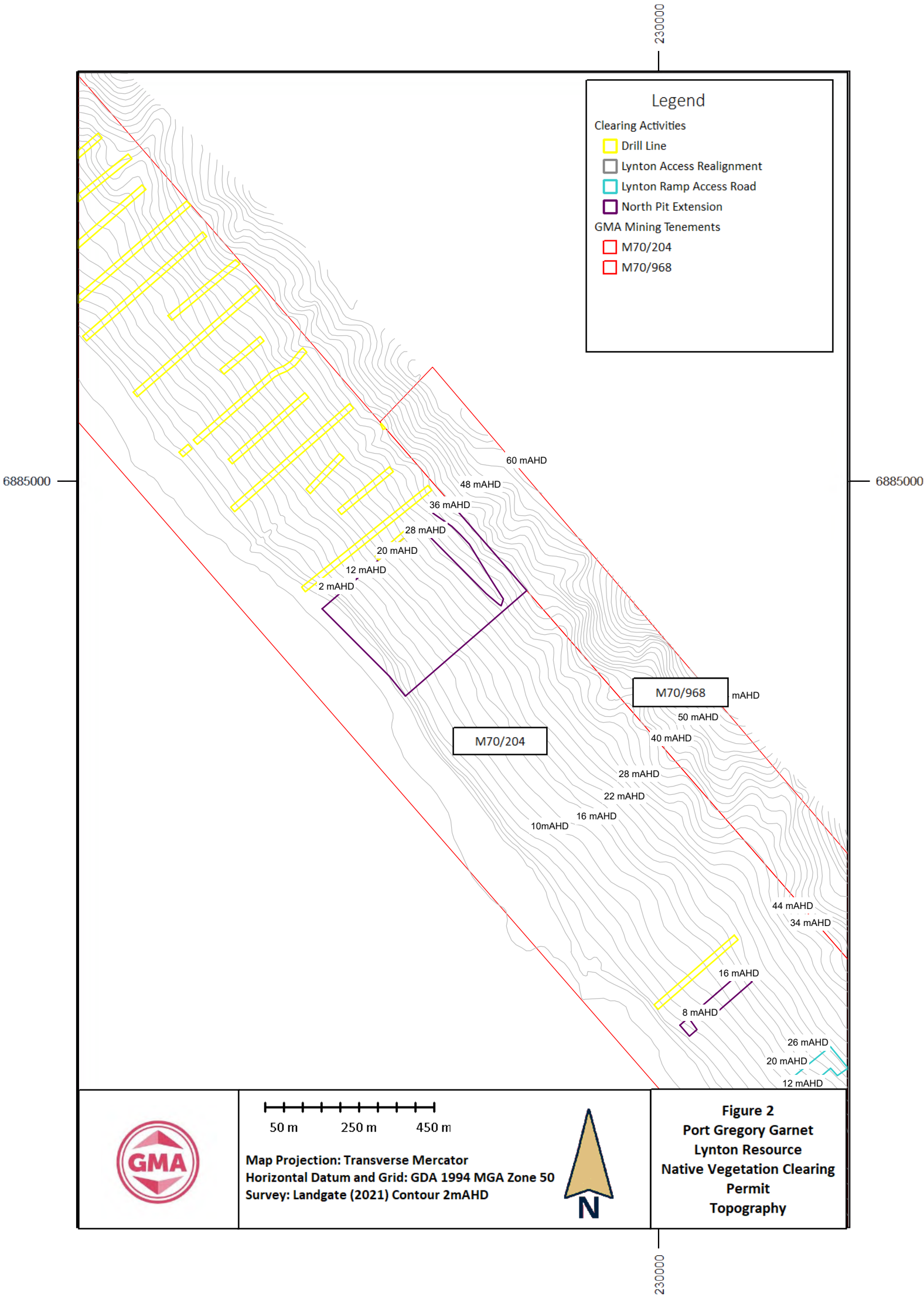
Native Vegetation Clearing
Permit
Topography


230000
6885000
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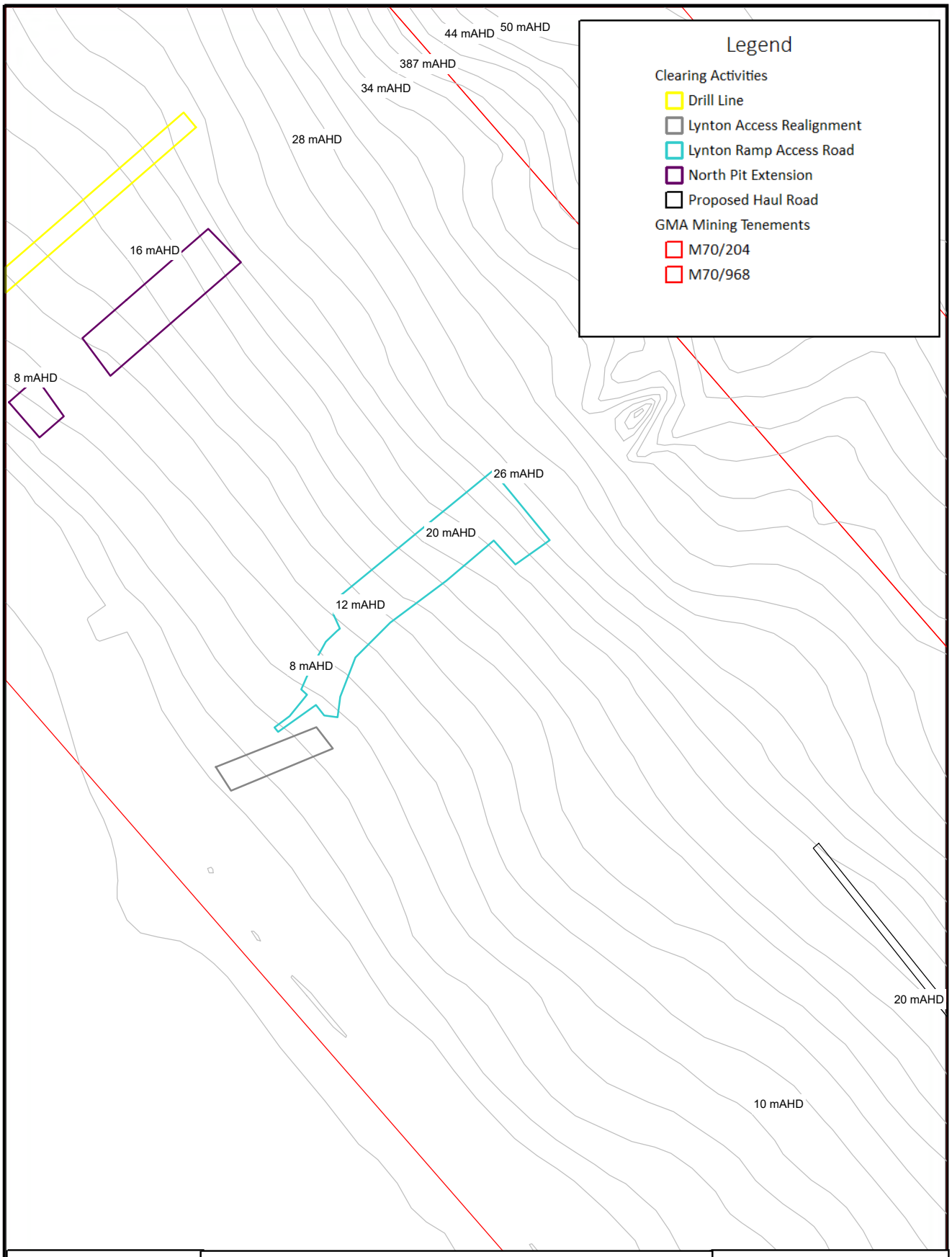
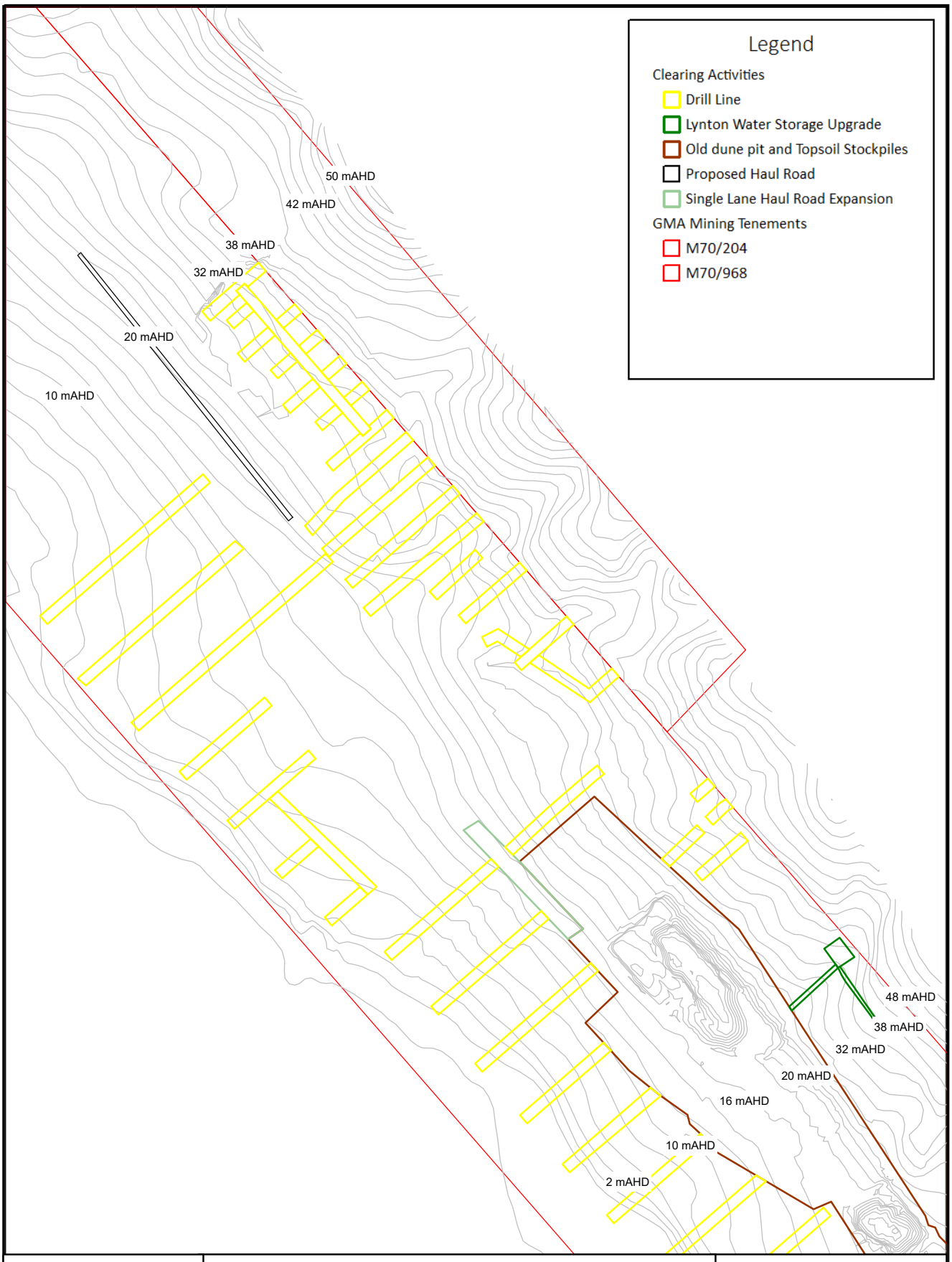
Legend
Clearing Activities
Drill Line
Lynton Access Realignment
Lynton Ramp Access Road
North Pit Extension
GMA Mining Tenements
M70/204
M70/968
60 mAHD
48 mAHD
36 mAHD
28 mAHD
20 mAHD
12 mAHD
2 mAHD
M70/968
mAHD
50 mAHD
40 mAHD
M70/204
28 mAHD
22 mAHD
16 mAHD
10mAHD
44 mAHD
34 mAHD
16 mAHD
8 mAHD
26 mAHD
20 mAHD
12 mAHD
50 m
250 m
450 m
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: Landgate (2021) Contour 2mAHD
N
Figure 2
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Topography
230000



Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: Landgate (2021) Contour 2mAHD

Figure 2
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Topography



0 m 150 m 300 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: Landgate (2021) Contour 2mAHD

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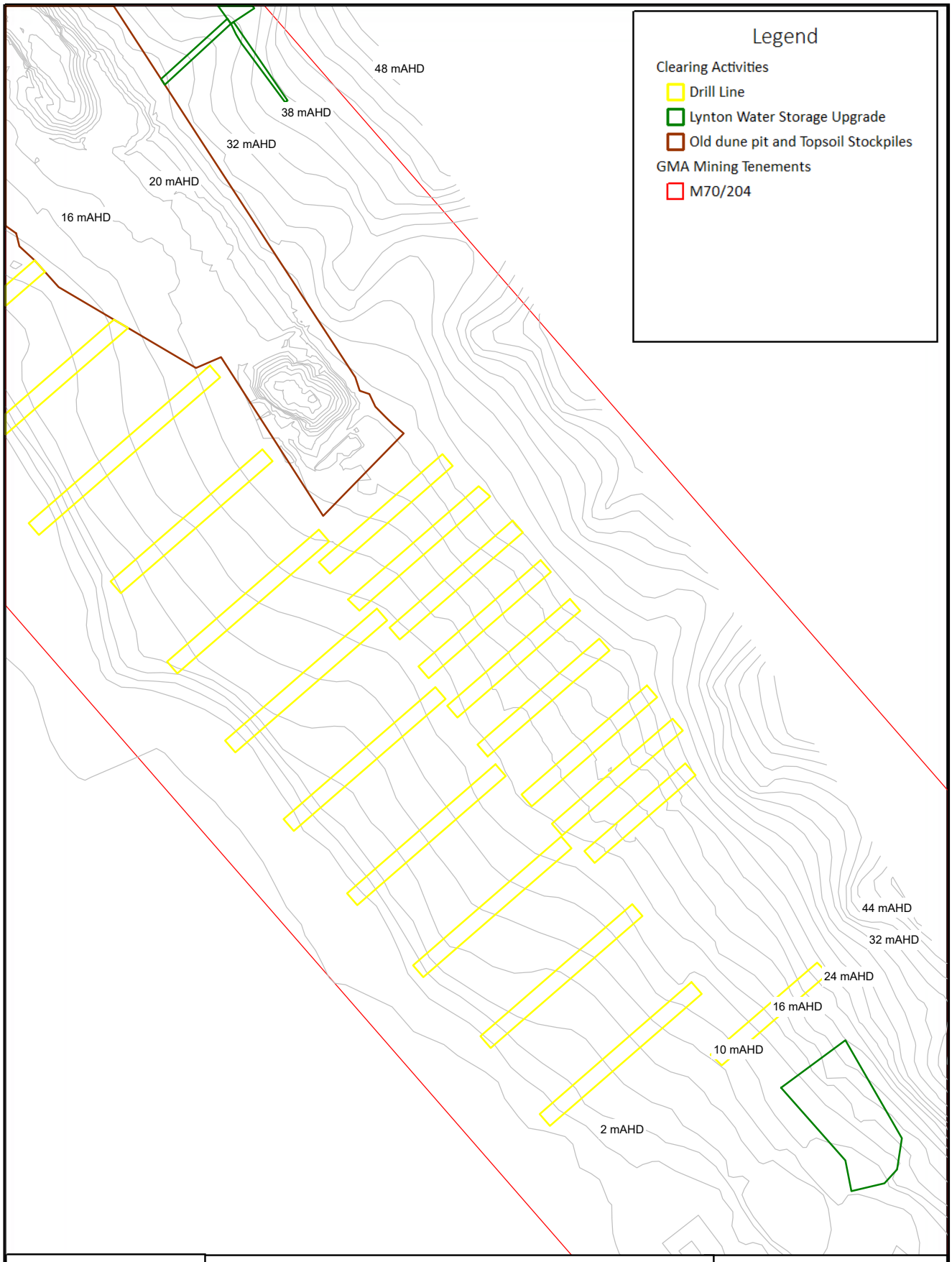
Figure 2
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Topography



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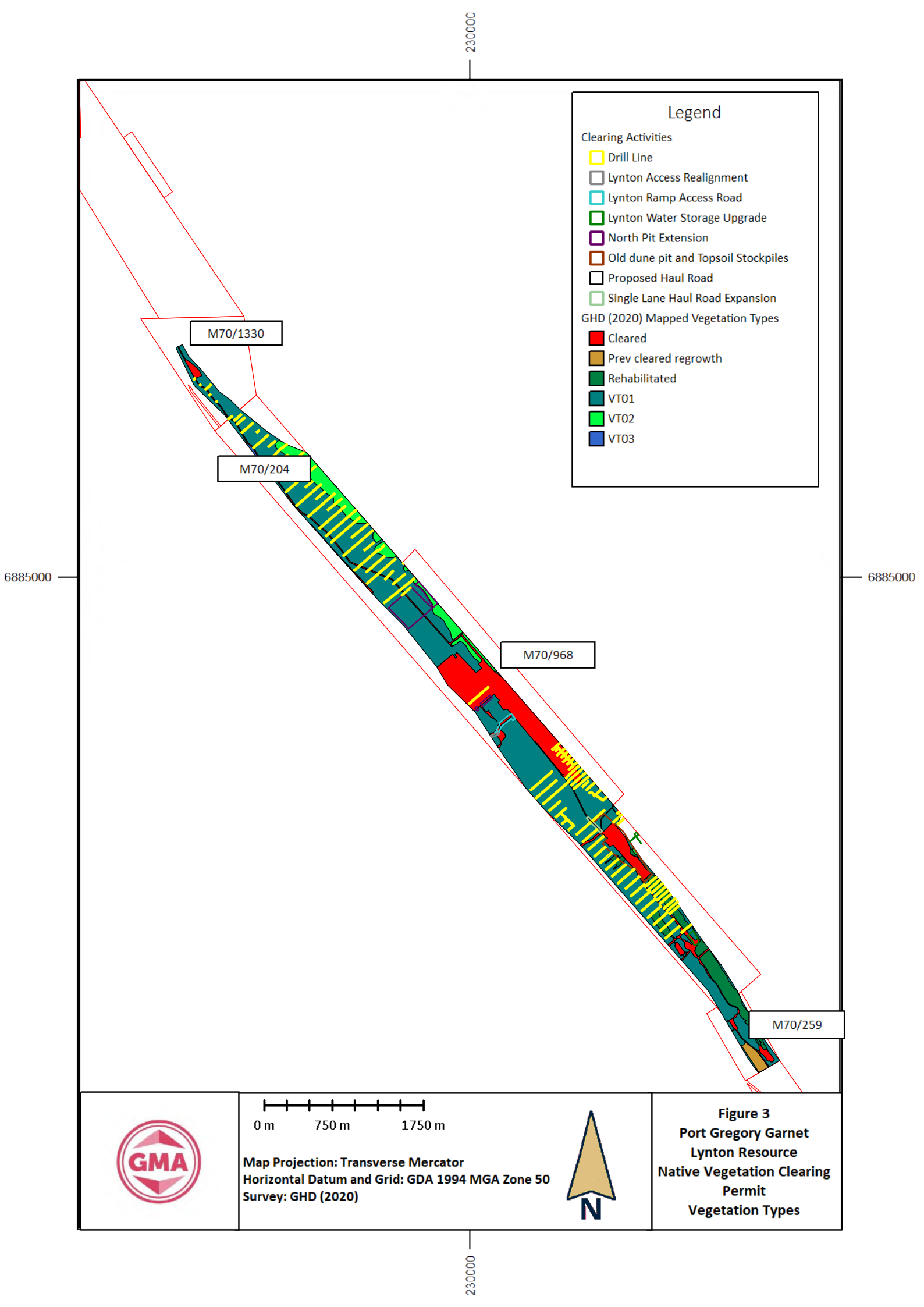
Survey: Landgate (2021) Contour 2mAHD

Figure 2
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Topography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6885000
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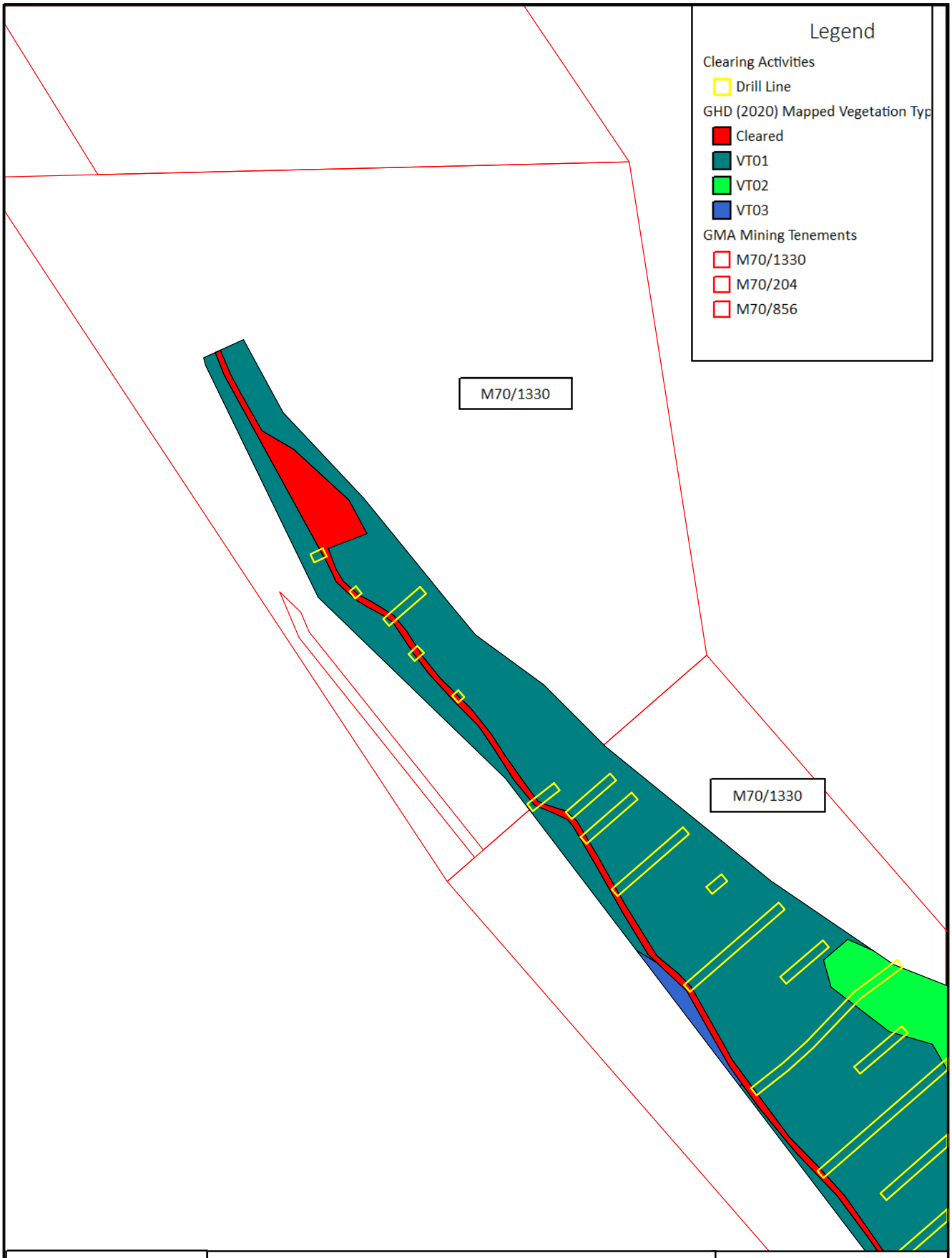
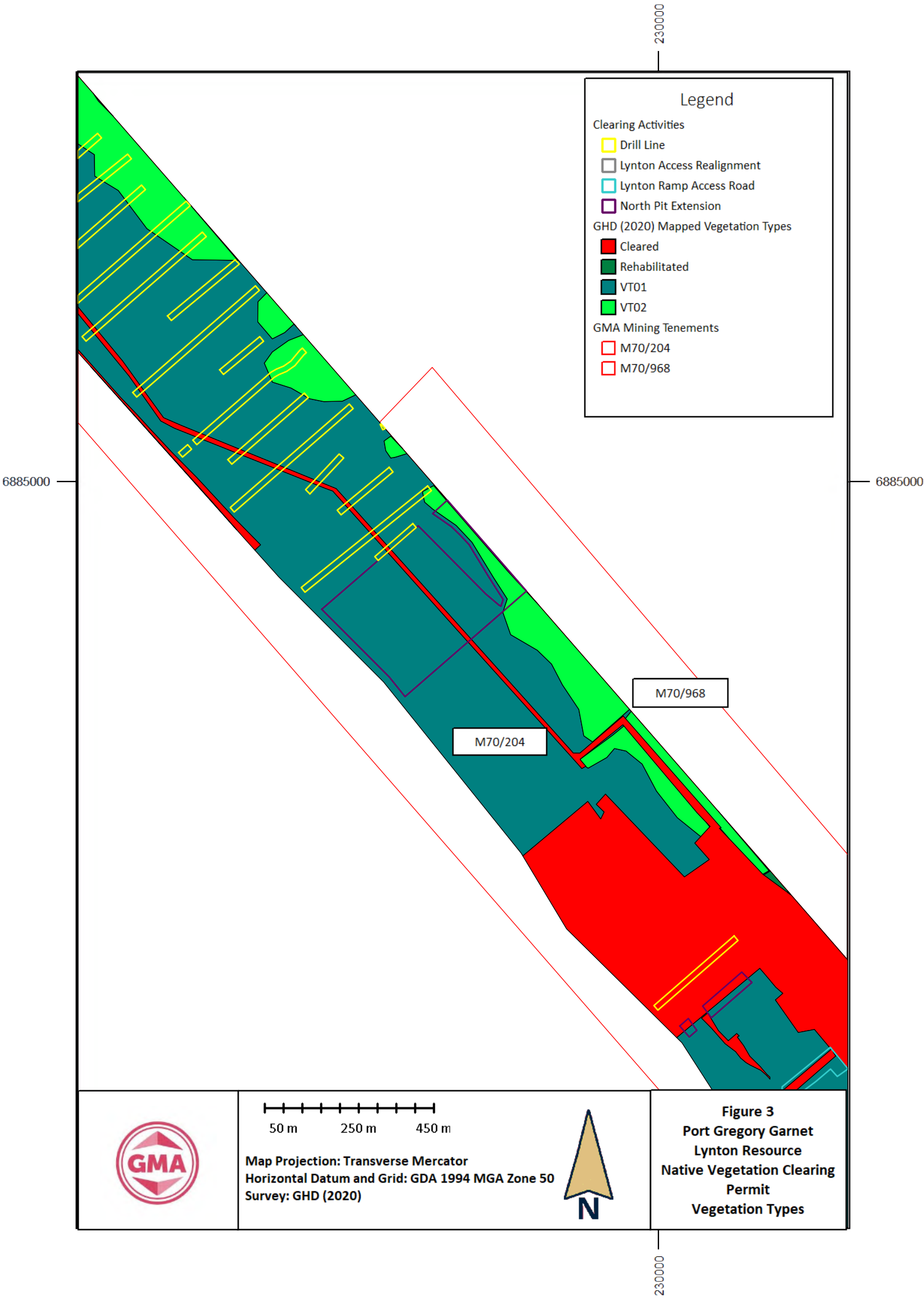
230000
Legend
Clearing Activities
Drill Line
Lynton Access Realignment
Lynton Ramp Access Road
Lynton Water Storage Upgrade
North Pit Extension
Old dune pit and Topsoil Stockpiles
Proposed Haul Road
Single Lane Haul Road Expansion
GHD (2020) Mapped Vegetation Types
Cleared
Prev cleared regrowth
Rehabilitated
VT01
VT02
VT03
M70/1330
M70/204
M70/968
M70/259
0 m
750 m
1750 m
N
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)
Figure 3
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Vegetation Types



Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

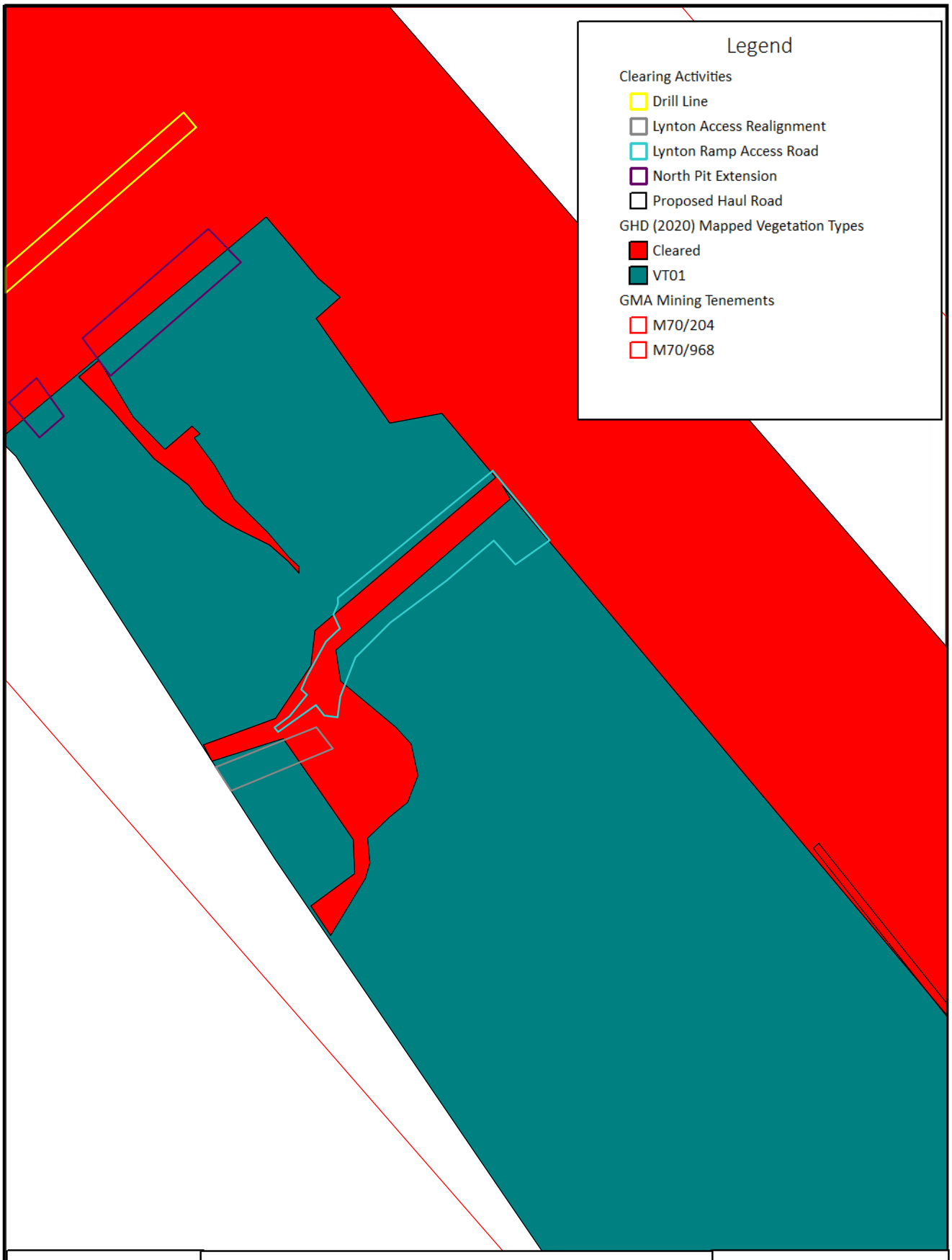
Figure 3
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Types



GMA

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

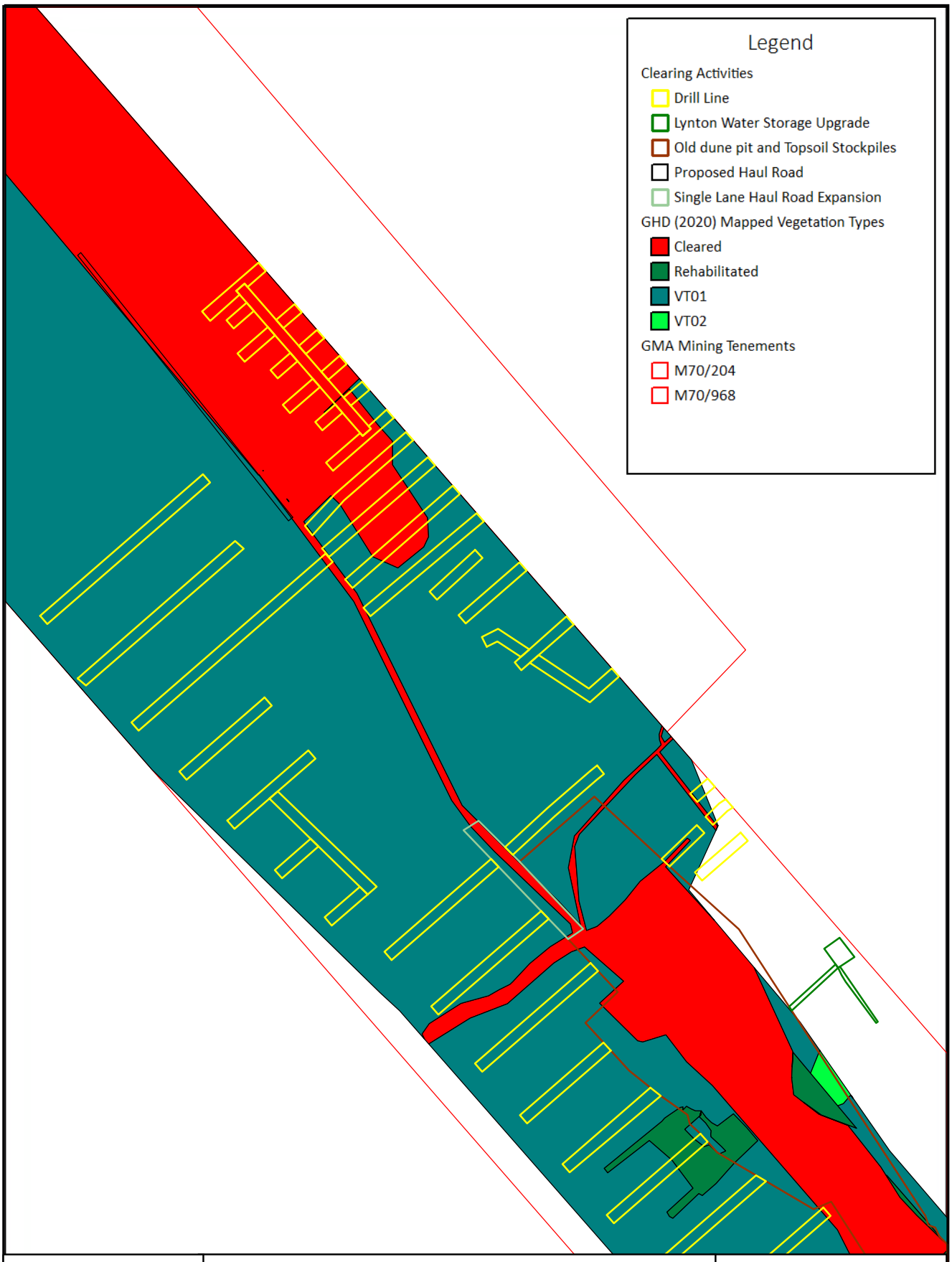
Figure 3
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Vegetation Types



GMA

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 3
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Types



0 m 150 m 300 m

N

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

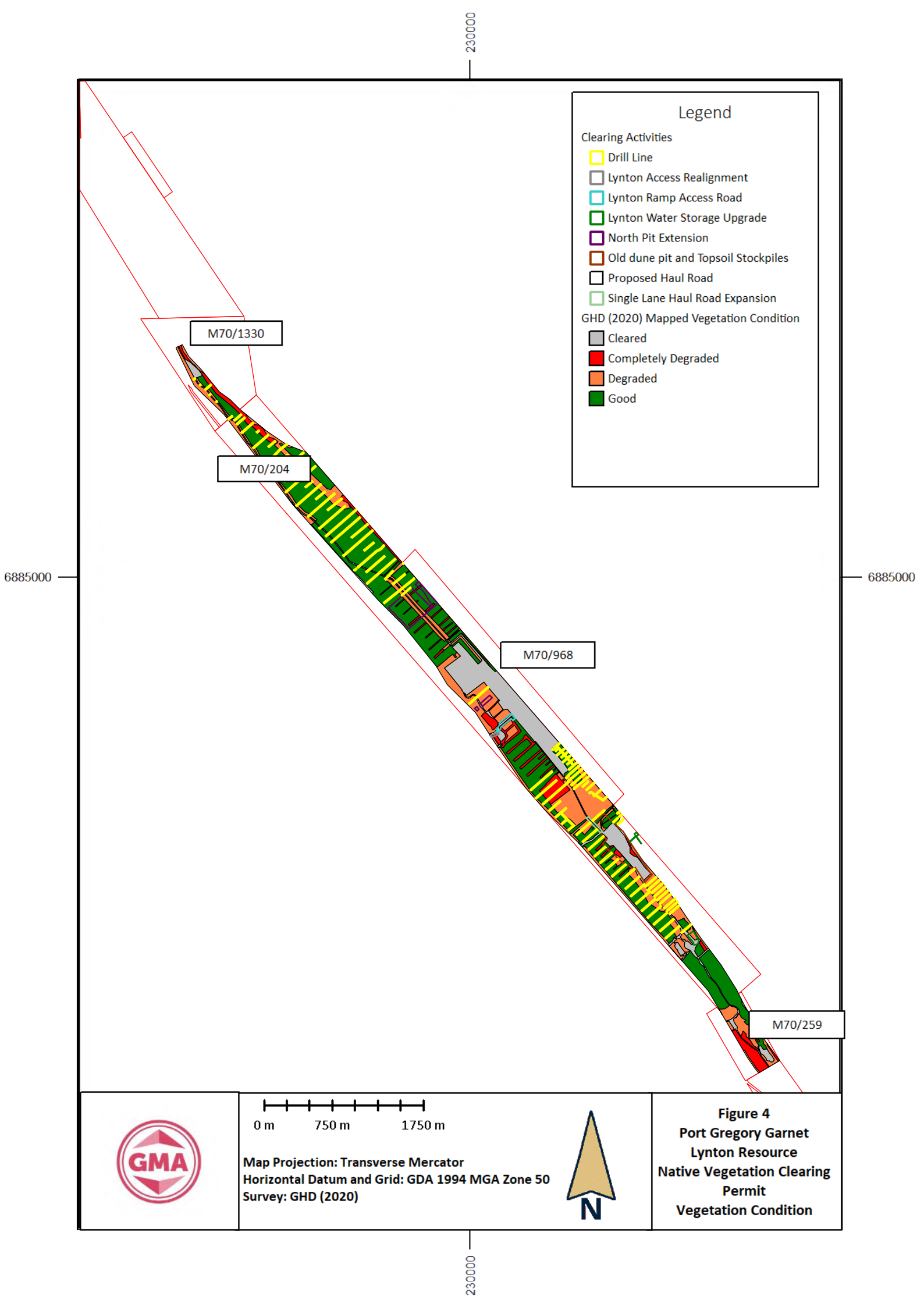
Figure 3
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Types

0 m 100 m 200 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

N

Figure 3
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Vegetation Types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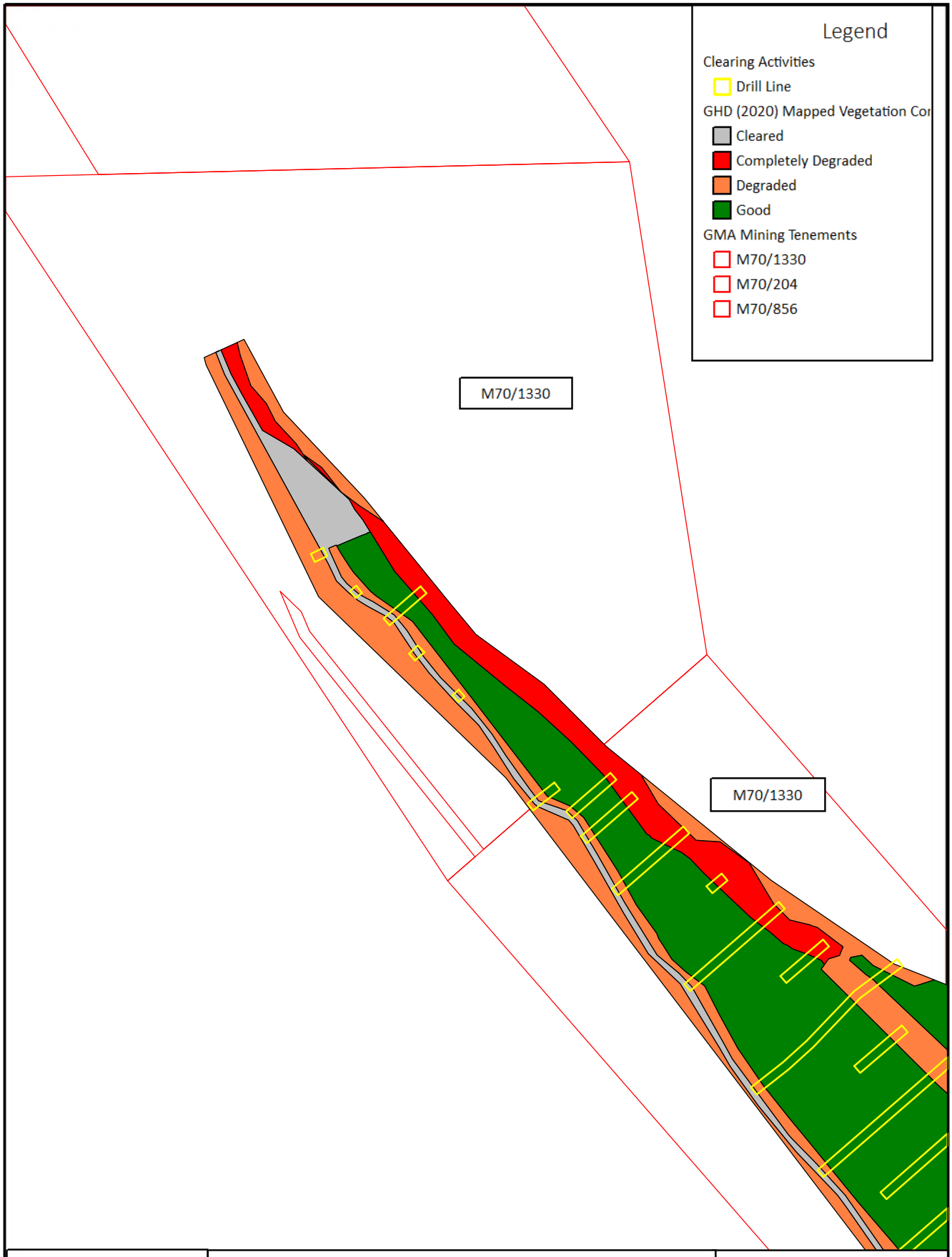
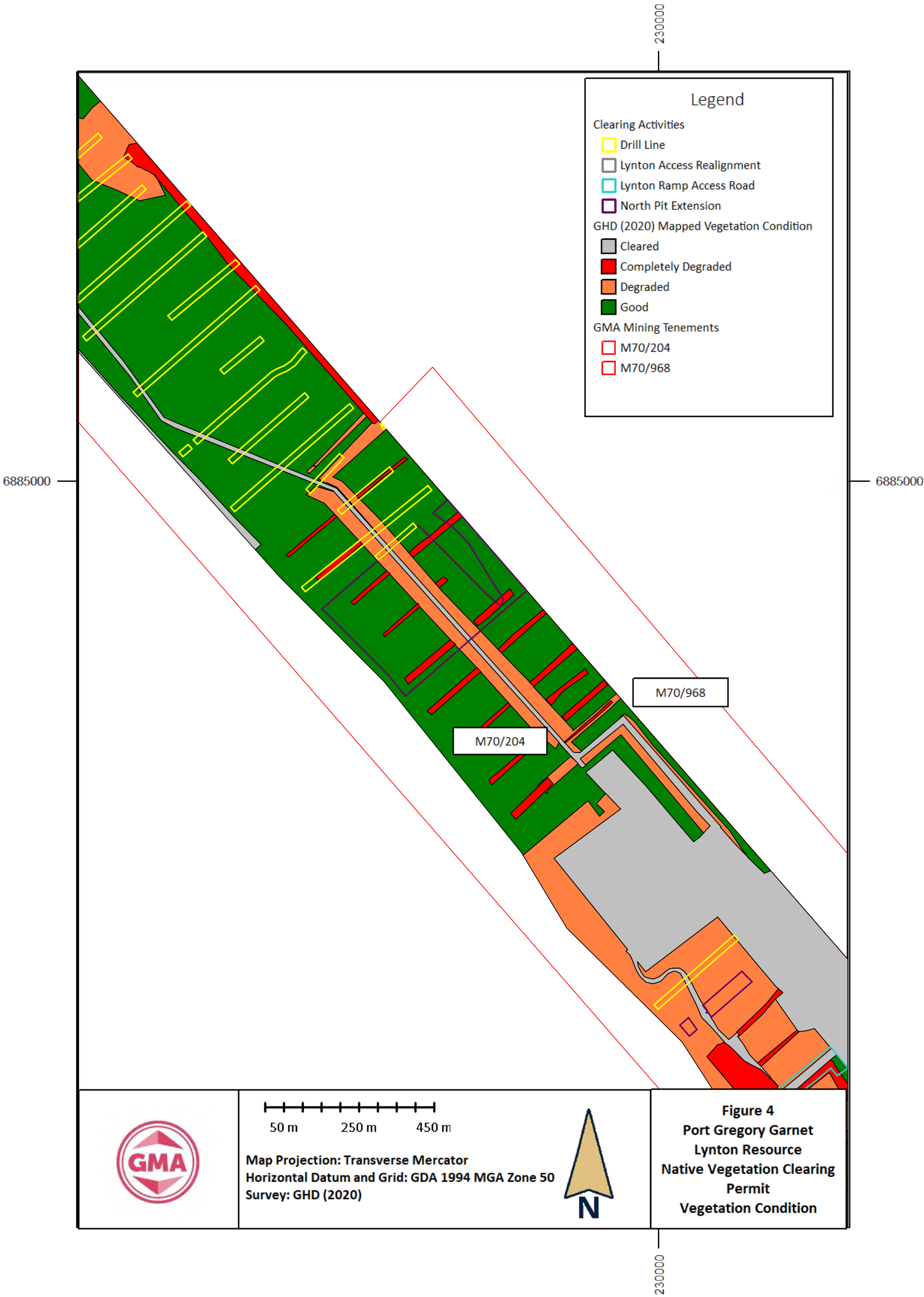
230000
Legend
Clearing Activities
Drill Line
Lynton Access Realignment
Lynton Ramp Access Road
Lynton Water Storage Upgrade
North Pit Extension
Old dune pit and Topsoil Stockpiles
Proposed Haul Road
Single Lane Haul Road Expansion
GHD (2020) Mapped Vegetation Condition
Cleared
Completely Degraded
Degraded
Good
M70/1330
M70/204
M70/968
M70/259
0 m
750 m
1750 m
N
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)
Figure 4
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Vegetation Condition



Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 4
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Condition


230000
6885000
6885000
Legend
Clearing Activities
Drill Line
Lynton Access Realignment
Lynton Ramp Access Road
North Pit Extension
GHD (2020) Mapped Vegetation Condition
Cleared
Completely Degraded
Degraded
Good
GMA Mining Tenements
M70/204
M70/968
M70/968
M70/204
50 m
250 m
450 m
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)
N
Figure 4
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Vegetation Condition
230000

GMA

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 4
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Condition

0 m 150 m 300 m

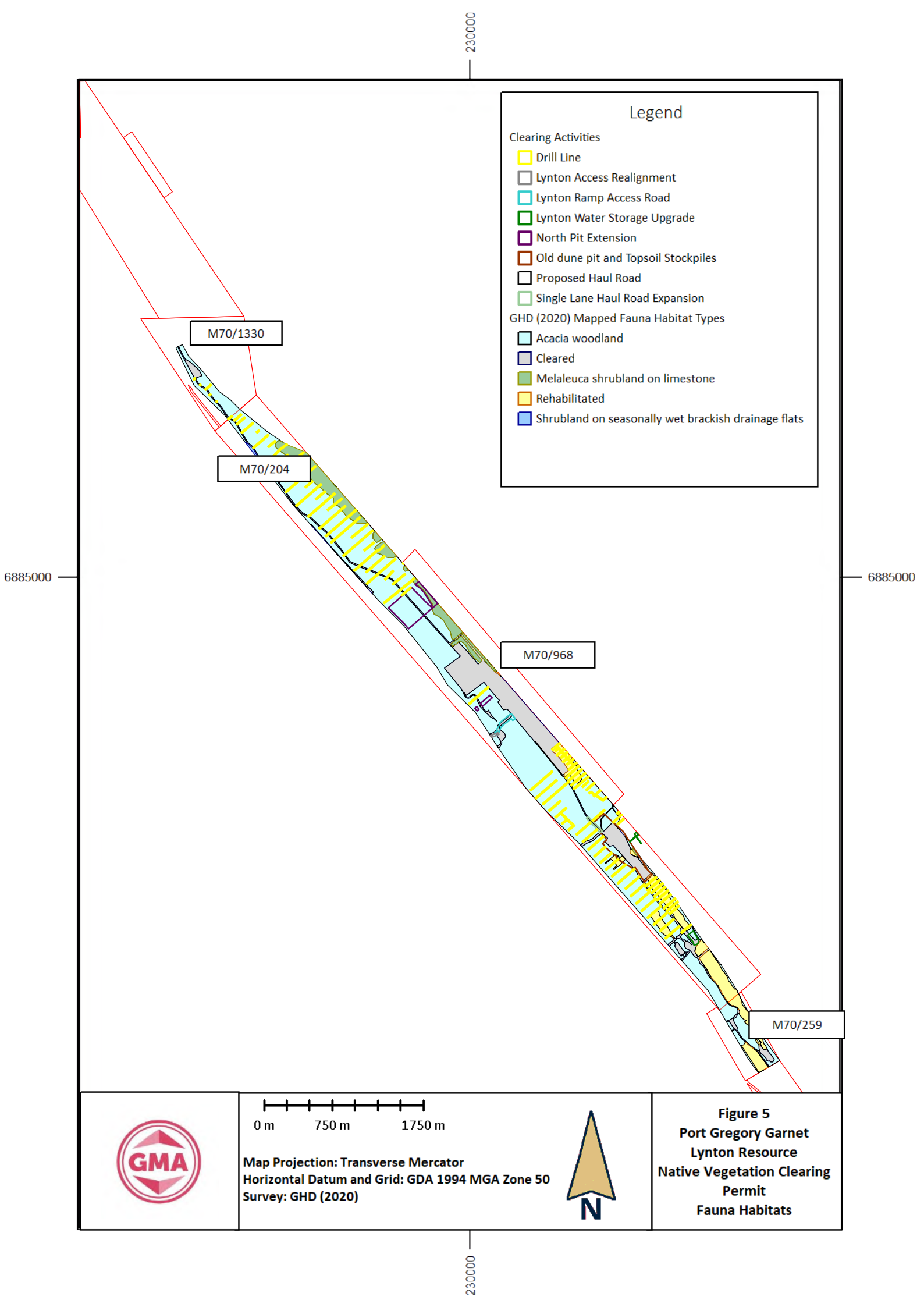
N

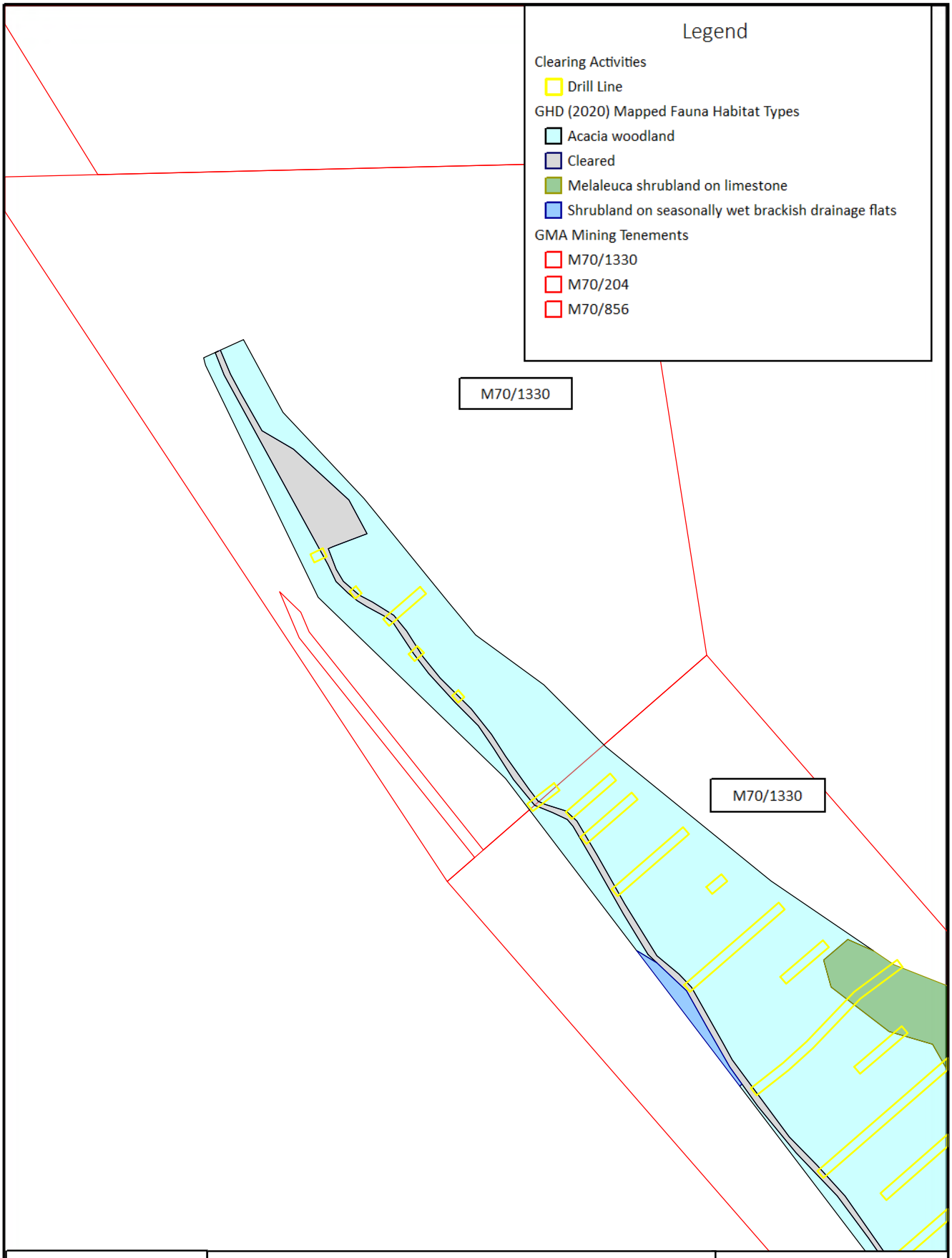
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 4
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Condition

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 4
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Vegetation Condition


230000
6885000
6885000
230000
Legend
Clearing Activities
Drill Line
Lynton Access Realignment
Lynton Ramp Access Road
Lynton Water Storage Upgrade
North Pit Extension
Old dune pit and Topsoil Stockpiles
Proposed Haul Road
Single Lane Haul Road Expansion
GHD (2020) Mapped Fauna Habitat Types
Acacia woodland
Cleared
Melaleuca shrubland on limestone
Rehabilitated
Shrubland on seasonally wet brackish drainage flats
M70/1330
M70/204
M70/968
M70/259
0 m
750 m
1750 m
N
Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)
Figure 5
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Fauna Habitats

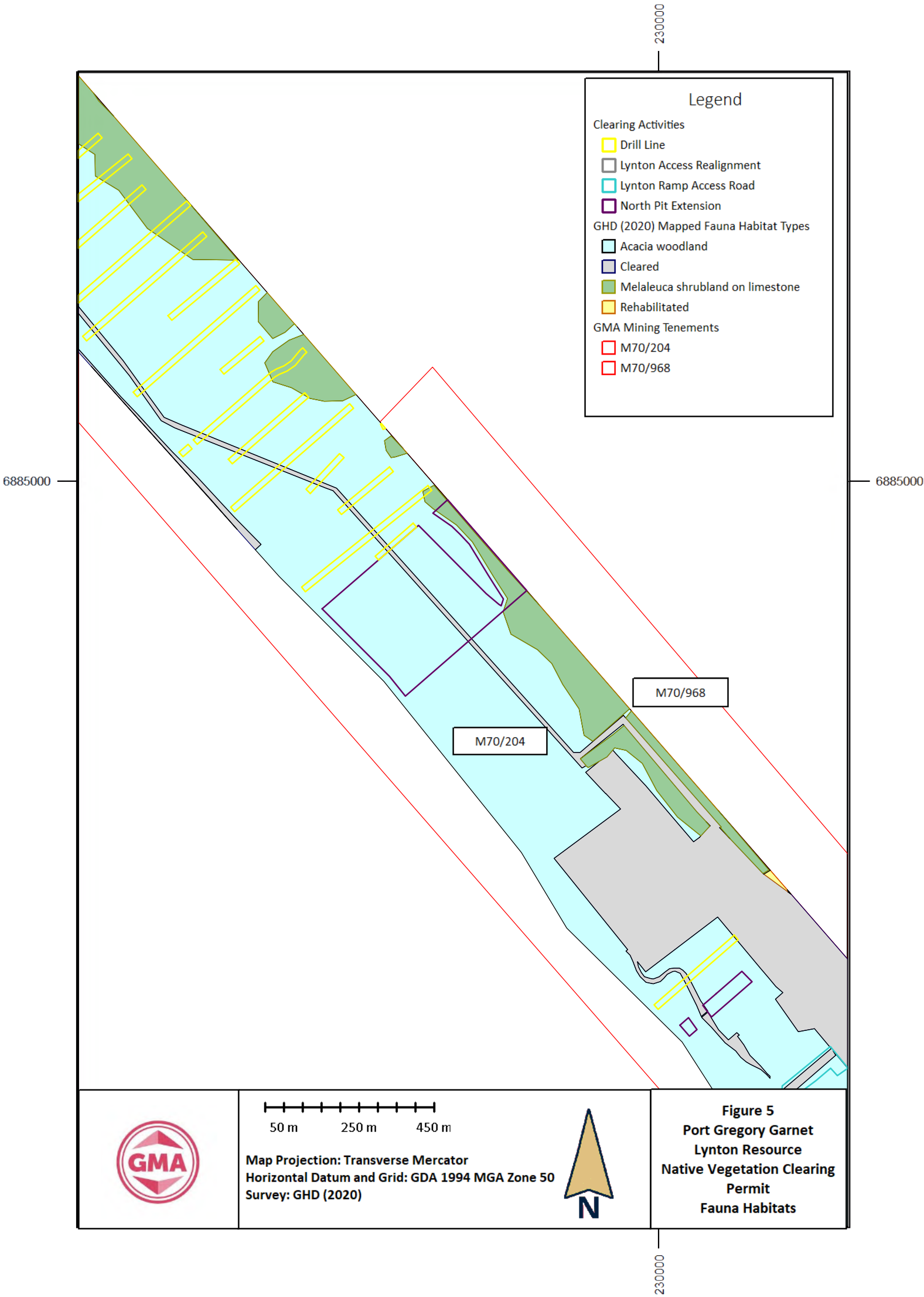


50 m 200 m 350 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

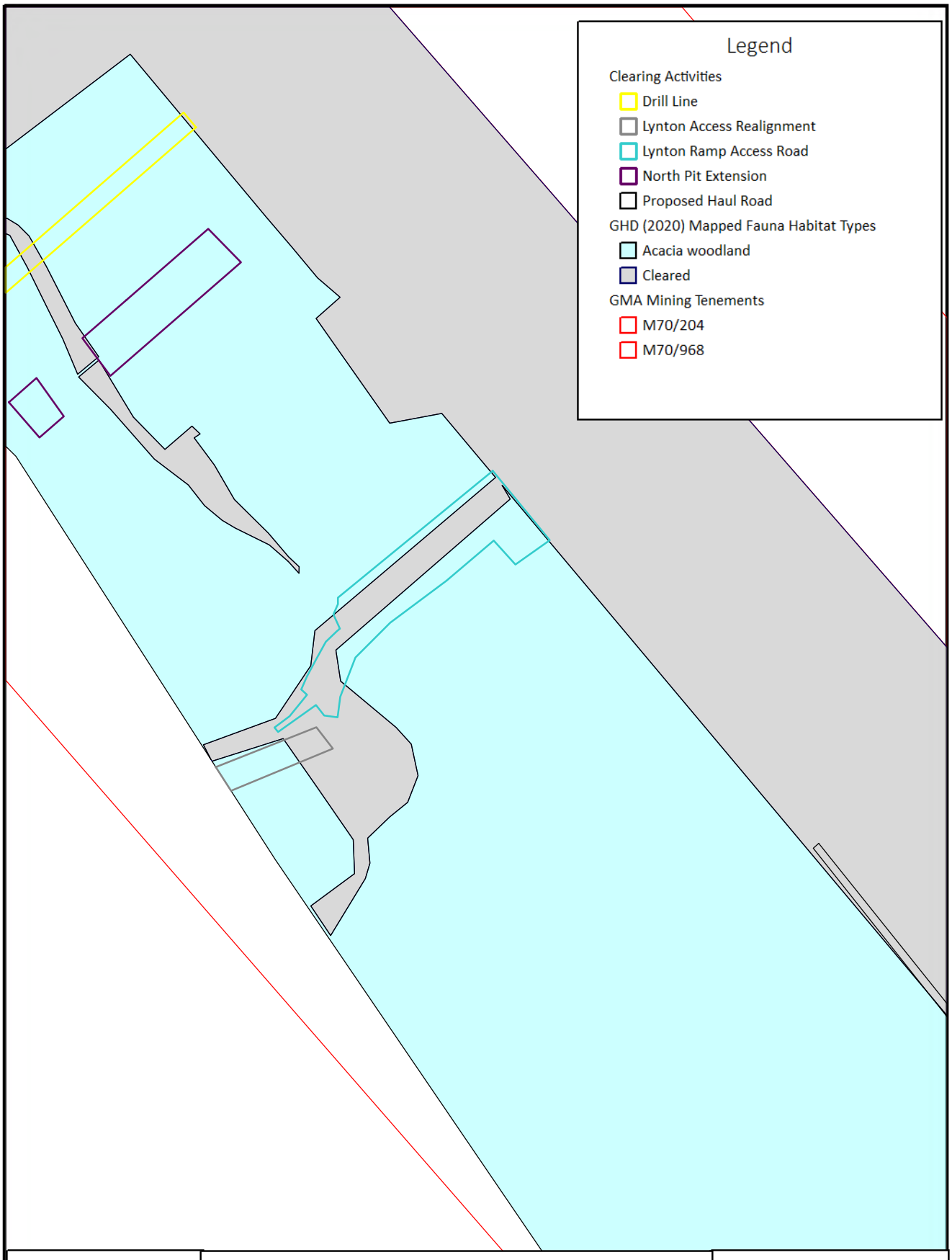
N

Figure 5
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Fauna Habitats



Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

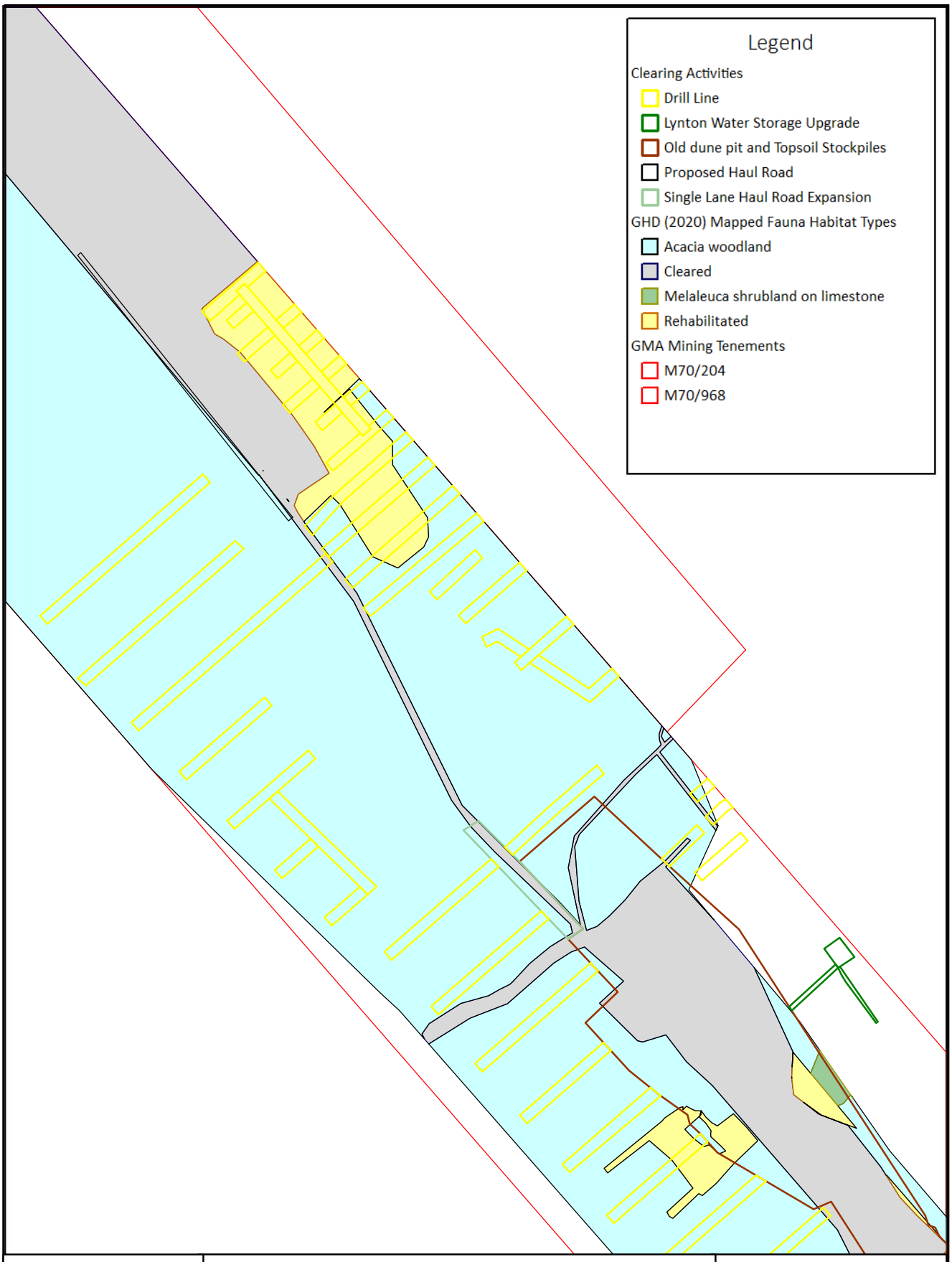
Figure 5
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Fauna Habitats



GMA

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 5
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Fauna Habitats



Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

Figure 5
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Fauna Habitats

0 m 100 m 200 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GHD (2020)

N

Figure 5
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing
Permit
Fauna Habitats

4. Risk Assessment and management

The risk assessment provided in the sections below, has been adopted from the GMA (2020) Port Gregory Project – Revised Mine Closure Plan (Reg. ID: 85076).

4.1 Risk identification

Environmental management of impacts are based on the risk management framework. The main objectives of environmental management are:

1. Identify activities that could result in significant environmental impacts to key factors.
2. Quantify the relative level of inherent risk from the activity (without control measures applied).
3. Develop processes to reduce the inherent risk to an acceptable level (residual risk).
4. Document these processes so they become part of the Company's environmental management requirements.
5. Monitor the effectiveness of implementing these processes.

A key outcome of risk management is to rank impacts and risks, so specific management measures can be developed for high-risk impacts, to reduce the risk to as low as practicable. GMA adopts the mitigation sequence (EPA 2006) for environmental management. The mitigation sequence is:

1. Avoid — avoid the impact altogether.
2. Minimise — limit the severity of the impact.
3. Rectify — rehabilitate affected site as soon as possible.
4. Reduce — eliminate impact over time.
5. Offset — if significant residual impacts remain to critical value assets.

The Australian and New Zealand Standard on Risk Management (AS/NZS 4360) defines risk as the product of the likelihood of an event occurring and the consequence of that event. The risk matrix based on AS/NZS 4360:2004 to assess the level of risk from activities undertaken within the application area (Table 5). To maximise the benefit of environmental management, it is important that manpower and other resources are allocated to issues on a priority basis. It is normally accepted that the highest risk issues receive the highest priority. Each cell in the risk matrix is assigned a priority number.

Table 9 details the outcome of the risk assessment undertaken for key environmental functions of the Port Gregory project. The priority risk rating from this analysis shows several activities with an inherent risk level of Medium and High but with management, residual risks are reduced to a low rating. Key conclusions from the information shown in Table 9 are:

1. No inherent risks ranked as 'extreme' have been identified at the site.
2. Implementing management and mitigation measures during mine operations or closure works reduce all inherent risks to a 'low' or 'medium' residual risk.

Table 5 Likelihood of risk occurring

Descriptor	Details	Frequency of occurrence	Likelihood of occurring each year
Almost Certain	Very high likelihood to occur. Factors increasing likelihood may include: • No internal controls implemented. • No treatment plan developed to prevent risk from occurring. • No resources provided to develop controls or treatment plan. • Risk has not previously been identified in project plan and is likely to impact project outcome or lead to project failure. • Risk has not previously been identified impacting delivery of strategic and/or core objectives.	Once per week	Greater than 90%
Likely	High likelihood to occur. Factors increasing likelihood may include: • Internal controls and treatment plan are inadequate to prevent risk from occurring and require prompt attention and review. • Insufficient management oversight of risk and implementation of controls. • Risk has not been given sufficient priority in project plan. • Risk could impact achievement of business objectives.	Once per month	50% to 90%
Possible	Moderate likelihood to occur. Factors decreasing likelihood may include: • Internal controls and treatment plan are implemented and will be regularly reviewed to ensure their robustness. • Impact upon achieving business objectives is considered minimal.	Once per year	10% to 50%
Infrequent	Low likelihood to occur. Factors decreasing likelihood may include: • Internal controls and treatment plan are robust and fully implemented. • Circumstances in which risk is likely to eventuate are considered remote. • Unlikely to impact on achieving business objectives.	Once per 10 years	2% to 10%
Rare	Low likelihood to occur. Factors decreasing likelihood may include: • Internal controls and treatment plan are robust and fully implemented. • Circumstances in which risk is likely to eventuate are considered remote. • Unlikely to impact on achieving business objectives.	Once per 100 years	Less than 2%

The consequence rating provides a qualitative measure of the consequence or impact should the risk event occur. The consequence ranking is outlined in

Table 6 Consequence of a risk occurring

Level	Descriptor	Environment
5	Critical	Widespread irreversible environmental harm
4	Major	Widespread environmental impact, not immediately contained
3	Moderate	Reversible environmental harm extending beyond site boundary, immediately contained
2	Minor	Reversible environmental impact, immediately contained
1	Insignificant	Very low environmental impact (localised spill)

The risk matrix associated with each risk is provided in Table 7. The risk matrix combines the level of likelihood and consequence to determine the level of associated risk. The resultant risk rating is described in Table 8 The environmental impact of each risk is then categorised as extreme (red), high (orange), medium (yellow) and low (green). Management measures for each identified risk is then included and the risk rating is re-categorised. A risk priority is assigned to each of the 25 possible outcomes.

Table 7 Risk matrix

	Consequence				
Likelihood	**Insignificant**	**Minor**	**Moderate**	**Major**	**Critical**
Almost Certain	8 - Medium	16 - High	18 - High	22 - Extreme	25 - Extreme
Likely	7 - Medium	10 - Medium	17 - High	21 - Extreme	24 - Extreme
Possible	3 - Low	9 - Medium	12 - Medium	19 - High	23 - Extreme
Infrequent	2 - Low	5 - Low	11 - Medium	14 - Medium	20 - High
Rare	1 - Low	4 - Low	6 - Low	13 - Medium	15 - Medium

Table 8 Risk Ranking

Risk Level	Priority	Example Action
Extreme	1	Managed by senior site management / General Manager (GM). Reported/monitored by the Board quarterly
High	2	Managed by Sectional Manager. Reported/monitored to the GM quarterly
Medium	3	Managed by Sectional supervisors
Low	4	Managed by operators and staff

Table 9 Risk assessment and management

Source/ Activities	Environmental Impact	C	L	Inherent Risk Level	Management	C	L	Treated risk
Mining	Loss of wildlife corridor	minor	possible	9 - medium	The application area includes the existing mining pit voids (mostly cleared), areas of native vegetation, native vegetation regrowth and historically cleared areas. Clearing activities are predominately required to facilitate mine expansion, rehabilitation and exploration works. A small portion of the application area is required to facilitate the Lynton Borefield Water Storage Upgrade Project and expansion of existing haul, and access roads. Mining of the Lynton North pit will progressively expand northwards, and it is anticipated 15 hectares of native vegetation will be cleared per annum. The method of mining permits the mining voids to be progressively backfilled and rehabilitated at the trailing edge of the pit, while mining activities continue at the leading edge, progressing northwards (Plate 1). GMA mine closure requirements for M70/204 are outlined in Port Gregory Project – Revised Mine Closure Plan and the Notice of	minor	Infrequent	5 – low
Mining Activities	Permanent loss of vegetation, fauna habitat and biodiversity	minor	possible	9 - medium		minor	Infrequent	5 - low

Source/ Activities	Environmental Impact	C	L	Inherent Risk Level	Management	C	L	Treated risk
					Intent – Mining Lease M70/204. GMA has an obligation to rehabilitate the mined area to pre-mining native vegetation communities. Therefore, there is no permanent loss of vegetation, biodiversity, fauna habitat or any wildlife corridors. A rehabilitation management plan has been prepared to guide rehabilitation and revegetation post-mining (refer to section 4.2). GMA has successfully rehabilitated and return areas to native vegetation (refer to section 4.2.5).			
Mining activities	Fugitive dust emissions associated with mining fleet movements and exposed area, causing impacts to health and condition of the surrounding vegetation and adjoining Hutt Lagoon.	moderate	likely	17- high	Dust management will be undertaken in accordance with the GMA's Dust Management Procedure provided in Appendix D. The following management measures are proposed: • Both visual and monitoring of the wind station located at Hose. • Progressively clear approximately 15 hectares of native vegetation clearing per annum to minimise exposed areas.	minor	infrequent	5 - low

Source/ Activities	Environmental Impact	C	L	Inherent Risk Level	Management	C	L	Treated risk
					• Pre-stripping will be kept to the minimum practicable work area. • Progressively rehabilitate all mined out areas including the existing the Lynton north pit located south of the application area. • Water carts will undertake dust suppression on haul roads and areas exposed by southerly winds during the summer. • Dust suppressant additives (mulches or polymer additives) will be used if water applicates is insufficient to ameliorate dust generation. To manage potential dust from stockpiles. • Any mining activities will cease in the event dust suppression controls fail to mitigate dust emissions.			
Mining Activities	Clearing of vegetation leading to erosion and sedimentation from surface water runoff leading to Hutt Lagoon	rare	insignificant	1 - low	No drainage lines were recorded within the clearing permit area. Due to the porous nature of the soils, any rainfall rapidly infiltrates directly through limestone. It is expected that most of the surface water will rapidly infiltrate. The progressive and final rehabilitation of the mining pit	rare	insignificant	1 - low

Source/ Activities	Environmental Impact	C	L	Inherent Risk Level	Management	C	L	Treated risk
					area will incorporate re-contouring to blend in with the surrounding landscape and ensure any pre-mining landforms reinstated. As a result, this management approach, there will be no effect on surface water flow.			
Rehabilitation	Incorrect storage of vegetation and soil removed ahead of mining.	minor	possible	9-medium	Storage and handling of rehabilitation materials as per the GMA Rehabilitation Management Plan (refer to section 4.2). Contingency actions to be implemented if rehabilitation is not achieving targets such as infill seeding/planting.	minor	infrequent	5 - Low
Rehabilitation	Prolonged storage of vegetation and soil removed ahead of mining.	minor	possible	9-medium	Storage and handling of rehabilitation materials as per the rehabilitation management plan. Contingency actions to be implemented if rehabilitation is not achieving targets such as infill seeding/planting.	minor	infrequent	5 - Low
Rehabilitation	Successful restoration of native vegetation is inhibited by weed infestation.	minor	likely	10-medium	Site is progressively rehabilitated. Natural vegetation condition is regularly monitored. Herbicides will be used to control weed growth as required.	minor	infrequent	5 - Low
Rehabilitation	Inadequate supply of topsoil for rehabilitation	moderate	possible	12 - medium	The application area includes historically topsoil stockpile areas, clearing of native regrowth is	minor	infrequent	5 - low

Source/ Activities	Environmental Impact	C	L	Inherent Risk Level	Management	C	L	Treated risk
					required to access these stockpiles. Where topsoil stripping is required, the depth is based on pre-mining topsoil survey. Topsoil stockpile locations selected to minimise wind erosion. Wind shielding as appropriate.			
Rehabilitation	Establishment of rehabilitated areas is inadequate or is dominated by one or two aggressive species (such as *Acacia rostellifera*).	Minor	Likely	10 – medium	Seed selection from local provenance species to increase diversity at initial rehabilitation. Early management of aggressive species such as *Acacia rostellifera*. Natural vegetation condition is regularly monitored. Reseeding and reapplication of fertiliser is conducted if required.	minor	Infrequent	5- low
Rehabilitation	Establishment of rehabilitated areas is inadequate and does not meet clearing permit requirements. Relinquishment delayed.	Major	Possible	19 – high	Seed selection from local provenance species to increase diversity at initial rehabilitation. Rehabilitation performance to be monitored every second year and contingency actions implemented such as infill planting / seeding if results if required.	Minor	Possible	9 – medium

4.2 *Rehabilitation*

The progress of revegetation establishment will be monitored through a combination of visual inspection and botanical survey.

4.2.1 *General Approach*

The table below presents the current rehabilitation approach adopted by GMA. The table also includes recommendations regarding stockpile storage.

Table 10 Rehabilitation Approach

Stage	Task	Action	Objective
1	Contour Survey	Topographical survey of location before vegetation clearing.	Completed pits are backfilled with mine waste and shaped to blend in with adjacent natural contours.
2	Seed Collection	Collection of seed of native species within Mine Site before vegetation clearing.	Retain genetic suite of remnant vegetation in Mine Site.
3	Vegetation Removal	100 m corridor removed per year within the mining lease.	Sequential clearing methodology minimising disturbances to fauna movement. Biological matter retained.
4	Topsoil removal	Standing remnant vegetation to be pushed into windrows for stockpiling for later respreading on areas rehabilitated.	Maximum retention of soil fertility and existing seed bank. Retention of biological material in topsoil. Reduction in change in the physical structure of the topsoil because of compaction and change in moisture content. Retention of preferred growth media to support plant growth in rehabilitated areas.
5	Overburden removal	Overburden (where present) to be progressively removed and stockpiled or placed directly over tailings during pit excavations.	Minimisation of the open area of pit.
6	Tailings storage	Tailings to be progressively returned to the trailing edge of the excavated mine pit (Plate 1).	Storage of tailings within landform profile.
7	Overburden return	Stockpiled overburden to be returned to the trailing edge of the excavated mine pit and over tailings as soon as practicable (Plate 1).	Construction of post-mining landform. Minimise storage time of overburden.
8	Landform construction	Contouring of completed mining area to natural contours to be achieved by earth-moving machinery.	Construction of post-mining landform to blend in with surrounding landforms. Height and footprint ensure that the rehabilitated area blends in with surrounding landscape.

Stage	Task	Action	Objective
			New landform does not restrict the existing hydrological regime present in the area.
9	Topsoil return	Topsoil is placed over subsoil (overburden, tails) to a minimum depth of 150 mm.	Construction of post-mining landform to match pre-mining landform.
10	Soil treatment (as required)	Addition of fertilisers suitable for native plant growth (as required).	Create conditions suitable for native plant growth, but minimising weed growth (stage may not be required).
11	Integration of topsoil and landform	Deep ripping of constructed landform to ensure integration of topsoil and subsoil.	Minimise the risk of erosion by wind and water.
12	Return of larger vegetative material	Spreading across landscape of stockpiled logs, branches, and other vegetative material pushed up into windrows.	Increase rainfall penetration of soil profile.
13	Seeding	Direct seeding of reconstructed landform with seeds collected from the Site.	Minimise the risk of erosion by wind and water.
14	Monitoring	Establishment of long-term monitoring sites.	Increase microhabitat.
15	Weed management	Ongoing weed management via a regular treatment program.	Increase seed retention areas for growth.

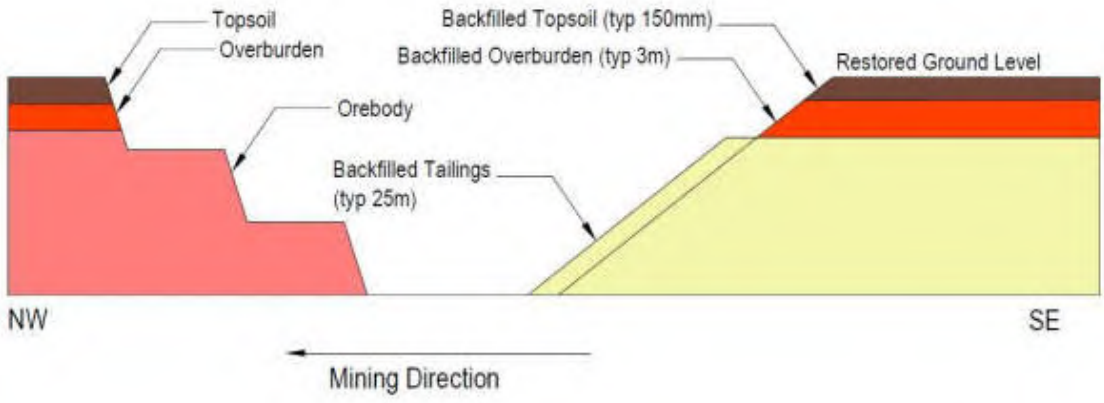


Plate 1 Pit Backfilling/Landform Construction

4.2.2 Vegetation Establishment

4.2.2.1 Erosion Control – Early Revegetation

Progressive rehabilitation will occur as soon as possible after being backfilled. The vegetative matter shall be return to the Site and strategically placed in windrows to help mitigate wind erosion and enhance the establishment of new native vegetation. If required, a wind fencing will be established to mitigate wind erosion. If required instate earthen bunds to protect topsoiled area.

4.2.2.2 Return of Local Native Species

The use of seed for rehabilitation must be obtained from the local area and appropriate for the targeted vegetation type. Seeds should be collected from vegetation within the Site, so that genetic diversity of the Site is retained and returned.

Weeds are problematic for the Site and it is recommended that revegetation efforts focus on fast growing plants (i.e. Some *Acacia*, Eucalypts and *Melaleuca*) rather than herbs in the initial years. It should be noted that the species list is not exhaustive.

4.2.2.3 Weed Management

Where there is a low likelihood of weeds being eradicated from areas such as existing paddocks. The weed management actions will focus on protecting areas of remnant native vegetation and native vegetation rehabilitation areas by preventing the spread of weeds into these areas. This form of management will be achieved through containment and land protection measures.

Longer-term objectives for dealing with well-established weed species will be to undertake measures to reduce the extent of the infestation of weed species (i.e aiming for a slow reduction in the extent of these infestations over time through a staged treatment of these areas). Strategically treating large areas starting from the outside and working inwards is the recommended approach for achieving this objective.

Weed species can potentially spread between sites by several different vectors including, but not limited to, contaminated machinery, vehicles, equipment, clothing and footwear. The implementation of weed hygiene procedures are critical to minimising the spread and/or introduction of weeds.

Appropriate weed hygiene measures will be implemented to minimise further spread and introduction of weed species. Weed hygiene measures must be followed by all site personnel, vehicles and equipment entering the site area.

Weed monitoring is an essential component of any weed management program as it provides a means of identifying how well control measures are working, the rate of spread of weeds and/or the detection of new weeds established in disturbed areas. The Pest and Weed Management Guideline/Procedure can be adapted as needed to improve results and accommodate changing circumstances or changes in the local environment.

Ongoing weed monitoring and management of weeds, particularly in disturbed areas, is a high priority. Follow up control is vital as many weed species have many long-lived seeds that have the potential to remain viable in the soil for many years. Ongoing surveillance monitoring of sites shall be undertaken throughout the year, especially after rain periods.

4.2.2.4 Revegetation Treatments

The topsoil shall be respread across the area at an optimal depth of 150 mm or greater (or topsoil pre-clearing survey results) and vegetative matter strategically placed in windrows to establish fauna habitat and windbreaks.

Direct seeding of the reconstructed post-mining landform is the most suitable method of developing the vegetation community. Seeds will be sourced locally from the Site and collected before vegetation is cleared, to preserve the genetic diversity.

Direct seeding shall be supplemented with additional planting of locally sourced native flora species. This will be undertaken to enhance biodiversity on-site where quick-growing colonisers may outcompete slower-

growing or recalcitrant species or where monitoring demonstrates a lack of species diversity in comparison to the biodiversity target criteria.

Direct planting will also be used in conjunction with the direct seed of the reconstructed post-mining landform to enhance soil stabilisation.

*4.2.3 **Monitoring***

Visual monitoring of rehabilitated areas will be conducted to assess:

- Any signs of poor rehabilitation development that may require treatment, supplementary seeding or earthworks
- Species recruitment
- Stability of rehabilitation sites.

Areas will be photographed from fixed positions so that changes with time can be clearly observed.

4.2.3.1 Objective and Completion Criteria

A baseline for the re-establishment of vegetation was developed to initially guide revegetation and monitor the success of the works. Indicative values for foliage cover and flora species diversity at set intervals were provided to guide the progress of native flora taxa within each stratum and weed species until practical completion (Table below).

The success of revegetation can be affected by a range of issues, which may be out of the control of GMA, such as lack of rainfall, storm events, insect attack and vandalism, but other success factors, such as weeds, grazing, and care of planting can be managed. The overarching outcome for revegetation is:

- To achieve similar species composition, structure and diversity to what was present before vegetation clearing. Small-scale vegetation structure and species combinations may vary

Practical completion is achieved when:

- An average of 75% species diversity of adjacent reference sites, +/- 5%, for a five-year period.
- An average of 50% plant cover in the ground and mid layers of the adjacent reference sites, +/- 5%, for a five-year period.
- The key upper storey species recorded in the vegetation type/adjacent reference site are present and likely to form an upper storey over time.

Table 11 Indicative Values to Guide Monitoring

M70/204					
Vegetation Type 1					
Stratum	**Background**	**6 months**	**1 years**	**5 years**	**10+ years**
Upper Stratum	39%	-	-	>10%	>25%
Middle Stratum	50%	-	>2%	>25%	>50%
Groundcover	11%	-	-	5%	≥11%
Mean Weed Foliage Cover (%)	<46%	<46%	<46%	<46%	<46%
Declared Pest	0	0	0	0	0
Weed Species Count	≤3	≤3	≤3	≤3	≤3
Flora Diversity Species Count (native flora)	≥9	≥2	≥4	≥7	≥9
Vegetation Type 2					
Stratum					
Upper Stratum	5%	-	-	>2%	5%
Middle Stratum	34%	-	5%	>20%	34%
Groundcover	4%	-	-	2%	4%
Mean Weed Foliage Cover (%)	<48%	<48%	<48%	<48%	<48%
Declared Pest	0	0	0	0	0
Weed Species Count	≤3	≤3	≤3	≤3	≤3
Flora Diversity Species Count (native flora)	≥15	≥2	≥2	≥8	≥15

4.2.4 Site Establishment and Data Collection

4.2.4.1 Site Establishment

At each mining tenement where revegetation is undertaken, a minimum of one permanent quadrats (10 x 10 m) will be established within both remnant vegetation and rehabilitation areas for each revegetation year with the aim of providing sufficient monitoring data.

The analogue quadrats (reference sites) established within the remnant vegetation will assist with measuring the progress of revegetation and be used to determine whether practical completion has been met.

Galvanised steel post will be installed in each corner of the quadrat and each corner will be geo-referenced.

4.2.4.2 Data collection, analysis and reporting

Site data collected from each quadrat will be recorded on pro-forma data sheets and will include the parameters described in Table 12.

Table 12 Example of Data Collection at Monitoring Quadrats

Parameters	Measurements
Collection attributes	Personnel/recorder, date, quadrat dimensions, GPS coordinates of all corners and photographs from each corner of the quadrat.
Rehabilitation details	Rehabilitation year and works
Physical attributes	Landform, drainage, soil, litter type and cover
Disturbances	Nature of disturbances, fire age
Vegetation	Structure: overall projected foliar cover of upper, mid- and ground stratums (based on cover classes of: 1-100%)
Flora	Composition (species diversity): list of all flora species and stratum abundance
Weeds and Declared Pests	Overall foliar cover of all weed species combined based on cover class of: 1 to 100%

4.2.4.3 Monitoring Frequency and Duration

Monitoring will be conducted every second year for a minimum of five years from the completion of rehabilitation activities, or until the closure objectives associated with each domain have been met. As monitoring for progressive rehabilitation is completed, this monitoring timeframe will be reviewed.

4.2.5 Rehabilitation Performance

Past rehabilitation of mined zones on southern M70/204 has been successful in restoring the pre-mining vegetation.

The GMA Rehabilitation Management Plan outlines the rehabilitation monitoring methodologies to be undertaken across areas to be returned to remnant vegetation.

The results of this monitoring are summarised in the section below and a copy of the reports attached in Appendix D. The rehabilitation monitoring included assessment of:

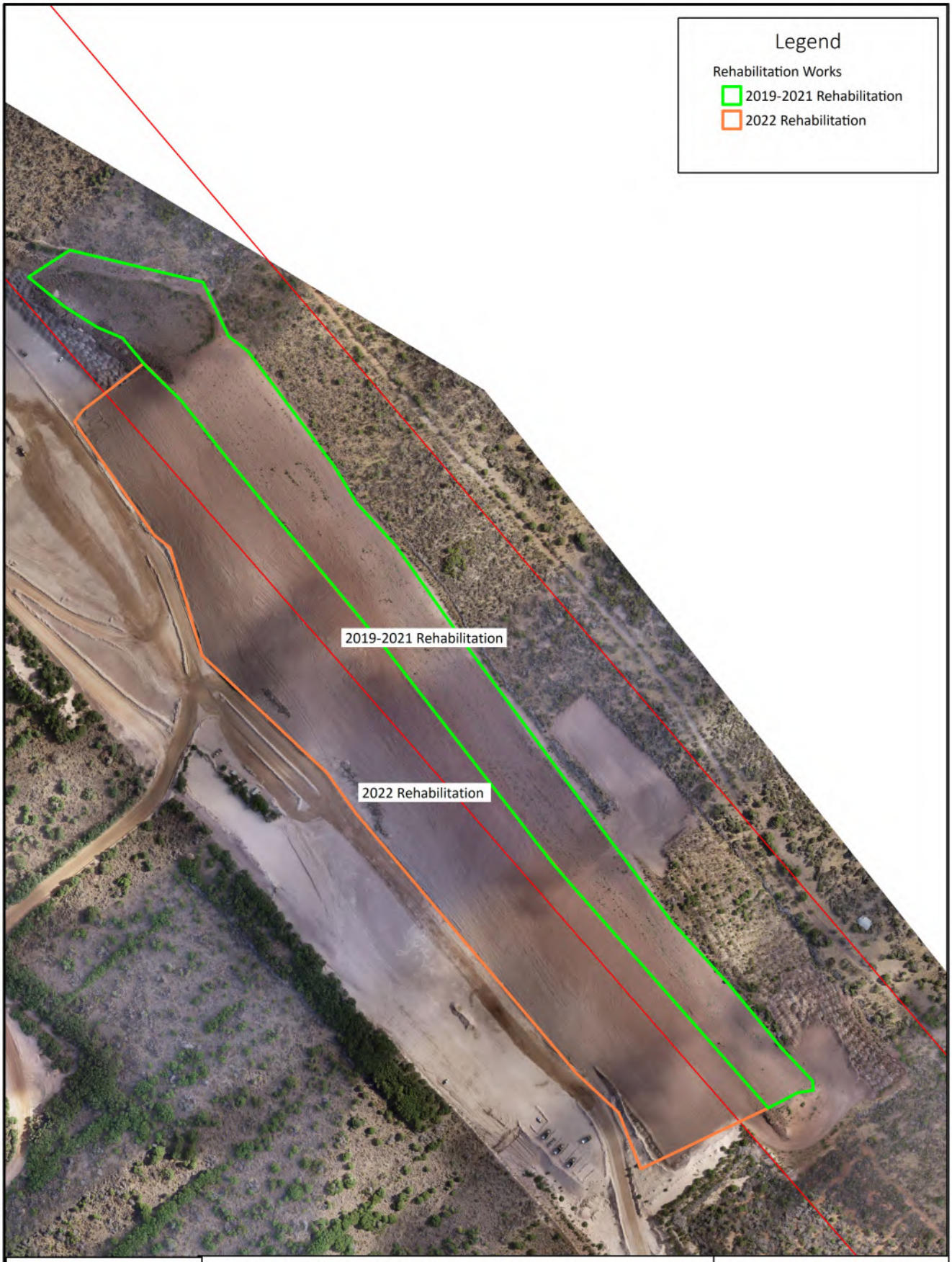
- Three revegetation sites – ranging from one year old to nine old revegetation
- Two reference (analogue) sites

Older areas of rehabilitation such as the site in 9-year-old rehabilitation exceeding the species diversity target and meeting completion criteria for middle and ground stratums. Upper stratum species were present but not forming an upper layer yet due to their height. Overall, the monitoring showed rehabilitation was on track to meet completion criteria with some recommendations identified such as weed management and infill planting.

4.3 Summary of Rehabilitation Works

Rehabilitation works undertaken are summarised below and shown in Figure 5:

- Approximately, 5.9 hectares of M70/204 and 2.8 hectares of M70/968 has undergone rehabilitation in 2022 including contouring and topsoil application. Ripping and spread of vegetation matter is proposed to be undertaken over the next six months.
- Approximately, 1.2 hectares of rehabilitation was undertaken in 2021, this included topsoil application and spread of vegetation matter.
- In 2021, seed application and vegetation brush was applied to approximately 9 ha of M70/968.



25 m 100 m 175 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Imagery: GMA (2022)
Survey: GMA (2022)

N

Figure 6
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Rehabilitation Effort

0 m 50 m 100 m

Map Projection: Transverse Mercator
Horizontal Datum and Grid: GDA 1994 MGA Zone 50
Survey: GMA (2021)
Imagery: GMA (2021)

N

Figure 6
Port Gregory Garnet
Lynton Resource
Native Vegetation Clearing Permit
Rehabilitation Effort

4.4 Summary of Rehabilitation Monitoring Results

GHD (2019) completed the first round of monitoring of M70/204 in Spring 2019. A summary of the results are provided in Table 13 and monitoring report provided in Appendix D.

Table 13 Summary of rehabilitation monitoring results

Tenement	Summary of findings
M70/204	• Revegetation quadrats in the six-year-old revegetation comprised 43% of the species recorded at the reference sites • The nine-year-old revegetation (Q12) exceeded the reference site species diversity and meets the completion criteria for diversity • The key flora taxa that define the remnant vegetation type were dominant within all ages of revegetation • The upper stratum within the revegetation sites have yet to establish and the middle stratum largely dominated the area, however as the key upper stratum species are present it is expected that with time the upper stratum will develop

5. Assessment of the Ten Clearing Principles

Clearing is required to progressively expand the mine pit and expand the existing single-lane haul road to a standard haul road. An assessment of the proposed clearing action against the ten clearing principles, as outline in Schedule 5 of the EP Act provided in Table 14.

The assessment indicates the clearing is 'not considered to be at variance with the Ten Clearing Principles'.

Table 14 Assessment of the Ten Clearing Principles

Clearing Principle	Assessment	Conclusion
Principle (a) – Native vegetation should not be cleared if it comprises a high level of biological diversity.	The application area is in the Geraldton Hill sub-region of the Geraldton Sandplains IBRA. Two Beard Vegetation Association has been mapped in the application area BVA 371 and BVA 17. The extent of the pre-European extent vegetation remaining for BVA 17 is greater than 80% at all levels. The extent of remaining for BVA 371 is 10.66 to 10.67% at a State, IBRA, Sub-IRA level. At an LGA level 36.9% of native vegetation extent remains. Mapping results from vegetation and flora survey conducted by GHD (2020a) described two vegetation types (*Acacia rostellifera* open woodland to woodland and shrublands on seasonally wet brackish drainage flats) within the application area, consistent with BVA 17 and BVA 371. Sixty-four flora taxa (including subspecies and varieties) representing 26 families and 50 genera recorded from the survey area during the field survey. This total comprised 49 native taxa and 15 introduced flora taxa. The species diversity ranged was 14 taxa per 100 m^2. As such, the species diversity is comparatively lower than that known within a 10 km radius, as according to *NatureMap* 455 flora taxa have been recorded (GHD 2020a). The application area is not within a TEC or PEC. Two priority flora species considered to potentially occur in the application area based on available range and habitat type. No threatened or priority flora taxa were recorded from the application area (GHD 2020a and 2020b). The application area is mostly cleared, where native vegetation is present, the vegetation conditions was rated good to completely degraded. Much of the understorey comprises weeds (GHD, 2020a). A total of 31 fauna species were recorded within the broader survey area. Of these, 24 are native, and seven introduced. One Migratory/Marine listed EPBC Act fauna species – *Pandion cristratus* (Osprey) was recorded nesting outside the application area. A 100 metre buffer has been implemented around the nesting site to ensure clearing will not impact on the nesting site (Figure 3).	The proposed clearing not considered to be at variance with this Principle.

Clearing Principle	Assessment	Conclusion
Principle (b) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	The EPBC Act PMST, *NatureMap* and DBCA Threatened and Priority Flora databases identified the presence/potential presence of 48 conservation significant flora taxa within 10 km of the survey area. Of these two were considered as likely to occur including *Apus pacificus* (Fork-tailed Swift) and *Falco peregrinus* (Peregrine Falcon). One Migratory/Marine listed fauna species *Pandion cristatus* (Osprey) nesting site was recorded within the south-western portion of the mining tenement. A 100-metre buffer has been implemented around the nesting site to ensure clearing will not impact on the nesting site.	The proposed clearing is not considered to be at variance with this Principle.
Principle (c) – Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No Threatened (Declared Rare) flora were recorded from the application area (GHD 2020a and 2020b).	The proposed clearing is not considered to be at variance with this Principle.
Principle (d) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	There are no known TECs within the application area. The vegetation types mapped within the application area are not considered to be representative of the TEC or PEC (GHD, 2020a).	The proposed clearing is not considered to be at variance with this Principle.
Principle (e) – Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	The application area comprises small tracts of remnant vegetation, two vegetation types were described by GHD (2020a) including *A. rostellifera* open woodland to woodland and *M. cardiophylla* shrubland to open shrubland. A comparison of vegetation types with the Beard Vegetation Associations mapped within the application area, indicates that vegetation type 1 and 2 closely aligns with BVA 17 (*Acacia rostellifera* dense thicket at 6 m in height, principal species comprise of *Alyogyne cuneiformis*, *Pimelea floribunda* and *Melaleuca cardiophylla*). In contrast, BVA 371 (Acacia low forest) which is a taller version of the *A. rostellifera* thicket exceeding 10 metres in height. It is very dense, and seems to be a pure stand of that species (*A. rostellifera)* (Beard and Burn 1976). The current extent of vegetation association Greenough_17 is greater than 30% of its pre-European extent at State, IBRA regional and sub-regional, and LGA levels. Clearing of native vegetation within the application area will not permanently reduce the extent of pre-European extents, as the application area is returned to	The proposed clearing is not considered to be at variance with this Principle.

Clearing Principle	Assessment	Conclusion
	pre-mining vegetation assemblages following the Mine Closure Plan and Notice of Intent conditions.	
Principle (f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	There are no watercourses within the application area. The nearest watercourse is the Hutt River, located 4 km south of the application area (GHD 2020). There are no wetlands within the application area. The nearest wetland is the Hutt Lagoon which is located approximately 200 metres from the application area (GHD 2020).	The proposed clearing is not considered to be at variance with this Principle.
Principle (g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation	The deep sands of the area have a high to very high wind erosion risk. GMA proposes to expand the northern portion of the current North Pit and the northern, eastern, and western portions of the existing Old Dune Pit. Mining will progressively expand northwards of the North Pit. This method of mining permits the mining voids to be progressively backfilled and rehabilitated at the trailing edge of the pit, while mining activities continue at the leading edge, progressing northwards GMA adopted the following vegetation clearing approach using a raised blade technique to remove vegetation. The method of mining also limits the extent of open areas. Given the proposed activities disturbance footprint includes a small tract of vegetation (both remnant and regrowth) and the intent to rehabilitate the area upon completion of mining, the proposed activity is unlikely is likely to cause appreciable land degradation. The clearing activities also include current and previously cleared areas. Clearing activities involve removal native vegetation regrowth in existing stockpile areas and within the mining void to facilitated rehabilitation and revegetation. The intent of these activities is to progressively rehabilitate the current extent of open areas across much of Lynton Old dune Pit Void. The proposed drill line tracks involve clearing of parallel linear corridors of native vegetation. Given the disturbance footprint the proposed activity includes narrow tracts, and the intent is to rehabilitate the area following the completion of works, impacts of wind erosion as a result of the proposed activity is considered low.	The proposed clearing is not considered to be at variance with this Principle.

Clearing Principle	Assessment	Conclusion
	The proposed Lynton Borefield Water Storage Upgrade Project involves clearing of native revegetation regrowth in mostly cleared areas. Given small clearing area required and that a large portion of the area will be covered by infrastructure, impacts of wind erosion from the proposed clearing activity are considered low. GMA proposes to clear narrow tracts to expand the current Lynton Ramp Access Road/fire break and Single Lane Haul Road/fire break. Given the proposed activities disturbance footprint is mostly cleared, it is unlikely clearing of native vegetation is likely to cause appreciable land degradation. Ongoing management of dust will be required, GMA's Dust Management Procedure outlines the adopted practices for management of dust on haul roads and access roads.	
Principle (h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	There are no conservation areas within the application area. The nearest reserve is Utcha Well, which is located approximately three kilometres north of the application area. There is no direct linkage between the reserve and application area; therefore, it is unlikely that clearing will have an impact on the environmental values of the nearby reserve. Also, the clearing proposed is temporary and returned to pre-mining vegetation assemblages as per the Mine Closure Plan and Notice of Intent conditions.	The proposed clearing is not considered to be at variance with this Principle.
Principle (i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water	Due to the porous nature of the soils, any rainfall rapidly infiltrates directly through limestone. It is expected most of the surface water will rapidly infiltrate. The progressive and final rehabilitation of the mining pit area will incorporate re-contouring to blend in with the surrounding landscape and ensure any pre-mining landforms are reinstated. As a result, this management approach, there will be no effect on surface water flow. The clearing is not considered likely to alter the quality of surface or groundwater within the application area. Mining operations are above the groundwater table as per Mine Closure Plan and Notice of Intent. The water table is too deep (greater than 16 to 35 m bgl) to support root systems of any species (URS 2013).	The proposed clearing is not considered to be at variance with this Principle.

Clearing Principle	Assessment	Conclusion
Principle (j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	The climate of the application is semi-arid to Mediterranean climate with 400 to 500 mm of rainfall per annum (Desmond and Chant, 2002). The region experiences short mild wet winter and the remainder of the year being warm to hot, dry to windy. Due to the porous nature of the soils, any rainfall rapidly infiltrates directly through limestone. It is expected most of the surface water will rapidly infiltrate. Clearing of native vegetation is not expected to cause or exacerbate the incidence or intensity of flooding. The application area occurs on sandy soils which are not prevalent to flooding events.	The proposed clearing is not considered to be at variance with this Principle.

6. Reference

Beard and Burns (1976) the Vegetation of Geraldton Area Western Australia, Map and Explanatory Memoir

Desmond, A and Chant, A (2001) Geraldton Sandplains (GS2 – Geraldton Hills Subregion). A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002.

EPA (2016) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment

GHD (2020a) *Lynton Mine Expansion Biological Survey.* Unpublished. Prepared for GMA Garnet

GHD (2020b) Targeted *Caladenia bryceana* subsp. *cracens* survey and conservation listed flora survey of proposed haul road. Unpublished. Prepared for GMA Garnet.

URS (2013) *Hose Mine Hydrological Assessment.* Unpublished. Prepared for GMA Garnet.

Appendix A. Environmental Surveys

GMA Garnet Pty Ltd

Lynton Mine Expansion

Biological Survey

February 2020

Executive summary

GMA Garnet Pty Ltd (GMA) currently own and operate the open pit Hose and Lynton Mines, located near Port Gregory, Western Australia.

GHD Pty Ltd (GHD) was commissioned to undertake a biological assessment across three tenements M70/204, M70/1330 and M70/259. The purpose of the survey was to delineate key flora, vegetation and fauna aspects.

The outcome of the survey and information supplied in the biological survey will be used to inform the environmental assessment and approvals process. This report is subject to, and must be read in conjunction with, the limitations set out in section 1.7 and the assumptions and qualifications contained throughout the report.

Key flora findings

- Three vegetation types were identified in the survey area, not including previously cleared areas (mining areas, tracks, cleared areas with no native species)
- The condition of the vegetation ranged from Good to Completely Degraded. Areas mapped as Good had vegetation that was largely intact with native species present across each structural layer, although had high weed cover and signs of high grazing impacts from pigs and kangaroos. Much of the survey area had undergone historical clearing (exploration) and rehabilitation of some of these areas
- No vegetation communities identified in the survey area were consistent with Threatened or Priority Environmental Communities
- Sixty-four flora taxa (including subspecies and varieties) representing 26 families and 50 genera were recorded from the survey area during the field survey
- No *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *Biodiversity Conservation Act 2016* (BC Act) listed flora were recorded within the survey area. No Priority flora, as listed by the Department of Biodiversity Conservation and Attraction, were recorded within the survey area
- The likelihood of occurrence assessment post-field survey concluded three species are considered possible to occur, five species unlikely to occur, and 40 species highly unlikely to occur in the survey area. The species considered possible to occur are; *Caladenia bryceana* subsp. *cracens*, *Anthocercis intricata* (P3) and *Balladonia aervoides* (P3).

Key fauna findings

- Five broad habitat types (including rehabilitated and cleared areas) were recorded during the survey
- Thirty-one fauna species were recorded within the survey area, including 21 bird, 8 mammal and 2 reptile species. Of these, 24 are native and seven are introduced/feral
- No Threatened fauna listed under the EPBC Act and/or BC Act or Priority fauna species listed by the DBCA was recorded during the survey
- The Eastern Osprey (*Pandion cristatus*) which is listed as Migratory and Marine under the EPBC Act and under International Agreement under the BC Act was recorded during the survey

- Of the 35 conservation significant fauna identified in the desktop searches one species has been identified as present (Osprey), two are considered likely to occur and the remaining species are considered unlikely or highly unlikely to occur within the survey area.

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Appendices

1. Introduction

1.1 Project background

GMA Garnet Pty Ltd (GMA) currently own and operate the open pit Hose and Lynton Mines, located near Port Gregory, Western Australia (WA). Mining activities are currently undertaken within M70/926, M70/204 and M70/968. Mining is undertaken using an open-cut sand mining methods. Mobile earthmoving equipment, including front-end loaders, excavator and dump trucks are used for pit excavation and backfilling. Soil and overburden are moved ahead of ore excavation and replaced in their original stratigraphic order over the backfilled tailings.

GMA are currently in the process of planning for the expansion of their operations within the Lynton Mine, located to the east of Hutt Lagoon, near Port Gregory in WA. Biological surveys are required to be undertaken to inform this expansion.

1.2 Purpose of this report

GMA commissioned GHD Pty Ltd (GHD) to undertake a biological assessment across three tenements M70/204, M70/1330 and M70/259. The purpose of the survey was to delineate key flora, vegetation and fauna aspects.

The outcome of the survey and information supplied in the biological survey will be used to inform the environmental assessment and approvals process.

1.3 Study area

The study area of the project is located in Geraldton, and encapsulates an area of 10 km around the survey area.

1.4 Survey area

The survey area for this project is located at Port Gregory, approximately 96 kilometres (km) north of Geraldton in the mid-west of WA. The survey area is 413 hectare (ha) in size and occurs across three tenements (M70/204, M70/1330 and M70/259). The survey area boundary is shown in Figure 1, Appendix A.

1.5 Scope of works

The scope of works was to undertake a desktop assessment and biological survey of the survey area. The following actions were completed to fulfil the scope:

- A desktop assessment of the survey area prior to the field survey to identify biological features and constraints, which may be in, or near the survey area
- A review of relevant publicly available or supplied by GMA environmental reports
- A field survey to verify/ground truth the desktop assessment findings through a detailed (single-season) vegetation and flora survey and level 1 fauna survey
- Identification and mapping of vegetation types to a scale appropriate for the bioregion and described according to the National Vegetation Information System (NVIS) structure and floristics
- Identification and mapping of Threatened or Priority Ecological Communities (TECs or PECs) inferred through the use of quadrats and relevés

- Assessment of the survey area's flora species diversity, density, composition, structure and weed cover, recording the percentage of each in nominated quadrats
- Delineation and mapping of fauna habitat types
- A flora and fauna likelihood of occurrence assessment based on the vegetation units and fauna habitat present within the survey area and known species distribution and habitat requirements
- Mapping using Geographic Information Systems (GIS) mapping software
- A concise report (this document) on the findings of the biological survey and targeted flora assessment.

1.6 Relevant legislation, conservation codes and background information

In WA some ecological communities, flora and fauna are protected under both Federal and State Government legislation. In addition, regulatory authorities also provide a range of guidance and information on expected standards and protocols for environmental surveys.

An overview of key legislation and guidelines, conservation codes and background information relevant to this biological survey is provided in Appendix B.

1.7 Report limitations and assumptions

This report has been prepared by GHD for GMA and may only be used and relied on by GMA for the purpose agreed between GHD and the GMA as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than GMA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

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

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

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

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Site conditions may change after the date of the field survey. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

This report has assessed the flora and fauna within the survey area (Figure 1, Appendix A). Should the survey area change or be refined, further assessment may be required.

2. Methodology

2.1 Desktop assessment

Prior to the commencement of the field survey, a desktop assessment was undertaken to identify relevant environmental information pertaining to the survey area and within 10 km of the survey area (referred to herein as the study area). This included a review of:

- The Department of the Environment and Energy (DotEE) Protected Matters Search Tool (PMST) to identify communities and species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) potentially occurring within the study area (DotEE 2019) (Appendix C)
- The Department of Biodiversity, Conservation and Attractions (DBCA) TEC and PEC database to determine the potential for conservation significant communities to be present within the study area
- The DBCA *NatureMap* database for flora and fauna species previously recorded within the study area (DBCA 2019) (Appendix C)
- The DBCA Threatened (Declared Rare) and Priority Flora (TPFL) database and the WA Herbarium database (WAHERB) for Threatened flora listed under the *Biodiversity Conservation Act 2016* (BC Act) and listed as Priority by the DBCA, previously recorded within the study area
- Existing datasets including previous pre-European vegetation mapping of the survey area (Beard 1976), aerial photography, hydrology information to provide background information on the variability of the environment, likely vegetation units and fauna habitats and to identify areas that potentially contain TECs and PECs
- Existing flora, fauna and vegetation reports and/or data:
  - GMA Port Gregory Mine Tenement M70/968 Vegetation, Flora and Fauna Assessment (GHD 2013)
  - GMA Garnet Port Gregory Mine Targeted Flora Survey (GHD 2014)
  - GMA Garnet Mining Lease M70/926 Biological Survey (GHD 2016)
  - GMA Port Gregory Mine Site M70/1380 Biological Survey (GHD 2019).

The mapped biological constraints within 10 km of the survey area is provided in Figure 2, Appendix A.

2.2 Field survey

2.2.1 Flora and vegetation

Two GHD botanists/ecologists completed a detailed (single-season) flora and vegetation survey from 8 - 12 December 2019. The field survey was undertaken to verify the results of the desktop assessment, identify and describe the dominant vegetation units, assess vegetation condition, and identify and record vascular flora taxa present at the time of survey. The survey seasonal timing did not allow for targeted searches for key conservation significant flora species, however potential habitat for significant flora were identified and mapped where present.

The survey methodology employed by GHD was undertaken with reference to the Environmental Protection Authority (EPA) Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).

Data collection

Field survey methods involved a combination of sampling quadrats and transects located in identified vegetation units and traversing the survey area by vehicle and foot. Twenty non-permanent quadrats and seven releves were placed within the survey area, which is deemed suitable for the represented vegetation types identified. Transects were spaced at 10 m intervals when traversing a specified vegetation type. The degraded condition of vegetation in much of the survey area caused transects to become spaced further apart (<50 m) as the survey progressed.

Quadrats (measuring 10 m x 10 m – area of 100 m^2) were located within each identified vegetation unit. Field data at each quadrat was recorded on a pro-forma data sheet and included the parameters detailed in Table 1.

Table 1 Data collected during the flora and vegetation field survey

Aspect	Measurement
Collection attributes	Site code, personnel/recorder, date, quadrat dimensions, photograph of the quadrat, marking method
Physical features	Landform, aspect, slope, soil attributes, ground surface cover, leaf and wood litter
Location	Coordinates recorded in GDA94 datum (Zone 50) using a hand-held Global Positioning System (GPS) tool to accuracy approximately ±5 m
Vegetation condition	Vegetation condition in accordance with the vegetation condition rating scale for the South-West Interzone Botanical Province (EPA 2016)
Disturbance	Level and nature of disturbances (e.g. weed presence, fire and time since last fire, impacts from grazing, exploration activities).
Flora	List of dominant flora from each structural layer, list of all species within the quadrat including stratum, average height and cover (using National Vegetation Information System (NVIS)).

Quadrat data is provided in Appendix D. A flora inventory was compiled from taxa listed in described quadrats, releves and opportunistic floristic records throughout the survey area (Appendix D).

Vegetation units

Vegetation units were identified and boundaries delineated using a combination of aerial photography, topographical features, field data/observations and statistical analyses.

Vegetation units were described based on structure, dominant taxa and cover characteristics as defined by quadrat data and field observations. Vegetation unit descriptions follow the NVIS and are consistent with NVIS Level V (Association). At Level V, three (or more) taxa per stratum are used to describe the association (NVIS Technical Working Group 2017).

Statistical analyses

PRIMER version 6 (Clarke and Gorley 2006) was used to examine the similarity between sites using collected data. A presence/absence matrix was created of all taxa (including perennials and annuals) present in GHD quadrats. The dissimilarity between quadrats was determined using the Bray-Curtis measure and the Resemblance function in PRIMER. A Cluster analysis (using Agglomerative Hierarchical Clustering technique) based on group average was undertaken using the Bray-Curtis similarity matrix and results presented as a dendrogram. In addition, a nonmetric multi-dimensional scaling analysis (MDS) was undertaken using the Bray-Curtis similarity matrix and results presented as a two dimensional scatter plot. The analysis was repeated using removing all singleton taxa. The outputs of the PRIMER analysis were used to inform decisions on vegetation units.

Vegetation condition

The vegetation condition of the survey area was assessed and mapped in accordance with the vegetation condition rating scale for the South-West Interzone Botanical Province of WA (devised by Keighery (1994) and adapted by the EPA (2016a)). The scales recognise the intactness of vegetation and consists of six rating levels as outlined in Appendix B.

Flora identification and nomenclature

Species that were well known to the survey botanists were identified in the field; all other species were collected and assigned a unique collection number to facilitate tracking. Flora collections were made under Joel Collin's DBCA Scientific Flora License (#FB620000200). All specimens collected during the field assessment were dried and processed in accordance with the requirements of the WA Herbarium. Species were identified by a qualified taxonomist using taxonomic literature, electronic keys and online electronic databases.

The conservation status of all recorded flora was compared against the current lists available on *FloraBase* (WA Herbarium 2020) and the EPBC Act Threatened species database provided by DotEE (2020). Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase* (WA Herbarium 2020).

2.2.2 Fauna

GHD ecologists undertook a Level 1 fauna survey (reconnaissance survey) in conjunction with the flora and vegetation survey from 8 - 12 December 2019. The survey area was traversed on foot over the course of the survey to identify and describe the dominant fauna habitat types present and their condition, assess habitat connectivity, and identify and record fauna species within the survey area. An assessment of the likelihood of conservation significant fauna occurring within the survey area was also undertaken.

The survey methodology employed by GHD was undertaken in accordance with the EPA *Technical Guidance – Sampling methods for terrestrial vertebrate fauna* (EPA 2016b) and *Technical Guidance – Terrestrial Fauna Surveys* (EPA 2016c).

Opportunistic fauna searches

Opportunistic fauna searches were conducted across the survey area. Opportunistic searches involved:

- Searching the survey area for tracks, scats, bones, diggings and feeding areas for both native and introduced/feral species
- Visual and aural surveys, which accounted for many bird species potentially utilising the survey area
- Recording GPS locations of any conservation significant fauna species observed.

Fauna species identification

Identification of fauna species was made in the field using available field guides and electronic guides (e.g. Morcombe 2011). Where identification was not possible, photographs of specimens were collected to be later identified.

Fauna nomenclature

Nomenclature used in this report follows that used by the Western Australian Museum and the DBCA NatureMap database (DBCA 2019) with the exception of birds, where Christidis & Boles (2008) was used.

2.3 Limitations

2.3.1 Desktop limitations

The EPBC Act PMST is based on bioclimatic modelling for the potential presence of species. As such, this does not represent actual records of the species within the area. The records from the DBCA searches of Threatened fauna provide more accurate information for the general area and local occurrence. However, some collection, sighting or trapping records cannot be dated and often misrepresent the current range of Threatened species

2.3.2 Field survey limitations

The EPA (2016a, b) states that flora and fauna survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field survey are discussed in Table 2.

Table 2 Flora and fauna survey limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area. • Pre-European vegetation mapping (Beard 1976) • GHD (2019) GMA Garnet Port Gregory Mine Mining Tenement M70/1380 Biological Survey • GHD (2016) GMA Garnet Mining Lease M70/926 • GHD (2014) GMA Garnet Port Gregory Mine Targeted Flora Survey • GHD (2013) GMA Garnet Port Gregory Mine M70/968 Vegetation, Flora and Fauna Assessment.
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not surveyed. Adequate time was available to complete the biological survey to the required standard.
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Moderate	The flora and vegetation survey was undertaken from 8 - 12 December 2019. Spring is considered the most optimal time to undertake vegetation surveys in the Geraldton bioregion. This survey is considered an out of season survey as seasonal conditions at the time of the survey are deemed unsatisfactory for some annuals and ephemeral species, such as orchids. The survey sampling and intensity was considered adequate. The vegetation survey was a broad scale and targeted assessment, undertaken to identify and describe the dominant vegetation units and map conservation significant flora. The portion of flora collected and identified was considered appropriate for the level of experience of the Senior Botanist undertaking the survey. All taxonomic groups were considered to be represented. The portion of flora collected and identified was considered moderate; and it is likely the survey under-recorded some grass species (Poaceae), annuals and herbs due to lower than average rainfall and out of season timing. However, based on the likelihood assessment it is unlikely these species would be conservation significant. The reconnaissance fauna survey was undertaken from 8 - 12 December 2019. The fauna assessment sampled those species that can be easily seen, heard or have distinctive signs, such as tracks, scats, diggings, etc. Many cryptic species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year. Of the fauna species recorded during the survey, all were identified to species level.
Flora determination	Minor	Flora determination was undertaken by GHD botanist/ecologist in the field and at the WA Herbarium by Botanist Frank Obbens. Four taxa could be identified to genus level only, due to lack of flowering and/or fruiting material required for identification. None of these taxa were considered to be conservation significant species. The taxonomy and conservation status of the WA flora is dynamic. This report was prepared with reliance on taxonomy and conservation status current at the time of report development, but it should be noted this may change in response to ongoing research and review of the International Union for Conservation Nature criteria.

Aspect	Constraint	Comment
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Minor	The majority of the survey area was accessible and was accessed by foot and vehicle. There were some areas of large piles of dead Acacia logs and branches which restricted movement by foot, however, these areas could still be ground-truthed.
Mapping reliability	Minor	The vegetation was mapped using high-resolution ESRI aerial imagery obtained from Landgate, topographical features, previous broad scale mapping (Beard 1976) and field data. Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within ±5 metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/ season/cycle	Moderate	The Detailed Flora and Level 1 fauna field survey was conducted in December 2019. In the six months prior to the flora survey (June -November), Lynton weather station (BoM 2020) recorded a total of 270 mm of rainfall. This rainfall total is slightly lower than the long-term average for the same period (June to November; 277 mm) (BoM 2020). • The weather conditions during the field survey included: • Daily maximum temperatures ranging from 25 to 35 ^{o}C • Daily minimum temperature ranging from 14 to 22 ^{o}C • No rainfall occurred during the survey. This survey is considered and an out of season flora survey as seasonal conditions at the time of the survey are deemed unsatisfactory for some annuals and ephemeral species, such as orchids. For majority of the other flora species the timing of detailed flora survey was considered appropriated due to a number of flora flowering or fruiting at the time of the survey.
Disturbances (e.g. fire, flood, accidental human intervention)	Minor	Much of the survey area had undergone historical clearing (exploration) and rehabilitation of some of these areas. Newly cleared or disturbed areas (roads and tracks) were also prevalent, as well as completely cleared areas, where the mine development has progressed. These disturbances did not limit the survey.
Resources	Nil	Adequate resources were employed during the field survey. Two staff over five days were spent undertaking the flora and fauna survey using a dedicated botanist and ecologist.
Access restrictions	Nil	No access problems were encountered during the survey. There were some areas of large piles of dead Acacia logs and branches which restricted movement by foot, however, these areas could still be ground-truthed.
Experience levels	Nil	The botanist/ecologists who executed the survey were practitioners suitably qualified in their respective fields. Joel Collins, is suitably qualified with over 16 years' experience in undertaking flora and fauna surveys and assessments in Western Australia. Joel has extensive experience undertaking flora and

Aspect	Constraint	Comment
		assessments on the Geraldton Sandplains. Sarah Flemington (Ecologist) has three years experience undertaking flora and fauna surveys across the South West and across the arid region and interzone.

3. Desktop assessment

3.1 Regional biogeography

The survey area is located within the Geraldton Sandplains bioregion and Geraldton Hills sub-region as described by the Interim Biogeographic Regionalisation of Australia (IBRA).

This region comprises of sandy earths of an extensive undulating and lateritic sandplain mantling Permian to Cretaceous strata. This region occurs within the southern end of the Carnarvon Basin and the northern end of the Perth Basin, with exposed areas of Permian/Silurian siltstone and Jurassic sandstones mostly overlain by sandplains, alluvial plains and coastal limestone. The vegetation consists primarily of proteaceous heath with *Banksia* - York gum woodlands on alluvial plains and *Acacia* scrub on limestone (Desmond and Chant, 2002).

3.2 Climate

The survey area experiences a Mediterranean type climate, characterised by warm to hot dry summers and mild wet winters. The Bureau of Meteorology (BoM) Kalbarri weather station (Number 8251) is the nearest active weather station to the survey area with continuous long-term temperature data (approximately 54 km from the survey area). Climatic data from this site indicates the mean maximum temperature of the area ranges from 21.8 degrees Celsius (°C) in July to 34.2 °C in February, and the mean minimum temperature ranges from 9.7 °C in July to 20.6 °C in February (Plate 1) (BoM 2020). Rainfall data has been sourced from the Lynton weather station (Number 8075), which was likely to better represent the survey area. The average annual rainfall measured at Lynton is 405.9 mm with the average monthly rainfall ranging 3.5 mm in December to 93.7 mm in June. Rainfall was significantly higher than the average for the area in June 2019, at 171.5 mm (Plate 1) (BoM 2020). Rainfall was not recorded at Lynton in 2019 for the months September to December. Results from 2018 have been supplemented for those months. The majority of rainfall occurs in the winter months and is generally associated with frontal systems from the south west. The summer rains are associated with isolated thunderstorms and tropical lows.

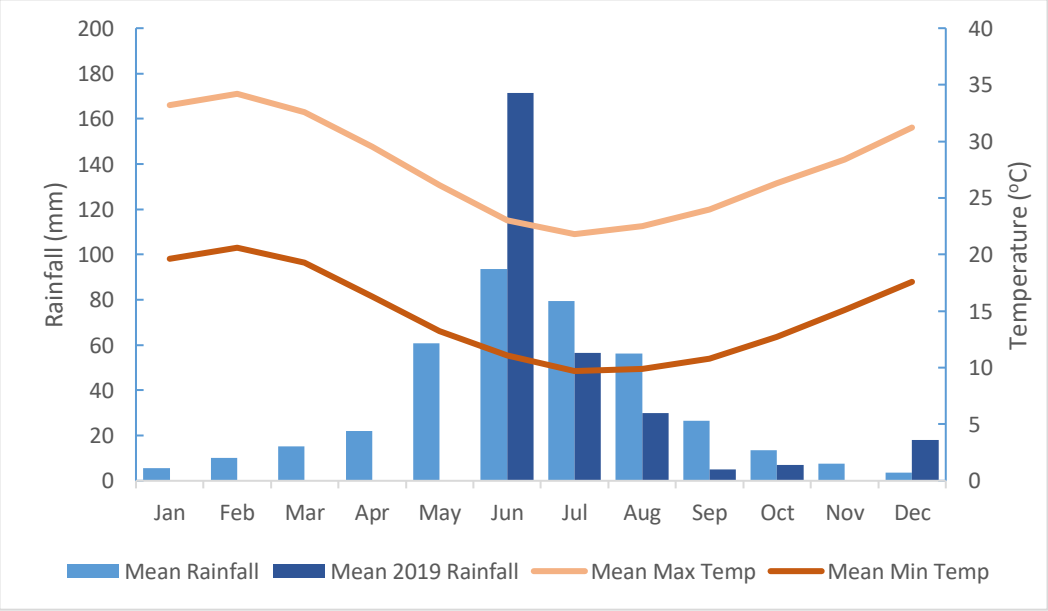

Plate 1 Mean rainfall for Lynton and temperatures for Kalbarri

3.3 Hydrology

3.3.1 Groundwater

The Department of Water and Environmental Regulation (DWER) Perth Groundwater Map indicates the survey area is located in within the Gascoyne Groundwater Area.

3.3.1 Surface water

There are no watercourses or wetlands located within the survey area. The closest watercourse is the Hutt River, which is located approximately 4 km south of the survey area and flows west into the ocean.

The Hutt Lagoon, which is located directly west of the survey area, is listed as a wetland of national importance on the Directory of Important Wetlands in Australia (DIWA) (DEC 2009). Hutt Lagoon is a macroscale elongate sumpland aligned northwest to southeast, parallel to the coast. It neighbours macroscale elongate floodplains (to the northwest and southeast) that include more than twenty microscale elongate sumplands such as Utcha Swamp (Jaensch 1992).Water supply for the Hutt Lagoon derives from direct precipitation, surface inform from several minor creeks and seepage of groundwater (DEC 2009).

3.4 Geology, landforms and soils

The survey area is located within the Tumblagooda Sandstone, which is characterised by sandstone, with minor siltstone and granulate to pebble conglomerate. The majority of the survey area is located on the Tamala North Land System, described as low hills with relict dunes and some limestone outcrop, which forms a coastal band 3 to 7 km wide. Parts of the western boundary of the survey area are located within the Grey Land System, described as river beds, terraces and alluvial flats, includes dissected margins of relic alluvial plains (Rogers et al. 1996).

3.5 Land use

3.5.1 Conservation reserves and estates

There are no conservation reserves or estates located within or immediately adjacent to the survey area. The closest conservation reserve, the Utcha Well Nature Reserve (R 640), is located approximately 3 km north of the survey area (Figure 2, Appendix A).

3.5.2 Environmentally sensitive areas

One Environmentally Sensitive Areas (ESAs) is located approximately 200 m west of the survey area. This ESA is associated with the Hutt Lagoon and does not intersect the survey area (Figure 2, Appendix A).

No PECs or TECs are located within the survey area. The nearest PEC, Kalbarri ironstone community (P1) is located approximately 8 km east of the survey area.

3.6 Vegetation and flora

3.6.1 Broad vegetation mapping and extents

Broad scale (1:250,000) pre-European vegetation mapping of the survey area has been completed by Beard (1975) at an association level. The mapping indicates that the survey area intersects two broad vegetation associations (BVA):

- Shrublands; *Acacia rostellifera* thicket: wattle, casuarina and teatree acacia-allocasuarina melaleuca alliance (association 17)
- Low forest; *Acacia rostellifera:* Acacia, Rottnest pine, coastal moort or mixed tropical forest, *Acacia rostellifera, Callitris preissii, Eucalyptus lehmannii, E. cornuta* (association 371).

The extents of these associations within the survey area are shown in Table 3.

The pre-European mapping has been adapted and digitised by Shepherd *et al.* (2002). The extent of the vegetation associations have been determined by the state-wide vegetation remaining extent calculations maintained by the DBCA (latest update March 2019 –Government of Australia (GoWA) 2020). As shown in Table 3 the current extent of vegetation association 17 is above 30 % of its pre-European extent at the State, IBRA bioregion, IBRA subregion and Local Government Authority (LGA) levels. Vegetation association 371 is below the 30% of the pre-European extents at all levels except for the LGA.

Table 3 Extents of vegetation associations mapped within the survey area (GoWA 2020)

Vegetation association	Scale	Pre-European extent (ha)	Current extent (ha)	Remaining (%)	Remaining within DBCA Managed lands (%)	Hectares (ha) within the survey area	% of current extent within the survey area
17	State: WA	76,633.84	67,605.49	88.22	13.06	52.70	0.07
	IBRA Bioregion: Geraldton Sandplains	54,078.08	45,159.85	83.51	13.44		0.11
	Sub-region: Geraldton Hills	49,605.04	42,016.28	84.70	13.26		0.12
	LGA: Shire of Northampton	49,549.89	41,939.33	84.64	13.29		0.12
371	State: WA	32,816.04	3,499.60	10.66	6.92	360.16	10.29
	IBRA Bioregion: Geraldton Sandplains	32,807.53	3.499.10	10.67	6.92		10.29
	Sub-region: Geraldton Hills	32,807.53	3,499.10	10.67	6.92		10.29
	LGA: Shire of Northampton	5,749.92	2,142.08	36.94	10.69		16.81

3.6.2 Conservation significant ecological communities

The PMST (DotEE 2019) did not identify any TECs listed under the EPBC Act within the study area. The DBCA TEC/PEC database identified two Priority 1 PECs within the study area, however none are known to occur within the survey area (Figure 2, Appendix A). The two PECs identified are (DBCA 2019a):

- Kalbarri Ironstone Community (Priority 1 PEC) – winter wet, mallee/Melaleuca over herbs. Dense shrubland when burnt. Surrounded by sandplain. Yerina springs and north Euardy Station. Z-bend loop, Junga Dam. The taxon *Eremophila microtheca* (previously declared rare flora) occurs in this community (located approximately 8 km east of the survey area)
- Shrubland of the Northampton Area, dominated by *Melaleuca* species over exposed Kockatea Shale (Priority 1 PEC) – Heath on breakaways located in Port Gregory, west of Northampton. Community includes priority taxa; *Ptilotus chortophytum* (P1), *Leucopogon* sp. Port Gregory, *Ozothamnus* sp. Northampton, *Gastrolobium propinquum* (P1), outlier of *Ptilotus helichrysoides*. Unusual geology (Kockatea Shale) outcropping at surface (closest record is approximately 5 km south-east of the survey area).

3.6.3 Flora diversity

The *NatureMap* database (DBCA 2019) identified 455 flora taxa, representing 85 families and 235 genera previously recorded within 10 km of the survey area. This total comprised 403 native flora taxa and 52 naturalised (introduced) flora taxa. Dominant families recorded included Myrtaceae (48 taxa), Asteraceae (36 taxa), Fabaceae (36 taxa) and Poaceae (30 taxa).

The *NatureMap* database search is provided in Appendix C.

3.6.4 Conservation significant flora

The EPBC Act PMST, *NatureMap* and DBCA Threatened and Priority Flora databases identified the presence/potential presence of 48 conservation significant flora taxa within 10 km of the survey area (Appendix C). The desktop searches recorded:

- 13 Threatened flora taxa listed under the EPBC Act and/or BC Act
- One taxa listed as Threatened under the EPBC Act and Priority 4 by DBCA
- Six Priority 1 taxa
- Seven Priority 2 taxa
- 14 Priority 3 taxa
- Seven Priority 4 taxa.

The locations of conservation significant flora registered on the DBCA databases are mapped on Figure 2, Appendix A. Previously recorded conservation significant flora in report *GMA Garnet Port Gregory Mine Moning Tenement M70/1380 Biological Survey* (see section 3.8) have also been represented in Figure 2, due to the proximity of these records to the survey area.

3.7 Fauna

3.7.1 Fauna diversity

The *NatureMap* database identified 176 terrestrial vertebrate fauna species previously recorded within 10 km of the survey area. This total comprised of four amphibians, 151 birds, 14 reptiles and seven mammals. Of the 176 fauna species previously recorded, 172 are native species and

four are naturalised (introduced) species (under the *Biosecurity and Agriculture Management Act 2007* (BAM Act)).

The *NatureMap* database search is provided in Appendix C.

3.7.2 Conservation significant fauna

The EPBC Act PMST and DBCA databases identified the potential presence of 33 conservation significant fauna within 10 km of the survey area (Appendix C). This total does not include species identified as exclusively marine (e.g. marine mammals and reptiles) as no marine habitat is present within the survey area.

The species listed include:

- 25 listed as Threatened under the EPBC Act and/or BC Act
- Five bird species listed as Migratory (terrestrial or wetland) only, under the EPBC Act and/or Schedule 5 (Migratory birds protected under an international agreement) of the BC Act
- One species listed as Schedule 7 (Specially Protected) under the BC Act
- Two listed as Priority 4 by the DBCA.

3.8 Previous survey results

GMA Garnet Port Gregory Mine Mining Tenement M70/1380 Biological Survey

The vegetation, flora and fauna assessment was undertaken by GHD between July and August 2019. The survey area was located within mining tenement M70/1380, approximately 1,465 ha in size. The key findings of the survey include:

- Eight vegetation types were delineated from the survey area. None of the vegetation types were considered representative of either a conservation significant ecological community or other significant vegetation community
- Six broad fauna habitat types were recorded from the survey area. Marginal foraging habitat was recorded that included 31.4 ha of Banksia woodland
- One hundred and sixty-five flora taxa (including subspecies and varieties) representing 61 families and 121 genera were recorded from the survey area. This total included 18 introduced flora
- One flora species (S*enna planitiicola*) considered to be an extension of its known range and has not been previously recorded within the Geraldton Sandplains IBRA however the species was recorded within a farming paddock and was considered to have been planted
- One EPBC Act / BC Act listed flora and three DBCA Priority listed flora species were identified within the survey area:
  - *Caladenia bryceana* subsp. *cracens* (Vulnerable – EPBC Act, Endangered – BC Act)
  - *Melaleuca huttensis* (Priority 3)
  - *Anthocercis intricata* (Priority 3)
  - *Diuris recurva* (Priority 4)
- A total of 42 fauna species, including one amphibian, 28 birds, nine mammals and four reptiles were recorded within the survey area of which eight were introduced
- No conservation significant fauna was identified during the survey.

GMA Garnet Mining Lease M70/926 Biological Survey

A biological survey was undertaken by GHD in August 2016 to identify environmental constraints within mining tenement M70/926, located approximately 7 km north of M70/1380. The key findings include:

- A total of four vegetation types were delineated from the study location including:
  - *Acacia rostellifera* Low Forest
  - *Acacia rostellifera* Tall Open Shrubland
  - *Acacia rostellifera* Low Shrubland on Shallow Soils
  - Cleared and Degraded.
- A total of 60 flora taxa from 28 families were recorded at the study location, of which 26 were introduced
- Twenty-one fauna taxa were recorded from the study location, including 17 birds and six mammals
- No conservation significant communities, flora or fauna were recorded.

GMA Garnet Port Gregory Mine Targeted Flora Survey

A targeted flora survey was undertaken by GHD in August 2014 for the Threatened flora species *Caladenia bryceana* subsp. *cracens* at M70/968. The key findings include:

- No Threatened Flora was recorded during the survey
- Habitat for the threatened orchid was considered extremely marginal
- Evidence of disturbances such as wild pigs, which further reduced the likelihood of the species occurrence
- Two State-listed Priority species were recorded including 23 individual plants of *Melaleuca huttensis* (Priority 1) and 54 individual plants of *Anthocercis intricata* (Priority 3).

GMA Garnet Port Gregory Mine Tenement M70/968 Vegetation, Flora and Fauna Assessment

The vegetation, flora and fauna assessments were undertaken by GHD in August 2013 to identify environmental constraints within mining tenement M70/968. The key findings include:

- Six vegetation types were recorded from the study location, none of which were considered conservation significant
- A total of 75 flora taxa from 39 families were recorded from the study location, No conservation significant communities or flora were present
- The study location was considered to be very marginal habitat for the Threatened *Caladenia bryceana* subsp. *cracens*
- There was evidence of current disturbances from feral fauna (rabbits and pigs)
- A total of five birds and two mammals were recorded from the study location, none were conservation significant.

4. Field results

4.1 Flora and vegetation

4.1.1 Vegetation types

Three vegetation types were identified in the survey area, not including previously cleared areas and regrowth/rehabilitated areas, which were mapped separately from the vegetation types (Table 4). Much of the survey area had undergone historical clearing (exploration) and rehabilitation of these areas. Newly cleared or disturbed areas (roads and tracks) were also prevalent, as well as completely cleared areas, where the mine development has progressed. Rehabilitated areas contained fragmented vegetation resembling VT01 (*Acacia rostellifera* open woodland), but with an understory dominated by introduced grasses.

A significant portion of the survey area consisted of *Acacia rostellifera* open woodland to woodland (VT01) (67.9% 280.43 ha). This vegetation type occurred in low-lying and middle to upper slopes. Both BVA 371 (Low forest, *Acacia rostellifera*) and BVA 17 (Shrublands, *Acacia rostellifera*) intersected VT01. The description of BVA 17 by Beard & Burns (1976) aligns closely with VT01 (*Acacia rostellifera* dense thicket at 6 m in height, principal species comprise *Alyogyne cuneiformis, Pimelea floribunda* and *Melaleuca cardiophylla*). *Melaleuca cardiophylla* shrubland to open shrubland (VT02) (6.8% 28.30 ha) occurred on the upper slopes, west facing of the survey area, to the north, on limestone. Beard & Burns (1976) describes *M. cardiophylla* as dominant, more or less as a sole species on the rockiest and steepest places in BVA 17, which strongly aligns with VT02. *Myoporum insulare* shrubland (VT03) (0.1% 0.45 ha) was isolated in occurrence, and consisted of chenopod shrubland with *Frankenia pauciflora* and *Threlkeldia diffusa*, due to saline influence. All 0.45 ha of VT03 was mapped within BVA 371.

The vegetation types VT01 and VT02 generally align with BVA 17, where VT01 contains mostly wooded areas (Low forest), and VT02 contains Melaleuca shrublands (thicket). VT03 does not align with BVA 371, which is likely, considering the small size of the vegetation type. However, VT03 does align with association 125 (Salt lake, lagoon, clay pan) (Beard 1975) that describes the Hutt Lagoon.

Floristic analysis

The similarity between the quadrats were examined using PRIMER with all species recorded in the quadrats analysed based on presence/absence. Quadrat Lyn12 (VT03) was removed from the analysis as it was very different from the other quadrats it impacted the MDS results, which did not allow for a useful analysis. A stress value of 0.16 was produced indicating a fair representation (Plate 2). The MDS scatter plot for VT01 and VT02 quadrats loosely grouped together, particularly for VT01. The vegetation types were mapped using a combination of statistical analysis, dominant species, landforms and field observations.

Table 4 Vegetation types identified within the survey area

Vegetation Types	Vegetation type description and landform	Representative quadrat/releve and Total area (ha)	Representative photograph
VT01 - *Acacia rostellifera* open woodland to woodland	*Acacia rostellifera* open woodland to woodland over *Rhagodia preissii* subsp. *obovata*, *Pimelea microcephala* subsp. *microcephala*, *Olearia* sp. Kennedy Range (G. Byrne 66) and *Stylobasium spathulatum* open shrubland over *Austrostipa elegantissima* and **Ehrharta longiflora* open grassland to grassland. Other common species include *Alyogyne hakeifolia, Roepera fruticulosa, Commicarpus australis* and *Euphorbia boophthona*. Occurs over lower and middle slopes on brown to orange sands. Previously disturbed through historic clearing and heavily disturbed by grazing.	Lyn04, Lyn05, Lyn06, Lyn07, Lyn08, Lyn09, Lyn13 (releve), Lyn14 (releve), Lyn17, Lyn19, Lyn20, Lyn22 (releve), Lyn 23 (releve), Lyn25, Lyn26, Lyn27 280.43 ha	

Vegetation Types	Vegetation type description and landform	Representative quadrat/releve and Total area (ha)	Representative photograph
VT02 - *Melaleuca cardiophylla* shrubland to open shrubland	*Melaleuca cardiophylla* shrubland to open shrubland over *Alyogyne hakeifolia*, *Pimelea microcephala* subsp. *microcephala* and *Rhagodia preissii* subsp. *obovata* open shrubland over *Ptilotus divaricatus* scattered forbland. Other common species include *Roepera fruticulosa, Pimelea gilgiana* and **Bromus diandrus*. Areas that contain deeper soils *Acacia rostellifera* was also recorded. Occurs on upper mid slopes on white-brown sand with limestone outcropping. Disturbances include high grazing impacts from feral pigs and other native species (kangaroo).	Lyn01, Lyn02, Lyn03, Lyn10, Lyn11, Lyn15 (releve), Lyn16 (releve), Lyn18 28.30 ha	

Vegetation Types	Vegetation type description and landform	Representative quadrat/releve and Total area (ha)	Representative photograph
VT03 – *Myoporum insulare* shrubland	*Myoporum insulare* shrubland over *Frankenia pauciflora* and *Threlkeldia diffusa* open chenopod shrubland over *Sporobolus virginicus* open grassland. Occurs on light brown clay on seasonally wet brackish drainage flats.	Lyn12 0.45 ha	

Vegetation Types	Vegetation type description and landform	Representative quadrat/releve and Total area (ha)	Representative photograph
Rehabilitation areas	Rehabiliation areas consisting of *Acacia rostellifera, Alyogyne hakeifolia, Pimelea microcephala* subsp. *microcephala, Stylobasium spathulatum* and *Olearia* sp. Kennedy Range (G. Byrne 66) on lower and middle slopes on brown to orange sands. The undertsorey is dominated by introduced grasses including **Avena barbata* and **Ehrharta calycina*.	Lyn21, Lyn24 (releve) 34.52 ha	

Vegetation Types	Vegetation type description and landform	Representative quadrat/releve and Total area (ha)	Representative photograph
Cleared areas (including mine areas, tracks, cleared areas containing no native species)	N/A	N/A 69.16 ha	

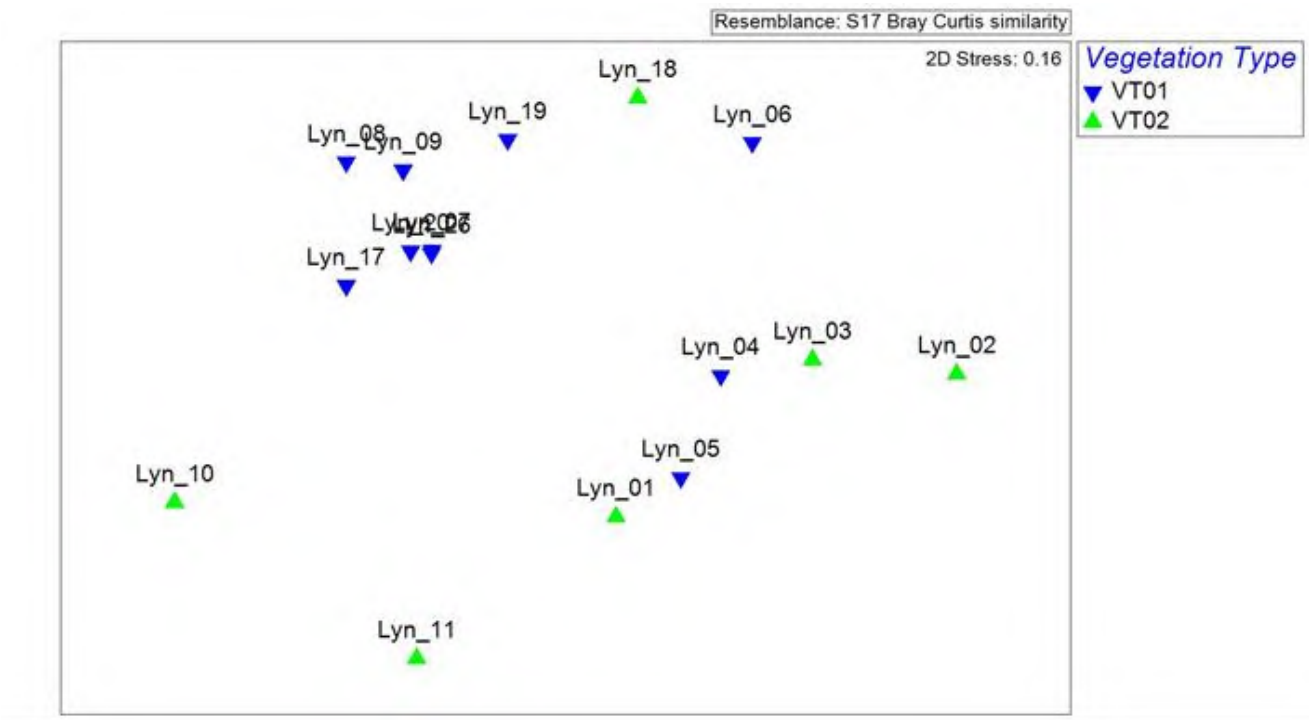

Plate 2 MDS showing broad clusters of quadrats for VT01 and VT02

4.1.2 Conservation significant ecological communities

Based on the results of the desktop searches, dominant species, landform features, field observations, and coupled with the statistical analyses no vegetation communities identified in the survey area were consistent with any TECs or PECs.

4.1.3 Other significant vegetation

No other vegetation considered significant as per EPA (2016a) was recorded from the survey area.

4.1.4 Vegetation condition

The condition of the vegetation within the survey area ranged from Good to Completely Degraded. The extents of the vegetation condition within the survey area are detailed in Table 5 and mapped in Figure 4, Appendix A.

Areas mapped as Good had vegetation that was largely intact with native species present across each structural layer, however, also had high weed cover and signs of high grazing impacts from pigs and kangaroos. Much of the survey area had undergone historical clearing (exploration) and rehabilitation of some of these areas. Newly cleared or disturbed areas (roads and tracks) were also prevalent, as well as completely cleared areas, where the mine development has progressed. Rehabilitated areas contained fragmented vegetation resembling VT01.

Table 5 Extent of vegetation condition ratings mapped in the survey area

Vegetation Condition	Extent in the survey area (ha) (%)
Cleared	69.83 (16.9)
Completely Degraded	34.34 (8.3)
Degraded	105.15 (25.4)
Good	203.54 (49.3)

4.1.5 Flora diversity

Sixty-four flora taxa (including subspecies and varieties) representing 26 families and 50 genera were recorded from the survey area during the field survey. This total comprised 49 native taxa and 15 introduced flora taxa.

Dominant families recorded from the survey area included:

- Poaceae (10 taxa)
- Chenopodiaceae (6 taxa)

Based on described quadrats, species diversity ranged from 9 to 21 (average 14) taxa per 100 m².

The full list of flora identified within the survey area complied by quadrat and species inventory by family is provided in Appendix D.

4.1.6 Introduced flora

Fifteen introduced flora species were recorded from the survey area. No introduced flora species recorded are listed as Declared Pests under the BAM Act or WoNS. All introduced flora species recorded are considered environmental weeds and all have been previously recorded on the Geraldton Sandplains bioregion.

4.1.7 Conservation significant flora

No EPBC Act or BC Act listed flora were recorded within the survey area. No Priority flora, as listed by the DBCA, were recorded within the survey area.

Likelihood of occurrence assessment

A likelihood of occurrence assessment was conducted post-field survey for all conservation significant flora taxa identified in the desktop assessment (Appendix D). This assessment took into account previous records, habitat requirements, efficacy of the survey, intensity of the survey, flowering times and any uniquely defining characteristics or interactions of species. Due to the size of the survey area and some seasonal limitation some of the potentially occurring species may be present, but not observed during the survey.

The likelihood of occurrence assessment post-field survey concluded that three species are considered possible to occur, 40 species highly unlikely and five species unlikely to occur in the survey area. The species considered possible to occur are:

- The Threatened *Caladenia bryceana* subsp. *cracens* is considered possible to occur in VT02 *Melaleuca cardiophylla* shrubland to open shrubland
- *Anthocercis intricata* (P3)
- *Balladonia aervoides* (P3).

4.1.8 Other significant flora

No other significant flora, such as significant range extensions, were recorded from the survey area.

4.2 Fauna

4.2.1 Fauna habitat

Five broad habitat types (including rehabilitated and cleared areas) were recorded during the survey (Figure 5, Appendix A). The five habitat types described in Table 6 closely align with vegetation types described in section 4.1.1. The five broad habitat types include:

- Acacia woodlands
- Melaleuca shrublands on limestone
- Shrublands on seasonally wet brackish drainage flats
- Rehabilitation areas
- Cleared areas.

4.2.2 Habitat corridors and linkages

The survey area comprises remnant vegetation much of which has been previously disturbed, cleared land for mine exploration and activity, and cleared agricultural land. Much of the land outside of the survey area is cleared for paddocks, or developed for the GMA processing area and existing roads. There is little contiguous vegetation remaining in the survey area and wider study area.

Within the survey area, regrowth vegetation and rehabilitated patches surround largely cleared areas, or are adjacent drive tracks. There is significant evidence of foraging within the survey area by feral pigs, European rabbits and sheep. Evidence of feral cat, red fox and domestic dog were also recorded. The patchy vegetation and drive tracks and roads may increase the likelihood of use by feral species, due to the access between habitats for these fauna.

Table 6 Fauna habitat types identified within the survey area

Fauna habitat type	Extent within survey area	Representative photo
Acacia woodlands This habitat type was recorded over the majority of the survey area and associated with lower and middle slopes on brown to orange sands. The vegetation type comprises *Acacia rostellifera* over chenopod shrubs (*Rhagodia preissii subsp. obovata*) and other mixed low shrubs, native and introduced grasses. The habitat contains a high level of wood and branches through previously cleared Acacia trees providing suitable habitat for reptiles and birds. There is evidence of high grazing impacts, including from feral pigs within this habitat type. **Conservation significant fauna** A nesting record of the Eastern Osprey (*Pandion cristatus*) was recorded within this habitat, with the species utilising the nearby coastline and saline system of the Hutt Lagoon for foraging. The habitat type is considered very rarely used by other conservation significant species, such as the Peregrine Falcon and Fork-tailed Swift.	280.43 ha	

Fauna habitat type	Extent within survey area	Representative photo
Melaleuca shrublands on limestone This habitat type was restricted to the shallow limestone upper mid slopes on white-brown sand with limestone outcropping on the eastern side of the survey area. This habitat type is dominated by *Melaleuca cardiophylla* on shallow limestone and in areas of deeper soils scattered *Acacia rostellifera* was present. The environment had areas of good ground cover, litter and debris. Some areas of outcropping with exfoliating rock and crevices was present and would provide excellent cover for a range of fauna species. There is evidence of high grazing impacts, including from feral pigs within this habitat type. **Conservation significant fauna** No conservation significant fauna were recorded within this habitat type. The habitat type is considered very rarely to be used by conservation significant species, such as the Peregrine Falcon and Fork-tailed Swift.	28.30 ha	
Shrubland on seasonally wet brackish drainage flats This habitat type occurred over a small area on the western boundary of the survey area. This habitat type was dominated by *Myoporum insulare*, *Frankenia pauciflora* and *Threlkeldia diffusa* shrubs with native marine couch grass. Occurs on light brown clay on seasonally wet brackish drainage flats. The dense vegetation provides ideal habitat for reptiles and birds. **Conservation significant fauna** No conservation significant fauna were recorded within this habitat type. The habitat type is considered to be marginal habitat for migratory bird species given the small size of the area and the major inundation occurring outside of the migratory bird species summer patterns. The habitat would also be very rarely to be used by conservation significant species, such as the Peregrine Falcon and Fork-tailed Swift.	0.45 ha	

Fauna habitat type	Extent within survey area	Representative photo
Rehabilitation areas Rehabiliation areas consisting of mixed trees and shrubs of *Acacia rostellifera*, *Alyogyne hakeifolia, Pimelea microcephala* subsp. *microcephala, Stylobasium spathulatum* and *Olearia* sp. Kennedy Range (G. Byrne 66) on lower and middle slopes on brown to orange sands. The undertsorey is dominated by introduced grasses including **Avena barbata* and **Ehrharta calycina*. The habitat contains moderate level of wood and branches with more open areas. There is evidence of high grazing impacts, including from feral pigs within this habitat type. **Conservation significant fauna** No conservation significant fauna were recorded within this habitat type. The habitat would also be very rarely to be used by conservation significant species, such as the Peregrine Falcon and Fork-tailed Swift.	34.52 ha	

Fauna habitat type	Extent within survey area	Representative photo
Cleared areas The cleared and degraded habitat type was associated with previously cleared areas, access tracks and firebreaks. Much of the cleared degraded areas comprised of introduced grasses . **Conservation significant fauna** No conservation significant fauna were recorded within this habitat type. The habitat would also be very rarely to be used by conservation significant species, such as the Peregrine Falcon and Fork-tailed Swift.	69.83 ha	

4.2.3 Fauna diversity

During the field survey 31 fauna species were recorded within the survey area, including 21 bird, 8 mammal and 2 reptile species. Of these, 24 are native and seven are introduced/feral (BAM Act) including:

- *Canis lupis* (Domestic Dog)
- *Felis catus* (Feral Cat)
- *Capra hircus* (Feral Goat)
- *Ovis aries* (Sheep)
- *Oryctolagus cuniculus* (European Rabbit)
- *Sus scrofa* (Wild Boar)
- *Streptopelia senegalensis* (Laughing Turtle-dove).

A full list of fauna recorded during the survey is provided in Appendix E.

4.2.4 Conservation significant fauna

No Threatened fauna listed under the EPBC Act and/or BC Act or Priority fauna species listed by the DBCA was recorded during the survey.

The Eastern Osprey (*Pandion cristatus*), listed as Migratory and Marine under the EPBC Act was recorded during the survey. A pair was recorded feeding a chick in a nest on the south-western portion of the survey area. The location of the Osprey nest is shown on Figure 5 with the coordinates presented in Table 7. Ospreys are generally found on or near the coast but also range inland along large rivers, mainly in northern Australia.

Table 7 Conservation listed fauna Osprey location coordinates

Species	EPBC Act	BC Act/ DBCA	Coordinates	
			Eastings	Northings
Eastern Osprey (*Pandion cristatus*)	MI	IA	230871.59	6882759.92

Likelihood of occurrence assessment

A likelihood of occurrence assessment was conducted for all conservation significant fauna species identified in the desktop assessment. This assessment was based on species biology, habitat requirements, the likely quality and availability of suitable habitat (based on vegetation associations present within the survey area) and records of the species in the vicinity of the survey area. The assessment is provided in Appendix E.

Of the 35 conservation significant fauna identified in the desktop searches one species has been identified as present (Osprey), two are considered likely to occur and the remaining species are considered unlikely or highly unlikely to occur within the survey area. The fauna species identified as present and likely to occur within the survey area are listed in Table 8.

Table 8 Conservation significant fauna present or likely to occur within the survey area

Species	EPBC Act	BC Act/ DBCA	Likelihood of occurrence
Osprey (*Pandion cristatus*)	MI	IA	Known – The survey area is situated near the coastline. This species was observed nesting within the survey area.
Fork-tailed Swift (*Apus pacificus*)	MI	IA	Likely – There are a number of records along the coast at Port Gregory and near Hutt Lagoon. This is a widespread species of coastal and sub-coastal areas. Fork-tailed Swifts are almost exclusively aerial and is likely to only utilise the survey area opportunistically.
Peregrine Falcon (*Falco peregrinus*)		OS	Likely – There are records of this species occurring around the Port Gregory area. This species may occur as an infrequent visitor, foraging within the survey area, however lacks suitable breeding habitat. Therefore likely to occur at least on an occasional basis for foraging.

No species of conservation significance are likely to be solely dependent on the habitats present within the survey area.

5. Recommendations

5.1 Recommendations

The following recommendations are provided to manage and minimise impacts to native vegetation and fauna:

- Minimise native vegetation clearing as much as practical
- Undertake further targeted flora surveys, in particular for *Caladenia bryceana* subsp. *cracens* (Threatened) as it is considered possible to occur in VT02 *Melaleuca cardiophylla* shrubland to open shrubland
- Revegetation should be undertaken by using local “provenance” native seed and / or seedlings
- Implement weed management during project activities to avoid spread of weeds
- Machinery to be maintained and cleaned to reduce the spread of weeds throughout the survey areas
- Restrict movement of machines and other vehicles to the limits of the areas cleared
- If any native fauna is disturbed during clearing it should be allowed to make its own way to adjacent vegetated areas
- Avoid disturbing habitat surrounding Osprey nest site, in particular during the nesting season (autumn – spring, April to February, and later in the season in the southern portion of Australia) (DotEE 2020; Morcombe 2011). An approximate buffer of 100 m around the nest site would be suitable, due to the discreet nature of breeding Osprey. The nest site is currently providing security through vegetation cover.
- Any injured wildlife as a result of vegetation clearing should be taken to a designated veterinary clinic, a DBCA nominated wildlife carer or suitable euthanasia by an appropriately experienced person.

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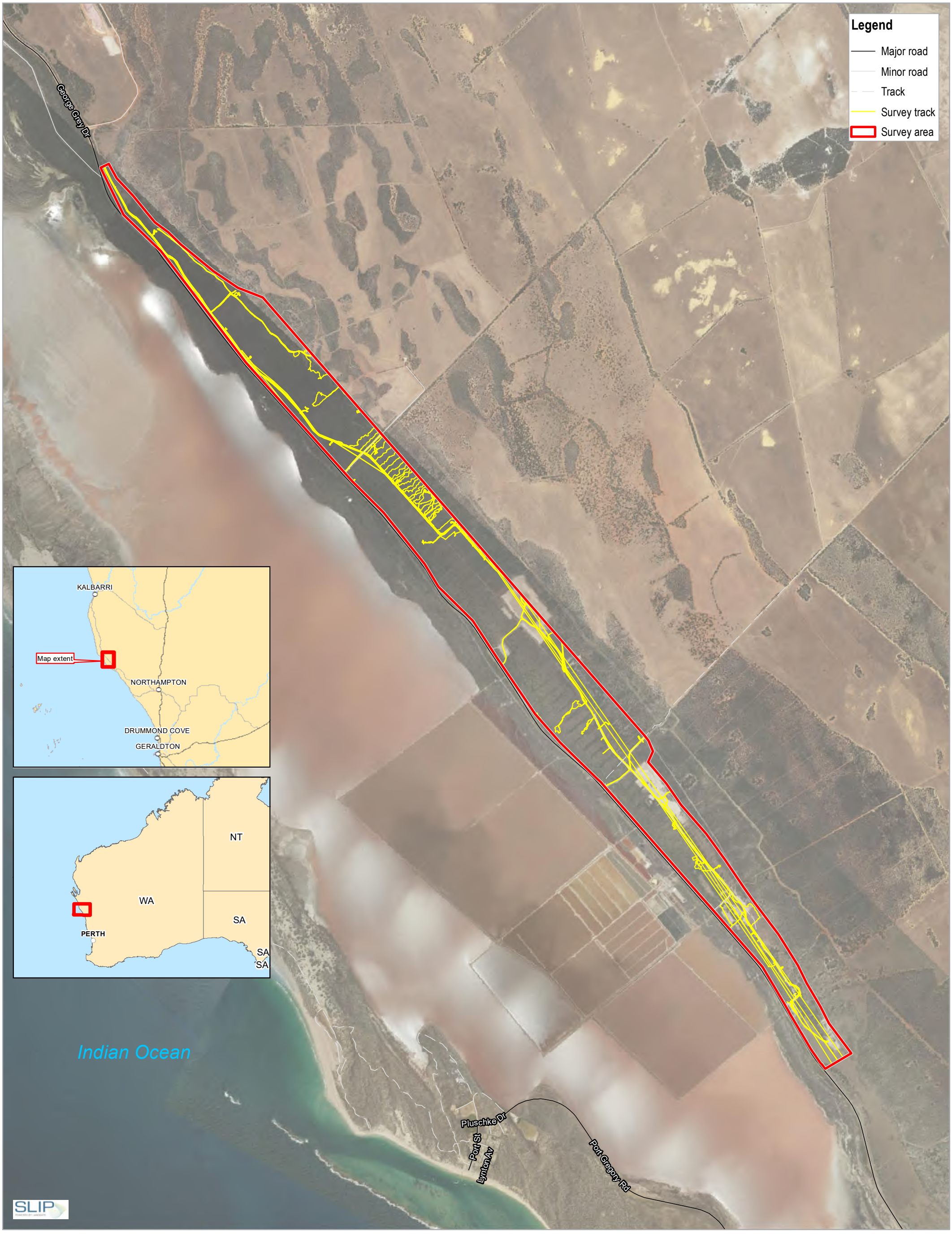
Appendices

Appendix A – Figures



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N

GMA Garnet Pty Ltd
Lynton Mine Expansion Biological Survey

Survey Location and Survey Effort

Project No. **61-37808-05**
Revision No. **0**
Date **06 Feb 2020**

FIGURE 1

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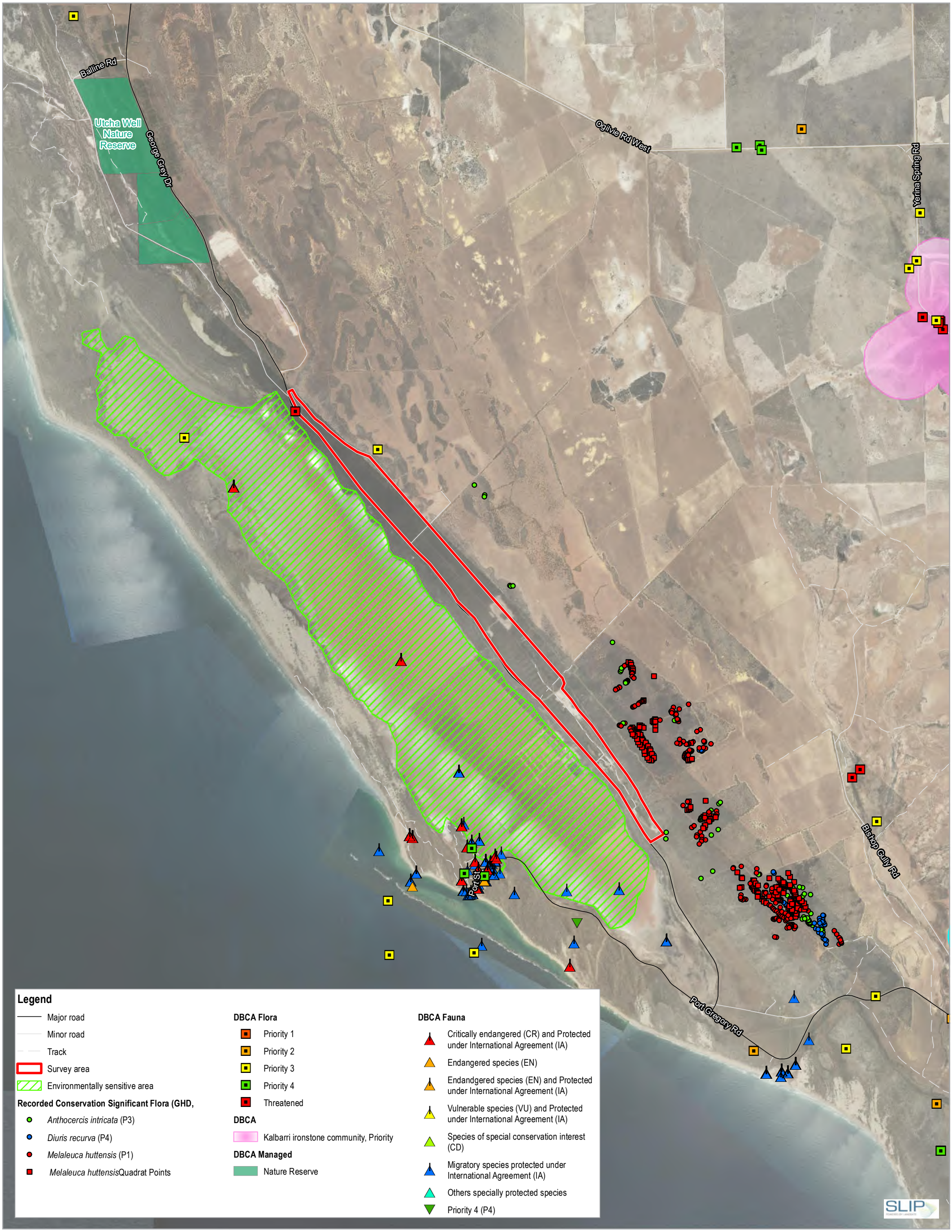

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GMA Garnet Pty Ltd
Lynton Mine Expansion Biological Survey

Environmental Constraints

Project No. **61-38125-05**
Revision No. **0**
Date **06 Feb 2020**

FIGURE 2

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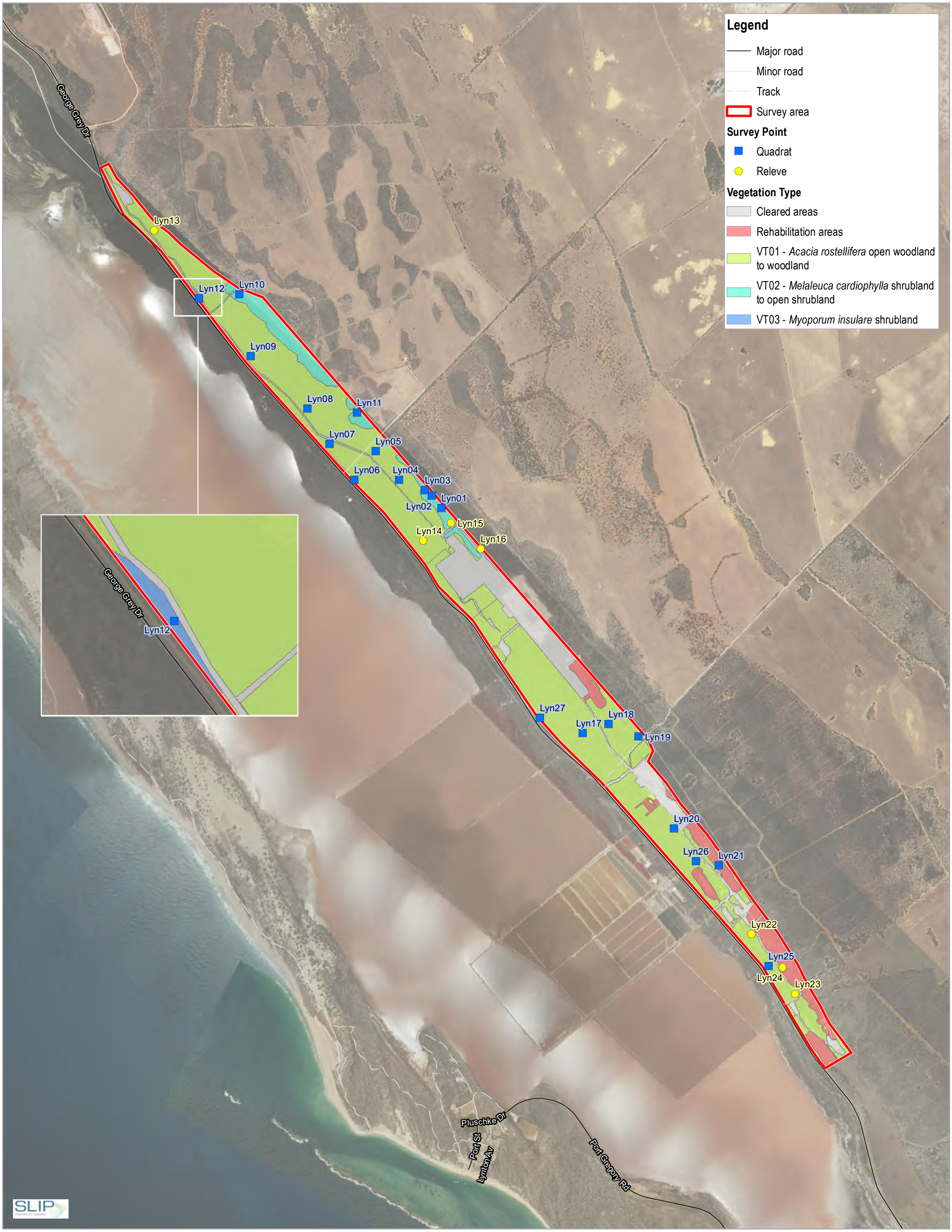

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GMA Garnet Pty Ltd
Lynton Mine Expansion Biological Survey

Vegetation Types

Project No. **61-38125-05**
Revision No. **0**
Date **07 Feb 2020**

FIGURE 3

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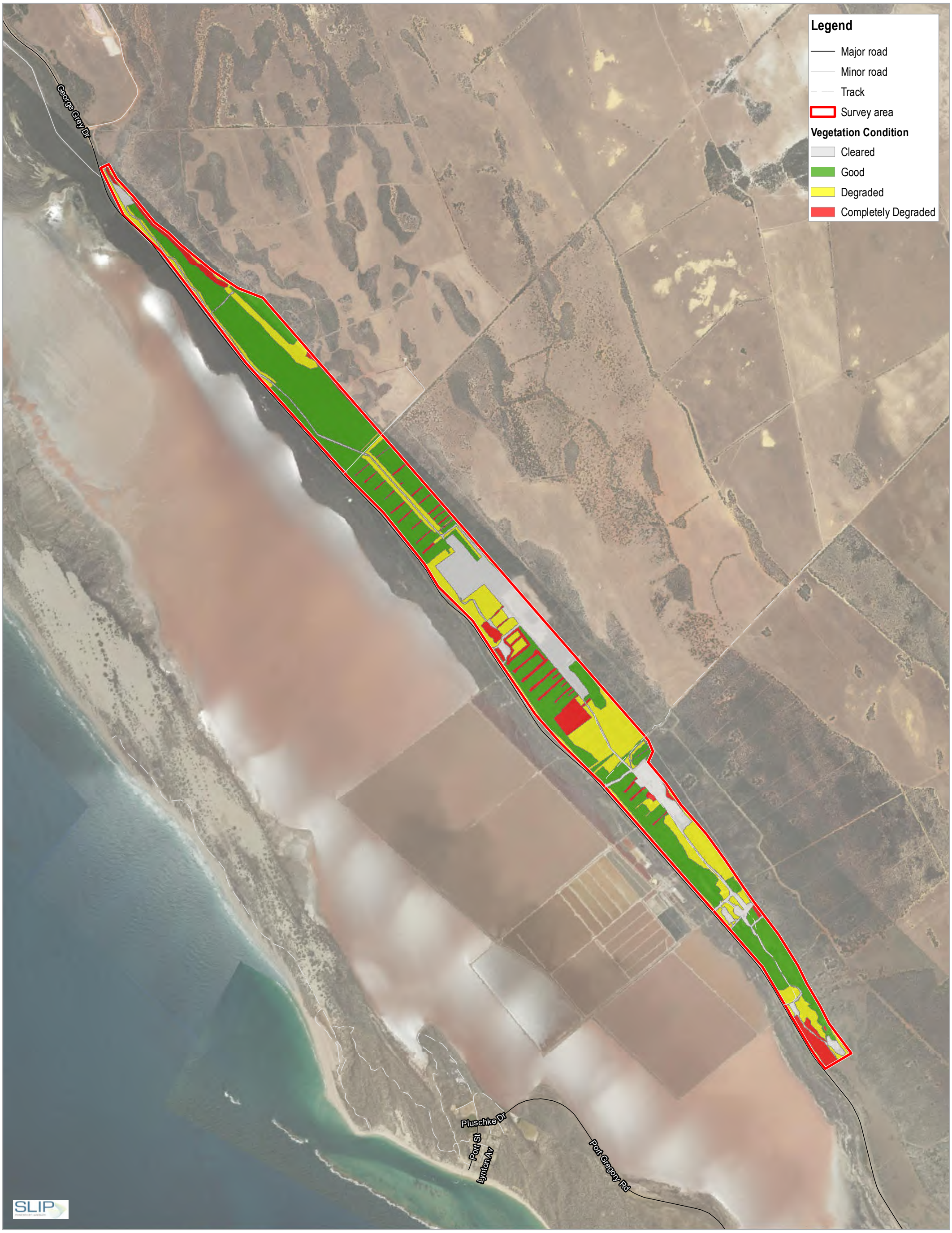

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Metres

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GMA Garnet Pty Ltd
Lynton Mine Expansion Biological Survey

Vegetation Condition

Project No. **61-38125-05**
Revision No. **0**
Date **07 Feb 2020**

FIGURE 4

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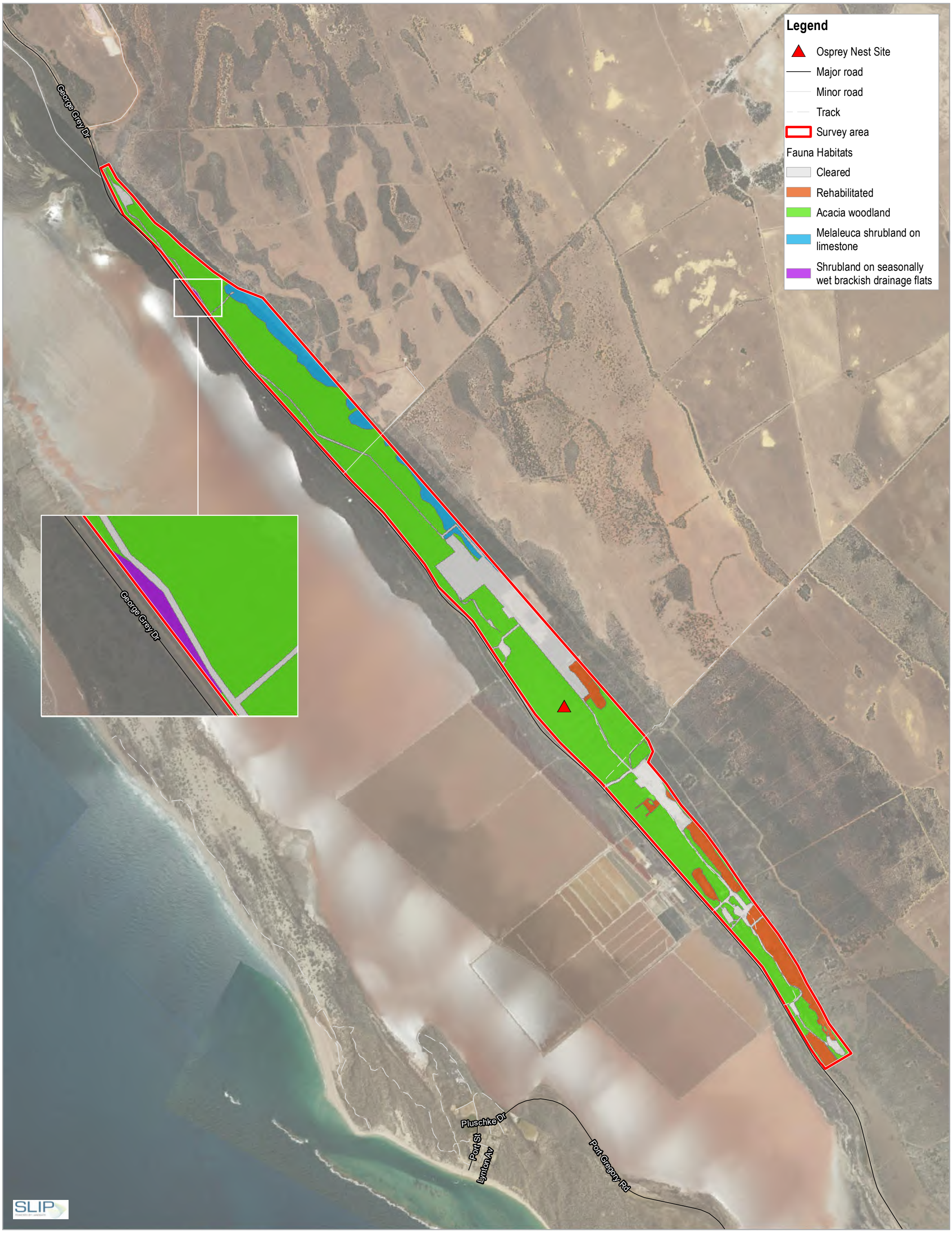

Paper Size ISO A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

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GMA Garnet Pty Ltd
Lynton Mine Expansion Biological Survey

Fauna Habitats

Project No. **61-38125-05**
Revision No. **0**
Date **07 Feb 2020**

FIGURE 5

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Data source: GHD: Survey area - 20191205, Fauna habitats, Osprey nest site - 20200114; Landgate: Roads, Imagery - November 2015 (accessed: 20200114). Created by: cgverzosa

Appendix B – Relevant legislation, background information and conservation code

Relevant legislation

Federal *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Federal Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES).

The biological aspects listed as MNES include:

- Nationally threatened flora and fauna species and ecological communities
- Migratory species

A person must not undertake an action that has, will have, or is likely to have a significant impact (direct or indirect) on MNES, without approval from the Federal Minister for the Environment.

The EPBC Act is administered by the Department of the Environment and Energy (DEE).

State *Environmental Protection Act 1986*

The *Environmental Protection Act 1986* (EP Act) is the primary legislative Act dealing with the protection of the environment in Western Australia. The Act allows the Environmental Protection Authority (EPA), to prevent, control and abate pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing. Part IV of the EP Act is administered by the EPA and makes provisions for the EPA to undertake environmental impact assessment of significant proposals, strategic proposals and land use planning schemes.

The Department of Water and Environment Regulation (DWER) is responsible for administering the clearing provisions of the EP Act (Part V). Clearing of native vegetation in Western Australia requires a permit from the DWER, unless exemptions apply. Applications for clearing permits are assessed by the Department and decisions are made to grant or refuse the application in accordance with the Act. When making a decision the assessment considers clearing against the ten clearing principles as specified in Schedule 5 of the EP Act:

a) Native vegetation should not be cleared if it comprises a high level of biodiversity.

b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significance habitat for fauna indigenous to Western Australia.

c) Native vegetation should not be cleared if it includes, or is necessary, for the continued existence of rare flora.

d) Native vegetation should not be cleared if it comprises the whole or part of native vegetation in an area that has been extensively cleared.

e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

g) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

h) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Exemptions for clearing include clearing that is a requirement of a written law or authorised under certain statutory processes (listed in Schedule 6 of the EP Act) and exemptions for prescribed low impact day-to-day activities (prescribed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004); these exemptions do not apply in environmentally sensitive areas (ESAs).

State *Biodiversity and Conservation Act 2016*

The *Biodiversity Conservation Act 2016* (BC Act) provides for the conservation and protection of biodiversity and biodiversity components, as well as the promotion of the ecologically sustainable use of biodiversity components in Western Australia. The BC Act replaces both the repealed *Wildlife Conservation Act 1950* (WC Act) and the *Sandalwood Act 1929* (Sandalwood Act), as well as their associated regulations. To attain the objectives of the BC Act, principles of ecological sustainable development have been established:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
- The conservation of biodiversity and ecological integrity should be a fundamental consideration indecision-making
- Improved valuation, pricing and incentive mechanisms should be promoted.

The BC Act is administered by the Department of Biodiversity Conservation and Attractions (DBCA).

State *Biosecurity and Agriculture Management Act 2007*

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) and associated regulations are administered by the Department of Primary Industries and Regional Development (DPIRD) and replace the repealed *Agriculture and Related Resources Protection Act 1976.* The main purposes of the BAM Act and its regulations are to:

- Prevent new animal and plant pests (vermin and weeds) and diseases from entering WA
- Manage the impact and spread of those pests already present in the state
- Safely manage the use of agricultural and veterinary chemicals
- Increased control over the sale of agricultural products that contain violative chemical residues.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act. A Declared Pest is a prohibited organism or an organism for which a declaration under Section 22(2) of the Act is in force. Declared Pests may be assigned a control category including: C1 (exclusion), C2 (eradication) and C3 (management). The category may apply to the whole of the State, LGAs, districts, individual properties or even paddocks, and all landholders are obliged to comply with the specific category of control. Categories of control are defined below.

DPIRD Categories for Declared Pests under the BAM Act

Control class code	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Background information

Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under Section 51B of the EP Act. The Table below outlines the aspects of areas declared as ESA in the Environmental Protection (Environmentally Sensitive Areas) Notice 2005.

Aspects of ESAs

Aspects of Environmentally Sensitive Areas
A declared World Heritage property as defined in Section 13 of the EPBC Act.
An area that is included on the Register of the National Estate (RNE), because of its natural values, under the *Australian Heritage Commission Act 1975* of the Commonwealth (the RNE was closed in 2007 and is no longer a statutory list – all references to the RNE were removed from the EPBC Act on 19 February 2012).
A defined wetland and the area within 50 m of the wetland. Defined wetlands include Ramsar wetlands, conservation category wetlands and nationally important wetlands.
The area covered by vegetation within 50 m of rare flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located.
The area covered by a Threatened Ecological Community.
A Bush Forever Site listed in "Bush Forever" Volumes 1 and 2 (2000), published by the Western Australia Planning Commission, except to the extent to which the site is approved to be developed by the Western Australia Planning Commission.
The areas covered by the *Environmental Protection (Gnangara Mound Crown Land) Policy 1992*.
The areas covered by the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002*.
The areas covered by the lakes to which the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes) applies.
Protected wetlands as defined in the *Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998*.

Reserves and conservation areas

Department of Biodiversity, Conservation and Attractions managed lands and waters

DBCA manages lands and waters throughout Western Australia to conserve ecosystems and species, and to provide for recreation and appreciation of the natural environment. DBCA managed lands and waters include national parks, conservation parks and reserves, marine parks and reserves, regional parks, nature reserves, State forest and timber reserves. DBCA managed conservation estate, is vested with the Conservation Commission of Western Australia. Access to, or through, some areas of DBCA managed lands may require a permit or could be restricted due to management activities. Proposed land use changes and development proposals that abut DBCA managed lands will generally be referred to DBCA throughout the assessment process.

Wetlands

Wetlands include not only lakes with open water, but areas of seasonally, intermittently or permanently waterlogged soil.

Ramsar Listed Wetlands

The Convention of Wetlands of International Importance was signed in 1971 at the Iranian town of Ramsar. The Convention has since been referred to as the Ramsar Convention. Ramsar Listed wetlands are "sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity … because of their ecological, botanical, zoological, limnological or hydrological importance" (DEE 2019b). Once a Ramsar Listed Wetland is designated, the country agrees to manage its conservation and ensure its wise use. Under the Convention, wise use is broadly defined as "maintaining the ecological character of a wetland" (DEE 2019b).

Nationally important wetlands

Wetlands of national significance are listed under the Directory of Important Wetlands in Australia. Nationally important wetlands are wetlands which meet at least one of the following criteria (DEE 2019a):

- It is a good example of a wetland type occurring within a biogeographic region in Australia
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
- The wetland supports one percent or more of the national populations of any native plant or animal taxa
- The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level
- The wetland is of outstanding historical or cultural significance

Vegetation extent and status

The National Objectives and Targets for Biodiversity Conservation 2001–2005 (Commonwealth of Australia 2001) recognise that the retention of 30 percent or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. This is the threshold level below which species loss appears to accelerate exponentially and loss below this level should not be permitted. This level of recognition is in keeping with the targets recommended in the review of the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC 2000).

The extent of remnant native vegetation in WA has been assessed by Shepherd et al. (2002) and the GoWA (2018), based on broadscale vegetation association mapping by Beard (various publications). The GoWA produces Statewide Vegetation Statistics Reports that are used for a number of purposes including conservation planning, land use planning and when assessing development applications. The reports are updated at least every two years.

Vegetation condition

The vegetation condition can be assessed in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces (EPA 2016a). The scale recognises the intactness of vegetation and consists of six rating levels as outlined below.

Vegetation condition rating scale for the South West and Interzone Botanical Provinces

Condition	South West and Interzone Botanical Provinces description
Pristine	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Conservation codes

Species of significant flora, fauna and communities are protected under both Federal and State Acts. The Federal EPBC Act provides a legal framework to protect and manage nationally important flora and communities. The State BC Act is the primary wildlife conservation legislation in Western Australia. Information on the conservation codes is summarised in the following sections.

Ecological communities

Conservation significant communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (English and Blyth 1997). Federally listed Threatened Ecological Communities (TECs) are protected under the EPBC Act. The BC Act provides for the Minister to list an ecological community as a TEC (section 27), or as a collapsed ecological community (section 31) statutory listing of State TECs by the Minister. The legislation also describes statutory processes for preparing recovery plans for TECs, the registration of their critical habitat, and penalties for unauthorised modification of TECs.

Possible TECs that do not meet survey criteria are added to the DBCA Priority Ecological Community (PEC) List under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5. PECs are not listed under any formal Federal or State legislation, however, may be listed as TECs under the EPBC Act.

Conservation codes and definitions for TECs listed under the EPBC Act and/ or BC Act

Categories	Definition
Federal Government Conservation Categories (EPBC Act)	
Critically Endangered (CR)	An ecological community if, at that time, is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Endangered (EN)	An ecological community if, at that time: A) is not critically endangered; and B) is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Vulnerable (VU)	An ecological community if, at that time: A) is not critically endangered or endangered; and B) is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Western Australia Conservation Categories (BC Act)	
Threatened Ecological Communities	

Categories	Definition
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.
Collapsed ecological communities	
An ecological community is eligible for listing as a collapsed ecological community at a particular time if, at that time – (a) there is no reasonable doubt that the last occurrence of the ecological community has collapsed); or (b) the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover – (i) its species composition or structure; or (ii) its species composition and structure. Section 33 of the BC Act provides for a collapsed ecological community to be regarded as a threatened ecological community if it is discovered in a state that no longer makes it eligible for listing as a collapsed ecological community.	

Conservation categories and definitions for PECS as listed by the DBCA

Category	Description
Priority 1	Poorly known ecological communities. Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority 2	Poorly known ecological communities. Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Category	Description
Priority 3	Poorly known ecological communities. (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
Priority 4	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority 5	Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Other significant vegetation

Vegetation may be significant for a range of reasons other than a statutory listing. The EPA (2016b) states that significant vegetation may include vegetation that includes the following:

- Restricted distribution
- Degree of historical impact from threatening processes
- Local endemism in restricted habitats
- Novel combinations of taxa
- A role as a refuge
- A role as a key habitat for Threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of a vegetation unit in ‘pristine’ condition in a highly cleared landscape, recently discovered range extensions, or isolated outliers of the main range)
- Being poorly reserved.

This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

Flora and fauna

Conservation significant flora and fauna

Species of significant flora are protected under both Federal and State legislation. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the BC Act can warrant referral to the DEE and/or the EPA.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act. The significance levels for flora and fauna used in the EPBC Act align with the International Union for Conservation of Nature (IUCN) Red List criteria, which are internationally recognised as providing best practice for assigning the conservation status of species. The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
- Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA)
- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)

The State conservation level of flora and fauna species and their significance status also follows the IUCN Red List criteria. Under the BC Act flora and fauna can be listed as Threatened, Extinct and as Specially Protected species.

Threatened species are those are species which have been adequately searched for and are deemed to be, in the wild, either rare, under identifiable threat of extinction, or otherwise in need of special protection, and have been gazetted as such. The assessment of the conservation status of Threatened species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria. Specially protected species meet one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as Threatened or Extinct species under the BC Act cannot also be listed as Specially Protected species.

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

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

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

For the purposes of this assessment, all species listed under the EPBC Act, BC Act and DBCA Priority species are considered conservation significant.

Conservation categories and definitions for EPBC Act and BC Act listed flora and fauna species

Conservation category	Definition
Threatened species	
Critically Endangered (CR)	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.
Endangered (EN)	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines
Vulnerable (VU)	Threatened species considered to be "facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.
Extinct species	
Extinct (EX)	Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
Extinct in the Wild (EW)	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).
Specially protected species	
Migratory (MI)	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species

Conservation category	Definition
Species of special conservation interest (conservation dependent fauna) (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Other specially protected fauna (OS)	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Conservation codes for DBCA listed Priority flora and fauna

Priority category	Definition
Priority 1	Poorly-known taxa Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	Poorly-known taxa Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	Poorly-known taxa Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4	Rare, Near Threatened and other taxa in need of monitoring A. Rare: Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. B. Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. C. Taxa that have been removed from the list of threatened taxa during the past five years for reasons other than taxonomy.

Other significant flora

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than a statutory listing. The EPA (2016b) states that significant flora may include taxa that have:

- A keystone role in a particular habitat for threatened or Priority flora or fauna species, or large populations representing a considerable proportion of the local or regional total population of a species
- Relictual status, being representation of taxonomic or physiognomic groups that no longer occur widely in the broader landscape
- Anomalous features that indicate a potential new discovery
- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- The presence of restricted subspecies, varieties, or naturally occurring hybrids
- Local endemism (a restricted distribution) or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
- Being poorly reserved

Other significant fauna

Fauna species may be significant for a range of reasons other than those protected by international agreement or treaty, Specially Protected or Priority Fauna. Significant fauna may include short-range endemic species, species that have declining populations or declining distributions, species at the extremes of their range, or isolated outlying populations, or species which may be undescribed (EPA 2010).

Introduced plants (weeds)

Declared Pests

Information on species considered to be Declared Pests is provided under *State Biosecurity and Agriculture Management Act 2007.*

Weeds of National Significance

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

- Invasiveness
- Impacts
- Potential for spread
- Socio-economic and environmental values

Australian state and territory governments have identified thirty-two Weeds of National Significance (WoNS); a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012.

References

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EPA 2016b, *Environmental Factor Guideline - Flora and Vegetation*, EPA, Perth, WA.

GoWA 2018, *Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full report)*, Current as of December 2017, Perth Western Australia, Department of Environment and Conservation, from https://www2.landgate.wa.gov.au/web/guest/downloader.

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Appendix C – Desktop searches

EPBC Act PMST (10 km)

Naturemap Flora report (10 km)

Naturemap Fauna report (10 km)

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

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

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

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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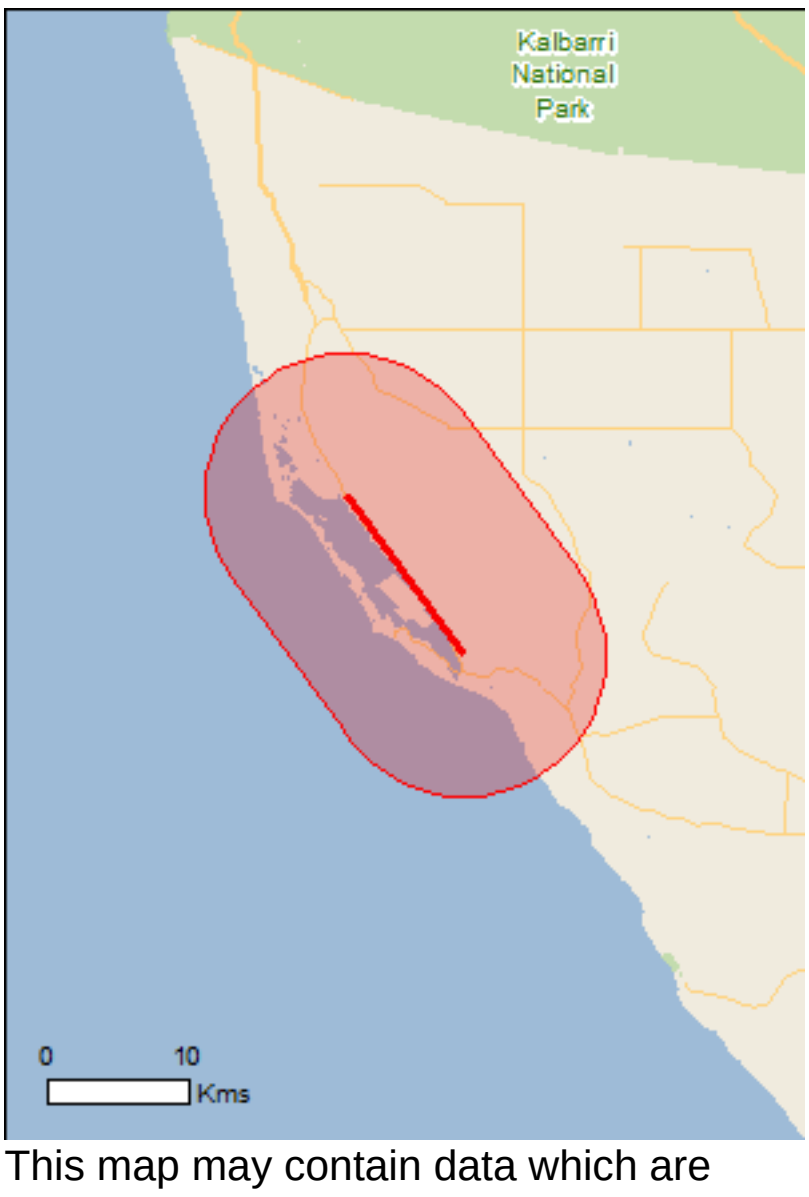

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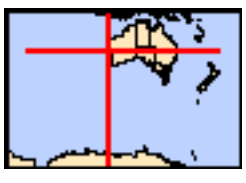

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	48
Listed Migratory Species:	46

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	76
Whales and Other Cetaceans:	11
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	15
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	2

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

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

Name

EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name

South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Other		
[Idiosoma nigrum](#) Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat may occur within area
Plants		
[Androcalva bivillosa](#) Straggling Androcalva [87807]	Critically Endangered	Species or species habitat likely to occur within area
[Caladenia barbarella](#) Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
[Caladenia bryceana subsp. cracens](#) Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat may occur within area
[Caladenia elegans](#) Elegant Spider-orchid [56775]	Endangered	Species or species habitat known to occur within area
[Caladenia hoffmanii](#) Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area
[Diuris drummondii](#) Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
[Drakaea concolor](#) Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat known to occur within area
[Drummondita ericoides](#) Morseby Range Drummondita [9193]	Endangered	Species or species habitat may occur within area
[Eucalyptus cuprea](#) Mallee Box [56773]	Endangered	Species or species habitat likely to occur within area
[Hypocalymma angustifolium subsp. Hutt River (S.Patrick 2982)](#) [85023]	Endangered	Species or species habitat known to occur within area
[Pterostylis sinuata](#) Northampton Midget Greenhood, Western Swan Grrenhood [84991]	Endangered	Species or species habitat known to occur within area
[Stachystemon nematophorus](#) Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
[Egernia stokesii badia](#) Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Hydroprogne caspia		
Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli		
Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus		
Bridled Tern [82845]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta		
Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]		
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur

Name	Threatened	Type of Presence within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern [814]		Foraging, feeding or related behaviour likely to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Port Gregory	WA
Utcha Well	WA

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Hutt Lagoon System	WA

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
Commonwealth marine environment within and	South-west
Western rock lobster	South-west

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-28.109489 114.219784,-28.199066 114.294036,-28.199947 114.294436,-28.199947 114.294436

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-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
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-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
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-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
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-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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Please feel free to provide feedback via the Contact Us page.

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NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 04/12/2019

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	114° 15' 04" E,28° 07' 59" S
Buffer	10km
Group By	Kingdom

Kingdom	Species	Records
Animalia	353	3102
Chromista	10	13
Fungi	18	33
Plantae	304	516
TOTAL	**685**	**3664**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Animalia					
1.		*Abudefduf sexfasciatus*			
2.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
3.		*Acanthistius pardalotus*			
4.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
5.		*Acariformes sp.*			
6.	25536	*Accipiter fasciatus (Brown Goshawk)*			
7.		*Acritoptila globosa*			
8.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
9.		*Adversaeschna brevistyla*			
10.		*Aeshnidae sp.*			
11.		*Agraptocorixa eurynome*			
12.		*Agraptocorixa sp.*			
13.		*Alboa worooa*			
14.		*Allotrochosina karri*			
15.		*Alona rigidicaudis*			
16.		*Alotanypus dalyupensis*			
17.	24312	*Anas gracilis (Grey Teal)*			
18.	24315	*Anas rhynchotis (Australasian Shoveler)*			
19.	24316	*Anas superciliosa (Pacific Black Duck)*			
20.		*Anax papuensis*			
21.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
22.		*Anisops elstoni*			
23.		*Anisops nasutus*			
24.		*Anisops thienemanni*			
25.		*Anopheles annulipes s.l.*			
26.	25634	*Anous stolidus (Common Noddy)*		IA	
27.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
28.		*Apocyclops dengizicus*			
29.		*Apogon doederleini*			
30.		*Apogon victoriae*			
31.	25554	*Apus pacificus (Fork-tailed Swift, Pacific Swift)*		IA	
32.	24285	*Aquila audax (Wedge-tailed Eagle)*			
33.		*Arcella sp. a (SAP)*			
34.		*Arcella sp. c (SAP)*			
35.		*Archaeosynthemis occidentalis*			
36.	25558	*Ardea ibis (Cattle Egret)*			
37.	41324	*Ardea modesta (great egret, white egret)*			
38.	24610	*Ardeotis australis (Australian Bustard)*			
39.	25736	*Arenaria interpres (Ruddy Turnstone)*		IA	
40.		*Armatalona macrocopa*			
41.		*Arrenurus (Truncaturus) sp. 25 (TST)*			
42.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
43.	24355	*Artamus minor (Little Woodswallow)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
44.	24356	*Artamus personatus (Masked Woodswallow)*			
45.		*Artemia sp.*			
46.		*Artoria cingulipes*			
47.		*Australocypris insularis*			
48.		*Australoeucyclops darwini (ex Paracyclops sp 1 nr timmsi)*			
49.		*Austrochiltonia subtenuis*			
50.		*Austrolestes aleison*			
51.		*Austrolestes annulosus*			
52.	24318	*Aythya australis (Hardhead)*			
53.		*Barnardius zonarius*			
54.		*Bdelloidea sp.*			
55.		*Berosus approximans*			
56.		*Berosus discolor*			
57.		*Berosus sp.*			
58.		*Bezzia sp. 2 (SAP)*			
59.	24319	*Biziura lobata (Musk Duck)*			
60.		*Brachionus plicatilis s.l.*			
61.		*Brentidae sp.*			
62.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
63.	24269	*Calamanthus campestris (Rufous Fieldwren)*			
64.		*Calamoecia clitellata*			
65.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
66.	24780	*Calidris alba (Sanderling)*		IA	
67.	25738	*Calidris canutus (Red Knot, knot)*		IA	
68.	24784	*Calidris ferruginea (Curlew Sandpiper)*		T	
69.	24786	*Calidris melanotos (Pectoral Sandpiper)*		IA	
70.	24788	*Calidris ruficollis (Red-necked Stint)*		IA	
71.	24789	*Calidris subminuta (Long-toed Stint)*		IA	
72.	24790	*Calidris tenuirostris (Great Knot)*		T	
73.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
74.		*Candonocypris novaezelandiae*			
75.		*Ceinidae sp.*			
76.		*Centropyxis cf kahlii*			Y
77.		*Cephalodella gibba*			
78.		*Ceratopogonidae sp.*			
79.	25575	*Charadrius leschenaultii (Greater Sand Plover)*		T	
80.	25576	*Charadrius mongolus (Lesser Sand Plover)*		T	
81.	24377	*Charadrius ruficapillus (Red-capped Plover)*			
82.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
83.	47909	*Cheramoeca leucosterna (White-backed Swallow)*			
84.		*Chironominae sp.*			
85.		*Chironomus aff. alternans (V24) (CB)*			
86.		*Choeroichthys suillus*			
87.		*Chroicocephalus novaehollandiae*			
88.	24288	*Circus approximans (Swamp Harrier)*			
89.		*Cladopelma curtivalva*			
90.	24774	*Cladorhynchus leucocephalus (Banded Stilt)*			
91.		*Cleidopus gloriamaris*			
92.		*Cletocamptus dietersi*			
93.		*Cloeon sp.*			
94.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
95.	24399	*Columba livia (Domestic Pigeon)*	Y		
96.		*Colurodontis paxmani*			
97.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
98.		*Corduliidae sp.*			
99.		*Corixidae sp.*			
100.	24416	*Corvus bennetti (Little Crow)*			
101.	25592	*Corvus coronoides (Australian Raven)*			
102.		*Corynoneura sp.*			
103.		*Corynoneura sp. (V49) (SAP)*			
104.		*Coxiella striatula*			
105.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
106.	25595	*Cracticus tibicen (Australian Magpie)*			
107.	25596	*Cracticus torquatus (Grey Butcherbird)*			
108.	25401	*Crinia pseudinsignifera (Bleating Froglet)*			
109.		*Cristiceps australis*			
110.	24881	*Ctenophorus maculatus subsp. maculatus (Spotted Military Dragon)*			
111.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
112.		*Culicidae sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
113.		*Culicoides sp.*			
114.	24322	*Cygnus atratus (Black Swan)*			
115.		*Cypretta baylyi*			
116.		*Dasyhelea sp.*			
117.		*Diacypris spinosa*			
118.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
119.		*Dicrotendipes conjunctus*			
120.		*Difflugia sp.*			
121.		*Diplacodes bipunctata*			
122.		*Dipulus caecus*			
123.	24470	*Dromaius novaehollandiae (Emu)*			
124.		*Dytiscidae sp.*			
125.		*Egretta novaehollandiae*			
126.		*Elanus axillaris*			
127.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
128.		*Enchytraeidae sp.*			
129.		*Eolophus roseicapillus*			
130.	24651	*Eopsaltria australis subsp. griseogularis (Western Yellow Robin)*			
131.		*Ephydridae sp. 6 (SAP)*			
132.		*Epinephelus coioides*			
133.	24567	*Epthianura albifrons (White-fronted Chat)*			
134.	24568	*Epthianura aurifrons (Orange Chat)*			
135.	24570	*Epthianura tricolor (Crimson Chat)*			
136.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
137.		*Euchlanis deflexa*			Y
138.		*Eucyclops australiensis*			
139.		*Eviota bimaculata*			
140.	25621	*Falco berigora (Brown Falcon)*			
141.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
142.	25623	*Falco longipennis (Australian Hobby)*			
143.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
144.		*Forcypomyia sp.*			
145.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
146.	24959	*Gehyra variegata*			
147.	47954	*Gelochelidon nilotica (Gull-billed Tern)*		IA	
148.	24401	*Geopelia cuneata (Diamond Dove)*			
149.	25585	*Geopelia striata (Zebra Dove)*			
150.	24443	*Grallina cyanoleuca (Magpie-lark)*			
151.		*Gymnothorax woodwardi*			
152.	25627	*Haematopus fuliginosus (Sooty Oystercatcher)*			
153.	24487	*Haematopus longirostris (Pied Oystercatcher)*			
154.	24293	*Haliaeetus leucogaster (White-bellied Sea-Eagle)*			
155.	24295	*Haliastur sphenurus (Whistling Kite)*			
156.		*Halichoeres brownfieldi*			
157.		*Halicyclops ambiguus*			Y
158.		*Haliplus fuscatus*			
159.		*Helcogramma decurrens*			
160.		*Helochares tenuistriatus*			
161.		*Hemicordulia tau*			
162.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
163.	47965	*Hieraaetus morphnoides (Little Eagle)*			
164.	25734	*Himantopus himantopus (Black-winged Stilt)*			
165.	24491	*Hirundo neoxena (Welcome Swallow)*			
166.		*Hydrachna australica*			
167.		*Hydrachna nr. approximata (SAP)*			
168.		*Hydroglyphus leai*			
169.		*Hydrophilidae sp.*			
170.	48587	*Hydroprogne caspia (Caspian Tern)*		IA	
171.		*Hydropsychidae sp.*			
172.		*Hyphydrus elegans*			
173.		*Hyphydrus sp.*			
174.		*Ischnura aurora aurora*			
175.		*Ischnura heterosticta heterosticta*			
176.		*Istiblennius meleagris*			
177.		*Kennethia cristata*			
178.		*Keratella procurva*			
179.		*Kiefferulus intertinctus*			
180.		*Labracinus lineatus*			
181.	25638	*Larus pacificus (Pacific Gull)*			
182.		*Lecane bulla*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
183.		*Lecane luna*			
184.		*Lecane thalera*			
185.		*Lepadichthys sandaracatus*			
186.		*Lepidoptera sp.*			
187.		*Leptoceridae sp.*			
188.	25148	*Lerista lineopunctulata*			
189.	25165	*Lerista praepedita*			
190.		*Lestidae sp.*			
191.		*Lethrinus genivittatus*			
192.		*Lethrinus miniatus*			
193.	25005	*Lialis burtonis*			
194.		*Libellulidae sp.*			
195.	25661	*Lichmera indistincta (Brown Honeyeater)*			
196.		*Limnichidae sp.*			
197.		*Limnocythere mowbrayensis*			
198.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
199.		*Limnophyes vestitus (V41)*			
200.	30932	*Limosa lapponica (Bar-tailed Godwit)*		IA	
201.	25388	*Litoria moorei (Motorbike Frog)*			
202.		*Lophoictinia isura*			
203.		*Lourinidae sp.*			Y
204.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
205.		*Macrothrix breviseta*			
206.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
207.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
208.	24544	*Malurus lamberti subsp. assimilis (Variegated Fairy-wren)*			
209.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
210.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
211.	25654	*Malurus splendens (Splendid Fairy-wren)*			
212.	24583	*Manorina flavigula (Yellow-throated Miner)*			
213.	25758	*Megalurus gramineus (Little Grassbird)*			
214.		*Megaporus sp.*			
215.	24598	*Merops ornatus (Rainbow Bee-eater)*			
216.		*Mesochra baylyi*			
217.		*Mesocyclops brooksi*			
218.		*Mesocyclops sp.*			
219.		*Mesostigmata sp.*			
220.		*Microcarbo melanoleucos*			
221.		*Micronecta robusta*			
222.		*Microvelia (Austromicrovelia) peramoena*			
223.		*Microvelia (Pacificovelia) oceanica*			
224.		*Microvelia sp.*			
225.	25191	*Morethia lineoocellata*			
226.	48008	*Morus serrator (Australasian Gannet)*			
227.		*Muraenichthys sp.*			
228.	24223	*Mus musculus (House Mouse)*	Y		
229.	25420	*Myobatrachus gouldii (Turtle Frog)*			
230.		*Mytilocypris mytiloides*			
231.		*Naididae (ex Tubificidae)*			
232.		*Nannophya occidentalis*			
233.		*Necterosoma penicillatus*			
234.		*Necterosoma sp.*			
235.		*Nematoda sp.*			
236.		*Nemertini sp.*			
237.		*Neohydrocoptus subfasciatus*			
238.	33984	*Neopasiphae simplicior (a short-tongued bee)*		T	
239.		*Nitocra sp. 3 (SAP)*			Y
240.		*Nitocra sp. 5 (nr reducta) (SAP)*			
241.		*Notolabrus parilus*			
242.		*Notonectidae sp.*			
243.	24799	*Numenius minutus (Little Curlew, Little Whimbrel)*		IA	
244.	25742	*Numenius phaeopus (Whimbrel)*		IA	
245.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
246.	24742	*Nymphicus hollandicus (Cockatiel)*			
247.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
248.		*Oecetis sp.*			
249.		*Oligochaeta sp.*			
250.		*Onychocamptus bengalensis*			
251.		*Onychohydrus sp.*			
252.		*Oribatida sp.*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
253.		*Orthetrum caledonicum*			
254.		*Orthocladiinae sp.*			
255.		*Orthocladiinae sp. I (SAP)*			
256.		*Oxyethira sp.*			
257.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
258.	48591	*Pandion cristatus (Osprey, Eastern Osprey)*		IA	
259.		*Paracyclops chiltoni*			
260.		*Paracyclops sp.*			
261.		*Paradoxostoma sp.*			Y
262.		*Parakiefferiella variegatus*			
263.		*Paralimnophyes pullulus (V42)*			
264.		*Paramerina levidensis*			
265.		*Parapercis haackei*			
266.		*Parma occidentalis*			
267.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
268.		*Pempheris mangula*			
269.		*Pescecyclops sp. 462*			
270.	48060	*Petrochelidon ariel (Fairy Martin)*			
271.	48061	*Petrochelidon nigricans (Tree Martin)*			
272.	25697	*Phalacrocorax carbo (Great Cormorant)*			
273.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
274.	25699	*Phalacrocorax varius (Pied Cormorant)*			
275.	24801	*Phalaropus lobatus (Red-necked Phalarope)*		IA	
276.	24409	*Phaps chalcoptera (Common Bronzewing)*			
277.	24802	*Philomachus pugnax (Ruff, reeve)*		IA	
278.		*Platynectes sp.*			
279.		*Plectorhinchus flavomaculatus*			
280.		*Plotiopsis sp.*			
281.		*Plotosus lineatus*			
282.	24382	*Pluvialis fulva (Pacific Golden Plover)*		IA	
283.	24383	*Pluvialis squatarola (Grey Plover)*		IA	
284.	25703	*Podargus strigoides (Tawny Frogmouth)*			
285.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
286.		*Polypedilum nr. convexum (SAP)*			
287.		*Polypedilum nubifer*			
288.		*Pomacentrus milleri*			
289.	24769	*Porzana fluminea (Australian Spotted Crake)*			
290.	24771	*Porzana tabuensis (Spotless Crake)*			
291.		*Priolepis nuchifasciata*			
292.		*Pristina sima*			
293.		*Procladius paludicola*			
294.		*Procladius villosimanus*			
295.		*Pseudochromis wilsoni*			
296.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
297.		*Pyralidae nr. sp. 39/40 of JHH (SAP)*			
298.	24245	*Rattus rattus (Black Rat)*	Y		
299.	24776	*Recurvirostra novaehollandiae (Red-necked Avocet)*			
300.	48096	*Rhipidura albiscapa (Grey Fantail)*			
301.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
302.		*Robertsonia sp.*			Y
303.		*Sargocentron rubrum*			
304.		*Sarscypridopsis aculeata*			
305.		*Schuettea woodwardi*			
306.		*Scirtidae sp.*			
307.		*Scorpaena sumptuosa*			
308.		*Scorpaenodes steenei*			
309.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
310.		*Sillago robusta*			
311.		*Simocephalus elizabethae*			
312.		*Simocephalus sp.*			
313.		*Simuliidae sp.*			
314.		*Simulium ornatipes*			
315.		*Solegnathus lettiensis*			
316.		*Staphylinidae sp.*			
317.		*Stegastes obreptus*			
318.	48594	*Sternula nereis (Fairy Tern)*			
319.		*Stratiomyidae sp.*			
320.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
321.	24942	*Strophurus spinigerus subsp. spinigerus*			
322.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
323.		*Tabanidae sp.*			
324.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
325.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
326.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
327.	30870	*Taeniopygia guttata (Zebra Finch)*			
328.		*Tanypodinae sp.*			
329.		*Tanytarsus barbitarsis*			
330.		*Tanytarsus fuscithorax/semibarbitarsus*			
331.		*Tanytarsus palmatus*			
332.		*Tanytarsus sp. D (SAP)*			
333.		*Tanytarsus sp. G (SAP)*			
334.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
335.	48597	*Thalasseus bergii (Crested Tern)*		IA	
336.		*Thalassoma septemfasciata*			
337.		*Thienemanniella sp. (V19) (SAP)*			
338.		*Tipulidae sp.*			
339.		*Tipulidae type F (SAP)*			
340.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
341.	48141	*Tribonyx ventralis (Black-tailed Native-hen)*			
342.	24803	*Tringa brevipes (Grey-tailed Tattler)*		P4	
343.	24806	*Tringa glareola (Wood Sandpiper)*		IA	
344.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	
345.	24809	*Tringa stagnatilis (Marsh Sandpiper, little greenshank)*		IA	
346.		*Triplectides australis*			
347.		*Turbellaria sp.*			
348.		*Veliidae sp.*			
349.		*Venatrix pullastra*			
350.		*Venonia micarioides*			
351.		*Xanthagrion erythroneurum*			
352.	41351	*Xenus cinereus (Terek Sandpiper)*		IA	
353.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			
Chromista					
354.	35910	*Canistrocarpus crispatus*			
355.	26586	*Caulocystis uvifera*			
356.	26766	*Dictyopteris muelleri*			
357.	26778	*Dictyota furcellata*			
358.	26810	*Encyothalia cliftonii*			
359.	26949	*Hydroclathrus clathratus*			
360.	27043	*Lobophora variegata*			
361.	27246	*Sargassum lacerifolium*			
362.	35911	*Scytosiphon lomentaria*			
363.	27373	*Zonaria turneriana*			
Fungi					
364.	27574	*Acarospora citrina*			
365.	31099	*Caloplaca kantvilasii*			
366.	48963	*Caloplaca lithophila*			
367.	48176	*Cladia beaugleholei*			
368.	48177	*Cladia muelleri*			
369.	28208	*Cladonia cervicornis subsp. verticillata*			
370.	27753	*Fulgensia bracteata*			
371.	27754	*Fulgensia subbracteata*			
372.		*Lecanora sp.*			
373.	27815	*Lecanora sphaerospora*			
374.		*Lecidea sp.*			
375.	30457	*Notocladonia cochleata*			
376.	27935	*Peltula euploca*			
377.	49073	*Peziza austrogeaster*			
378.	27999	*Psora crystallifera*			
379.	28000	*Psora decipiens*			
380.	28060	*Siphula coriacea*			
381.	28070	*Thysanothecium hookeri*			
Plantae					
382.	16111	*Acacia alata var. biglandulosa*			
383.	3225	*Acacia ashbyae*			
384.	3376	*Acacia idiomorpha*			
385.	11611	*Acacia lasiocarpa var. lasiocarpa*			
386.	14612	*Acacia latipes subsp. licina*		P3	
387.	14134	*Acacia pelophila*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
				P1	
388.	15481	*Acacia pulchella var. glaberrima*			
389.	3521	*Acacia ridleyana*		P3	
390.	3525	*Acacia rostellifera (Summer-scented Wattle)*			
391.	3532	*Acacia scirpifolia*			
392.	3549	*Acacia spathulifolia*			
393.	15484	*Acacia sphacelata subsp. sphacelata*			
394.	1208	*Acanthocarpus preissii*			
395.	20797	*Acanthocarpus sp. Ajana (C.A. Gardner 8596)*			
396.	1775	*Adenanthos cygnorum (Common Woollybush)*			
397.	11837	*Adenanthos cygnorum subsp. cygnorum (Common Woollybush)*			
398.	17422	*Adriana tomentosa var. tomentosa*			
399.	36277	*Aloe vera var. officinalis*	Y		
400.	4905	*Alyogyne hakeifolia*			
401.	4906	*Alyogyne huegelii (Lilac Hibiscus)*			
402.	42940	*Alyogyne sp. Geraldton (R. Davis 3487)*			
403.	13267	*Amyema linophylla subsp. linophylla*			
404.	13266	*Amyema miraculosa subsp. miraculosa*			
405.	40914	*Androcalva gaudichaudii*			
406.	11434	*Anigozanthos humilis subsp. humilis*			
407.	1410	*Anigozanthos kalbarriensis (Kalbarri Catspaw)*			
408.	11565	*Anigozanthos manglesii subsp. quadrans*			
409.	11725	*Anthocercis ilicifolia subsp. ilicifolia*			
410.	6949	*Anthocercis littorea (Yellow Tailflower)*			
411.	3180	*Aphanopetalum clematideum*			
412.	26486	*Asparagopsis taxiformis*			
413.	20695	*Astroloma sp. Kalbarri (D. & B. Bellairs 1368)*		P2	
414.	16369	*Atriplex canescens*	Y		Y
415.	2452	*Atriplex cinerea (Grey Saltbush)*			
416.	2463	*Atriplex isatidea (Coast Saltbush)*			
417.	2470	*Atriplex paludosa (Marsh Saltbush)*			
418.	11525	*Atriplex paludosa subsp. baudinii*			
419.	17237	*Austrostipa elegantissima*			
420.	17240	*Austrostipa flavescens*			
421.	17244	*Austrostipa macalpinei*			
422.	17246	*Austrostipa nitida*			
423.	233	*Avena barbata (Bearded Oat)*	Y		
424.	48221	*Balladonia aervoides*		P3	
425.	32524	*Banksia fraseri var. ashbyi*			
426.	11386	*Banksia leptophylla var. melletica*			
427.	32079	*Banksia sessilis var. flabellifolia*			
428.	1852	*Banksia telmatiaea (Swamp Fox Banksia)*			
429.	743	*Baumea juncea (Bare Twigrush)*			
430.	747	*Baumea rubiginosa*			
431.	748	*Baumea vaginalis (Sheath Twigrush)*			
432.	31606	*Blackallia nudiflora (Wedge-leaved Cryptandra)*		P3	
433.	11381	*Boronia ramosa subsp. anethifolia*			
434.	3719	*Bossiaea spinescens*			
435.	8661	*Brachypodium distachyon (False Brome)*	Y		
436.	249	*Bromus diandrus (Great Brome)*	Y		
437.	6213	*Bupleurum semicompositum*	Y		
438.	29439	*Caesia sp. Wongan (K.F. Kenneally 8820)*			
439.	13618	*Caladenia elegans*		T	
440.	15348	*Caladenia flava subsp. flava*			
441.	15349	*Caladenia flava subsp. maculata*			
442.	17760	*Caladenia nobilis*			
443.	2860	*Calandrinia polyandra (Parakeelya)*			
444.	19304	*Calectasia browneana*		P2	
445.	5401	*Calothamnus blepharospermus*			
446.	35758	*Calothamnus quadrifidus subsp. homalophyllus (Murchison Clawflower)*			
447.	5450	*Calytrix depressa*			
448.	5460	*Calytrix fraseri (Pink Summer Calytrix)*			
449.	7911	*Carthamus lanatus (Saffron Thistle)*	Y		
450.	2948	*Cassytha aurea*			
451.	12073	*Cassytha aurea var. aurea*			
452.	2952	*Cassytha glabella (Tangled Dodder Laurel)*			
453.	2957	*Cassytha racemosa (Dodder Laurel)*			
454.	11799	*Cassytha racemosa forma racemosa*			
455.	48455	*Caulerpa geminata*			
456.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
457.	1124	*Centrolepis cephaloformis*			
458.	17685	*Chaetanthus aristatus*			
459.	2494	*Chenopodium murale (Nettle-leaf Goosefoot)*	Y		
460.	29619	*Chondrophycus brandenii*			
461.	4853	*Clematicissus angustissima*			
462.	26683	*Codium spongiosum*			
463.	4550	*Comesperma calymega (Blue-spike Milkwort)*			
464.	4554	*Comesperma flavum*			
465.	4564	*Comesperma virgatum (Milkwort)*			
466.	40872	*Commersonia borealis*			
467.	2776	*Commicarpus australis (Perennial Tar Vine)*			
468.	15607	*Conospermum acerosum subsp. acerosum*			
469.	15608	*Conospermum acerosum subsp. hirsutum*			
470.	15513	*Conospermum boreale subsp. boreale*			
471.	15611	*Conospermum stoechadis subsp. stoechadis (Common Smokebush)*			
472.	12028	*Conostylis aculeata subsp. septentrionora*			
473.	1423	*Conostylis aurea (Golden Conostylis)*			
474.	1446	*Conostylis prolifera (Mat Cottonheads)*			
475.	1456	*Conostylis stylidioides*			
476.	6614	*Convolvulus remotus*			
477.	3137	*Crassula colorata (Dense Stonecrop)*			
478.	35839	*Cristonia stenophylla*			
479.	4802	*Cryptandra mutila*			
480.	6663	*Cuscuta epithymum (Lesser Dodder, Greater Dodder)*	Y		
481.	283	*Cynodon dactylon (Couch)*	Y		
482.	794	*Cyperus gymnocaulos (Spiny Flat-sedge)*			
483.	801	*Cyperus laevigatus*	Y		
484.	7421	*Dampiera altissima (Tall Dampiera)*			
485.	11723	*Dampiera incana var. incana*			
486.	7459	*Dampiera oligophylla (Sparse-leaved Dampiera)*			
487.	5522	*Darwinia pauciflora*			
488.	5534	*Darwinia virescens (Murchison Darwinia)*			
489.	18561	*Daviesia divaricata subsp. lanulosa*			
490.	1287	*Dichopogon capillipes*			
491.	1290	*Dichopogon tyleri*			
492.	15270	*Diplolaena geraldtonensis*			
493.	4456	*Diplolaena grandiflora (Wild Rose)*			
494.	4748	*Diplopeltis petiolaris*			
495.	7961	*Dittrichia graveolens (Stinkwort)*	Y		
496.	10796	*Diuris drummondii (Tall Donkey Orchid)*		T	
497.	12936	*Diuris recurva*		P4	
498.	13633	*Drakaea concolor*		T	
499.	3113	*Drosera neesii (Jewel Rainbow)*			
500.	3116	*Drosera omissa (Bright Sundew)*			
501.	346	*Ehrharta brevifolia (Annual Veldt Grass)*	Y		
502.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
503.	353	*Eleusine indica (Crowsfoot Grass)*	Y		
504.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
505.	5538	*Eremaea brevifolia*			
506.	5539	*Eremaea ebracteata*			
507.	14102	*Eremaea ebracteata var. ebracteata*			
508.	17175	*Eremophila glabra subsp. albicans*			
509.	14193	*Eremophila glabra subsp. carnosa*			
510.	7241	*Eremophila microtheca (Heath-like Eremophila)*		P4	
511.	4333	*Erodium cicutarium (Common Storksbill)*	Y		
512.	12740	*Erymophyllum tenellum*			
513.	12895	*Eucalyptus arachnaea subsp. arachnaea*			
514.	5730	*Eucalyptus oraria (Ooragmandee)*			
515.	4620	*Euphorbia boophthona (Gascoyne Spurge)*			
516.	4644	*Euphorbia sharkoensis*			
517.	4648	*Euphorbia terracina (Geraldton Carnation Weed)*	Y		
518.	5193	*Frankenia confusa*		P4	
519.	5209	*Frankenia pauciflora (Seaheath)*			
520.	907	*Gahnia trifida (Coast Saw-sedge)*			
521.	12780	*Gilberta tenuifolia*			
522.	3938	*Glycine canescens (Silky Glycine)*			
523.	7983	*Gnaphalium indutum (Tiny Cudweed)*			
524.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
525.	7495	*Goodenia berardiana*			
526.	18116	*Grevillea commutata subsp. commutata*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
527.	2032	*Grevillea leucopteris (White Plume Grevillea)*			
528.	8838	*Grevillea pinaster*			
529.	2113	*Grevillea triloba*		P3	
530.	5011	*Guichenotia ledifolia*			
531.	6696	*Halgania sericiflora*			
532.	47213	*Halimeda versatilis*			
533.	5120	*Hibbertia desmophylla*			
534.	5171	*Hibbertia spicata*			
535.	450	*Hordeum marinum*	Y		
536.	6234	*Hydrocotyle medicaginoides (Trefoil Pennywort)*			
537.	35071	*Hypocalymma angustifolium subsp. Hutt River (S. Patrick 2982)*		T	
538.	5821	*Hypocalymma longifolium*		T	
539.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
540.	1070	*Hypolaena exsulca*			
541.	7396	*Isotoma hypocrateriformis (Woodbridge Poison)*			
542.	3992	*Isotropis cuneifolia (Granny Bonnets)*			
543.	14780	*Jacksonia arenicola*			
544.	14785	*Jacksonia rigida*			
545.	1175	*Juncus acutus (Spiny Rush)*	Y		
546.	1178	*Juncus bufonius (Toad Rush)*	Y		
547.	11922	*Juncus kraussii subsp. australiensis*			
548.	4044	*Kennedia prostrata (Scarlet Runner)*			
549.	5043	*Lasiopetalum oldfieldii*		P3	
550.	13289	*Lawrencella davenportii*			
551.	4955	*Lawrencia glomerata*			
552.	4959	*Lawrencia squamata*			
553.	4960	*Lawrencia viridigrisea*			
554.	7572	*Lechenaultia expansa*			
555.	7580	*Lechenaultia linarioides (Yellow Leschenaultia)*			
556.	946	*Lepidosperma striatum*			
557.	6487	*Limonium companyonis*	Y		
558.	41780	*Limonium hyblaeum*	Y		
559.	9289	*Lobelia anceps (Angled Lobelia)*			
560.	7403	*Lobelia heterophylla (Wing-seeded Lobelia)*			
561.	1227	*Lomandra hastilis*			
562.	1231	*Lomandra maritima*			
563.	4060	*Lotus australis (Austral Trefoil)*			
564.	18049	*Lyginia imberbis*			
565.	36375	*Lysimachia arvensis (Pimpernel)*	Y		
566.	2839	*Macarthuria australis*			
567.	19384	*Melaleuca bisulcata*			
568.	5887	*Melaleuca cardiophylla (Tangling Melaleuca)*			
569.	18112	*Melaleuca leuropoma*			
570.	5959	*Melaleuca rhaphiophylla (Swamp Paperbark)*			
571.	5987	*Melaleuca viminea (Mohan)*			
572.	13280	*Melaleuca viminea subsp. viminea*			
573.	4085	*Melilotus indicus*	Y		
574.	2813	*Mesembryanthemum crystallinum (Iceplant)*	Y		
575.	2814	*Mesembryanthemum nodiflorum (Slender Iceplant)*	Y		
576.	4100	*Mirbelia spinosa*			
577.	19177	*Moraea setifolia*	Y		
578.	7291	*Myoporum insulare (Blueberry Tree, boobialla)*			
579.	17158	*Myoporum montanum (Native Myrtle)*			
580.	138	*Najas marina (Prickly Water Nymph)*			
581.	2401	*Nuytsia floribunda (Christmas Tree, Mudja)*			
582.	6138	*Oenothera drummondii (Beach Evening Primrose)*	Y		
583.	18256	*Opercularia spermacocea*			
584.	516	*Parapholis incurva (Coast Barbgrass)*	Y		
585.	12670	*Parietaria cardiostegia*			
586.	1762	*Parietaria debilis (Pellitory)*			
587.	2290	*Petrophile conifera*			
588.	2301	*Petrophile macrostachya*			
589.	551	*Phalaris minor (Lesser Canary Grass)*	Y		
590.	4675	*Phyllanthus calycinus (False Boronia)*			
591.	6008	*Phymatocarpus porphyrocephalus*			
592.	20220	*Pileanthus rubronitidus*			
593.	18250	*Pileanthus vernicosus*			
594.	5246	*Pimelea gilgiana*			
595.	5256	*Pimelea microcephala (Shrubby Riceflower, Banjine)*			
596.	573	*Poa drummondiana (Knotted Poa)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
597.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
598.	8188	*Pogonolepis stricta*			
599.	582	*Polypogon monspeliensis (Annual Beardgrass)*	Y		
600.	1671	*Prasophyllum elatum (Tall Leek Orchid)*			
601.	1672	*Prasophyllum fimbria (Fringed Leek Orchid)*			
602.	37460	*Pterostylis sinuata*		T	
603.	2717	*Ptilotus divaricatus (Climbing Mulla Mulla)*			
604.	2719	*Ptilotus eriotrichus*			
605.	2766	*Ptilotus villosiflorus*			
606.	592	*Puccinellia stricta (Marsh Grass)*			
607.	41041	*Quoya atriplicina*			
608.	11728	*Rhagodia latifolia subsp. latifolia*			
609.	2584	*Rhagodia preissii*			
610.	13241	*Rhodanthe chlorocephala subsp. rosea*			
611.	48887	*Roepera billardierei*			
612.	48891	*Roepera fruticulosa*			
613.	40426	*Rytidosperma occidentale*			
614.	2906	*Sagina apetala (Annual Pearlwort)*	Y		
615.	48433	*Salicornia blackiana*			
616.	48430	*Salicornia quinqueflora*			
617.	6484	*Samolus repens (Creeping Brookweed)*			
618.	14107	*Samolus repens var. paucifolius*			
619.	2356	*Santalum acuminatum (Quandong, Warnga)*			
620.	7614	*Scaevola globulifera*			
621.	17026	*Scaevola kallophylla*		P4	
622.	7634	*Scaevola phlebopetala (Velvet Fanflower)*			
623.	12588	*Scaevola virgata*			
624.	972	*Schoenus armeria*			
625.	994	*Schoenus humilis*			
626.	1011	*Schoenus rigens*			
627.	1018	*Schoenus subfascicularis*			
628.	6034	*Scholtzia laxiflora*			
629.	49129	*Scholtzia pentamera subsp. pentamera*			
630.	15427	*Scholtzia spatulata*			
631.	6041	*Scholtzia umbellifera*			
632.	6544	*Sebaea ovata (Yellow Sebaea)*			
633.	8207	*Senecio glossanthus (Slender Groundsel)*			
634.	3069	*Sisymbrium erysimoides (Smooth Mustard)*	Y		
635.	6988	*Solanum americanum (Glossy Nightshade)*	Y		
636.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
637.	7025	*Solanum oldfieldii*			
638.	7037	*Solanum symonii*			
639.	9367	*Sonchus hydrophilus (Native Sowthistle)*			
640.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
641.	2915	*Spergularia rubra (Sand Spurry)*	Y		
642.	635	*Sporobolus virginicus (Marine Couch)*			
643.	19953	*Stachystemon nematophorus*		P4	
644.	43601	*Stackhousia sp. Mid west coastal (D. & B. Bellairs 6561)*			
645.	2316	*Stirlingia latifolia (Blueboy)*			
646.	27318	*Struvea plumosa*			
647.	7693	*Stylidium brunonianum (Pink Fountain Triggerplant)*			
648.	17412	*Stylidium kalbarriense*			
649.	25837	*Stylidium purpureum (Purple Fountain Triggerplant)*			
650.	19247	*Stylidium septentrionale*			
651.	3182	*Stylobasium spathulatum (Pebble Bush)*			
652.	2639	*Suaeda australis (Seablite)*			
653.	4220	*Swainsona canescens (Grey Swainsona)*			
654.	25902	*Symphyotrichum squamatum (Bushy Starwort)*	Y		
655.	33236	*Tecticornia halocnemoides (Shrubby Samphire)*			
656.	33319	*Tecticornia indica subsp. bidens*			
657.	31618	*Tecticornia pruinosa*			
658.	31716	*Tecticornia syncarpa*			
659.	31717	*Tecticornia undulata*			
660.	2820	*Tetragonia decumbens (Sea Spinach)*	Y		
661.	2823	*Tetragonia implexicoma (Bower Spinach)*			
662.	673	*Themeda triandra*			
663.	2644	*Threlkeldia diffusa (Coast Bonefruit)*			
664.	1339	*Thysanotus multiflorus (Many-flowered Fringe Lily)*			
665.	1356	*Thysanotus teretifolius*			
666.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
667.	4312	*Trifolium striatum (Knotted Clover)*	Y		
668.	147	*Triglochin mucronata*			
669.	151	*Triglochin striata*			
670.	152	*Triglochin trichophora*			
671.	98	*Typha domingensis (Bulrush, Djandjid)*			
672.	15725	*Verbesina encelioides*	Y		
673.	7666	*Verreauxia reinwardtii (Common Verreauxia)*			
674.	12402	*Verticordia chrysanthella*			
675.	48829	*Wahlenbergia capillaris*			
676.	13331	*Waitzia acuminata var. acuminata*			
677.	13330	*Waitzia acuminata var. albicans*			
678.	13328	*Waitzia nitida*			
679.	8281	*Waitzia podolepis*			
680.	8282	*Waitzia suaveolens (Fragrant Waitzia)*			
681.	6658	*Wilsonia backhousei (Narrow-leaf Wilsonia)*			
682.	6659	*Wilsonia humilis (Silky Wilsonia)*			
683.	12072	*Wurmbea dioica subsp. alba*			
684.	1398	*Wurmbea monantha*			
685.	1256	*Xanthorrhoea preissii (Grass tree, Palga)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix D – Flora data

Flora species list

Quadrat data

Flora likelihood of occurrence

Flora Species List

Family	Taxon	Status
Amaranthaceae	*Ptilotus divaricatus*	
Amaranthaceae	*Ptilotus stirlingii sp. stirlingii*	
Apocynaceae	*Alyxia buxifolia*	
Asparagaceae	*Acanthocarpus canaliculatus*	
Asparagaceae	*Acanthocarpus preissii*	
Asparagaceae	*Lomandra maritima*	
Asparagaceae	*Thysanotus ?manglesianus*	
Asteraceae	*Hypochaeris glabra*	*
Asteraceae	*Helianthus annuus*	*
Asteraceae	*Reichardia tingitana*	*
Asteraceae	*Sonchus oleraceus*	*
Asteraceae	*Asteraceae sp (insufficient material)*	
Asteraceae	*Austrostipa nitida*	
Asterceae	*Olearia sp. Kennedy Range (G Byrne 66)*	
Azioaceae	*Mesembryanthemum crystallinum*	*
Azioaceae	*Tetragonia implexicoma*	
Brassicaceae	*Brassica tournefortii*	*
Brassicaceae	*Sisymbrium orientale*	*
Chenopodiaceae	*Atriplex cinerea*	
Chenopodiaceae	*Enchylaena tomentosa*	
Chenopodiaceae	*Rhagodia latifolia ssp. latifolia*	
Chenopodiaceae	*Rhagodia preissii subsp. obovata*	
Chenopodiaceae	*Salsola australis*	
Chenopodiaceae	*Threlkeldia diffusa*	
Convolvulaceae	**Cuscuta epithymum*	*
Euphorbiaceae	*Euphorbia boophthona*	
Euphorbiaceae	*Euphorbia terracina*	*
Fabaceae	*Acacia rostellifera*	
Fabaceae	*Acacia saligna*	
Fabaceae	*Acacia sclerosperma* subsp. *sclerosperma*	
Fabaceae	*Glycine canescens*	
Fabaceae	*Templetonia retusa*	
Frankeniaceae	*Frankenia tingitana*	
Goodeniaceae	*Scaevola tomentosa*	
Lauraceae	*Cassytha aurea var. aurea*	
Loranthaceae	*Amyema preissii*	
Malvaceae	*Alyogyne hakeifolia*	
Malvaceae	*Commersonia boeralis*	
Myrtaceae	*Eucalyptus baudiniana*	
Myrtaceae	*Eucalyptus utilis* (planted non-local)	
Myrtaceae	*Melaleuca cardiophylla*	
Nyctaginaceae	*Commicarpus australis*	

Phyllanthaceae	*Phyllanthus calycinus*	
Pittosporaceae	*Pittosporum ligustrifolium*	
Poaceae	*Avena barbata*	*
Poaceae	*Cenchrus ciliatus*	*
Poaceae	*Brachypodium distachyon*	*
Poaceae	*Bromus diandrus*	*
Poaceae	*Ehrharta longiflora*	*
Poaceae	*Ehrharta brevifolia*	*
Poaceae	*Aristida sp* (insufficient material)	
Poaceae	*Austrostipa elegantissima*	
Poaceae	*Austrostipa nitida*	
Poaceae	*Poaceae sp.* (insufficient material)	
Poaceae	*Sporobolus virginicus*	
Proteaceae	*Grevillea argyrophylla*	
Scrophulariaceae	*Myoporum insulare*	
Solanaceae	*Anthocercis littorea*	
Surianaceae	*Stylobasium spathulatum*	
Thymelaeaceae	*Pimelea gilgiana*	
Thymelaeaceae	*Pimelea microcephala* subsp *microcephala*	
Thymelaeaceae	*Pimelea gilgiana*	
Zygophyllaceae	*Roepera apiculata*	
Zygophyllaceae	*Roepera fruticulosa*	

* Denoted an introduced species

Flora species by site matrix (Site:Lyn_X)

Taxon	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
**Avena barbata*	1				1		1	1			1		1		1		1	1	1	1	1	1	1	1		1	
**Brachypodium distachyon*	1														1	1			1								
**Brassica tournefortii*	1				1		1	1	1	1				1					1	1					1	1	
**Bromus diandrus*												1															
**Bromus diandrus*	1		1	1	1					1	1																
**Cuscuta epithymum*					1						1																
**Ehrharta longiflora*							1	1	1	1		1		1			1	1	1	1	1	1	1	1	1	1	1
**Hypochaeris glabra*																					1						
**Reichardia tingitana*					1																						
**Sisymbrium orientale*		1	1	1	1																						
**Sonchus oleraceus*				1			1	1				1								1						1	
Acacia rostellifera	1	1	1	1	1	1	1	2	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Acacia saligna										1																	
Acacia sclerosperma subsp. sclerosperma	1	1	1		2							1															
Acanthocarpus canaliculatus		1																									

Acanthocarpus preissii		1													1	1												
Alyogyne hakeifolia	1	1		1		1						1	1	1	1	1	1	1			1	1	1	1	1		
Alyxia buxifolia										1																		
Anthocercis littorea																									1			
Aristida sp (insufficient material)	1				1					1																		1
Asteraceae sp (insufficient material)	1	1	1	1															1						1			
Austrostipa nitida						1																						
Austrostipa elegantissima	1		1	1	1	1	1	1	1		1		1		1	1		1	1	2	1		1		1	1	1
Austrostipa nitida		1	1																									
Cassytha aurea var. aurea			1			1	1													1					1			
Commicarpus australis	1	1		1	1		1	1	1				1	1	1	1	1		1	1	1				1	1	1
Enchylaena tomentosa		1					1			1		1																
Eucalyptus baudiniana																1												
Euphorbia boophthona	1			1	1															1								1
Frankenia tingitana												1																
Glycine canescens	1				1		1																					

Grevillea argyrophylla											1																	
Lomandra maritima		1																										
Melaleuca cardiophylla	1	1	1							2	1		1		1	1												
Myoporum insulare												1																
Olearia sp. Kennedy Range (G Byrne 66)	1	1	1	1	1		1							1	1	1		1	1		1			1	1	1		
Phyllanthus calycinus																									1			
Pimelea gilgiana	1	1	1							1					1			1							1			
Pimelea microcephala subsp microcephala	1	1	1	1	1	1	1	2	2	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	
Pimelea gilgiana																1												
Pittosporum ligustrifolium																									1			
Poaceae sp. (insufficient material)												1																
Ptilotus divaricatus										1	1				1	1	1									1		
Ptilotus stirlingii sp. stirlingii	1																											
Rhagodia latifolia ssp. latifolia																		1	1									

Rhagodia preissii subsp. obovata	1	1	2	1	1	1	1	1	1	3	2		1	1	1		1	1	2	1	1		1	1	1	1	1
Roepera apiculata										1			1						1								
Roepera fruticulosa	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1			1			1	1
Salsola australis																								1	1		
Scaevola tomentosa													1														
Sporobolus virginicus												1															
Stylobasium spathulatum			1	1	1	1								1	1	1		1	1		1				1		
Templetonia retusa	1	1																									
Tetragonia implexicoma			1		1	1	1				1			1	1	1	1			1						1	1
Threlkeldia diffusa											1	1													1		
Thysanotus ?manglesianus		1																1	1								

Flora site raw data

Site number	Taxon	Cover (%)	Height (m)	Form/Stratum	Opportunistic
Lyn_01	**Avena barbata*	0.5	0.25	Other grass (G)	
Lyn_01	**Brachypodium distachyon*	2	0.1	Other grass (G)	
Lyn_01	**Brassica tournefortii*	0.1	0.1	Forb (G)	
Lyn_01	**Bromus diandrus*	50	0.1	Other grass (G)	
Lyn_01	*Acacia rostellifera*	2	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Acacia sclerosperma subsp. sclerosperma*	0.5	0.25	Forb (G)	
Lyn_01	*Alyogyne hakeifolia*	3	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Aristida sp (insufficient material)*	0.5	0.25	Other grass (G)	
Lyn_01	*Asteraceae sp (insufficient material)*	0.1	0.1	Forb (G)	
Lyn_01	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_01	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Euphorbia boophthona*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Glycine canescens*	0.5	0.25	Vine (G)	
Lyn_01	*Melaleuca cardiophylla*	10	1.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Olearia sp. Kennedy Range (G Byrne 66)*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Pimelea gilgiana*	0.5	0.25	Forb (G)	
Lyn_01	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_01	*Ptilotus stirlingii sp. stirlingii*	0.1	0.25	Shrub, cycad, grass-tree, tree-fern (M)	

Lyn_01	*Rhagodia preissii subsp. obovata*	2	1.25	Chenopod shrub (M)	
Lyn_01	*Roepera fruticulosa*	4	0.5	Vine (G)	
Lyn_01	*Templetonia retusa*	1	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	**Sisymbrium orientale*	0.1	0.1	Forb (G)	
Lyn_02	*Acacia rostellifera*	5	4	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Acacia sclerosperma subsp. sclerosperma*	0.5	0.25	Forb (G)	
Lyn_02	*Acanthocarpus canaliculatus*	20	0.1	Other grass (G)	
Lyn_02	*Acanthocarpus preissii*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Alyogyne hakeifolia*	3	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Asteraceae sp (insufficient material)*	0.1	0.1	Forb (G)	
Lyn_02	*Austrostipa nitida*	0.1	0.25	Other grass (G)	
Lyn_02	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Enchylaena tomentosa*	0.1	0.25	Chenopod shrub (M)	
Lyn_02	*Lomandra maritima*	0.1	0.25	Forb (G)	
Lyn_02	*Melaleuca cardiophylla*	1	3.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Olearia sp. Kennedy Range (G Byrne 66)*	4	0.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Pimelea gilgiana*	0.5	0.25	Forb (G)	
Lyn_02	*Pimelea microcephala subsp microcephala*	5	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Rhagodia preissii subsp. obovata*	2	1.25	Chenopod shrub (M)	
Lyn_02	*Roepera fruticulosa*	4	0.5	Vine (G)	

Lyn_02	*Templetonia retusa*	10	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_02	*Thysanotus ?manglesianus*	0.1	0.25	Forb (G)	
Lyn_03	**Bromus diandrus*	1	0.1	Other grass (G)	
Lyn_03	**Sisymbrium orientale*	0.1	0.1	Forb (G)	
Lyn_03	*Acacia rostellifera*	1	1.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_03	*Acacia sclerosperma subsp. sclerosperma*	0.5	0.5	Forb (G)	
Lyn_03	*Asteraceae sp (insufficient material)*	0.1	0.1	Forb (G)	
Lyn_03	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_03	*Austrostipa nitida*	0.5	0.25	Other grass (G)	
Lyn_03	*Cassytha aurea var. aurea*	0.5	0.25	Vine (G)	
Lyn_03	*Melaleuca cardiophylla*	50	3.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_03	*Olearia sp. Kennedy Range (G Byrne 66)*	4	0.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_03	*Pimelea gilgiana*	0.5	0.25	Forb (G)	
Lyn_03	*Pimelea microcephala subsp microcephala*	2	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_03	*Rhagodia preissii subsp. obovata*	2	0.25	Chenopod shrub (M)	
Lyn_03	*Rhagodia preissii subsp. obovata*	0.1	0.75	Chenopod shrub (M)	
Lyn_03	*Roepera fruticulosa*	1	0.5	Vine (G)	
Lyn_03	*Stylobasium spathulatum*	2	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_03	*Tetragonia implexicoma*	0.5	0.25	Forb (G)	
Lyn_04	**Bromus diandrus*	25	0.1	Other grass (G)	

Lyn_04	**Sisymbrium orientale*	5	0.1	Forb (G)	
Lyn_04	**Sonchus oleraceus*	0.1	0.1	Forb (G)	
Lyn_04	*Acacia rostellifera*	1	4	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_04	*Alyogyne hakeifolia*	2	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_04	*Asteraceae sp (insufficient material)*	0.1	0.1	Forb (G)	
Lyn_04	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_04	*Commicarpus australis*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_04	*Euphorbia boophthona*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_04	*Olearia sp. Kennedy Range (G Byrne 66)*	4	0.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_04	*Pimelea microcephala subsp microcephala*	5	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_04	*Rhagodia preissii subsp. obovata*	5	1	Chenopod shrub (M)	
Lyn_04	*Roepera fruticulosa*	1	0.5	Vine (G)	
Lyn_04	*Stylobasium spathulatum*	5	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	**Avena barbata*	2	0.25	Other grass (G)	
Lyn_05	**Brassica tournefortii*	1	0.25	Forb (G)	
Lyn_05	**Bromus diandrus*	20	0.1	Other grass (G)	
Lyn_05	**Cuscuta epithymum*	0.1	0.1	Vine (G)	
Lyn_05	**Reichardia tingitana*	0.1	0.1	Forb (G)	
Lyn_05	**Sisymbrium orientale*	5	0.1	Forb (G)	
Lyn_05	*Acacia rostellifera*	8	4	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Acacia sclerosperma subsp. sclerosperma*	2	0.75	Forb (G)	

Lyn_05	*Acacia sclerosperma subsp. sclerosperma*		1.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Aristida sp (insufficient material)*	0.1	0.5	Other grass (G)	
Lyn_05	*Austrostipa elegantissima*		0.25	Other grass (G)	
Lyn_05	*Commicarpus australis*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Euphorbia boophthona*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Glycine canescens*	0.1	0.25	Vine (G)	
Lyn_05	*Olearia sp. Kennedy Range (G Byrne 66)*	1	0.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Pimelea microcephala subsp microcephala*	5	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Rhagodia preissii subsp. obovata*	5	1	Chenopod shrub (M)	
Lyn_05	*Roepera fruticulosa*	10	0.5	Vine (G)	
Lyn_05	*Stylobasium spathulatum*	10	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_05	*Tetragonia implexicoma*	0.5	0.25	Chenopod shrub (M)	
Lyn_06	*Acacia rostellifera*	60	6	Tree, palm (U)	
Lyn_06	*Alyogyne hakeifolia*	5	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_06	*Austrostipa nitida*	0.5	0.75	Other grass (G)	
Lyn_06	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_06	*Cassytha aurea var. aurea*	3	0.25	Vine (G)	
Lyn_06	*Pimelea microcephala subsp microcephala*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_06	*Rhagodia preissii subsp. obovata*	5	1	Chenopod shrub (M)	

Lyn_06	*Roepera fruticulosa*	40	0.5	Vine (G)	
Lyn_06	*Stylobasium spathulatum*	3	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_06	*Tetragonia implexicoma*	2	0.25	Chenopod shrub (M)	
Lyn_07	**Avena barbata*	5	0.25	Other grass (G)	
Lyn_07	**Brassica tournefortii*	0.5	0.25	Forb (G)	
Lyn_07	**Ehrharta longiflora*	55	0.25	Other grass (G)	
Lyn_07	**Sonchus oleraceus*	0.1	0.1	Forb (G)	
Lyn_07	*Acacia rostellifera*	30	8	Tree, palm (U)	
Lyn_07	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_07	*Cassytha aurea var. aurea*	3	0.25	Vine (G)	
Lyn_07	*Commicarpus australis*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_07	*Enchylaena tomentosa*	0.5	0.25	Chenopod shrub (M)	
Lyn_07	*Glycine canescens*	0.1	0.25	Vine (G)	
Lyn_07	*Olearia sp. Kennedy Range (G Byrne 66)*	1	0.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_07	*Pimelea microcephala subsp microcephala*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_07	*Rhagodia preissii subsp. obovata*	35	1	Chenopod shrub (M)	
Lyn_07	*Roepera fruticulosa*	40	0.5	Vine (G)	
Lyn_07	*Tetragonia implexicoma*	2	0.25	Chenopod shrub (M)	
Lyn_08	**Avena barbata*	1	0.25	Other grass (G)	
Lyn_08	**Brassica tournefortii*	2	0.25	Forb (G)	
Lyn_08	**Ehrharta longiflora*	20	0.25	Other grass (G)	
Lyn_08	**Sonchus oleraceus*	0.1	0.1	Forb (G)	
Lyn_08	*Acacia rostellifera*	20	8	Tree, palm (U)	

Lyn_08	*Acacia rostellifera*	5	3	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_08	*Austrostipa elegantissima*	1	0.25	Other grass (G)	
Lyn_08	*Commicarpus australis*	5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_08	*Pimelea microcephala subsp microcephala*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_08	*Pimelea microcephala subsp microcephala*	0.5	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_08	*Rhagodia preissii subsp. obovata*	60	1	Chenopod shrub (M)	
Lyn_09	**Brassica tournefortii*	0.1	0.25	Forb (G)	
Lyn_09	**Ehrharta longiflora*	30	0.25	Other grass (G)	
Lyn_09	*Acacia rostellifera*	30	8	Tree, palm (U)	
Lyn_09	*Austrostipa elegantissima*	1	0.25	Other grass (G)	
Lyn_09	*Commicarpus australis*	5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_09	*Pimelea microcephala subsp microcephala*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_09	*Pimelea microcephala subsp microcephala*	0.5	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_09	*Rhagodia preissii subsp. obovata*	60	1	Chenopod shrub (M)	
Lyn_09	*Roepera fruticulosa*	5	0.5	Vine (G)	
Lyn_10	**Brassica tournefortii*	2	0.25	Forb (G)	
Lyn_10	**Bromus diandrus*	1	0.1	Other grass (G)	
Lyn_10	**Ehrharta longiflora*	30	0.25	Other grass (G)	
Lyn_10	*Acacia rostellifera*	1	1.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_10	*Acacia saligna*	0.5	0.75	Shrub, cycad, grass-tree, tree-fern (M)	

Lyn_10	*Alyxia buxifolia*	1	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_10	*Aristida sp (insufficient material)*	0.1	0.75	Other grass (G)	
Lyn_10	*Enchylaena tomentosa*	0.5	0.25	Chenopod shrub (M)	
Lyn_10	*Melaleuca cardiophylla*	10	3.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_10	*Melaleuca cardiophylla*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_10	*Pimelea gilgiana*	0.5	0.25	Forb (G)	
Lyn_10	*Pimelea microcephala subsp microcephala*	1	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_10	*Ptilotus divaricatus*	0.5	0.5	Forb (G)	
Lyn_10	*Rhagodia preissii subsp. obovata*	25	0.25	Chenopod shrub (M)	
Lyn_10	*Rhagodia preissii subsp. obovata*	8	0.25	Other grass (G)	
Lyn_10	*Rhagodia preissii subsp. obovata*	5	1	Chenopod shrub (M)	
Lyn_10	*Roepera apiculata*	5	0.25	Chenopod shrub (M)	
Lyn_10	*Roepera fruticulosa*	3	0.5	Vine (G)	
Lyn_11	**Avena barbata*	60	0.25	Other grass (G)	
Lyn_11	**Bromus diandrus*	5	0.1	Other grass (G)	
Lyn_11	**Cuscuta epithymum*	0.1	0.1	Vine (G)	
Lyn_11	*Austrostipa elegantissima*	0.1	0.25	Other grass (G)	
Lyn_11	*Grevillea argyrophylla*	0.5	1.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_11	*Melaleuca cardiophylla*	40	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_11	*Pimelea microcephala subsp microcephala*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_11	*Ptilotus divaricatus*	1	0.5	Forb (G)	

Lyn_11	*Rhagodia preissii subsp. obovata*	5	0.25	Chenopod shrub (M)	
Lyn_11	*Rhagodia preissii subsp. obovata*	1	1	Chenopod shrub (M)	
Lyn_11	*Roepera fruticulosa*	20	0.5	Vine (G)	
Lyn_11	*Tetragonia implexicoma*	1	0.5	Chenopod shrub (M)	
Lyn_11	*Threlkeldia diffusa*	0.5	0.5	Chenopod shrub (M)	
Lyn_12	**Bromus diandrus*	2	0.25	Other grass (G)	
Lyn_12	**Ehrharta longiflora*	40	0.5	Other grass (G)	
Lyn_12	**Sonchus oleraceus*	0.5	0.25	Forb (G)	
Lyn_12	*Acacia sclerosperma subsp. Sclerosperma*	20	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_12	*Alyogyne hakeifolia*	2	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_12	*Enchylaena tomentosa*	5	0.25	Chenopod shrub (M)	
Lyn_12	*Frankenia tingitana*	5	0.25	Chenopod shrub (M)	
Lyn_12	*Myoporum insulare*	45	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_12	*Poaceae sp. (insufficient material)*	5	0.25	Other grass (G)	
Lyn_12	*Sporobolus virginicus*	10	0.1	Other grass (G)	
Lyn_12	*Threlkeldia diffusa*	10	0.5	Chenopod shrub (M)	
Lyn_13	**Avena barbata*	80	0.25	Other grass (G)	
Lyn_13	*Acacia rostellifera*	20	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_13	*Alyogyne hakeifolia*	15	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_13	*Austrostipa elegantissima*	0.1	0.25	Other grass (G)	
Lyn_13	*Commicarpus australis*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	

Lyn_13	*Melaleuca cardiophylla*	5	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_13	*Pimelea microcephala subsp microcephala*	5	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_13	*Rhagodia preissii subsp. obovata*	15	1	Chenopod shrub (M)	
Lyn_13	*Roepera apiculata*	1	0.25	Chenopod shrub (M)	
Lyn_13	*Roepera fruticulosa*	20	0.5	Vine (G)	
Lyn_13	*Scaevola tomentosa*	0.5	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	**Brassica tournefortii*	0.1	0.25	Forb (G)	
Lyn_14	**Ehrharta longiflora*	0.5	0.25	Other grass (G)	
Lyn_14	*Acacia rostellifera*	20	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	*Alyogyne hakeifolia*	1	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	*Commicarpus australis*	1	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	*Olearia sp. Kennedy Range (G Byrne 66)*	1	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	*Pimelea microcephala subsp microcephala*	2	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	*Rhagodia preissii subsp. obovata*	40	1	Chenopod shrub (M)	
Lyn_14	*Roepera fruticulosa*	5	0.5	Vine (G)	
Lyn_14	*Stylobasium spathulatum*	1	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_14	*Tetragonia implexicoma*	30	0.5	Chenopod shrub (M)	
Lyn_15	**Avena barbata*	0.5	0.25	Other grass (G)	
Lyn_15	**Brachypodium distachyon*	20	0.1	Other grass (G)	
Lyn_15	*Acacia rostellifera*	10	3	Tree, palm (U)	

Lyn_15	*Acanthocarpus preissii*	0.5	0.25	Forb (G)	
Lyn_15	*Alyogyne hakeifolia*	3	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_15	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_15	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_15	*Melaleuca cardiophylla*	10	3	Tree, palm (U)	
Lyn_15	*Olearia sp. Kennedy Range (G Byrne 66)*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_15	*Pimelea gilgiana*	0.5	0.25	Forb (G)	
Lyn_15	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_15	*Ptilotus divaricatus*	0.5	0.25	Forb (G)	
Lyn_15	*Rhagodia preissii subsp. obovata*	2	1.25	Chenopod shrub (M)	
Lyn_15	*Roepera fruticulosa*	4	0.5	Vine (G)	
Lyn_15	*Stylobasium spathulatum*	1	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_15	*Tetragonia implexicoma*	10	0.5	Chenopod shrub (M)	
Lyn_16	**Brachypodium distachyon*	20	0.1	Other grass (G)	
Lyn_16	*Acacia rostellifera*	0.5	3	Tree, palm (U)	
Lyn_16	*Acanthocarpus preissii*	0.5	0.25	Forb (G)	
Lyn_16	*Alyogyne hakeifolia*	3	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_16	*Austrostipa elegantissima*	0.5	0.25	Other grass (G)	
Lyn_16	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_16	*Eucalyptus baudiniana*	0.5	3	Mallee shrub (M)	
Lyn_16	*Melaleuca cardiophylla*	40	3	Tree, palm (U)	

Lyn_16	*Olearia sp. Kennedy Range (G Byrne 66)*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_16	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_16	*Pimelea gilgiana*	0.5	0.25	Forb (G)	
Lyn_16	*Ptilotus divaricatus*	0.5	0.25	Forb (G)	
Lyn_16	*Roepera fruticulosa*	4	0.5	Vine (G)	
Lyn_16	*Stylobasium spathulatum*	1	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_16	*Tetragonia implexicoma*	10	0.5	Chenopod shrub (M)	
Lyn_17	**Avena barbata*	0.5	0.25	Other grass (G)	
Lyn_17	**Ehrharta longiflora*	25	0.25	Other grass (G)	
Lyn_17	*Acacia rostellifera*	50	8	Tree, palm (U)	
Lyn_17	*Alyogyne hakeifolia*	2	1.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_17	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_17	*Pimelea microcephala subsp microcephala*	0.5	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_17	*Ptilotus divaricatus*	0.5	0.25	Forb (G)	
Lyn_17	*Rhagodia preissii subsp. obovata*	45	1	Chenopod shrub (M)	
Lyn_17	*Roepera fruticulosa*	1	0.5	Vine (G)	
Lyn_17	*Tetragonia implexicoma*	30	0.5	Chenopod shrub (M)	
Lyn_18	**Avena barbata*	25	0.25	Other grass (G)	
Lyn_18	**Ehrharta longiflora*	65	0.25	Other grass (G)	
Lyn_18	*Acacia rostellifera*	20	8	Tree, palm (U)	
Lyn_18	*Alyogyne hakeifolia*	4	1.75	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_18	*Austrostipa elegantissima*	5	0.25	Other grass (G)	

Lyn_18	*Olearia sp. Kennedy Range (G Byrne 66)*	1	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_18	*Pimelea gilgiana*	1	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_18	*Pimelea microcephala subsp microcephala*	5	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_18	*Rhagodia latifolia ssp. latifolia*	5	1.25	Chenopod shrub (M)	
Lyn_18	*Rhagodia preissii subsp. obovata*	2	1	Chenopod shrub (M)	
Lyn_18	*Roepera fruticulosa*	1	0.5	Vine (G)	
Lyn_18	*Stylobasium spathulatum*	1	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_18	*Thysanotus ?manglesianus*	0.5	1	Forb (G)	
Lyn_19	**Avena barbata*	2	0.25	Other grass (G)	
Lyn_19	**Brachypodium distachyon*	1	0.25	Other grass (G)	
Lyn_19	**Brassica tournefortii*	0.1	0.25	Forb (G)	
Lyn_19	**Ehrharta longiflora*	75	0.25	Other grass (G)	
Lyn_19	*Acacia rostellifera*	30	8	Tree, palm (U)	
Lyn_19	*Asteraceae sp (insufficient material)*	0.1	0.1	Forb (G)	
Lyn_19	*Austrostipa elegantissima*	6	0.25	Other grass (G)	
Lyn_19	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_19	*Olearia sp. Kennedy Range (G Byrne 66)*	1	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_19	*Pimelea microcephala subsp microcephala*	5	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_19	*Rhagodia latifolia ssp. latifolia*	1	1.25	Chenopod shrub (M)	

Lyn_19	*Rhagodia preissii subsp. obovata*	2	1	Chenopod shrub (M)	
Lyn_19	*Rhagodia preissii subsp. obovata*				
Lyn_19	*Roepera apiculata*	0.5	0.1	Chenopod shrub (M)	
Lyn_19	*Roepera fruticulosa*	5	0.5	Vine (G)	
Lyn_19	*Stylobasium spathulatum*	5	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_19	*Thysanotus ?manglesianus*	0.1	1	Forb (G)	
Lyn_20	**Avena barbata*	1	0.25	Other grass (G)	
Lyn_20	**Brassica tournefortii*	1	0.25	Forb (G)	
Lyn_20	**Ehrharta longiflora*	75	0.25	Other grass (G)	
Lyn_20	**Sonchus oleraceus*	0.1	0.1	Forb (G)	
Lyn_20	*Acacia rostellifera*	60	6	Tree, palm (U)	
Lyn_20	*Austrostipa elegantissima*	6	0.25	Other grass (G)	
Lyn_20	*Austrostipa elegantissima*	5	0.25	Other grass (G)	
Lyn_20	*Cassytha aurea var. aurea*	1	1	Vine (G)	
Lyn_20	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_20	*Euphorbia boophthona*	0.1	0.25	Forb (G)	
Lyn_20	*Pimelea microcephala subsp microcephala*	5	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_20	*Rhagodia preissii subsp. obovata*	2	1	Chenopod shrub (M)	
Lyn_20	*Roepera fruticulosa*	5	0.5	Vine (G)	
Lyn_20	*Tetragonia implexicoma*	10	0.5	Chenopod shrub (M)	
Lyn_21	**Avena barbata*	70	0.25	Other grass (G)	
Lyn_21	**Ehrharta longiflora*	10	0.25	Other grass (G)	

Lyn_21	**Hypochaeris glabra*	2	0.1	Forb (G)	
Lyn_21	*Acacia rostellifera*	30	3	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_21	*Alyogyne hakeifolia*	30	2.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_21	*Austrostipa elegantissima*	2	0.25	Other grass (G)	
Lyn_21	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_21	*Olearia sp. Kennedy Range (G Byrne 66)*	1	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_21	*Pimelea microcephala subsp microcephala*	1	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_21	*Rhagodia preissii subsp. obovata*	2	1	Chenopod shrub (M)	
Lyn_21	*Stylobasium spathulatum*	2	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_22	**Avena barbata*	40	0.25	Other grass (G)	
Lyn_22	**Ehrharta longiflora*	30	0.25	Other grass (G)	
Lyn_22	*Acacia rostellifera*	20	7	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_22	*Alyogyne hakeifolia*	5	2.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_22	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_23	**Avena barbata*	5	0.25	Other grass (G)	
Lyn_23	**Ehrharta longiflora*	5	0.25	Other grass (G)	
Lyn_23	*Acacia rostellifera*	40	7	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_23	*Alyogyne hakeifolia*	2	2.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_23	*Austrostipa elegantissima*	2	0.25	Other grass (G)	

Lyn_23	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_23	*Rhagodia preissii subsp. obovata*	10	1	Chenopod shrub (M)	
Lyn_23	*Roepera fruticulosa*	1	0.5	Vine (G)	
Lyn_24	**Avena barbata*	85	0.25	Other grass (G)	
Lyn_24	**Ehrharta longiflora*	5	0.25	Other grass (G)	
Lyn_24	*Acacia rostellifera*	30	4	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_24	*Alyogyne hakeifolia*	2	2.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_24	*Olearia sp. Kennedy Range (G Byrne 66)*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_24	*Rhagodia preissii subsp. obovata*	2	1	Chenopod shrub (M)	
Lyn_24	*Salsola australis*	0.5	0.5	Chenopod shrub (M)	
Lyn_25	**Brassica tournefortii*	0.1	0.1	Forb (G)	
Lyn_25	**Ehrharta longiflora*	1	0.25	Other grass (G)	
Lyn_25	*Acacia rostellifera*	30	4	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Alyogyne hakeifolia*	2	2.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Anthocercis littorea*	0.5	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Asteraceae sp (insufficient material)*	0.1	0.1	Forb (G)	
Lyn_25	*Austrostipa elegantissima*	2	0.25	Other grass (G)	
Lyn_25	*Cassytha aurea var. aurea*	4	1.5	Vine (G)	
Lyn_25	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Olearia sp. Kennedy Range (G Byrne 66)*	5	1	Shrub, cycad, grass-tree, tree-fern (M)	

Lyn_25	*Phyllanthus calycinus*	0.5	0.5	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Pimelea gilgiana*	0.5	0.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Pittosporum ligustrifolium*	1	1.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Rhagodia preissii subsp. obovata*	5	1.25	Chenopod shrub (M)	
Lyn_25	*Salsola australis*	0.5	0.5	Chenopod shrub (M)	
Lyn_25	*Stylobasium spathulatum*	1	2.25	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_25	*Threlkeldia diffusa*	2	0.25	Chenopod shrub (M)	
Lyn_26	**Avena barbata*	30	0.25	Other grass (G)	
Lyn_26	**Brassica tournefortii*	0.1	0.1	Forb (G)	
Lyn_26	**Ehrharta longiflora*	35	0.25	Other grass (G)	
Lyn_26	**Sonchus oleraceus*	0.1	0.1	Forb (G)	
Lyn_26	*Acacia rostellifera*	10	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_26	*Austrostipa elegantissima*	2	0.25	Other grass (G)	
Lyn_26	*Commicarpus australis*	0.5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_26	*Olearia sp. Kennedy Range (G Byrne 66)*	10	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_26	*Pimelea microcephala subsp microcephala*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_26	*Ptilotus divaricatus*	0.1	0.5	Forb (G)	
Lyn_26	*Rhagodia preissii subsp. obovata*	20	1	Chenopod shrub (M)	
Lyn_26	*Roepera fruticulosa*	1	0.5	Vine (G)	

Lyn_26	*Tetragonia implexicoma*	20	1.25	Chenopod shrub (M)	
Lyn_27	**Ehrharta longiflora*	75	0.25	Other grass (G)	
Lyn_27	*Acacia rostellifera*	60	2	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_27	*Aristida sp (insufficient material)*	0.1	0.25	Other grass (G)	
Lyn_27	*Austrostipa elegantissima*	8	0.25	Other grass (G)	
Lyn_27	*Commicarpus australis*	2	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_27	*Euphorbia boophthona*	0.5	0.25	Forb (G)	
Lyn_27	*Pimelea microcephala subsp microcephala*	5	1	Shrub, cycad, grass-tree, tree-fern (M)	
Lyn_27	*Rhagodia preissii subsp. obovata*	10	1.25	Chenopod shrub (M)	
Lyn_27	*Roepera fruticulosa*	1	0.5	Vine (G)	
Lyn_27	*Tetragonia implexicoma*	20	1.25	Chenopod shrub (M)	
	**Helianthus annuus*				x
	**Cenchrus ciliatus*				x
	**Ehrharta brevifolia*				x
	**Euphorbia terracina*				x
	**Mesembryanthemum crystallinum*				x
	Amyema preissii				x
	Atriplex cinerea				x
	Commersonia boeralis				x
	Eucalyptus utilis (planted non-local)				x

Quadrat and point data

Site	Lyn_01	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229786.45, N 6884508.45		
Vegetation Type: VT02		
Landform: Hillslope /moderate	Drainage: Good	
Soil Colour & Type: Brown/white sand		
Vegetation Condition: n/a		
Disturbances :weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 11-30%**	

Site	Lyn_02	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229700.52 N 6884617.32		
Vegetation Type: VT02		
Landform: Hillslope /moderate	Drainage: Good	
Soil Colour & Type: Brown/white sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 31-70%**	

Site	Lyn_03	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229640.3 N 6884668.98		
Vegetation Type: VT02		
Landform: Hillslope/moderate	Drainage: Good	
Soil Colour & Type: Pale/red brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 31-70%	**Litter: 11-30%**	

Site	Lyn_04	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229410.34 N 6884757.73		
Vegetation Type: VT01		
Landform: Hillslope /moderate	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 31-70%**	

Site	Lyn_05	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229204.34 N 6885011.92		
Vegetation Type: VT01		
Landform: Hillslope/moderate	Drainage: Good	
Soil Colour & Type: Pale brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 31-70%	**Litter: 31-70%**	

Site	Lyn_06	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229015.06 N 6884757.82		
Vegetation Type: VT01		
Landform: Sandplain /gentle	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: <2%	**Litter: 11—30%**	

Site	Lyn_07	
Type: Quadrat	**Size:** 10 x 10	
Location: E 228795.5 N 6885075.98		
Vegetation Type: VT01		
Landform: Sandplain /gentle	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: <2%	**Litter: 11-30%**	

Site	Lyn_08	
Type: Quadrat	**Size:** 10 x 10	
Location: E 228600.3 N 6885391.62		
Vegetation Type: VT01		
Landform: Sandplain /gentle	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: <2%	**Litter: 11-30%**	

Site	Lyn_09	
Type: Quadrat	**Size:** 10 x 10	
Location: E 228096.99 N 6885852.3		
Vegetation Type: VT01		
Landform: Sandplain /negligible	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: <2%	**Litter: 31-70%**	

Site	Lyn_10	
Type: Quadrat	**Size:** 10 x 10	
Location: E 227994.53 N 6886401.6		
Vegetation Type: VT02		
Landform: Footslope /moderate	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 2-10%**	

Site	Lyn_11	
Type: Quadrat	**Size:** 10 x 10	
Location: E 229040.02 N 6885353.38		
Vegetation Type: VT02		
Landform: Boulders/rockpile /moderate	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 11-30%**	

Site	Lyn_12	
Type: Quadrat	**Size:** 10 x 10	
Location: E 227639.13 N 6886366.05		
Vegetation Type: VT03		
Landform: Drainage area/flooplain/ negligible	Drainage: Seasonally wet	
Soil Colour & Type: Light brown clay		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 2-10%**	

Site	Lyn_13	
Type: Releve	**Size:** 10 x 10	
Location: E 227241.68 N 6886969.47		
Vegetation Type: VT01		
Landform: Hillslope /moderate	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 11-30%**	

Site	Lyn_14	
Type: Releve	**Size:** 10 x 10	
Location: E 229622.99 N 6884218.17		
Vegetation Type: VT01		
Landform: Sandplain /gentle	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 31-70%**	

Site	Lyn_15	
Type: Releve	**Size:** 10 x 10	
Location: E 229870.34 N 6884378.17		
Vegetation Type: VT02		
Landform: Hillslope /moderate	Drainage: Good	
Soil Colour & Type: Brown/white sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 31-70%	**Litter: 11-30%**	

Site	Lyn_16	
Type: Releve	**Size:** 10 x 10	
Location: E 230131.9 N 6884144.79		
Vegetation Type: VT02		
Landform: Hillslope /moderate	Drainage: Good	
Soil Colour & Type: Brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 31-70%**	

Site	Lyn_17	
Type: Quadrat	**Size:** 10 x 10	
Location: E 231034.5 N 6882513.78		
Vegetation Type: VT01		
Landform: Sandplain /negligible	Drainage: Good	
Soil Colour & Type: Brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 31-70%**	

Site	Lyn_18	
Type: Quadrat	**Size:** 10 x 10	
Location: E 231264.75 N 6882595.25		
Vegetation Type: VT01		
Landform: Footslope /gentle	Drainage: Good	
Soil Colour & Type: Brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 11-30%**	

Site	Lyn_19	
Type: Quadrat	**Size:** 10 x 10	
Location: E 231529.36 N 6882483.33		
Vegetation Type: VT01		
Landform: Footslope /gentle	Drainage: Good	
Soil Colour & Type: Brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 11-30%**	

Site	Lyn_20	
Type: Quadrat	**Size:** 10 x 10	
Location: E 231844.61 N 6881671.02		
Vegetation Type: VT01		
Landform: Hillcrest/Upper Hillslope	Drainage: Good	
Soil Colour & Type: Brown sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 2-10%**	

Site	Lyn_21	
Type: Quadrat	**Size:** 10 x 10	
Location: E 232238.85 N 6881343.07		
Vegetation Type: Rehabilitation area		
Landform: Hillslope/moderate	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 11-30%**	

Site	Lyn_22	
Type: Releve	**Size:** 10 x 10	
Location: E 232528.44 N 6880732.71		
Vegetation Type: VT01		
Landform: Hillcrest/upper Hillslope	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 2-10%**	

Site	Lyn_23	
Type: Releve	**Size:** 10 x 10	
Location: E 232917.63 N 6880203.95		
Vegetation Type: VT01		
Landform: Hillcrest/upper Hillslope /negigliable	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances: weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 31-70%	**Litter: 11-30%**	

Site	Lyn_24	
Type: Releve	**Size:** 10 x 10	
Location: E 232806.62 N 6880438.81		
Vegetation Type: Rehabilitation areas		
Landform: Flat/ Negligible	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 2-10%	**Litter: 2-10%**	

Site	Lyn_25	
Type: Quadrat	**Size:** 10 x 10	
Location: E 232681.45 N 6880449.53		
Vegetation Type: Rehabilitation areas		
Landform: Flat /Negligible	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 11-30%**	

Site	Lyn_26	
Type: Quadrat	**Size:** 10 x 10	
Location: E 232038.67 N 6881377.85		
Vegetation Type: VT01		
Landform: Flat /Negligible	Drainage: Good	
Soil Colour & Type: Light brown sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing/clearing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: 11-30%	**Litter: 11-30%**	

Site	Lyn_27	
Type: Quadrat	**Size:** 10 x 10	
Location: E 230656.58 N 6882650.17		
Vegetation Type: VT01		
Landform: Flat /Gentle	Drainage: Good	
Soil Colour & Type: Dark brown sand		
Vegetation Condition: n/a		
Disturbances:weeds/grazing		
Fire Age and Intensity: Old 6+yr		
Bare Ground: <2%	**Litter: 31-70%**	

Flora likelihood of occurrence assessment guidelines

Likelihood of occurrence	Guideline
Known	Species recorded within study area from field project results (none as this is a desktop search only).
Likely	Species previously recorded within 2 km and large areas of suitable habitat occur in the survey area.
Possible	Species previously recorded within 10 km and areas of suitable habitat occur/may occur in the survey area.
Unlikely	Species previously recorded within 20 km, or suitable habitat does not occur in the survey area.
Highly unlikely	Species not previously recorded within 20 km, suitable habitat does not occur in the survey area and/or the survey area is outside the natural distribution of the species.
Other considerations	Date of known records, cryptic nature of species, anecdotal evidence from previous studies/surveys

Definitions

Term	Description
Study area	A 10 km buffer around the survey area
Survey area	The potential project footprint
Cr	Critically endangered
En	Endangered
T	Threatened
Vu	Vulnerable
P1 – P4	Priority 1 – Priority 4
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
DBCA	Department of Biodiversity and Conservation Attractions 2018. WA Government, Department of Parks and Wildlife Threatened (Declared Rare) and Priority Flora List
BC Act	Biodiversity Conservation Act 2016

Flora likelihood of occurrence assessment of conservation significant flora identified in the desktop assessment as potentially occurring within 10 km of the survey area

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
Amaranthaceae	*Ptilotus chortophytus*		P1	Erect perennial herb to 0.15 m high. Flowers yellow. Hillside. Kockatea, breakaway, quartz and shale. The nearest record is approximately 7 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Asteraceae	*Balladonia aervoides*		P3	Annual herb. Calcareous sand or sandy loam. Flowers August to October. The nearest record is approximately 3 km west of the survey area.	Possible – there is suitable habitat within the survey area.
Asteraceae	*Ozothamnus vespertinus*		P1	Perennial small shrub, 0.6 m high x 0.5 m wide. White flowers in globular head. Edge of breakaway. Mudstone/shale gravel. Fine white loam/clay. Closest known record is approximately 8 km south-east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Colchicaceae	*Wurmbea tubulosa*	En	T	Cormous, perennial, herb, 0.01-0.03 m high, dioecious or sometimes andromonoecious. Fl. white-pink, Jun to Aug. Clay, loam. River banks, seasonally-wet places. The nearest record is approxmately 8 km south.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Dasypogonaceae	*Calectasia browneana*		P2	Spreading, caespitose perennial, herb, 0.2-0.5 m high, to 0.4 m wide. Flowers blue-purple, Jund to August. White-grey sand, laterite. Adjacent to wet areas of creekline. The nearest recorded in 9 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Ericaceae	*Leucopogon* sp. Port Gregory (C. Page 33)		P1	Erect shrub to 0.3 m and 0.5 m wide. Flowers white. Shale breakaway. Wet red brown soil on	Highly Unlikely – there is no suitable habitat for this species

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
				shale. The nearest know record approximately 8 km east and south-east of the survey area.	within the survey area.
Ericaceae	*Styphelia cernua* (previously known as *Astroloma* sp. Kalbarri (D. & B. Bellairs 1368)		P2	Shrub up to 1.7 m with white flowers, green young fruit. Yellow sandplain, undulating plain, white/grey sand, dunes. Closest record approximately 10 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Euphorbiaceae	*Beyeria cinerea* subsp. *cinerea*		P3	Shrub to 1 m high. Flowers yellow. Limestone ridge. Dry, rocky brown sand over limestone, grey sands. The nearest record is approximately 10 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Euphorbiaceae	*Stachystemon nematophorus*	Vu	P4	Woody, dense shrub, to 1.2 m high. Dry sand, sandy gravel over laterite, sandstone. Exposed rocky sites, disturbed ground. The nearest recorded is approximately 8 km east and south-east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Fabaceae	*Acacia latipes* subsp. *licina*		P3	Pungent shrub, 0.4-1.2 m high. White sand, granitic soils. Limestone hills, sandplains. Flowers yellow, June to September. The nearest record is approximately 200 m east of the survey area.	Unlikely – suitable survey effort did not record this species
Fabaceae	*Acacia pelophila*		P1	Dense, spreading shrub, 0.9-2 m high. Clay. Saline creeklines. Flowers yellow, July to August. The nearest recorded is approximately 8 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
Fabaceae	*Acacia ridleyana*		P3	Spreading, sprawling shrub, 0.2-0.9 m high, 0.5-2 m wide. Grey or yellow/brown sand, gravelly clay, granitic loam. Flowers yellow, August to December. The closest record is approximately 10 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Fabaceae	*Gastrolobium propinquum*		P3	Low, bushy shrub, to 1(-1.8) m high. Flowers orange & yellow & red, June to September. Clay, clay-loam or sandy clay soils, granite, shale. Hills, flats, drainage lines, winter-wet areas. The nearest record is 8 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Frankeniaceae	*Frankenia confusa*		P4	Low, diffuse shrub, to 0.75 m high, to 0.75 wide. Wet pale brown sand, brown clay, grey soil. Banks of rivers & waterholes, river floodplains. Flowers pink, September. The nearest record is approximately 3 km west of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Goodeniaceae	*Scaevola kallophylla*		P4	Erect, compact shrub, to 1 m high. Sandy soils over limestone. Coastal plain. Flowers white, May or August to December. The nearest record is located approximately 3 km west of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Goodeniaceae	*Scaevola oldfieldii*		P3	Erect shrub to 1.5 m and 1.2 m wide. Flowers white. Sandplains, grey sand, brown gravelly loam. The nearest record is 8 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Hydatellaceae	*Trithuria australis*		P4	Small annual aquatic herb. Seasonally wet poorly drained flat, edge of wetlands, along drying margins, grey and black clayey soils.	Highly Unlikely – there is no suitable habitat for this species

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
				The nearest record is approximately 7.5 km south of the survey area.	within the survey area.
Lamiaceae	*Hemigenia pimelifolia*		P2	Shrub, 0.2-1 m high. Flowers blue-purple/violet, July to October. Gravelly soils. The nearest record is approximately 7 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Lamiaceae	*Prostanthera scutata*		P2	Erect, compact shrub, 0.2 – 0.3 m high. Flowers blue-violet, October or December to January. Gravelly sand. The nearest record is approximately 7 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Lamiaceae	*Teucrium* sp. Hutt River (W.H. Butler 54)		P1	No available information. Only one known record of this species (from 1964), located approximately 7 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Malvaceae	*Androcalva bivillosa*	Cr	T	Low spreading shrub. Occur on flats and slopes, reddish-brown or yellow sand with lateritic gravel. Road verge lateritic gravel and orange brown clayey sand. Recent soil disturbance. White flowers July to October. Fruit present during late October to December. The closest known record is approximately 38 km south-east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Malvaceae	*Androcalva microphylla*		P2	Spreading recumbent dwarf shrub 30 cm x 100 cm. White flowers. White grey sand over sandstone. The nearest record is 10 km north of the survey area.	Highly Unlikely – there is no suitable habitat for this species

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
					within the survey area.
Malvaceae	*Guichenotia quasicalva*		P2	Erect, compact shrub, to 0.5 m high. Flowers blue-purple, September to October. Sandy clay over laterite. Drainage line. The nearest recorded in 7 km south-east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Malvaceae	*Lasiopetalum oldfieldii*		P3	Shrub, 0.2-0.8 m high. Sandy soils. Flowers pink, August to October. The nearest record is less than 2 km west of the survey area.	Unlikely – there is suitable habitat within the survey area, however, suitable survey effort did not record this species
Menyanthaceae	*Liparophyllum congestiflorum*		P4	Small annual herb to 20 cm, yellow petals, green sepals. Occurs in winter wet low lying area, low plain, grey sand over sandstone. The nearest record is approximately 7 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Myrtaceae	*Calytrix harvestiana*		P2	Shrub, 0.3-0.7 m high. White or yellow sand. Flats. Flowers purple-pink/violet, September to December. Sandplain, yellow sand. Sandstone, brown sand. The nearest record is 4 km south of the survey area.	Unlikely – there is suitable habitat within the survey area, however, suitable survey effort did not record this species
Myrtaceae	*Calytrix pimeleoides*		P3	Erect, perennial shrub 1 m high x .5 m wide. Flowers yellow. Ridge. Dry, gravelly yellow-brown	Highly Unlikely – there is no suitable habitat

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
				sand. The nearest record is approximately 8 km east of the survey area.	for this species within the survey area.
Myrtaceae	*Chamelaucium* sp. Coolcalalaya (A.H. Burbidge 4233)		P1	Dense and compact shrub to 1.5 m, red-purple/ white flowers. Undulating dunes, white sandplains. Yellow sandy loam. Closest known record is approximately 9 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Myrtaceae	*Eucalyptus blaxellii*		P4	(Mallee), 1-4 m high, bark smooth. Flowers white-cream, August to November. Grey sand, clay. Rocky hillsides, creek flats. The nearest record is approximately 8 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Myrtaceae	*Eucalyptus cuprea*	En	T	(Mallee), 2.5-5 m high, bark rough to 1.5 m, box-type. Flowers white, August to November. Shallow soils over granite. The nearest record is 16 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Myrtaceae	*Hypocalymma angustifolium* subsp. Hutt River (S. Patrick 2982)	Vu	T	Shrub. Moist, brown black peat clay with sand. The nearest record is approximately 9 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Myrtaceae	*Hypocalymma longifolium*	Vu	T	Open shrub, to 1 m high. Grey sand or clay, sandstone. Rocky breakaways, swampland. Flowers white/cream, August to September. The nearest record is approximately 9 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
Myrtaceae	*Melaleuca huttensis*		P3	Erect shrub to 1.5 m high, flowers cream. Generally occurs on brown sand over laterite, but has been previously recorded in the survey area in orange, white and yellow sands on lower slopes of undulating plains and sandplains (GHD 2019). Flat plain. There area records located in M70/968, located less than 500 m east of the survey area (GHD 2014).	Unlikely – there is suitable habitat within the survey area, however, suitable survey effort did not record this species
Myrtaceae	*Verticordia densiflora* var. *roseostella*		P3	Open shrub, 0.4-1.3 m high. Flowers pink-white, September to December. Sandy gravelly soils. The nearest record is approximately 9 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Orchidaceae	*Caladenia barbarella*	En	T	Tuberous, perennial, herb, 0.08-0.25 m high. Flowers green, August to September. Occur on shallow, grey, dark brown, sandy clayey loam. Rocky ledges, alongside seasonal creeklines, winter-wet depressions. Closest known record is approximately 43 km north-east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Orchidaceae	*Caladenia bryceana* subsp. *cracens*	Vu	T	Tuberous, perennial, herb, 0.03-0.08 m high. Flowers green-yellow, August to September. Sand over limestone, and shallow beige sands under moist areas beneath *M. cardiophylla* and *Grevillea argyropylla*, in the study area (GHD 2019). South of Kalbarri in low heath on limestone hills; north in winter-moist flats. The nearest records are approximately 23 km north and south of the survey area. GHD have recorded this species in adjacent tenements, with the closest record approximately 600 m east (GHD 2019).	Possible – suitable habitat (VT02) is present in the survey area and targeted surveys during the species flowering period may possibly record the species

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
Orchidaceae	*Caladenia elegans*	En	T	Tuberous, perennial, herb, 0.2-0.3 m high. Flowers yellow, July to August. Clayey loam. Winter-wet clay flats. The nearest record is approximately 35 metres from the northern end of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area. The record of this species was recorded in 2009, and the land has since been dramatically altered.
Orchidaceae	*Caladenia hoffmanii*	En	T	Tuberous, perennial, herb, 0.13-0.3 m high. Flowers green and yellow and red, August to October. Clay, loam, laterite, granite. Rocky outcrops and hillsides, ridges, swamps and gullies. The nearest record is 8 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Orchidaceae	*Diuris drummondii*	Vu	T	Tuberous, perennial, herb, 0.5-1.05 m high. Flowers yellow, November to December or January. Low-lying depressions, swamps. The nearest record is approximately 9 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Orchidaceae	*Diuris recurva*		P4	Tuberous, perennial, herb, 0.2-0.3 m high. Flowers yellow & brown, July to August. Loam. Winter-wet areas. In the study area, has been recorded on pale brown/yellow sand in sparsely vegetated areas with *M. huttensis* and *Grevillea argyrophylla* heath, and *M. huttensis* and *Acacia rostellifera* shrubland (GHD 2019).The nearest DBCA record is approximately 8 km east of the survey area. The species has been recorded recently approximately 600 m east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
Orchidaceae	*Drakaea concolor*	Vu	T	Tuberous, perennial, herb, 0.25-0.3 m high. Flowers red and yellow, August to September. Grows in moist sandy sites in the Northampton region along the Murchison and Hutt River. The nearest record is approximately 3.5 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Orchidaceae	*Pterostylis sinuata*	En	T	Small tuberous herb 5-10 cm tall. The flower spike emerges from a basal rosette of leaves and bears between two and twenty pale green 'greenhood' flowers, each of which are approximately 5 x 5 mm (Hoffman and Brown 1998). Fl. August to early September. Prefers open *Melaleuca uncinata* and *Hakea recurva* low scrub over low heath in winter-wet clay soils over laterite. The nearest record is 9 km south-east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Polygalaceae	*Comesperma rhadinocarpum*		P3	Perennial, herb. Flowers blue, October to November. Sandy soils. The nearest record is approximately 8 km north of the survey area.	Unlikely – suitable survey effort did not record this species
Proteaceae	*Grevillea triloba*		P3	Diffuse or spreading shrub, (0.4-) 0.9-1.5 (-2.5) m high. Flowers white/pink-white, June to October. Sandy loam on sandstone or limestone, lateritic soils. The nearest record is from the Port Gregory area near the Murchison (GPS record incorrect on Naturemap).	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Rhamnaceae	*Blackallia nudiflora*		P3	Shrub, 0.3-1 m high, often with spinescent branchlets. Clay or sandy clay with granite. On hills or breakaways, plains. The nearest record is approximately 4 km east of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.

Family	Taxa	Status		Description and closest record information (if available) (WA Herbarium 2020, DBCA 2019)	Likelihood of occurrence
		Federal	State		
Rutaceae	*Drummondita ericoides*	En	T	Divaricately branched shrub, 0.3-1 m high. Flowers yellow and white and violet/purple, September to October. Occur on rocky places. Closest known record is approximately 44 km south of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Scrophulariaceae	*Eremophila microtheca*		P4	Erect shrub, 0.7-1.6 m high. Sandy clay. Winter wet flats, saline flats, sandplains. Flowers blue-purple, August to September. The nearest record is approximately 3 km west of the survey area.	Highly Unlikely – there is no suitable habitat for this species within the survey area.
Solanaceae	*Anthocercis intricata*		P3	Dense, spinescent shrub, 0.9-3 m high. Flowers white-cream, June to September. Sand or loam over limestone. In the study area, orange/yellow sand in *M. huttensi*s and *Acacia rostellifera* shrubland (GHD 2019). Consolidated sand dunes. The nearest DBCA record is 5 km south however GHD has recorded this species in adjacent tenements, with records less than 500 m from the survey area (GHD 2014, GHD 2019).	Possible – suitable habitat occurs within the survey area, however, the habitat is degraded.

Appendix E – Fauna data

Fauna species list

Fauna likelihood of occurrence

Fauna species recorded during the survey

Family	Genus	Species	Common Name	Status
Birds				
Acanthizidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumped Thornbill	
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle	
Accipitridae	*Pandion*	*cristatus*	Eastern Osprey	Mi, IA
Accipitrinae	*Elanus*	*axillaris*	Black-Shouldered Kite	
Artimidae	*Artamus*	*minor*	Little Woodswallow	
Artimidae	*Cracticus*	*nigrogularis*	Pied Butcherbird	
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike	
Corvidae	*Corvus*	*coronoides*	Australian Raven	
Columbidae	*Streptopelia*	*senegalensis*	Laughing Turtle Dove	*
Falconidae	*Falco*	*cenchroides*	Australian Kestrel	
Halcyonidae	*Todiramphus*	*sanctus*	Sacred Kingfisher	
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow	
Hirundinidae	*Petrochelidon*	*nigricans*	Tree Martin	
Maluridae	*Malurus*	*lamberti*	Variegated Fairy-wren	
Maluridae	*Malurus*	*splendid*	Splendid Fairy-wren	
Meliphagidae	*Gavicalis*	*virscens*	Singing Honeyeater	
Meliphagidae	*Lichmera*	*indistincta*	Brown Honeyeater	
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater	
Pachycephalidae	*Pachycephala*	*pectoralis*	Golden Whistler	
Petroicidae	*Eopsaltria*	*georgiana*	White-breasted Robin	
Pomatostomidae	*Pomatostomus*	*superciliosus*	White-browed Babbler	
Timaliidae	*Zosterops*	*lateralis*	Silvereye	
Tytonidae	*Tyto*	*alba*	Barn Owl	
Mammals				
Bovidae	*Ovis*	*aries*	Sheep	*
Canidae	*Canis*	*lupis*	Domestic Dog	*
Canidae	*Vulpes*	*vulpes*	Red Fox	*
Felidae	*Felis*	*catus*	Feral Cat	*
Leporidae	*Oryctolagus*	*cuniculus*	European Rabbit	*
Macropodidae	*Macropus*	*fuliginosus*	Western Grey Kangaroo	
Macropodidae	*Osphranter*	*rufus*	Red Kangaroo	
Suidae	*Sus*	*scrofa*	Wild Boar	*
Reptiles				
Agamidae	*Pogona*	*minor minor*	Bearded Dragon	
Scincidae	*Tiliqua*	*rugosa*	Bobtail Skink	

* Introduced (BAM Act)

Parameters of fauna likelihood of occurrence assessment

Assessment outcome	Description
Present	Species recorded during the field survey or from recent, reliable records from within or close proximity to the survey area.
Likely	Species are **likely** to occur in the survey area where there is suitable habitat within the survey area and there are recent records of occurrence of the species in close proximity to the survey area. OR Species known distribution overlaps with the survey area and there is suitable habitat within the survey area.
Unlikely	Species assessed as **unlikely** include those species previously recorded within 10 km of the survey area however: • There is limited (i.e. the type, quality and quantity of the habitat is generally poor or restricted) habitat in the survey area. • The suitable habitat within the survey area is isolated from other areas of suitable habitat and the species has no capacity to migrate into the survey area. OR Those species that have a known distribution overlapping with the survey area however: • There is limited habitat in the survey area (i.e. the type, quality and quantity of the habitat is generally poor or restricted). • The suitable habitat within the survey area is isolated from other areas of suitable habitat and the species has no capacity to migrate into the survey area.
Highly unlikely	Species that are considered **highly unlikely** to occur in the survey area include: • Those species that have no suitable habitat within the survey area. • Those species that have become locally extinct, or are not known to have ever been present in the region of the survey area.

Definitions

Term	Description
Study area	A 20 km buffer around the survey area
Survey area	The potential project footprint
Cr	Critically endangered
En	Endangered
Vu	Vulnerable
IA	International agreement
Mi, Ma	Migratory, Marine
CD	Conservation dependent
OS	Other specially protected fauna
P1 – P4	Priority 1 – Priority 4
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
DBCA	Department of Biodiversity and Conservation Attractions 2019 WA Government, Department of Parks and Wildlife Threatened and Priority fauna rankings
BC Act	*Biodiversity Conservation Act 2016*

Fauna likelihood of occurrence assessment of conservation significant fauna identified in the desktop assessment as potentially occurring within the study area

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Anous tenuirostris melanops Australian Lesser Noddy	Vu	En			X	The Australian Lesser Noddy is usually found only around its breeding islands in the Houtman Abrolhos Islands in Western Australia. There are also some records north of the breeding islands, for example at the Wallabi Group of islands, in the northern Houtman Abrolhos Islands, on Barrow Island, and at Webb Island. The species usually occupies coral-limestone islands that are densely fringed with White Mangrove *Avicennia marina*. It occasionally occurs on shingle or sandy beaches (Higgins & Davies 1996). The Australian Lesser Noddy roosts mainly in mangroves, especially at night but may sometimes rest on beaches.	Highly unlikely There is no suitable habitat within the survey area. The closest known records are from the Abrolhos Islands, over 60 km off the coast.
Calidris canutus Red knot, Knot	En	En, IA			X	In Australasia the Red Knot mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps (DEE 2017). They are found near mudflats and estuaries from Murchison to Bunbury but are then uncommon from Wilson Inlet to Esperance. In the Perth region they are mainly found in Alfred Cove and Peel Inlet (Nevill 2013).	Unlikely The species has been recorded from the nearby Hutt Lagoon, however there is no suitable habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Calidris ferruginea Curlew Sandpiper	Cr	Cr	X		X	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters (Higgins & Davies 1996). Curlew Sandpipers forage on mudflats and nearby shallow water. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy shores. At high tide, they forage among low sparse emergent vegetation, such as saltmarsh, and sometimes forage in flooded paddocks or inundated saltflats. Curlew Sandpipers generally roost on bare dry shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands, occasionally roosting in dunes during very high tides and sometimes in saltmarsh (Higgins & Davies 1996).	Unlikely The species has been recorded multiple times from Hutt Lagoon and nearby coastal areas, however there is no suitable habitat within the survey area.
Calidris tenuirostris Great Knot	Cr	Cr	X			In Australasia, the species typically prefers sheltered coastal habitats, with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons. They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, saltlakes and non-tidal lagoons. The Great Knot rarely occurs on inland lakes and swamps. Typically, the Great Knot roosts in large groups in	Unlikely The species has been recorded from Hutt Lagoon, however there is no suitable habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
						open areas, often at the waters edge or in shallow water close to feeding grounds (DotEE 2020).	
Calyptorhynchus latirostris Carnaby's Cockatoo	En	En	X	X	X	Carnaby's Black-cockatoo occurs in uncleared or remnant native eucalypt woodlands, especially those that contain salmon gum, wandoo, marri, jarrah and karri, and in shrubland or kwongan heathland dominated by Hakea, Dryandra, Banksia and Grevillea species. Breeding activity is restricted to eucalypt woodlands mainly in the semiarid and subhumid interior, from Kalbarri in the north, Three Springs District south to the Stirling Range, west to Cockleshell Gully and east to Manmanning. The species has expanded its breeding range westward and south into the jarrah-marri forests of the Darling Scarp and into the tuart forests of the Swan Coastal Plain, including the Yanchep area, Lake Clifton and near Bunbury. It nests in trees older than 120-150 years (DotEE 2020).	Unlikely The survey area is located within the non-breeding range of the modelled distribution of the Carnaby's Cockatoo (DSEWPaC 2012). However, there is no suitable habitat (foraging or roosting habitat) present within the survey area.
Charadrius leschenaultii Greater Sand Plover	Vu	Vu	X		X	In the non-breeding grounds in Australasia, the species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons and inshore reefs, rock platforms, small rocky islands or sand cays on coral reefs. They are occasionally recorded on near-coastal saltworks and saltlakes, including marginal saltmarsh, and on brackish swamps (DotEE 2020).	Unlikely The species has been recorded multiple times from Hutt Lagoon and nearby coastal areas, however there is no suitable habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Charadrius leschenaultii Lesser Sand Plover	En, Mi	En	X			In non-breeding grounds in Australia, the Lesser Sand Plover usually occurs in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. It also sometimes occurs in short saltmarsh or among mangroves, in saltworks and near-coastal saltpans, brackish swamps and sandy or silt islands in river beds. The species is seldom recorded away from the coast, at margins of lakes, soaks and swamps associated with artesian bores (DotE 2016). The Lesser Sand Plover mainly occurs in northern regions, and becomes more scarce in the south west (Nevill 2013).	Unlikely The species has been recorded multiple times from Hutt Lagoon and nearby coastal areas, however there is no suitable habitat within the survey area.
Diomedea amsterdamensis (Amsterdam Albatross) *Diomedea epomophora* (Southern Royal Albatross) *Diomedea exulans* (Wandering Albatross) *Thalassarche carteri* (Indian Yellow-nosed Albatross) *Thalassarche cauta cauta* (Shy Albatross) *Thalassarche cauta steadi* (White-capped Albatross)	En, Mi Vu, Mi Vu, Mi Vu, Mi Vu, Mi Vu, Mi	Cr Vu Vu En Vu Vu			X	All the Albatross species have been grouped together as they are all primarily marine, pelagic, aerial birds.	Highly Unlikely No suitable habitat is present within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Thalassarche impavida Campbell Albatross *Thalassarche melanophris* Black-browed Albatross	Vu, Mi Vu, Mi	Vu En					
Leipoa ocellata Malleefowl	Vu	Vu		X	X	The Malleefowl generally occurs in semi-arid areas of WA, in shrublands and low woodlands that are dominated by mallee vegetation, as well as native pine Callitris woodlands, Acacia shrublands, paperbark, skheoak, Broombush *Melaleuca uncinata* vegetation, eucalypt woodlands, or coastal heathlands. Mostly they are found where there are sandy or gravel soils. The nest is a large mound of sand or soil and organic matter (Jones & Goth 2008; Morcombe 2011; Nevill 2013). In WA they are found from the southwest Nullarbor to Albany, north, and then west from Moore River up to Shark Bay, past Cue, across to Wiluna and east to the northern Victoria Desert south of the Blackstone Ranges (Nevill 2013; Pizzey & Knight 2012).	Unlikely The distribution of this species within this region is restricted to the Kalbarri National Park, which is located approximately 40 km north of the survey area. No evidence of this species was observed during the survey.
Limosa lapponica Bar-tailed Godwit / Northern Siberian Bar-tailed Godwit	Vu or Cr, Mi	Vu or Cr, IA			X	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh (Morcombe 2011). They usually forage near the edge of water or in shallow water, mainly in tidal estuaries and harbours and roost on sandy beaches, sandbars, spits and also in near-coastal saltmarshs (Marchant & Higgins 1993).	Unlikely The species has been recorded from Hutt Lagoon, however there is no suitable habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Macronectes giganteus Southern Giant-Petrel	En, Mi	IA			X	The Southern Giant-Petrel is marine bird that occurs in Antarctic to subtropical waters. In summer, it mainly occurs over Antarctic waters, and it is widespread south as far as the pack-ice and onto the Antarctic continent (Marchant & Higgins 1990). The species is not known to breed in Australia.	Highly unlikely There is no suitable habitat within the survey area.
Macronectes halli Northern Giant Petrel	Vu, Mi	Mi				The Northern Giant Petrel breeds in the sub-Antarctic and visits areas off the Australian mainland during the winter months (May-Oct). They are usually seen in waters off the south of Australia (DotEE 2020). The species is primarily Marine.	Highly unlikely There is no suitable habitat within the survey area.
Numenius madagascariensis Eastern Curlew	Cr, Mi	Cr			X	The Eastern Curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (Marchant & Higgins 1993).	Highly unlikely There is no suitable habitat within the survey area.
Pterodroma mollis Soft-plumaged Petrel	Vu				X	The Soft-plumaged Petrel is a marine, oceanic species. Soft-plumaged Petrels are mainly subantarctic, but occur over a wide range of sea surface-temperatures. Soft-plumaged Petrels breed on Maatsuyker Island off southern Tasmania. Beachcast birds have been found from Maryborough, Queensland, south to NSW, Tasmania, Victoria, South Australia and south-west Western Australia (DotEE 2020).	Highly unlikely There is no suitable habitat within the survey area.
Rostratula australis Australian Painted Snipe	En	En			X	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Australian Painted Snipe breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both	Highly unlikely There is no suitable habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
						upper and canopy cover nearby. The species rarely occurs in south-western Australia, where it was once more common (Marchant & Higgins 1993; Garnett and Crowley 2000).	
Sternula nereis nereis Australian Fairy Tern	Vu	Vu			X	The Fairy Tern occurs along the coast of WA as far north as the Dampier Archipelago near Karratha, but mostly in the southern part of Australia including most of the coastline in the south west. It nests on sheltered sandy beaches, coastal inlets, spits and banks above the high tide line and below vegetation. It has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands, and mainland coastline (DotEE 2020; Nevill 2013). They can also be seen in saltfields, saline or brackish lakes, and sewage ponds near the coast (Pizzey and Knight 2012).	Highly unlikely There is no suitable habitat within the survey area.
Pandion cristatus Osprey	Mi	IA	X	X	X	Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging. They frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes. They exhibit a preference for coastal cliffs and elevated islands in some parts of their range but may also occur on low sandy, muddy or rocky shores and over coral cays. The distribution of the species around the northern coast (south-western WA to	Present An individual was observed nesting in a dead *Acacia* tree within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
						south-eastern NSW) appears continuous except for a possible gap at Eighty Mile Beach (DotEE 2020).	
Apus pacificus Fork-tailed Swift	Mi	IA	X	X	X	The Fork-tailed Swift are widespread in coastal and sub-coastal areas between Augusta and Carnarvon, including some on nearshore and offshore islands. This species is almost exclusively aerial, flying less than 1 m to at least 300 m above ground. Occupies low to very high airspace over varied habitat, rainforest to semi-desert; most active just ahead of summer storm fronts. They do not breed in Australia (DotEE 2020)	Likely There are a number of records along the coast at Port Gregory and near Hutt Lagoon.
Pluvialis fulva Pacific Golden Plover	Mi	IA	X	X	X	In Australia the Pacific Golden Plover usually inhabits coastal habitats, on beaches, mudflats and sandflats (sometimes in vegetation such as mangroves, low saltmarsh such as Sarcocornia, or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in saltworks. It is sometimes recorded on islands, sand and coral cays and exposed reefs and rocks. They are less often recorded in terrestrial habitats, but can be seen in habitats with short grass in paddocks, crops or airstrips, or ploughed or	Unlikely This species is largely restricted to coastal areas. There are records of this species around Port Gregory and Hutt Lagoon however it is considered unlikely to utilise habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
						recently burnt areas. This species does not breed in Australia (DotEE 2020).	
Falco peregrinus Peregrine Falcon		OS	X			The Peregrine Falcon is found on and near cliffs, gorges, timbered watercourses, riverine environments, wetlands, plains, open woodlands, and pylons and spires of buildings, though less frequently in desert regions (Morcombe 2011; Pizzey & Knight 2012). They are not common but can be found almost anywhere throughout WA and in the southwest, including particularly at Fitzgerald River, Stirling Range, Porongurup National Parks, Kondinin, and Peak Charles, with many more locations north of Perth (Nevill 2013).	Likely There are records of this species occurring around the Port Gregory area. This species may occur as an infrequent visitor, foraging within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Calidris acuminata Sharp-Tailed Sandpiper	Mi	IA	X	X	X	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. Sometimes they occur on rocky shores. They are widespread from Cape Arid to Carnarvon, around coastal and subcoastal plains of Pilbara Region to south-west and east Kimberley Division (DotEE 2020).	Unlikely There are multiple records of this species occurring within Hutt Lagoon and Port Gregory, however there is no suitable habitat within the survey area.

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Calidris melanotos Pectoral Sandpiper	Mi	IA	X	X	X	In Australia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum. In Western Australia the species is rarely recorded (DotEE 2020).	Unlikely There are records of this species occurring from Port Gregory, however this species is unlikely to utilise the habitat within the survey area.
Tringa brevipes Grey-tailed Tattler		P4	X			Habitat coastal; forages in inter-tidal pools, shallows, soft surfaces of mudflats and sand beaches as well as rock ledges, reefs. Often perches on branches, posts or jetties. Common summer migrant to northern Australia and uncommon in the south (Morcombe 2011).	Unlikely There is one record from the Gregory/Hutt Lagoon area. The survey area does not contain suitable habitat for this species.
Mammals							

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Dasyurus geoffroii Chuditch, Western Quoll	Vu	Vu		X	X	The Chuditch inhabits eucalypt forest (especially Jarrah, E. marginata), dry woodland, mallee shrublands, heaths, and desert, particularly in the south coast of WA. They also occur at lower densities in drier woodland and mallee shrubland in the goldfields and wheatbelt, as well as in Kalbarri National Park (translocated). Chuditch require adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows) to survive (DEC 2012a). In Jarrah forest, Chuditch populations occur in both moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest (Van Dyck and Strahan 2008). The species can travel large distances, and for this reason requires habitats that are of a suitable size and not excessively fragmented (DEC 2012a).	Highly unlikely The closest known record is approximately 20 km north-east of the survey area (dated 2008). Chuditch have been successfully translocated to Kalbarri National Park, however they are considered a geographically isolated population. The area surrounding the survey area has been largely cleared/fragmented due to agriculture. Given the lack of key habitat for this species, it is considered unlikely to occur.
Notamacropus eugenii subsp. *derbianus* Tammar Wallaby		P4	X	X		The Tammar Wallaby inhabits dense, low vegetation for daytime shelter and open grassy areas for feeding. It inhabits coastal scrub, heath, dry sclerophyll (leafy) forest and thickets in mallee and woodland. The tammar wallaby is currently known to inhabit three islands in the Houtman Abrolhos group, Garden Island near Perth, Middle and North Twin Peak Islands in the Archipelago of the Recherche, and at least nine sites on the mainland including Dryandra, Boyagin, Tutanning Batalling (reintroduced) Perup, private property near Pingelly, Jaloran Road timber reserve near Wagin, Hopetown, Stirling Range National Park, and Fitzgerald River National Park (DEC 2012; Van Dyck and Strahan 2008).	Unlikely There are two historic records approximately 7 and 18 km south east of the survey area. The species was considered locally extinct however they have been successfully re-introduced into the Kalbarri National Park.
Reptiles							

Species	Status		Desktop Search			Ecology and habitat	Likelihood of occurrence
	Federal	State	NM	DBCA Data	PMST		
Egernia stokesii badia Western Spiny-tailed Skink	En	Vu			X	*Egernia stokesii badia* occurs in open eucalypt woodlands and Acacia-dominated shrublands in semi-arid to arid areas of south-western WA (Geraldton Sandplains and Yalgoo IBRA) and, depending on taxonomic clarification, around Shark Bay including Peron Penisula, Edel Land and Dirk Hartog Island (Geraldton Sandplain and Carnarvon IBRA). It tends to shelter in logs, in cavities in the trunks and branches of shrubs, as well as in houses and ruins, especially in accumulations of old corrugated iron (DEC 2012b).	Highly Unlikely The closest known record is more than 90 km south east of the survey area.

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6138125-89649/https://projects.ghd.com/oc/WesternAustralia2/gmagarnetmcpandmp/Delivery/Documents/6138125_REP-A_GMA Garnet Biological Survey.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S Flemington	D. Farrar		D. Farrar		5/02/2020

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Memorandum

09 September 2020

To	GMA Garnet Pty Ltd		
Copy to			
From	Sarah Flemington	Tel	+61 8 62228638
Subject	Targeted *Caladenia bryceana* subsp. *cracens* survey and conservation listed flora survey of proposed haul road	Job no.	12528268

1 Introduction

1.1 Background

GMA Garnet Pty Ltd (GMA) are in the planning phase for expanding their operations within the Lynton Mine, located east of Hutt Lagoon, in Port Gregory, WA (the project). The expansion includes excavation for expansion of an open-cut mine and associated haul road. GMA has identified it will be necessary to clear vegetation to facilitate the expansion works.

GHD (2020) undertook a survey in December 2019 for the Project, with the purpose of assessing the vegetation and potential environmental values. Based on the results of this survey, GMA and GHD have determined that a targeted Threatened orchid survey is required to support the environmental approval, anticipated to be a Native Vegetation Clearing Permit (NVCP) under Part V of the *Environmental Protection Act 1986* (EP Act).

Caladenia bryceana subsp. *cracens* is known from 15 populations between Northampton and Kalbarri. The habitat and distribution is distinctly different to that of the subspecies *bryceana,* where it is geographically isolated from subsp. *cracens. C. bryceana* subsp. *cracens* is known to grow scattered in low heath in shallow soil on coastal limestone. The northern section of its distribution forms populations on winter-wet flats or in swales beneath thickets of *Melaleuca uncinata* in pale red-brown sandy loam or brown sandy clay (Commonwealth of Australia, 2013).

1.2 Purpose

GMA commissioned GHD to undertake a targeted survey for the Threatened orchid, *Caladenia bryceana* subsp. *cracens* (Northern Dwarf Spider-orchid), listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Endangered under the *Biodiversity Conservation Act 2016* (BC Act 2016). The purpose of the survey was to support a NVCP application. The outcomes of the survey will be provided to the Department of Mines Industry Regulation and Safety (DMIRS) to inform their environmental assessment. This memorandum should be read in conjunction with GHD (2020) *GMA Garnet Pty Ltd Lynton Mine Expansion Biological*

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Survey report which contains an assessment of the flora and vegetation values of the entire Project area.

1.3 Scope of works

The scope of works involved a targeted orchid survey of potential habitat for *Caladenia bryceana* subsp. *cracens* within the survey area (Figure 1). The survey area in total is approximately 28.3 hectares (ha). GHD implemented the following scope of works to achieve the purpose of the commission:

- Assessment of the desktop results as summarised in GHD (2020) prior to undertaking the field survey
- Undertake a targeted survey for *Caladenia bryceana* subsp. *cracens* (Threatened) in relevant habitat
- Undertake a targeted survey for conservation listed flora for the proposed haul road
- Draft a memorandum (this report) that documents the methods and results of the field survey
- Provide spatial data suitable to support the submission of a NVCP application to DMIRS.

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Paper Size ISO A3

0 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

O

GHD

GMA Garnet
GMA Garnet targeted orchid survey

Project Location

Project No. 12528268
Revision No. 0
Date 9/09/2020

FIGURE 1

G:\61\12528268\GIS\Maps\Working\12528268_GMAGarnetTargetedOrchid\12528268_GMAGarnetTargetedOrchid.aprx\12528268_001_SurveyLocation_RevA
Print date: 09 Sep 2020 - 14:08

Data source: Landgate_Subscription_Imagery\WANbw Landgate / SLIP. Created by: bmorgan

1.4 Limitations and assumptions

This memorandum has been prepared by GHD for GMA Garnet Pty Ltd and may only be used and relied on by GMA Garnet Pty Ltd for the purpose agreed between GHD and the GMA Garnet Pty Ltd as set out in section 1.2 of this memorandum.

GHD otherwise disclaims responsibility to any person other than GMA Garnet Pty Ltd arising in connection with this memorandum. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this memorandum were limited to those specifically detailed in the memorandum and are subject to the scope limitations set out in the memorandum.

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

The opinions, conclusions and any recommendations in this memorandum are based on information obtained from specific sample points. Site conditions at other areas of the site may be different from the site conditions found at the specific sample points. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this memorandum on the basis of information provided by GMA Garnet Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the memorandum which were caused by errors or omissions in that information.

2 Methodology

The targeted orchid survey was carried out by GHD Senior Botanist Joel Collins and Ecologist Sarah Flemington over four days from 11 – 14 August 2020. The targeted survey methodology has been conducted with reference to the Environmental Protection Authority (EPA) 2016 *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* and the Commonwealth of Australia 2013 *Survey Guidelines for Australia's Threatened Orchids*.

Prior to the survey a known population of *Caladenia bryceana* subsp. *cracens* west of the survey area, recorded during a previous survey (GHD 2019), was visited to confirm the species was in flower and assess habitat type. The population outside of the survey area was confirmed as being in full flower (Plate 1).

Areas of potentially suitable habitat occurring within the survey site (VT02 *Melaleuca cardiophylla* shrubland to open shrubland) that was previously mapped (GHD 2020) were surveyed by undertaking systematic transects spaced 10 meters apart (Figure 2) across all mapped VT02 areas within the survey area.

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A targeted survey for conservation listed flora was also undertaken across and adjacent the proposed haul road in the north-eastern section of the survey area (Figure 2). The haul road and nearby areas were traversed using the same methodology described above.

2.1 Field survey limitations

The EPA (2016) states flora survey reports for environmental impact assessment in WA should contain a section describing the limitations of the survey methods used. The limitations and constraints associated with this field survey are discussed in Table 1.

Table 1 Field survey limitations

Aspect	Constraint	Comment
Sources of information and availability of contextual information.	Nil	Adequate information is available for the survey area.
Scope (what life forms were sampled etc.)	Nil	Vascular flora were sampled during the survey. Non-vascular flora were not surveyed. The survey focused on *Caladenia bryceana* subsp. *cracens* (Threatened) and other conservation listed flora species for the proposed haul road.
Proportion of flora collected and identified (based on sampling, timing and intensity)	Nil	The survey focused on *Caladenia bryceana* subsp. *cracens* (Threatened) and other conservation listed flora species for the proposed haul road.
Flora determination	Nil	Flora determination was undertaken by GHD Botanist/Ecologist's in the field. All taxa could be identified to species level. The taxonomy and conservation status of the WA flora is dynamic. This report was prepared with reliance on taxonomy and conservation status current at the time report development, but it should be noted this may change in response to ongoing research and review of International Union for Conservation Nature criteria.
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Nil	The complete survey area was traversed on foot (Figure 2). All areas of the survey area were adequately surveyed for the purpose of the assessment.

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Aspect	Constraint	Comment
Mapping reliability	Nil	Data was recorded in the field using hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The GPS units used for this survey are accurate to within ±4 metres on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.
Timing/weather/ season/cycle	Nil	The field survey was conducted on 11-14 August 2020. The timing of the survey is not considered to be a limitation as all flora present was actively growing with flowering on many species observed. In addition *Caladenia bryceana* subsp. *cracens* at the time of the survey was flowering. The rainfall in the three months prior to timing of the survey (August), were drier than average for the area (Lynton -station 8075) (BoM, 2020), however, significantly higher than average rainfall was experienced in August (103mm compared to 56.6mm). This is sufficient for active growth and flowering of flora species. The survey timing was considered appropriate for the field survey. The weather conditions recorded during the survey were considered unlikely to have impacted upon the vegetation and flora survey.
Disturbances (e.g. fire, flood, accidental human intervention)	Nil	Much of the survey area has been subjected to historical disturbance events (e.g. clearing, tracks, feral grazing, weeds); however, these disturbances did not impact the survey.
Intensity (in retrospect, was the intensity adequate)	Nil	The survey area was sufficiently covered by the GHD Botanist/Ecologist's during the survey.
Resources	Nil	Adequate resources were employed during the field surveys. Four person day was spent surveying the survey area.
Access restrictions	Nil	All areas of the survey area was accessed on foot during the survey with no restrictions.
Experience levels	Nil	The GHD Botanist/Ecologist's who executed the field survey is suitably qualified and experienced in his field. Joel Collins (Senior Botanist) has over 17 years' experience in undertaking flora and vegetation surveys and assessments in Western Australia. Joel has extensive experience undertaking targeted flora assessments on the Geraldton Sandplains and within the local area. Sarah Flemington (Ecologist) has previously undertaken flora surveys on the Geraldton Sandplains.

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Legend

- Major Road
- Minor Road
- Track
- Haul Road Alignment
- Tracklogs
- Survey Area
- VT02 - *Melaleuca cardiophylla* shrubland to open shrubland

George Grey Dr

Port St

Port Gregory Rd

SLIP

Paper Size ISO A3

0 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

GMA Garnet
GMA Garnet targeted orchid survey

Targeted Orchid Survey

Project No. 12528268
Revision No. 0
Date 9/09/2020

FIGURE 2

G:\61\12528268\GIS\Maps\Working\12528268_GMAGarnetTargetedOrchid\12528268_GMAGarnetTargetedOrchid.aprx\12528268_002_VegTypes_RevA
Print date: 09 Sep 2020 - 14:09

Data source: Landgate_Subscription_Imagery\WANlow Landgate / SLIP. Created by: bmorgan

3 Results

The field survey did not record any individuals of *Caladenia bryceana* subsp. *cracens* within VT02. This was attributed to the habitat type, which did not align with the habitats containing known records of the species (GHD 2019). In addition there was the presence of invasive weeds throughout the majority of the survey area and significant wild pig grazing (Plate 3).

No conservation listed flora species were recorded within the proposed haul road. The haul road followed an existing track, and contained adjacent areas of previously cleared vegetation, mostly inundated by weeds. For these reasons, the habitats traversed within and adjacent the proposed haul road were not suitable for *C. bryceana* subsp*. cracens*.

4 Conclusion

The location of the orchids visited northeast of the survey area, were noted to be occurring on shallow beige sand on moist rocky limestone areas, higher in the landscape, (Plate 4). The vegetation type at this population is a dense shrubland of *Allocasuarina campestris*, *Melaleuca cardiophylla* and *Grevillea argyrophylla* over *Ecdeiocolea monostachya* sedgeland. These species were identified as the dominant and/or indicator species for the orchid habitat. Other individuals were growing on yellow sandy-loam soils also under *Allocasuarina campestris* (Plate 4).

This vegetation type did not occur in the survey area. *C. bryceana* subsp*. cracens* does not occur in the survey area. No conservation listed flora species occur within or adjacent the proposed haul road.

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Plate 1 *Caladenia bryceana* subsp. *cracens*

Plate 2 Limestone habitat at known population of Caladenia bryceana subsp. cracens

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Plate 3 Condition of vegetation within traversed habitat

Plate 4 *Caladenia bryceana* subsp. *cracens* occurring on sandy-loam soil

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5 References

Bureau of Meteorology 2020, Climate Data Online. Commonwealth of Australia.

Commonwealth of Australia 2013, Survey Guidelines for Australia's Threatened Orchids Guidelines for detecting orchids listed as 'Threatened' under the Environment Protection and Biodiversity Conservation Act 1999.

Department of Agriculture, Water and the Environment 2020, Approved Conservation Advice for Caladenia bryceana subsp. cracens (Northern Dwarf Spider-orchid).

GHD 2019, GMA Garnet Pty Ltd, Port Gregory Mine Mining Tenement M70/1380. November

2019.

GHD 2020, GMA Garnet Pty Ltd Lynton Mine Expansion Biological Survey. February 2020.

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Appendix B. Notice of Intent – Mining Lease M70/204

~~EMP~~ 3461 ~~SR~~

NOI 3461

GMA GARNET PTY LTD INC IN WA
ACN 009 344 227

LIBRARY COPY.
EMP : 58.
FILE : 1188/90.

NOTICE OF INTENT

MINING LEASE M70/204

PREPARED BY: GMA GARNET PTY LTD
September 19, 1995

P.O. Box 188 Geraldton, Western Australia 6530 Tel (099) 23 3644 Fax (099) 23 3747

TABLE OF CONTENTS

INTRODUCTION

SUMMARY

GMA Garnet Pty. Ltd. operates an open cut alluvial garnet mine and wet gravity separation plant on Mining Lease M70/204, 4 kilometres inland from the coast mid-way between Geraldton and Kalbarri. The nearest town site is Gregory ("Port Gregory") in the Northampton Shire.

The Port Gregory mine and plant has been operating since 1981 and supplies garnet concentrate to GMA's Narngulu facility (Geraldton industrial area). The Narngulu site dries and upgrades the concentrate to >97% garnet, then screens and packages the garnet for distribution. Finished product is stored on site at Narngulu and in a 10,000 tonne bulk storage facility at the Geraldton wharf.

GMA garnet is supplied throughout Australia, and exported to Europe, the United Kingdom, the Middle East, USA, Middle and South-East Asia, where it is used primarily for abrasive sandblasting. Over 50% of GMA's production is exported, and this proportion is increasing each year.

The Port Gregory garnet reserves are in excess of 6 million tonnes (inferred), making the resource possibly the largest alluvial garnet deposit in the world. GMA is the world's leading garnet sand producer, producing 70,000 tonnes of garnet abrasives during the 1994 - 95 financial year.

GMA currently employs 48 people divided between three sites; 17 people at the Port Gregory mine and wet separation plant, 27 at Narngulu, and 4 in Perth. All employees are sourced from local communities, and live within daily commuting distance of their workplace.

GMA has the relevant approvals from the Northampton Shire Council, Water Authority, and Department of Minerals and Energy to operate the mine and separation plant, draw ground water, and haul concentrate to Geraldton via shire roads.

COMMITMENTS

GMA operates within the guidelines and requirements of the Mining Act (1978 - 1987) and Mines Regulation Act (1976).

In order to safeguard the environment GMA Garnet will continue to;

1. Clear drill lines just sufficiently wide enough for a drill rig when conducting mine plan drilling.

2. Keep clearing of bush in the mine path to the minimum width for the pit and haul road, so as to minimise ground disturbance.

3. Stockpile the top 15 cm of topsoil prior to mining.

4. Progressively backfill all excavations, and re-contour all surfaces to suit the natural landscape.

5. Return stockpiled topsoil to the re-contoured areas and promote natural revegetation.

6. Monitor and regulate all groundwater extraction in accordance with Water Authority licence requirements.

7. Keep dust to a minimum by the use of a water truck, and conducting clearing operations during winter whenever possible.

8. Remove all used vehicle and equipment oil from site when no longer required.

9. Remove all roadways and facilities at the completion of mining and rehabilitate these areas.

OPERATIONS

An open cut mine and wet gravity separation plant have been in operation since 1981 when approvals were given under previous mineral claims 70/11560 - 11565 and 70/11619 (16924). These mineral claims were later converted to M70/204 under the transitional provisions of the mining Act.

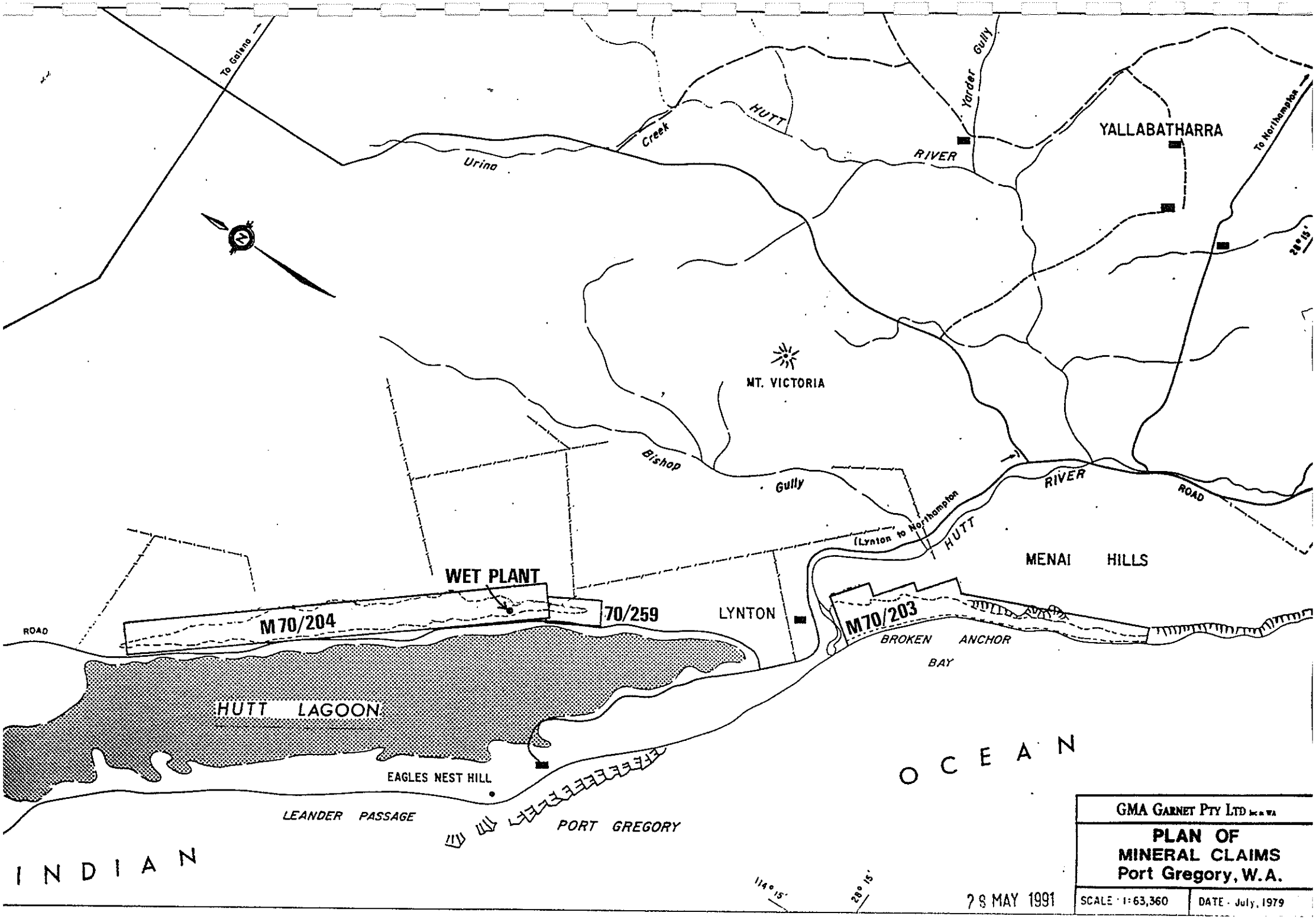
The wet plant is of simple demountable design and the process uses only basic elements of water assisted gravity separation (hydrosizer, spirals, cyclones, etc.) without requiring any chemical treatment. Several minor upgrades have been made over the years and the plant's capacity is now 15 tph of garnet.

It is expected that future plant upgrades and relocation of the plant (so as to reduce the distance travelled by trucks transporting ore and tailings between the pit and plant) will be required to match anticipated growth in the market for garnet.

Mining will continue to be by open cut methods with continuous back-filling and restoration of the mined area.

LOCATION

South West Mineral Field, Locality of Victoria, (Lot 6, Plan 12041). The lease is located on the east side of Hutt Lagoon (a salt lake), on the west side of which is the small crayfishing town of Gregory ("Port Gregory"). The nearest major town is Northampton, located some 50km by road to the South - East. The lease is located within the Shire of Northampton. Figure 1 is taken from the Hutt 1:100,000 topographic map sheet (1741).



GMA GARNET PTY LTD (ACN 009 450 052)

PLAN OF MINERAL CLAIMS Port Gregory, W.A.

SCALE - 1:63,360

DATE - July, 1979

28 MAY 1991

OWNERSHIP

Lessees of M70/204 - Garnet Producers NL
- Barton Joint Venture Corp.
- B-L (Australia) Inc.

Managing / Operating Company - GMA Garnet Pty Ltd.
P.O. Box 188
Geraldton W.A. 6531

HISTORY

1. Wide spaced vacuum drilling (300 x 40m) in 1975 indicated a large high grade resource of alluvial garnet.

2. Private property covering M70/204 and M70/259 was purchased in 1978. This land was formerly part of Lynton Station and used for sheep grazing.

3. Infill vacuum drilling (100 x 20m) at southern end of M70/204 delineated mineable reserves of garnet sand.

4. A small 4tph wet gravity separation plant (at present plant site) and nearby open pit mining by front end loader commenced late 1981.

5. Since 1981 the same wet plant has had several upgrades lifting its production capacity to 15tph garnet. Open pit mining, backfilling, contouring, soil replacement and rehabilitation has continued in the vicinity of this plant, slowly progressing northward to the present pit location.

EXISTING FACILITIES

Already located on M70/204 are:

Mine Pits And Associated Private Unsealed Haul Roads

Feed Stockpile Area and Feed Hoppers

Demountable Wet Separation Plant

Mobile Equipment Storage Shed (Demountable)

Vehicle Workshop (Demountable)

Diesel Fuel Tanks (Free Standing)

Product Stockpile Area

Tailings Return Area

Slimes Return Pits

10 Non-Artesian Water Bores, Fresh and Recycle Water Tanks

Transportable Site Office, Ablutions, and Amenities

Transportable Electrical Store

EXISTING ENVIRONMENT

REGIONAL SETTING

M70/204 is approximately 600m wide by 8300m long, and is located along the base of a limestone escarpment of relict coastal dunes, some 4 km inland from the present coastline near Port Gregory with its southern limit approximately 5 km north of the Hutt River. Immediately to the west of the mining lease is Hutt Lagoon (salt lake). The present coastline is to the west of recent dune formations located on the west side of Hutt Lagoon.

Local topography is typical of coastal limestone and related sandy alluvium / colluvium, with large elongate dune ridges paralleling the coast now stabilised by thick vegetation..

Western Biotechnology Pty. Ltd. presently occupy the southern end of Hutt Lagoon, and have created shallow ponds within the lagoon for cultivating *Dunaliella saline* algae, a source of beta carotene. Western Biotechnology's processing plant used for harvesting the algae is located some 700m north-west of GMA's wet separation plant.

GEOLOGY

The ore deposit consists of a Late Pleistocene - Recent heavy mineral strandline and overlying dune ores, both of which are garnet rich. The strandline is located on a relict wave-cut platform at the base of a buried scarp of older Pleistocene Tamala Limestone. The strandline is overlain by garnet enriched aeolian sands, which have blown up and over parts of the Tamala Limestone scarp. Inferred resources are some 6 million tonnes of garnet sand.

Dune ore occurs at depths of 1 to 13m below the surface, and in a band 80 to 400+m wide. Strandline ore occurs beneath the dune ore and/or overburden, and is between 5 and 8m thick.

The ore consists predominantly of unconsolidated quartz sand, with varying amounts of shell sand, carbonate cement, garnet and ilmenite, with trace amounts of zircon and rutile. The garnet and associated heavy minerals are probably derived from the garnet granulites of the Proterozoic Northampton Block. Their concentration on M70/204 seems to be a result of transportation to the coast via the Hutt River, presumably during wetter climatic periods, combined with long-shore drift and onshore winds predominantly from the south-west at a time when the sea level was about 8m higher than at present.

HYDROLOGY

No surface run-off exists in the lease area, as any rainfall quickly soaks into the porous limestone and sand. The only surface water in the nearby area is Hutt Lagoon salt lake, which intermittently fills with water. After winter rains, the water soon becomes hyper-saline and dries out in summer. There is no potential of flooding from Hutt Lagoon, as almost all of M70/204 is several meters above lake level.

A lens of semi-saline (1800 ppm TDS) water up to 10m thick underlies parts of M70/204, which is in turn underlain by saline water. All sub-surface drainage is to the west. The semi-saline water is thought to be generated from a broad undulating elevated catchment area east of the Tamala Limestone escarpment.

Detailed reports on the hydrogeology of M70/204 are submitted annually to the Water Authority in accordance with the conditions of Groundwater Well Licence No. 0053830.

CLIMATE

The Geraldton - Kalbarri region of coastline exhibits a Dry Warm Mediterranean type climate, with hot dry summers and mild wet winters. Average rainfall is 463mm, and evaporation is 2383mm. The majority of rainfall occurs during the May - September period, with the growing season being May to September. Mean temperatures range from 19 to 35°C during summer (January), and from 6 to 17°C during winter (August). Prevailing winds are from the South-South-West during summer, and variable during winter. Figure 2 is the seasonal rainfall and temperature chart for Geraldton.

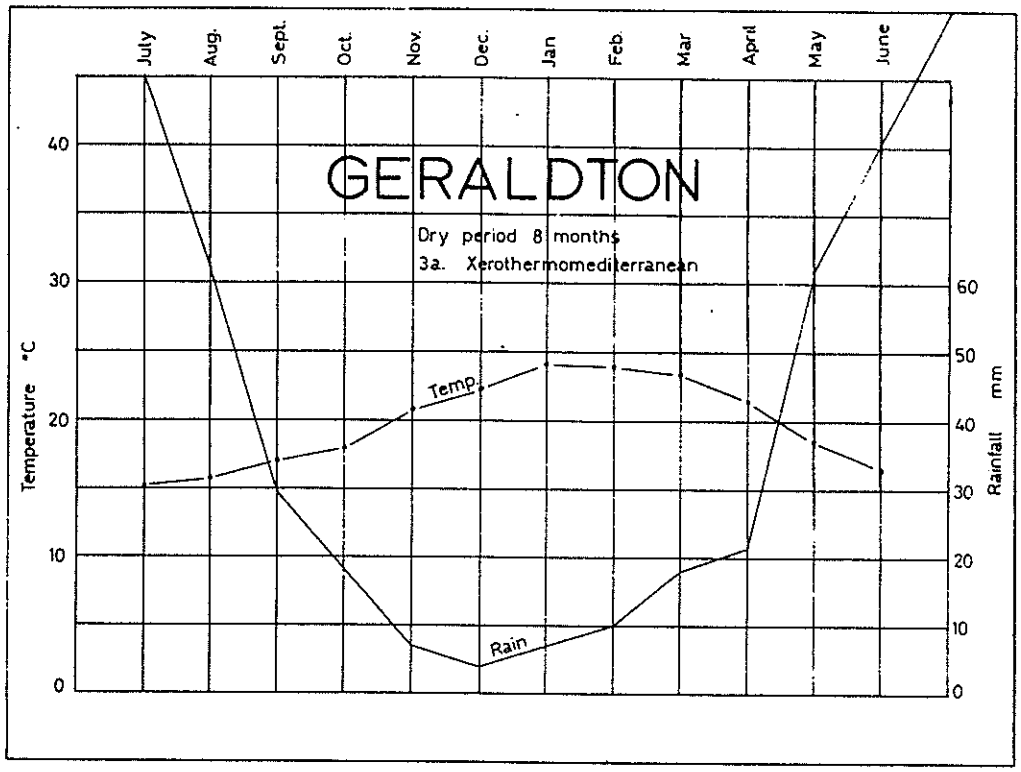


Figure 2. Seasonal rainfall and temperature diagram for Geraldton.

FLORA

The M70/204 lease area is located within the South-West Botanical Province of the Irwin Botanical District 1. Various flora studies of the province have been carried out, of which the 1: 250,000 Vegetation Survey of Western Australia (1976) places the lease area in the Greenough Vegetation System. The Greenough System is associated with the coastal limestone and extends along the coast from Kalbarri to Dongara. Soil in the lease area is leached sand consisting of quartz and carbonate fragments with a uniform textured profile darkened by organic matter at the surface. This overlies limestone or a uniform profile of thick quartzose - calcareous sands, underlain by limestone at depth.

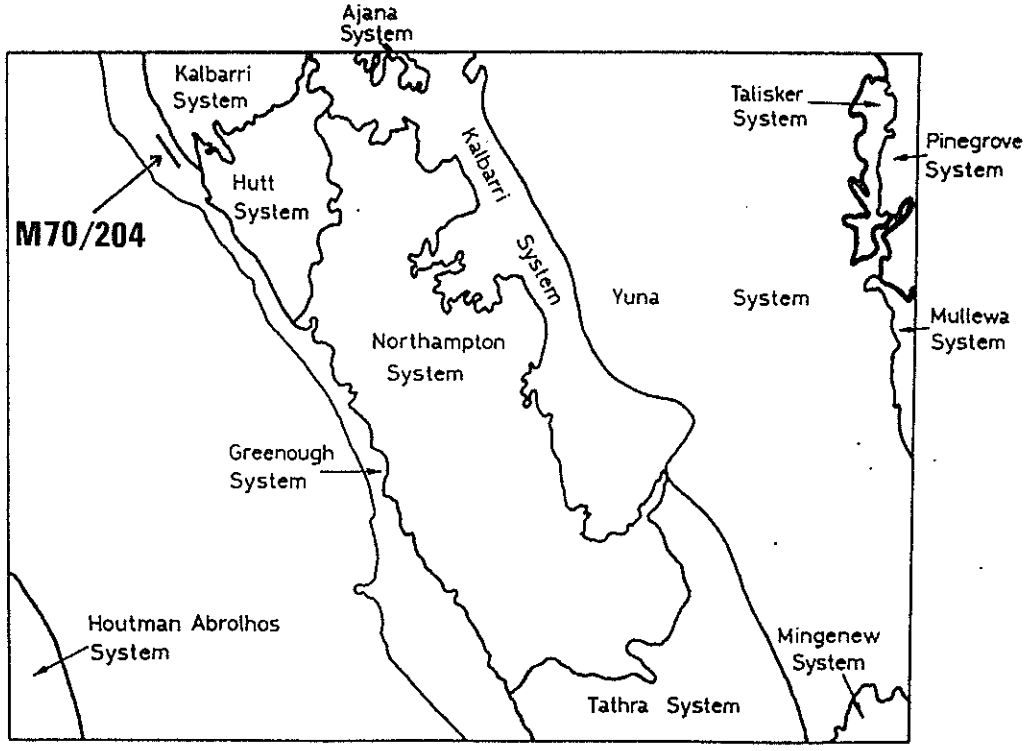


Figure 3. Vegetation Systems in the Geraldton area.

The lease area is partially covered by *Acacia rostellifera* thicket <10m tall with a mid-dense canopy (projective foliage cover of 30 - 70%), (see map - Appendix C).

The *Acacia rostellifera* community is common on the coastal limestone hinterland between Hutt River and Kalbarri National Park. A description of the *Acacia rostellifera* community follows;

> "*Acacia rostellifera* thicket is a dense shrub community consisting principally of the *species A. rostellifera, A. ligulata, A scirpifolia, A. xanthina, Eucalyptus eudesmioides* and *E. oleosa* (both as mallees), and *Melaleuca cardiophylla* among the large dominant shrubs. *Alyogyne cuniformis, Calothamnus quadrifidus, Grevillea biformis, Labichea sp., Helichrysum sp.,*

Hibiscus huegelii, *Pimelea floribunda* and *solanum simile* are among the smaller plants. There is no definite small shrub layer. In the rockiest and steepest places *Melaleuca cardiophylla* assumes dominance as more or less the sole species."[1].

As the M70/204 lease area was previously station land and is still used for grazing sheep by the owners of adjoining Lynton Station, the Acacia community within M70/204 has been affected by grazing, partially attributable to a significant European Rabbit population. A large population of introduced weeds and grasses are present throughout the lease area, many of which have been transported by sheep and other mammals into the Acacia thicket from adjacent pastoral land. The northern and southern portions of the lease have at some time been cleared for cropping and sheep grazing. Much of the previously cleared area has since returned to *Acacia rostellifera* thicket through vigorous self regeneration

FAUNA

As both the northern and southern ends of the lease have been cleared in the past and used for pastoral purposes, introduced mammals are common. European Rabbits, domestic mice, foxes, and feral domestic cats have all been sighted in addition to sheep that still graze the area.

The diversity and occurrence of native fauna within the lease area has not been studied in specific detail, but as far as GMA can ascertain from studies conducted by the Main Roads Department of W.A. for the Horrocks - Kalbarri Road Project, there are no occurrences of fauna classified under the Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 1994 within the areas that will be affected by mining and processing operations.

[1] J.S. Beard & A.C. Burns, 1976, "The Vegetation of the Geraldton Area, Western Australia" Map and Explanatory Memoir 1:250,000 Series., Vegmap Publications, Perth.

PROJECT DESCRIPTION

MINING

All mining operations on lease M70/204 are conducted under the requirements of the Mining Act and Regulations and are subject to regular inspection by the relevant inspectors.

Mining operations are generally conducted 24 hours a day, five days a week, in three 8 hour shifts.

Mining and restoration is conducted by wheel loaders (2) and off-road articulated dump-trucks (2), with occasional assistance from hired bulldozer and excavator. The mine is a moving pit, being mined at one end and being progressively backfilled and restored at the other. The maximum depth of the pit is no more than 22m, and is typically 6 to 19m deep. The ground is poorly cemented by carbonate calcretes, with some areas of surface caprock.

Appendix A contains photographs of the mining operation. Appendix D contains a plan of the present pits and an aerial photograph of the mine area.

Mining is conducted in six stages:

1. A bulldozer is used to clear the existing bush along narrow east-west drilling lines (100 or 50m spacing), and grade control drilling and sampling follow.

2. A bulldozer is used to clear the bush remaining immediately ahead of the mine path.

3. The bulldozer then pushes 15-30cm of topsoil into stockpiles adjacent to the mine path.

4. Wheel loaders (and occasionally an excavator) are used to remove overburden in 3 - 5m benches, which is trucked to the backfill end of the pit.

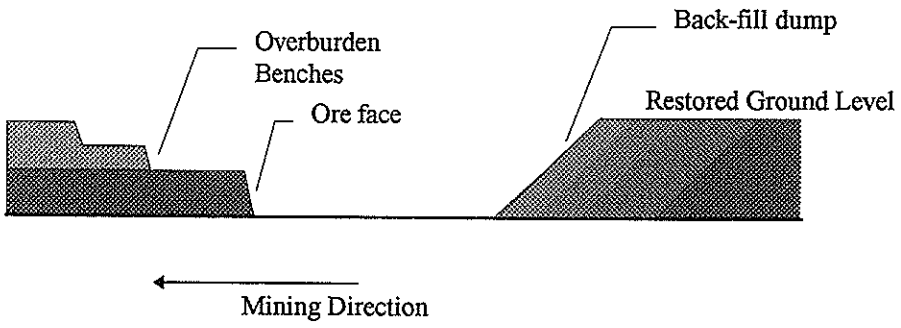
5. Wheel loaders (and occasionally an excavator) are used to mine the ore in 2 or 3 benches each 3 - 5m high. The ore is trucked to stockpiles near the wet processing plant.

6. Tailings from the wet separation plant are trucked to the backfill end of the pit, and when the natural ground level is achieved, the area is re-contoured and the stockpiled topsoil is spread by bulldozer. After topsoil replacement the mined areas are fenced to prevent sheep damaging the Acacia regrowth, which is vigorous after the first winter rains.

At all stages of mining, dust suppression is aided by the use of a water truck.

At present there are two pits on M70/204, the main working pit and a test pit ahead of the working pit. Over the next 12 - 15 months these will join to form a single pit with backfilling continuing northwards. The mining direction is to the North-North-West, and it is envisaged that this will continue for the foreseeable future. Mine progression rate varies between 20 and 80m movement north per month, depending on the size and morphology of the ore body. The progression rate will decrease as the ore body widens in the vicinity of the test pit.

Figure 4. North - South Cross-section through northward moving pit.



Approximately 15% by volume of the material mined is removed from site as saleable product, though this loss of volume from the mined areas is more than compensated for by the increase in volume due to the swelling of overburden material. Carbonate cemented overburden increases in volume by up to 30% after being broken out, transported, and dumped during mining.

At all times, a buffer of undisturbed bush is left between Grey Road (parallel to M70/204 and down-slope) and the mining and processing operations so as to reduce or eliminate any visual impact.

ORE PROCESSING

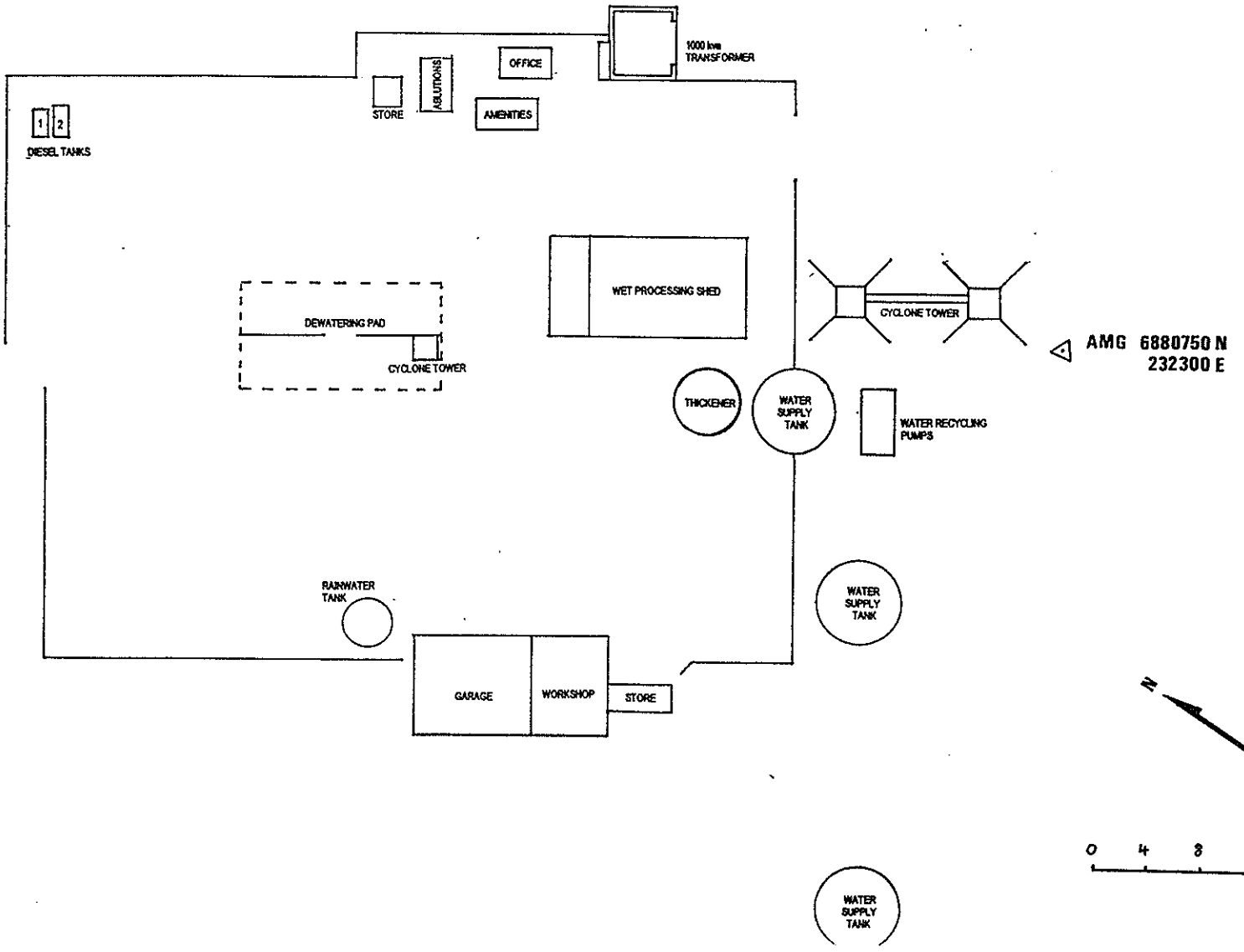
Ore processing is generally carried out 24 hours a day, five days a week, in three 8 hour shifts per day. Weekends are sometimes worked when concentrate stocks are low or time is lost during the normal working week.

Ore processing is via simple water assisted wet gravity separation. Stockpiled feed is fed to two hoppers and grizzlies by wheel loader. The ore is conveyed to a wet trash screen from where it is pumped to a nearby demountable wet gravity separation plant. Separation is achieved by a combination of hydrosizer, spirals, and hydrocyclones using local bore water. The concentrate is mechanically attritioned, washed, de-watered and stockpiled ready for cartage by a trucking contractor to the Geraldton dry plant. Tailings are de-watered by cyclone and allowed to drain prior to being returned to the back-fill end of the pit. Process water is recycled through a thickener. Thickener underflow (calcareous slimes) is allowed to drain prior to being returned with tailings to the back-fill end of the pit. Appendix D contains a plan of the processing plant location and an aerial photograph. Figure 5 is a plan of the processing plant layout.

The only dangerous goods used or kept on site (other than the diesel fuel store), are two density gauges containing radioactive sources. These are registered by the Radiation Health Branch of the Radiological Council (Health Department), Registration No. RS 100/94 9433.

GMA GARNET PTY LTD - PORT GREGORY MINE-SITE

WET SEPARATION PLANT



TAILINGS DISPOSAL

All tailings from the wet separation plant are returned to the progressively back-filled pit. Tails consist of quartz sand and carbonate fragments, with minor amounts of heavy minerals. Thickener underflow (carbonate mud) is de-watered and returned with tailings to the back-filling area of the pit. Tailings from the Geraldton dry plant (quartz, carbonate, ilmenite) are returned by truck and dumped at a temporary pad prior to being returned to the pit by GMA's earthmoving equipment. When the back-filled pit has reached the surrounding ground level, the surface is re-contoured to a natural looking topography. Stockpiled topsoil is then spread over the surface and Acacia self regeneration begins. Appendix A contains photographs of the backfill operation.

SUPPORT FACILITIES

The various support facilities and their locations are shown on the supplied plan (Appendix D)

Support facilities consist of:

1. Site office (single room transportable building).
2. Amenities - lunch room (single room transportable building).
3. Ablutions (male/female/toilet & shower transportable building).
4. Electrical / Radioactive Source Container Store (single room transportable building).
5. Workshop - adjoining the main plant building (demountable shed).
6. Vehicle workshop and store (demountable shed).
7. Transformer compound - brick compound containing a 1000KVA ground mounted transformer for the plant electricity supply.
8. Fuel store - two above-ground (7200 & 5300 Litre) free standing diesel tanks with containment bunds.
9. Scrap item storage yard.
10. Ten (10) non-artesian water bores and eight (8) 90,000L water storage tanks (7 fibreglass, 1 concrete).

WORKFORCE

17 full-time persons are employed by GMA at the mine and wet processing plant, and 3 contractor employed persons are engaged full-time driving one contractor owned dump truck at the site (soon to be replaced by GMA's own dump truck and personnel). Of the 17 GMA employees, one is the mine manager, the rest being plant and mobile equipment operators.

All GMA employees at the site (except for the mine manager) are employed on a five day week, eight hour shift roster. The employees are locals sourced from the towns of Northampton, Horrocks, Gregory, or nearby private properties. These employees commute to and from the site at the change of each shift. Company transport is provided between the mine and Northampton where the majority of employees live, a distance of 50km.

TRANSPORTATION CORRIDORS

All ore and tails haulage to and from the mine and wet processing plant is via a private haul road located within M70/204, which itself is located within private property owned by GMA.

Transportation of garnet concentrate from the wet processing plant to Geraldton, and the return of dry tailings to the mine from Geraldton is via eight wheel tipper truck and trailer owned and operated by the contract holders, Giacci Bros. Pty. Ltd. Written permission for the transport of mineral sands between the mine-site and Geraldton has been obtained from the Shire of Northampton (Appendix B), and Giacci Bros. Pty Ltd. hold the necessary permits to operate their vehicles from the Main Roads Department and Geraldton/Greenough Shires. As part of the mine-to-Geraldton road is unsealed (Grey Road near Hutt Lagoon), transportation is halted when weather conditions make damage to the road surface likely. The remaining unsealed road will progressively be upgraded and sealed as part of the Horrocks - Kalbarri Road project.

UTILITY REQUIREMENTS

All electrical power for the wet separation plant and associated facilities is derived from a Western Power 33 KV reticulation line that crosses M70/204 some several hundred meters north of the plant. The 33 KV supply is stepped down to 440V via a ground mounted transformer within the plant compound.

Diesel for the earthmoving equipment is supplied by fuel company road tanker, and is stored in two above-ground tanks (7200L and 5300L) within the plant compound (Licensed under the Explosives and Dangerous Goods Act, 1961).

The wet gravity separation plant is licensed to extract up to 130,000 kilolitres of water per annum from the 10 non-artesian bores (Groundwater Well Licence No. 0053830).

An additional 100,000 kilolitres per annum of fresh (500ppm TDS) can be supplied from Victoria Location 1428 (Appatarra Well) via a 7km pipeline. This is licensed by the Water Authority as Groundwater Well Licence No. 47201.

All potable water for the site is supplied from rain-water tanks collecting from the plant and garage shed roofs.

ACCOMMODATION AND HOUSING

No accommodation or housing is provided by GMA. All employees live in the nearby towns of Northampton, Horrocks, and Gregory, or nearby private properties, and commute to the site by private or GMA vehicles.

ENVIRONMENTAL IMPACT AND MANAGEMENT

WATER

All 10 bores located on M70/204 used for process water supply are monitored monthly in accordance with the conditions of Groundwater Well Licence No. 0053830. A report to the Water Authority by a competent hydrogeologist is submitted by 30th July each year. No decline in water quality or supply has been noticed in the two years since the bores were licensed and regular monitoring began.

As the sub-surface hydraulic gradient is toward Hutt Lagoon, GMA is the last user of fresh or semi-saline groundwater prior to the water entering the sub-surface of the lagoon (below sea-level). There are no up-stream groundwater users within the area of influence of the ten bores (no drawdown is observed at greater than 50m from a pumping bore).
Western Biotechnology Ltd. is located adjacent to M70/204 on the downstream side, but require water with high salinity for their operations.

No mine de-watering is necessary, as all mining operations are conducted above the natural water table.

The product and tailings stockpiles drain through the sandy soil and return to the aquifer down-gradient of the bores, and continue their flow toward the hyper-saline Hutt Lagoon. This water is only slightly more saline than when it was extracted (extracted at 1800-2000ppm TDS, returned at 2200ppm TDS).

No drainage control is necessary as surface runoff is non-existent in the sandy soils.

FLORA AND FAUNA

As the mine pit varies in width between 80 and 400+m, so does the amount of bushland required to be cleared. Approximately 43% of M70/204 is land that has not previously been cleared for pastoral uses, but will require clearing at some stage during the mine life. This is an ongoing process, with only the area immediately ahead of the mine path being cleared at any one time. Clearing is kept to a minimum at all times, with the area cleared being of sufficient area for the mine pit and haul road only. Preliminary clearing ahead of the mine path is kept at 1 to 1.5 years worth of mine progression so as to allow at least one winter of rainfall to dampen the ground prior to mining, reducing dust and providing a firmer surface for vehicles to work on.

No known rare or endangered floral or faunal species will be disturbed by mining operations on M70/204. Approximately 46% of the *Acacia rostellifera* thicket found on M70/204 will remain undisturbed by mining, and the remaining areas will undergo continuous rehabilitation as the mine pit progresses.

The Acacia community is very quick to re-establish after mining, with substantial regeneration occurring within 3 years of soil replacement. As the mined areas are bounded to the east and west by undisturbed Acacia thicket, faunal species can easily move back into rehabilitated areas.

WASTE PRODUCTS

Combustible domestic wastes are safely incinerated on-site, while liquid domestic wastes (sewerage) are disposed of via a septic tank. A temporary scrap equipment and waste collection area is used to consolidate rubbish for batch removal to municipal disposal sites.

Mineral tailings and de-watered slimes are returned to backfill the progressing pit as described earlier.

TOXIC MATERIALS

Diesel fuel is the only dangerous good transported regularly to the lease, and this is the responsibility the fuel distributor. Used lubricating oil from earthmoving equipment is removed from the site by GMA and safely disposed of.

Radioactive sources for the two density gauges in the plant are handled in accordance with the Code of Practice for the Safe Use of Radiation Gauges (1982). Road transport of these items (although a rare event), is conducted in accordance with the same Code of Practice.

ATMOSPHERIC POLLUTION

In order to reduce wind-borne dust, clearing operations are conducted whenever possible during winter or less windy times of the year. Clearing is also carried out sufficiently early so that any area to be mined has at least one winter to absorb moisture, aiding dust control. If left uncleared until just prior to mining, the vegetation prevents moisture penetrating below 2 to 3m.

A water truck operates on all haul roads, and all of GMA's earthmoving equipment is equipped with sealed cabins and filtered air-conditioning.

No dust is emitted from the processing plant, as all material handling (after the feed hoppers) is in the form of slurries. Tailings and slimes are returned to the pit while still damp, and concentrate is usually still damp when loaded out to Geraldton. Dry concentrate is free of dust due sizing and washing in the plant.

NOISE

No blasting or rock-breaking is necessary in the mining operations, and all earthmoving equipment is modern Volvo or Caterpillar equipment with sound-proofed cabins and muffled exhausts.

In the processing plant, the only noise producing items are electric motors driving pumps and attrition machines. All operators are supplied with hearing protection, and the site has been approved by the Mines Department Inspectorate.

REHABILITATION

The aim of GMA's rehabilitation process is to return the land to its original state with the original flora and fauna. This will be achieved with minimal change to the pre-mining topography. Appendix A contains a series of photographs illustrating the rehabilitation process. The aerial photograph in Appendix D also illustrates the extent of rehabilitation.

As of May 1995, a total of 35.6 ha of M70/204 had been cleared for mining, stockpile, and processing plant uses. This is divided up into;

4.7 ha Processing plant and stockpiles
15.7 haMine pits, backfill, and land cleared prior to mining.
7.2 ha Cleared for grade control drilling
8.0 ha Backfilled, re-contoured, topsoil replaced, and progressively re-vegetated.

Of these areas, only the 4.7 ha used for plant facilities and stockpiles will remain cleared for an extended period of time. All other cleared land is progressively mined, backfilled, and restored.

Rehabilitation of mined areas consists of four stages;

1. Ripping of haul roads no longer required.
2. Re-contouring of the completed back-fill to suit the natural landscape.
3. Replacement of topsoil stockpiled prior to mining.
4. Re-vegetation. The native flora re-grows rapidly after winter rains, and is fenced to protect the young plants from sheep grazing. This fencing is removed when the flora is sufficiently strong enough to survive grazing by sheep.

The *Acacia rostellifera* community is quick to regenerate from disturbed areas after the return of the topsoil. Drill lines cleared in 1975 are now completely undetectable from either the air or ground, and an area cleared in 1990 for mine plan drilling is now thicket 2.0 - 2.5m high and impassable to a 4WD.

Wind erosion of mined or rehabilitated areas has not been a problem, as the gentle slope of the lease area and the thick Acacia forest to the immediate east and west of the pit area provide adequate shelter for the young regrowth. Similarly water erosion is non-existent due to the low rainfall of the region, gentle slope and the sandy soils.

DECOMMISSIONING

Decommissioning of the processing plant facilities will consist of complete removal of all plant items, buildings, haul roads, water tanks, power and water reticulation, stockpiles, etc. This will be followed by re-contouring of the plant and stockpile area, ripping of compacted soils, replacement of topsoil, and fencing to protect young regrowth. When all regrowth is sufficiently able to survive grazing by sheep, the fencing will be removed. The only items that will remain will be the water bores, which under Water Authority licensing conditions must be made available to nearby or future land-holders.

COMPLETION CRITERIA

The ultimate objective of GMA's operations on M70/204 once all commercially viable garnet resources have been extracted, is to return all areas affected by mining or processing operations to the original *Acacia rostellifera* community.

SOCIAL IMPACTS

ABORIGINAL SITES

GMA will abide by the Provisions of the Aboriginal Heritage Act, and will report to the W.A. Museum any findings of sites of Aboriginal significance or artefacts within the boundaries of M70/204. As such no sites or artefacts have been discovered within the lease area by GMA, the previous land-owner or Aboriginal consultants examining a proposed road alignment through M70/204.

HERITAGE

Any items of European Heritage discovered in the lease area will be defined, recorded, and relocated or preserved as necessary. The W.A. Museum will be notified if it is thought that any such items may be of cultural significance.

No items of European Heritage have yet been discovered in the lease area.

LAND USE

The M70/204 lease is mostly private land held by GMA. As detailed earlier, there are no adverse environmental impacts on neighbouring properties.

GMA allows (by way of special agreement at the time of purchase) the previous land-owner to run sheep on M70/204, and GMA is not responsible for any stock losses that may occur due to mining activities. Under this agreement the upkeep of boundary fences and watering points is the grazier's responsibility.

SOCIAL ENVIRONMENTAL

The mining and processing operation carried out by GMA on M70/204 is one of the largest non-government enterprises in the Northampton Shire. As all GMA employees at the site are Northampton Shire residents, the company is a significant contributor to the local economy.

At all times a buffer of Acacia low forest is maintained between Grey Rd and the mine and processing facilities. This makes GMA's operations almost invisible from Grey Rd, and hides most parts of the mine from the Gregory townsite 3km away on the far side of Hutt Lagoon.

APPENDIX A

SITE PHOTOGRAPHS

View looking North - West along mining direction showing ore face and overburden benches in the main pit.

View looking South - East over the backfill dump. Overburden and tailings are used to backfill the pit as it moves northward, recreating a natural looking topography.

View to the North - West along the mining direction. In the foreground is stockpiled topsoil ready to be spread over the backfilled area in the middle of the photograph. The mine pit is in the middle distance.

View looking South - East over mined out areas to east of the plant buildings and feed stockpiles. Areas in the foreground and middle distance have recently had the topsoil replaced.

The previous photograph re-taken 4 months later. Grasses cover the topsoil and prevent wind erosion until the Acacia regrowth is established. The thick wattle in the left centre distance is the product of 3 year's regrowth.

This view shows three stages of regrowth. The foreground has had one year of growth, while the centre (low scrub) has had two years of growth. The Acacia thicket in the middle distance is three seasons old.

A view of the two year old regrowth in the foreground with the three year old growth behind. The fence in the foreground is to keep out sheep until the wattle is large enough to survive grazing.

The three year old Acacia regrowth behind the vehicle is now large enough and thick enough to prevent grazing by sheep, and the fence has been removed.

APPENDIX B

NORTHAMPTON SHIRE APPROVAL

SHIRE OF NORTHAMPTON

PLEASE ADDRESS ALL COMMUNICATIONS
TO THE SHIRE CLERK
TELEPHONE: 34 1202, 34 1008
P.O. BOX 61 NORTHAMPTON, W.A. 6535
FAX No. (099) 34 1072

RECEIVED
30 MAY 1995

Our Ref: DT1

Your Ref:

Mr M Ingram
Geologist
GMA Garnet Pty Ltd
P O Box 188
GERALDTON WA 6531

Dear Michael

This is to advise that Council approves of the following for GMA Garnet Pty Ltd.

1. Operate your Port Gregory mine and wet separation plant on Mining Lease M70/204.

2. Draw water from Appatarra Well (Victoria Location 1428, Groundwater Well Licence No. 47201).

3. Transport garnet concentrate and tailings to and from your Geraldton plant via Giacci Bros. Pty Ltd's eight wheel tipper and trailer combinations.

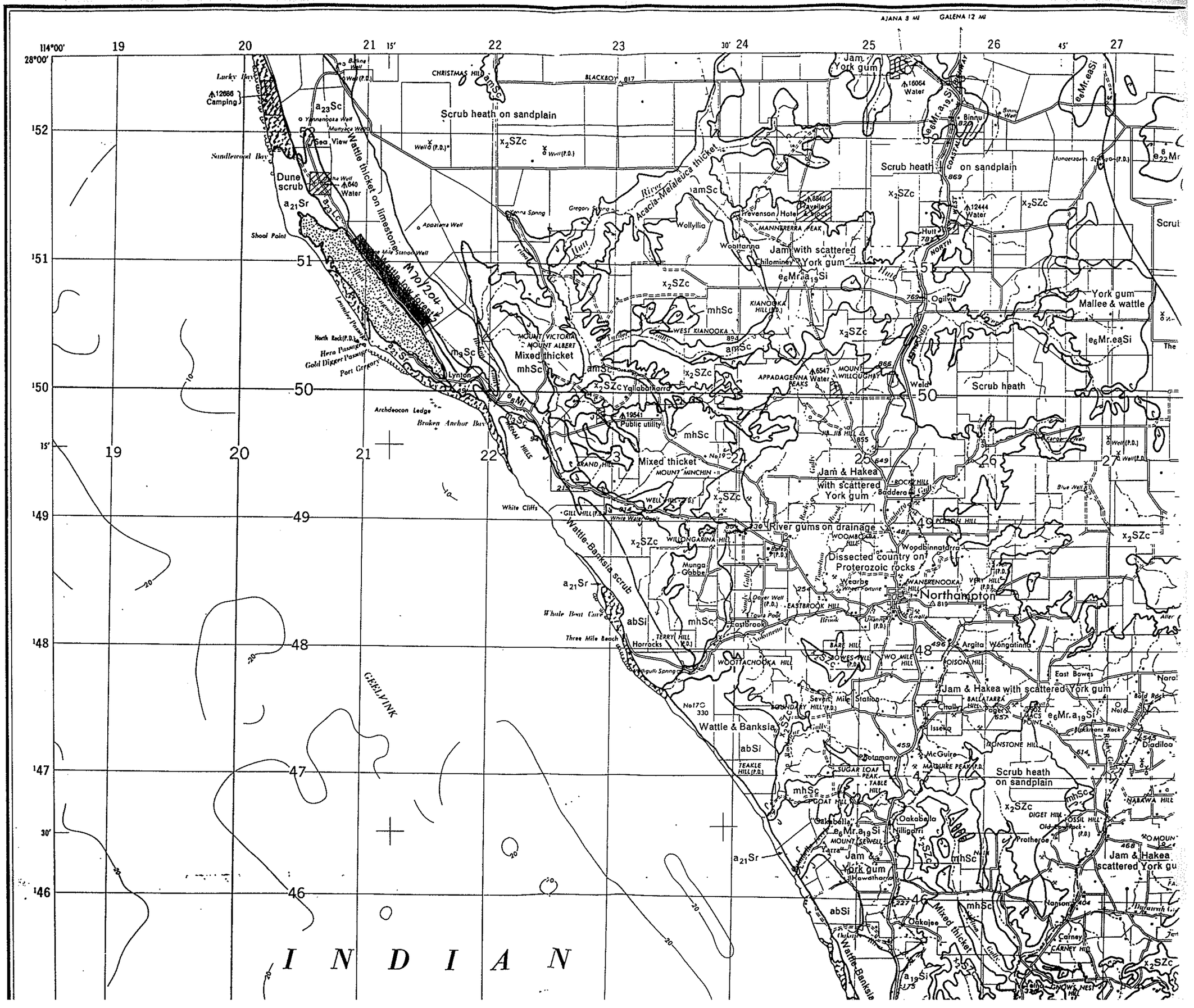
Yours faithfully

Mr C J Perry
SHIRE CLERK

26 May 1995
mcliff/sh/gmagarnet

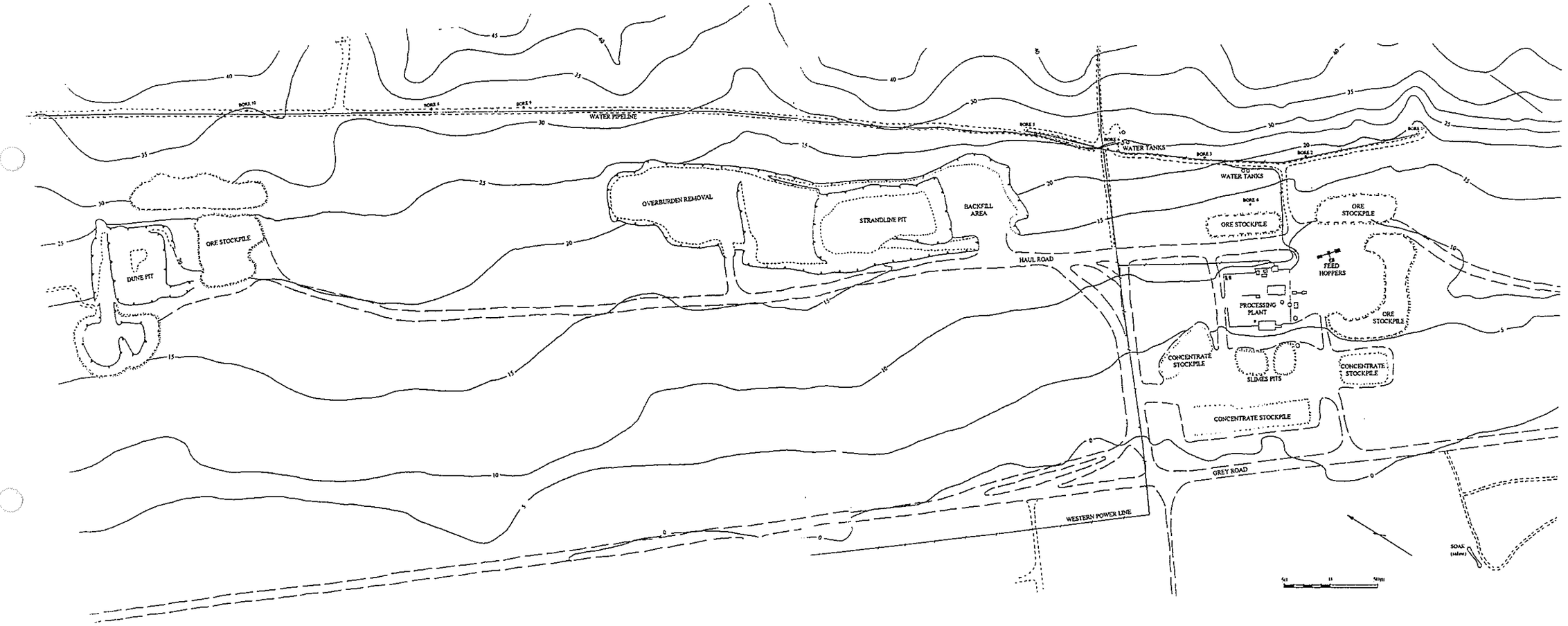
APPENDIX C

1:250,000 VEGETATION MAP


AJANA 3 MI
GALENA 12 MI
114°00'
28°00'
Lucky Bay
12686 Camping
Sandlewood Bay
Shoal Point
Dune scrub
Sea View
Wattle thicket on limestone
Wattle low forest
Scrub heath on sandplain
CHRISTMAS HILL
BLACKBOY 817
Jam York gum
16064 Water
Binnu
Acacia-Melaleuca thicket
Gregory Spring
Appaliera Well
Wollyllia
Woottarna
Jam with scattered York gum
Chilominey
Provenson Hotel
MANNERERRA PEAK
12444 Water
Hull
Ogilvie
York gum Mallee & wattle
MOUNT VICTORIA
MOUNT ALBERT
Mixed thicket
WEST KIANOOKA
KIANOOKA HILL (P.D.)
APPADAGEMMA PEAKS
MOUNT WILLOUGHBY
Scrub heath
Lynton
North Rock (P.D.)
Hera Passenger
Gold Digger Passenger
Port Gregory
Archdeacon Ledge
Broken Anchor Bay
ORIGINAL HILLS
Yallabatharra
Public utility
19541
Mixed thicket
MOUNT MUNCHIN
GRAND HILL
Jam & Hakea with scattered York gum
White Cliffs
GILL HILL (P.D.)
WELL HILL
Wattle-Banksia scrub
WILLONGARINA HILL
River gums on drainage
Munga Gabbe
Dissected country on Proterozoic rocks
Wearbe
WANERENOOKA HILL
Northampton
EASTBROOK HILL
Eastbrook
Whistle Bowl Cave
Three Mile Beach
Horrocks
TERRY HILL (P.D.)
WOOTTACHOOKA HILL
BOWES HILL (P.D.)
TWO MILE HILL
POISON HILL
Argita Wongatinna
Jam & Hakea with scattered York gum
Seven Mile Station
LAUNDRY HILL (P.D.)
Wattle & Banksia
Issekio
IRONSTONE HILL
McGuire
Potamany
MADURE PEAK (P.D.)
Scrub heath on sandplain
GEELVINK
INDIAN
Oakabella
Hilligerri
MOUNT SEWELL
Jam & York gum
Howatharra
Oakajee
Wattle-Banksia
CARNEY HILL
SNOWS NEST
Jam & Hakea scattered York gu
Diadiloa
Protheroe
NABAWA HILL
DIGET HILL
FOSSIL HILL
Argyle
Ogee
Mixed thicket
Jam & Hakea with scattered York gum
Baddera
ROCKY HILL
POISON HILL
Woodbinnatarra
Blue Well
Binnu
East Bowes
Bold Rock
Blackmans Rock
Scrub heath on sandplain
Scrut
The
Nara
Aller
Ogee
Mixed thicket
Jam & Hakea with scattered York gum
Scrub heath
Scrub heath on sandplain
Jam & Hakea scattered York gu
Wattle & Banksia
Wattle-Banksia scrub
Wattle-Banksia
Mixed thicket
Jam & Hakea with scattered York gum
Scrub heath on sandplain
Jam & Hakea scattered York gu
Wattle & Banksia
Wattle-Banksia scrub
Wattle-Banksia
Mixed thicket
Jam & Hakea with scattered York gum
Scrub heath on sandplain
Jam & Hakea scattered York gu
Wattle & Banksia
Wattle-Banksia scrub
Wattle-Banksia

APPENDIX D

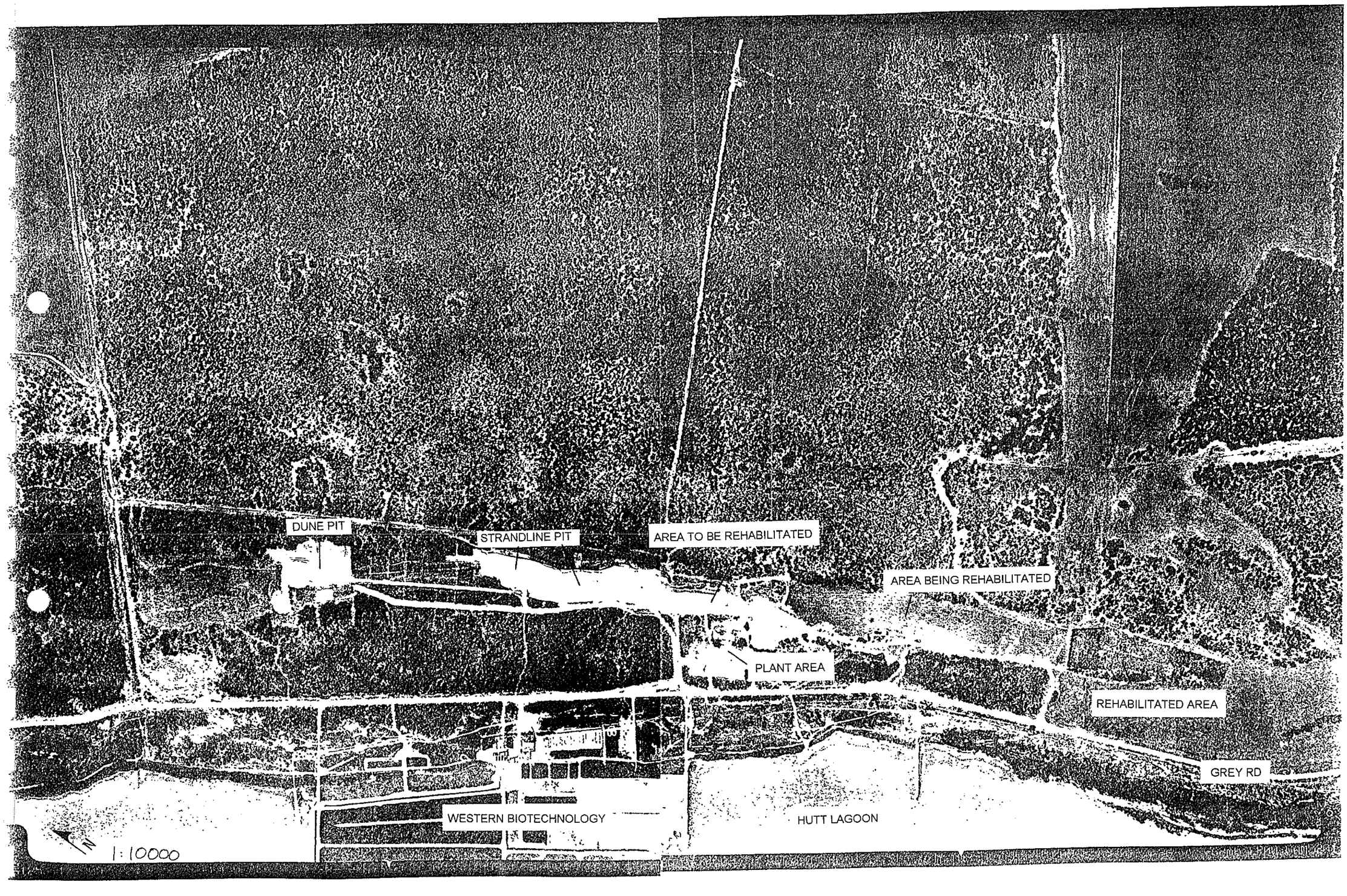
PROCESSING PLANT AND MINE LOCATION PLAN
PROCESSING PLANT AND MINE AERIAL PHOTOGRAPHS



GMA Garnet Pty Ltd. - Port Gregory Mine-Site

PROCESSING PLANT AND MINE LOCATION

10/5/1995


DUNE PIT
STRANDLINE PIT
AREA TO BE REHABILITATED
AREA BEING REHABILITATED
PLANT AREA
REHABILITATED AREA
GREY RD
WESTERN BIOTECHNOLOGY
HUTT LAGOON
N
1:10000

EMP 3461 58

NOI 3461

GMA GARNET PTY LTD INC IN WA

ACN 009 344 227

EMP 58

FILE 1188/90

NOTICE OF INTENT

MINING LEASE M70/204

PREPARED BY: GMA GARNET PTY LTD
September 19, 1995

P.O. Box 188 Geraldton, Western Australia 6530 Tel (099) 23 3644 Fax (099) 23 3747

TABLE OF CONTENTS

INTRODUCTION

SUMMARY

GMA Garnet Pty. Ltd. operates an open cut alluvial garnet mine and wet gravity separation plant on Mining Lease M70/204, 4 kilometres inland from the coast mid-way between Geraldton and Kalbarri. The nearest town site is Gregory ("Port Gregory") in the Northampton Shire.

The Port Gregory mine and plant has been operating since 1981 and supplies garnet concentrate to GMA's Narngulu facility (Geraldton industrial area). The Narngulu site dries and upgrades the concentrate to >97% garnet, then screens and packages the garnet for distribution. Finished product is stored on site at Narngulu and in a 10,000 tonne bulk storage facility at the Geraldton wharf.

GMA garnet is supplied throughout Australia, and exported to Europe, the United Kingdom, the Middle East, USA, Middle and South-East Asia, where it is used primarily for abrasive sandblasting. Over 50% of GMA's production is exported, and this proportion is increasing each year.

The Port Gregory garnet reserves are in excess of 6 million tonnes (inferred), making the resource possibly the largest alluvial garnet deposit in the world. GMA is the world's leading garnet sand producer, producing 70,000 tonnes of garnet abrasives during the 1994 - 95 financial year.

GMA currently employs 48 people divided between three sites; 17 people at the Port Gregory mine and wet separation plant, 27 at Narngulu, and 4 in Perth. All employees are sourced from local communities, and live within daily commuting distance of their workplace.

GMA has the relevant approvals from the Northampton Shire Council, Water Authority, and Department of Minerals and Energy to operate the mine and separation plant, draw ground water, and haul concentrate to Geraldton via shire roads.

COMMITMENTS

GMA operates within the guidelines and requirements of the Mining Act (1978 - 1987) and Mines Regulation Act (1976).

In order to safeguard the environment GMA Garnet will continue to;

1. Clear drill lines just sufficiently wide enough for a drill rig when conducting mine plan drilling.

2. Keep clearing of bush in the mine path to the minimum width for the pit and haul road, so as to minimise ground disturbance.

3. Stockpile the top 15 cm of topsoil prior to mining.

4. Progressively backfill all excavations, and re-contour all surfaces to suit the natural landscape.

5. Return stockpiled topsoil to the re-contoured areas and promote natural revegetation.

6. Monitor and regulate all groundwater extraction in accordance with Water Authority licence requirements.

7. Keep dust to a minimum by the use of a water truck, and conducting clearing operations during winter whenever possible.

8. Remove all used vehicle and equipment oil from site when no longer required.

9. Remove all roadways and facilities at the completion of mining and rehabilitate these areas.

OPERATIONS

An open cut mine and wet gravity separation plant have been in operation since 1981 when approvals were given under previous mineral claims 70/11560 - 11565 and 70/11619 (16924). These mineral claims were later converted to M70/204 under the transitional provisions of the mining Act.

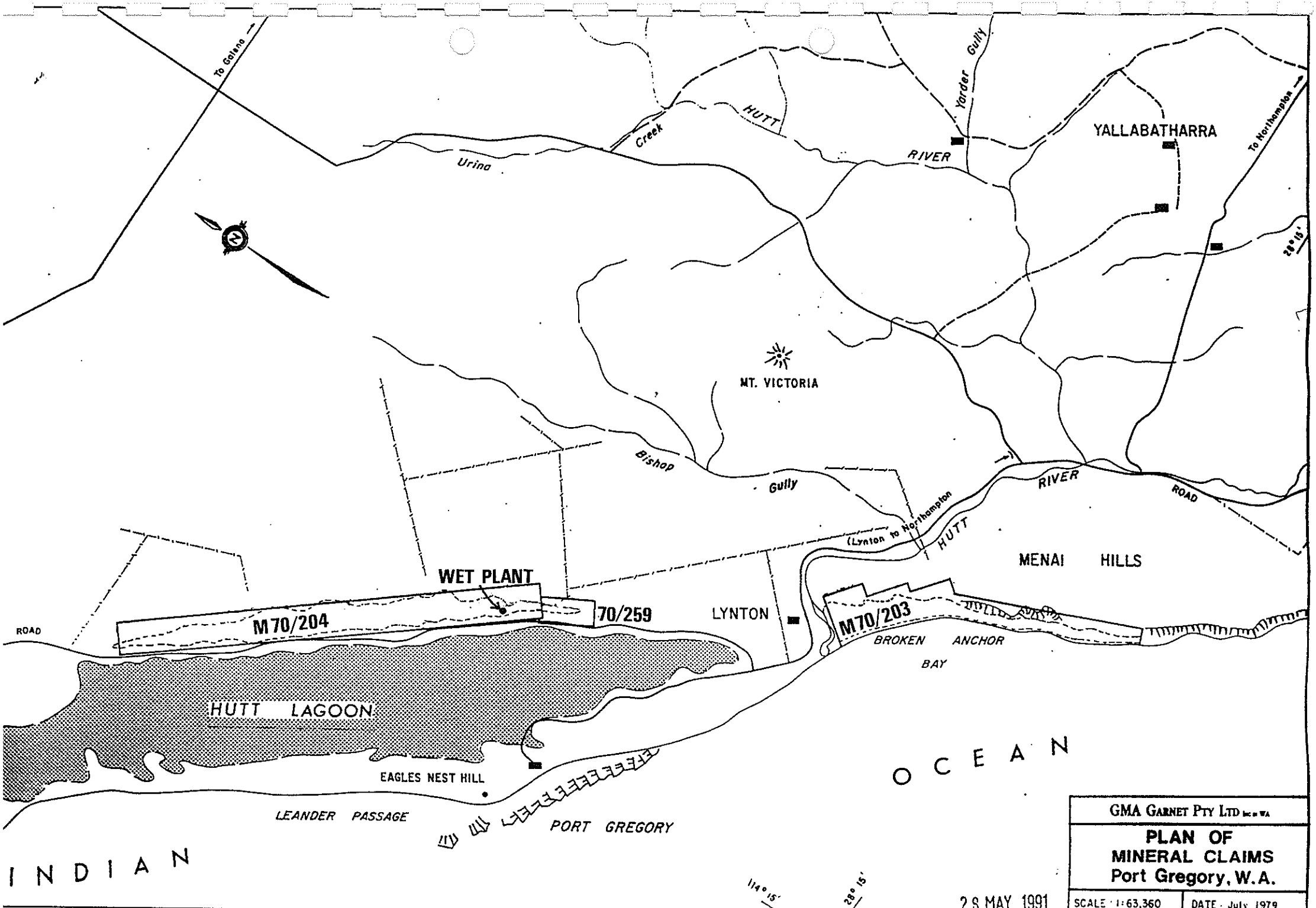
The wet plant is of simple demountable design and the process uses only basic elements of water assisted gravity separation (hydrosizer, spirals, cyclones, etc.) without requiring any chemical treatment. Several minor upgrades have been made over the years and the plant's capacity is now 15 tph of garnet.

It is expected that future plant upgrades and relocation of the plant (so as to reduce the distance travelled by trucks transporting ore and tailings between the pit and plant) will be required to match anticipated growth in the market for garnet.

Mining will continue to be by open cut methods with continuous back-filling and restoration of the mined area.

LOCATION

South West Mineral Field, Locality of Victoria, (Lot 6, Plan 12041). The lease is located on the east side of Hutt Lagoon (a salt lake), on the west side of which is the small crayfishing town of Gregory ("Port Gregory"). The nearest major town is Northampton, located some 50km by road to the South - East. The lease is located within the Shire of Northampton. Figure 1 is taken from the Hutt 1:100,000 topographic map sheet (1741).



GMA GARNET PTY LTD

PLAN OF MINERAL CLAIMS Port Gregory, W.A.

SCALE 1:63,360 | DATE - July, 1979

28 MAY 1991

OWNERSHIP

Lessees of M70/204 - Garnet Producers NL
- Barton Joint Venture Corp.
- B-L (Australia) Inc.

Managing / Operating Company - GMA Garnet Pty Ltd.
P.O. Box 188
Geraldton W.A. 6531

HISTORY

1. Wide spaced vacuum drilling (300 x 40m) in 1975 indicated a large high grade resource of alluvial garnet.

2. Private property covering M70/204 and M70/259 was purchased in 1978. This land was formerly part of Lynton Station and used for sheep grazing.

3. Infill vacuum drilling (100 x 20m) at southern end of M70/204 delineated mineable reserves of garnet sand.

4. A small 4tph wet gravity separation plant (at present plant site) and nearby open pit mining by front end loader commenced late 1981.

5. Since 1981 the same wet plant has had several upgrades lifting its production capacity to 15tph garnet. Open pit mining, backfilling, contouring, soil replacement and rehabilitation has continued in the vicinity of this plant, slowly progressing northward to the present pit location.

EXISTING FACILITIES

Already located on M70/204 are:

Mine Pits And Associated Private Unsealed Haul Roads

Feed Stockpile Area and Feed Hoppers

Demountable Wet Separation Plant

Mobile Equipment Storage Shed (Demountable)

Vehicle Workshop (Demountable)

Diesel Fuel Tanks (Free Standing)

Product Stockpile Area

Tailings Return Area

Slimes Return Pits

10 Non-Artesian Water Bores, Fresh and Recycle Water Tanks

Transportable Site Office, Ablutions, and Amenities

Transportable Electrical Store

EXISTING ENVIRONMENT

REGIONAL SETTING

M70/204 is approximately 600m wide by 8300m long, and is located along the base of a limestone escarpment of relict coastal dunes, some 4 km inland from the present coastline near Port Gregory with its southern limit approximately 5 km north of the Hutt River. Immediately to the west of the mining lease is Hutt Lagoon (salt lake). The present coastline is to the west of recent dune formations located on the west side of Hutt Lagoon.

Local topography is typical of coastal limestone and related sandy alluvium / colluvium, with large elongate dune ridges paralleling the coast now stabilised by thick vegetation..

Western Biotechnology Pty. Ltd. presently occupy the southern end of Hutt Lagoon, and have created shallow ponds within the lagoon for cultivating *Dunaliella saline* algae, a source of beta carotene. Western Biotechnology's processing plant used for harvesting the algae is located some 700m north-west of GMA's wet separation plant.

GEOLOGY

The ore deposit consists of a Late Pleistocene - Recent heavy mineral strandline and overlying dune ores, both of which are garnet rich. The strandline is located on a relict wave-cut platform at the base of a buried scarp of older Pleistocene Tamala Limestone. The strandline is overlain by garnet enriched aeolian sands, which have blown up and over parts of the Tamala Limestone scarp. Inferred resources are some 6 million tonnes of garnet sand.

Dune ore occurs at depths of 1 to 13m below the surface, and in a band 80 to 400+m wide. Strandline ore occurs beneath the dune ore and/or overburden, and is between 5 and 8m thick.

The ore consists predominantly of unconsolidated quartz sand, with varying amounts of shell sand, carbonate cement, garnet and ilmenite, with trace amounts of zircon and rutile. The garnet and associated heavy minerals are probably derived from the garnet granulites of the Proterozoic Northampton Block. Their concentration on M70/204 seems to be a result of transportation to the coast via the Hutt River, presumably during wetter climatic periods, combined with long-shore drift and onshore winds predominantly from the south-west at a time when the sea level was about 8m higher than at present.

HYDROLOGY

No surface run-off exists in the lease area, as any rainfall quickly soaks into the porous limestone and sand. The only surface water in the nearby area is Hutt Lagoon salt lake, which intermittently fills with water. After winter rains, the water soon becomes hyper-saline and dries out in summer. There is no potential of flooding from Hutt Lagoon, as almost all of M70/204 is several meters above lake level.

A lens of semi-saline (1800 ppm TDS) water up to 10m thick underlies parts of M70/204, which is in turn underlain by saline water. All sub-surface drainage is to the west. The semi-saline water is thought to be generated from a broad undulating elevated catchment area east of the Tamala Limestone escarpment.

Detailed reports on the hydrogeology of M70/204 are submitted annually to the Water Authority in accordance with the conditions of Groundwater Well Licence No. 0053830.

CLIMATE

The Geraldton - Kalbarri region of coastline exhibits a Dry Warm Mediterranean type climate, with hot dry summers and mild wet winters. Average rainfall is 463mm, and evaporation is 2383mm. The majority of rainfall occurs during the May - September period, with the growing season being May to September. Mean temperatures range from 19 to 35°C during summer (January), and from 6 to 17°C during winter (August). Prevailing winds are from the South-South-West during summer, and variable during winter. Figure 2 is the seasonal rainfall and temperature chart for Geraldton.

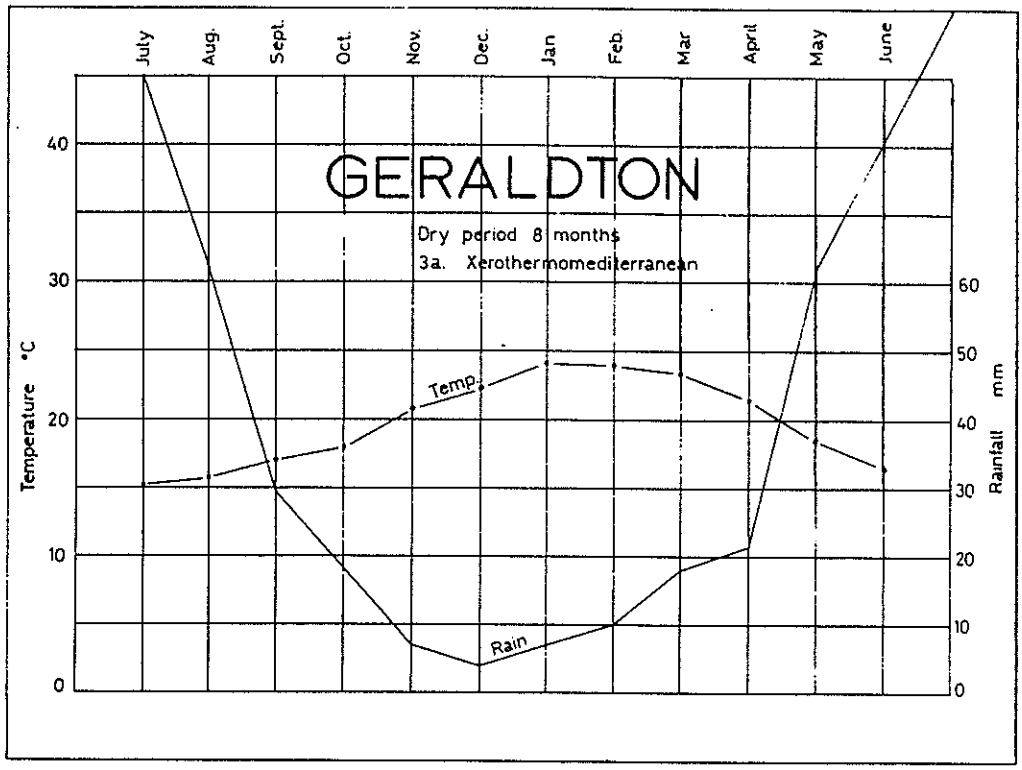


Figure 2. Seasonal rainfall and temperature diagram for Geraldton.

FLORA

The M70/204 lease area is located within the South-West Botanical Province of the Irwin Botanical District 1. Various flora studies of the province have been carried out, of which the 1: 250,000 Vegetation Survey of Western Australia (1976) places the lease area in the Greenough Vegetation System. The Greenough System is associated with the coastal limestone and extends along the coast from Kalbarri to Dongara. Soil in the lease area is leached sand consisting of quartz and carbonate fragments with a uniform textured profile darkened by organic matter at the surface. This overlies limestone or a uniform profile of thick quartzose - calcareous sands, underlain by limestone at depth.

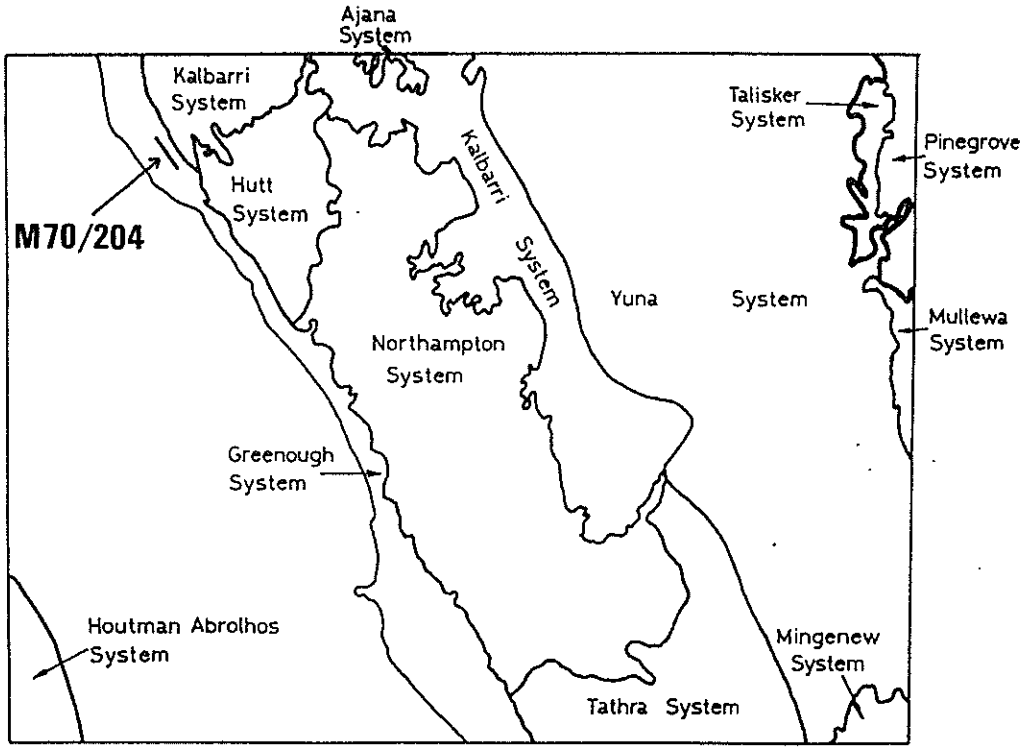


Figure 3. Vegetation Systems in the Geraldton area.

The lease area is partially covered by *Acacia rostellifera* thicket <10m tall with a mid-dense canopy (projective foliage cover of 30 - 70%), (see map - Appendix C).

The *Acacia rostellifera* community is common on the coastal limestone hinterland between Hutt River and Kalbarri National Park. A description of the *Acacia rostellifera* community follows;

> "*Acacia rostellifera* thicket is a dense shrub community consisting principally of the *species A. rostellifera, A. ligulata, A scirpifolia, A. xanthina, Eucalyptus eudesmioides* and *E. oleosa* (both as mallees), and *Melaleuca cardiophylla* among the large dominant shrubs. *Alyogyne cuniformis, Calothamnus quadrifidus, Grevillea biformis, Labichea sp., Helichrysum sp.*,

Hibiscus huegelii, *Pimelea floribunda* and *solanum simile* are among the smaller plants. There is no definite small shrub layer. In the rockiest and steepest places *Melaleuca cardiophylla* assumes dominance as more or less the sole species."[1].

As the M70/204 lease area was previously station land and is still used for grazing sheep by the owners of adjoining Lynton Station, the Acacia community within M70/204 has been affected by grazing, partially attributable to a significant European Rabbit population. A large population of introduced weeds and grasses are present throughout the lease area, many of which have been transported by sheep and other mammals into the Acacia thicket from adjacent pastoral land. The northern and southern portions of the lease have at some time been cleared for cropping and sheep grazing. Much of the previously cleared area has since returned to *Acacia rostellifera* thicket through vigorous self regeneration

FAUNA

As both the northern and southern ends of the lease have been cleared in the past and used for pastoral purposes, introduced mammals are common. European Rabbits, domestic mice, foxes, and feral domestic cats have all been sighted in addition to sheep that still graze the area.

The diversity and occurrence of native fauna within the lease area has not been studied in specific detail, but as far as GMA can ascertain from studies conducted by the Main Roads Department of W.A. for the Horrocks - Kalbarri Road Project, there are no occurrences of fauna classified under the Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 1994 within the areas that will be affected by mining and processing operations.

[1] J.S. Beard & A.C. Burns, 1976, "The Vegetation of the Geraldton Area, Western Australia" Map and Explanatory Memoir 1:250,000 Series., Vegmap Publications, Perth.

PROJECT DESCRIPTION

MINING

All mining operations on lease M70/204 are conducted under the requirements of the Mining Act and Regulations and are subject to regular inspection by the relevant inspectors.

Mining operations are generally conducted 24 hours a day, five days a week, in three 8 hour shifts.

Mining and restoration is conducted by wheel loaders (2) and off-road articulated dump-trucks (2), with occasional assistance from hired bulldozer and excavator. The mine is a moving pit, being mined at one end and being progressively backfilled and restored at the other. The maximum depth of the pit is no more than 22m, and is typically 6 to 19m deep. The ground is poorly cemented by carbonate calcretes, with some areas of surface caprock.

Appendix A contains photographs of the mining operation. Appendix D contains a plan of the present pits and an aerial photograph of the mine area.

Mining is conducted in six stages:

1. A bulldozer is used to clear the existing bush along narrow east-west drilling lines (100 or 50m spacing), and grade control drilling and sampling follow.

2. A bulldozer is used to clear the bush remaining immediately ahead of the mine path.

3. The bulldozer then pushes 15-30cm of topsoil into stockpiles adjacent to the mine path.

4. Wheel loaders (and occasionally an excavator) are used to remove overburden in 3 - 5m benches, which is trucked to the backfill end of the pit.

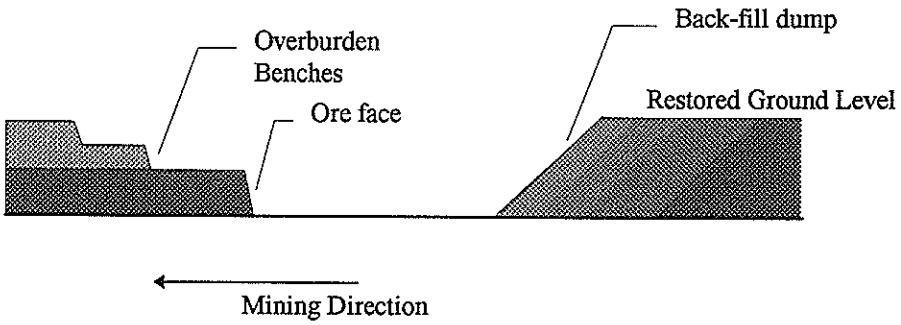
5. Wheel loaders (and occasionally an excavator) are used to mine the ore in 2 or 3 benches each 3 - 5m high. The ore is trucked to stockpiles near the wet processing plant.

6. Tailings from the wet separation plant are trucked to the backfill end of the pit, and when the natural ground level is achieved, the area is re-contoured and the stockpiled topsoil is spread by bulldozer. After topsoil replacement the mined areas are fenced to prevent sheep damaging the Acacia regrowth, which is vigorous after the first winter rains.

At all stages of mining, dust suppression is aided by the use of a water truck.

At present there are two pits on M70/204, the main working pit and a test pit ahead of the working pit. Over the next 12 - 15 months these will join to form a single pit with backfilling continuing northwards. The mining direction is to the North-North-West, and it is envisaged that this will continue for the foreseeable future. Mine progression rate varies between 20 and 80m movement north per month, depending on the size and morphology of the ore body. The progression rate will decrease as the ore body widens in the vicinity of the test pit.

Figure 4. North - South Cross-section through northward moving pit.



Approximately 15% by volume of the material mined is removed from site as saleable product, though this loss of volume from the mined areas is more than compensated for by the increase in volume due to the swelling of overburden material. Carbonate cemented overburden increases in volume by up to 30% after being broken out, transported, and dumped during mining.

At all times, a buffer of undisturbed bush is left between Grey Road (parallel to M70/204 and down-slope) and the mining and processing operations so as to reduce or eliminate any visual impact.

ORE PROCESSING

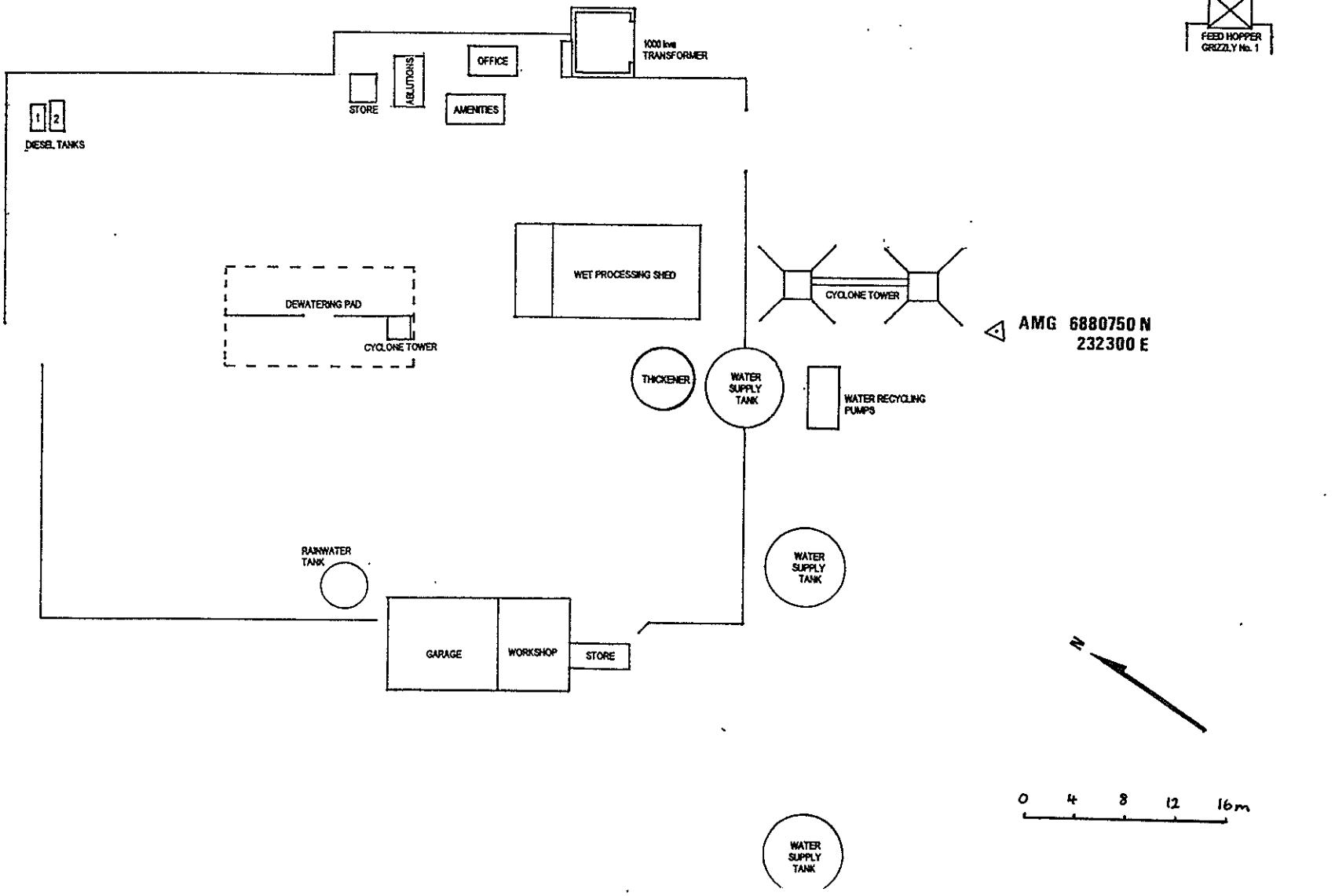
Ore processing is generally carried out 24 hours a day, five days a week, in three 8 hour shifts per day. Weekends are sometimes worked when concentrate stocks are low or time is lost during the normal working week.

Ore processing is via simple water assisted wet gravity separation. Stockpiled feed is fed to two hoppers and grizzlies by wheel loader. The ore is conveyed to a wet trash screen from where it is pumped to a nearby demountable wet gravity separation plant. Separation is achieved by a combination of hydrosizer, spirals, and hydrocyclones using local bore water. The concentrate is mechanically attritioned, washed, de-watered and stockpiled ready for cartage by a trucking contractor to the Geraldton dry plant. Tailings are de-watered by cyclone and allowed to drain prior to being returned to the back-fill end of the pit. Process water is recycled through a thickener. Thickener underflow (calcareous slimes) is allowed to drain prior to being returned with tailings to the back-fill end of the pit. Appendix D contains a plan of the processing plant location and an aerial photograph. Figure 5 is a plan of the processing plant layout.

The only dangerous goods used or kept on site (other than the diesel fuel store), are two density gauges containing radioactive sources. These are registered by the Radiation Health Branch of the Radiological Council (Health Department), Registration No. RS 100/94 9433.

GMA GARNET PTY LTD - PORT GREGORY MINE-SITE

WET SEPARATION PLANT



TAILINGS DISPOSAL

All tailings from the wet separation plant are returned to the progressively back-filled pit. Tails consist of quartz sand and carbonate fragments, with minor amounts of heavy minerals. Thickener underflow (carbonate mud) is de-watered and returned with tailings to the back-filling area of the pit. Tailings from the Geraldton dry plant (quartz, carbonate, ilmenite) are returned by truck and dumped at a temporary pad prior to being returned to the pit by GMA's earthmoving equipment. When the back-filled pit has reached the surrounding ground level, the surface is re-contoured to a natural looking topography. Stockpiled topsoil is then spread over the surface and Acacia self regeneration begins. Appendix A contains photographs of the backfill operation.

SUPPORT FACILITIES

The various support facilities and their locations are shown on the supplied plan (Appendix D)

Support facilities consist of:

1. Site office (single room transportable building).
2. Amenities - lunch room (single room transportable building).
3. Ablutions (male/female/toilet & shower transportable building).
4. Electrical / Radioactive Source Container Store (single room transportable building).
5. Workshop - adjoining the main plant building (demountable shed).
6. Vehicle workshop and store (demountable shed).
7. Transformer compound - brick compound containing a 1000KVA ground mounted transformer for the plant electricity supply.
8. Fuel store - two above-ground (7200 & 5300 Litre) free standing diesel tanks with containment bunds.
9. Scrap item storage yard.
10. Ten (10) non-artesian water bores and eight (8) 90,000L water storage tanks (7 fibreglass, 1 concrete).

WORKFORCE

17 full-time persons are employed by GMA at the mine and wet processing plant, and 3 contractor employed persons are engaged full-time driving one contractor owned dump truck at the site (soon to be replaced by GMA's own dump truck and personnel). Of the 17 GMA employees, one is the mine manager, the rest being plant and mobile equipment operators.

All GMA employees at the site (except for the mine manager) are employed on a five day week, eight hour shift roster. The employees are locals sourced from the towns of Northampton, Horrocks, Gregory, or nearby private properties. These employees commute to and from the site at the change of each shift. Company transport is provided between the mine and Northampton where the majority of employees live, a distance of 50km.

TRANSPORTATION CORRIDORS

All ore and tails haulage to and from the mine and wet processing plant is via a private haul road located within M70/204, which itself is located within private property owned by GMA.

Transportation of garnet concentrate from the wet processing plant to Geraldton, and the return of dry tailings to the mine from Geraldton is via eight wheel tipper truck and trailer owned and operated by the contract holders, Giacci Bros. Pty. Ltd. Written permission for the transport of mineral sands between the mine-site and Geraldton has been obtained from the Shire of Northampton (Appendix B), and Giacci Bros. Pty Ltd. hold the necessary permits to operate their vehicles from the Main Roads Department and Geraldton/Greenough Shires. As part of the mine-to-Geraldton road is unsealed (Grey Road near Hutt Lagoon), transportation is halted when weather conditions make damage to the road surface likely. The remaining unsealed road will progressively be upgraded and sealed as part of the Horrocks - Kalbarri Road project.

UTILITY REQUIREMENTS

All electrical power for the wet separation plant and associated facilities is derived from a Western Power 33 KV reticulation line that crosses M70/204 some several hundred meters north of the plant. The 33 KV supply is stepped down to 440V via a ground mounted transformer within the plant compound.

Diesel for the earthmoving equipment is supplied by fuel company road tanker, and is stored in two above-ground tanks (7200L and 5300L) within the plant compound (Licensed under the Explosives and Dangerous Goods Act, 1961).

The wet gravity separation plant is licensed to extract up to 130,000 kilolitres of water per annum from the 10 non-artesian bores (Groundwater Well Licence No. 0053830).

An additional 100,000 kilolitres per annum of fresh (500ppm TDS) can be supplied from Victoria Location 1428 (Appatarra Well) via a 7km pipeline. This is licensed by the Water Authority as Groundwater Well Licence No. 47201.

All potable water for the site is supplied from rain-water tanks collecting from the plant and garage shed roofs.

ACCOMMODATION AND HOUSING

No accommodation or housing is provided by GMA. All employees live in the nearby towns of Northampton, Horrocks, and Gregory, or nearby private properties, and commute to the site by private or GMA vehicles.

ENVIRONMENTAL IMPACT AND MANAGEMENT

WATER

All 10 bores located on M70/204 used for process water supply are monitored monthly in accordance with the conditions of Groundwater Well Licence No. 0053830. A report to the Water Authority by a competent hydrogeologist is submitted by 30th July each year. No decline in water quality or supply has been noticed in the two years since the bores were licensed and regular monitoring began.

As the sub-surface hydraulic gradient is toward Hutt Lagoon, GMA is the last user of fresh or semi-saline groundwater prior to the water entering the sub-surface of the lagoon (below sea-level). There are no up-stream groundwater users within the area of influence of the ten bores (no drawdown is observed at greater than 50m from a pumping bore).
Western Biotechnology Ltd. is located adjacent to M70/204 on the downstream side, but require water with high salinity for their operations.

No mine de-watering is necessary, as all mining operations are conducted above the natural water table.

The product and tailings stockpiles drain through the sandy soil and return to the aquifer down-gradient of the bores, and continue their flow toward the hyper-saline Hutt Lagoon. This water is only slightly more saline than when it was extracted (extracted at 1800-2000ppm TDS, returned at 2200ppm TDS).

No drainage control is necessary as surface runoff is non-existent in the sandy soils.

FLORA AND FAUNA

As the mine pit varies in width between 80 and 400+m, so does the amount of bushland required to be cleared. Approximately 43% of M70/204 is land that has not previously been cleared for pastoral uses, but will require clearing at some stage during the mine life. This is an ongoing process, with only the area immediately ahead of the mine path being cleared at any one time. Clearing is kept to a minimum at all times, with the area cleared being of sufficient area for the mine pit and haul road only. Preliminary clearing ahead of the mine path is kept at 1 to 1.5 years worth of mine progression so as to allow at least one winter of rainfall to dampen the ground prior to mining, reducing dust and providing a firmer surface for vehicles to work on.

No known rare or endangered floral or faunal species will be disturbed by mining operations on M70/204. Approximately 46% of the *Acacia rostellifera* thicket found on M70/204 will remain undisturbed by mining, and the remaining areas will undergo continuous rehabilitation as the mine pit progresses.

The Acacia community is very quick to re-establish after mining, with substantial regeneration occurring within 3 years of soil replacement. As the mined areas are bounded to the east and west by undisturbed Acacia thicket, faunal species can easily move back into rehabilitated areas.

WASTE PRODUCTS

Combustible domestic wastes are safely incinerated on-site, while liquid domestic wastes (sewerage) are disposed of via a septic tank. A temporary scrap equipment and waste collection area is used to consolidate rubbish for batch removal to municipal disposal sites.

Mineral tailings and de-watered slimes are returned to backfill the progressing pit as described earlier.

TOXIC MATERIALS

Diesel fuel is the only dangerous good transported regularly to the lease, and this is the responsibility the fuel distributor. Used lubricating oil from earthmoving equipment is removed from the site by GMA and safely disposed of.

Radioactive sources for the two density gauges in the plant are handled in accordance with the Code of Practice for the Safe Use of Radiation Gauges (1982). Road transport of these items (although a rare event), is conducted in accordance with the same Code of Practice.

ATMOSPHERIC POLLUTION

In order to reduce wind-borne dust, clearing operations are conducted whenever possible during winter or less windy times of the year. Clearing is also carried out sufficiently early so that any area to be mined has at least one winter to absorb moisture, aiding dust control. If left uncleared until just prior to mining, the vegetation prevents moisture penetrating below 2 to 3m.

A water truck operates on all haul roads, and all of GMA's earthmoving equipment is equipped with sealed cabins and filtered air-conditioning.

No dust is emitted from the processing plant, as all material handling (after the feed hoppers) is in the form of slurries. Tailings and slimes are returned to the pit while still damp, and concentrate is usually still damp when loaded out to Geraldton. Dry concentrate is free of dust due sizing and washing in the plant.

NOISE

No blasting or rock-breaking is necessary in the mining operations, and all earthmoving equipment is modern Volvo or Caterpillar equipment with sound-proofed cabins and muffled exhausts.

In the processing plant, the only noise producing items are electric motors driving pumps and attrition machines. All operators are supplied with hearing protection, and the site has been approved by the Mines Department Inspectorate.

REHABILITATION

The aim of GMA's rehabilitation process is to return the land to its original state with the original flora and fauna. This will be achieved with minimal change to the pre-mining topography. Appendix A contains a series of photographs illustrating the rehabilitation process. The aerial photograph in Appendix D also illustrates the extent of rehabilitation.

As of May 1995, a total of 35.6 ha of M70/204 had been cleared for mining, stockpile, and processing plant uses. This is divided up into;

4.7 ha Processing plant and stockpiles
15.7 haMine pits, backfill, and land cleared prior to mining.
7.2 ha Cleared for grade control drilling
8.0 ha Backfilled, re-contoured, topsoil replaced, and progressively re-vegetated.

Of these areas, only the 4.7 ha used for plant facilities and stockpiles will remain cleared for an extended period of time. All other cleared land is progressively mined, backfilled, and restored.

Rehabilitation of mined areas consists of four stages;

1. Ripping of haul roads no longer required.
2. Re-contouring of the completed back-fill to suit the natural landscape.
3. Replacement of topsoil stockpiled prior to mining.
4. Re-vegetation. The native flora re-grows rapidly after winter rains, and is fenced to protect the young plants from sheep grazing. This fencing is removed when the flora is sufficiently strong enough to survive grazing by sheep.

The *Acacia rostellifera* community is quick to regenerate from disturbed areas after the return of the topsoil. Drill lines cleared in 1975 are now completely undetectable from either the air or ground, and an area cleared in 1990 for mine plan drilling is now thicket 2.0 - 2.5m high and impassable to a 4WD.

Wind erosion of mined or rehabilitated areas has not been a problem, as the gentle slope of the lease area and the thick Acacia forest to the immediate east and west of the pit area provide adequate shelter for the young regrowth. Similarly water erosion is non-existent due to the low rainfall of the region, gentle slope and the sandy soils.

DECOMMISSIONING

Decommissioning of the processing plant facilities will consist of complete removal of all plant items, buildings, haul roads, water tanks, power and water reticulation, stockpiles, etc. This will be followed by re-contouring of the plant and stockpile area, ripping of compacted soils, replacement of topsoil, and fencing to protect young regrowth. When all regrowth is sufficiently able to survive grazing by sheep, the fencing will be removed. The only items that will remain will be the water bores, which under Water Authority licensing conditions must be made available to nearby or future land-holders.

COMPLETION CRITERIA

The ultimate objective of GMA's operations on M70/204 once all commercially viable garnet resources have been extracted, is to return all areas affected by mining or processing operations to the original *Acacia rostellifera* community.

SOCIAL IMPACTS

ABORIGINAL SITES

GMA will abide by the Provisions of the Aboriginal Heritage Act, and will report to the W.A. Museum any findings of sites of Aboriginal significance or artefacts within the boundaries of M70/204. As such no sites or artefacts have been discovered within the lease area by GMA, the previous land-owner or Aboriginal consultants examining a proposed road alignment through M70/204.

HERITAGE

Any items of European Heritage discovered in the lease area will be defined, recorded, and relocated or preserved as necessary. The W.A. Museum will be notified if it is thought that any such items may be of cultural significance.

No items of European Heritage have yet been discovered in the lease area.

LAND USE

The M70/204 lease is mostly private land held by GMA. As detailed earlier, there are no adverse environmental impacts on neighbouring properties.

GMA allows (by way of special agreement at the time of purchase) the previous land-owner to run sheep on M70/204, and GMA is not responsible for any stock losses that may occur due to mining activities. Under this agreement the upkeep of boundary fences and watering points is the grazier's responsibility.

SOCIAL ENVIRONMENTAL

The mining and processing operation carried out by GMA on M70/204 is one of the largest non-government enterprises in the Northampton Shire. As all GMA employees at the site are Northampton Shire residents, the company is a significant contributor to the local economy.

At all times a buffer of Acacia low forest is maintained between Grey Rd and the mine and processing facilities. This makes GMA's operations almost invisible from Grey Rd, and hides most parts of the mine from the Gregory townsite 3km away on the far side of Hutt Lagoon.

APPENDIX A

SITE PHOTOGRAPHS

View looking North - West along mining direction showing ore face and overburden benches in the main pit.

View looking South - East over the backfill dump. Overburden and tailings are used to backfill the pit as it moves northward, recreating a natural looking topography.

View to the North - West along the mining direction. In the foreground is stockpiled topsoil ready to be spread over the backfilled area in the middle of the photograph. The mine pit is in the middle distance.

View looking South - East over mined out areas to east of the plant buildings and feed stockpiles. Areas in the foreground and middle distance have recently had the topsoil replaced.

The previous photograph re-taken 4 months later. Grasses cover the topsoil and prevent wind erosion until the Acacia regrowth is established. The thick wattle in the left centre distance is the product of 3 year's regrowth.

This view shows three stages of regrowth. The foreground has had one year of growth, while the centre (low scrub) has had two years of growth. The Acacia thicket in the middle distance is three seasons old.

A view of the two year old regrowth in the foreground with the three year old growth behind. The fence in the foreground is to keep out sheep until the wattle is large enough to survive grazing.

The three year old Acacia regrowth behind the vehicle is now large enough and thick enough to prevent grazing by sheep, and the fence has been removed.

APPENDIX B

NORTHAMPTON SHIRE APPROVAL

SHIRE OF NORTHAMPTON

PLEASE ADDRESS ALL COMMUNICATIONS
TO THE SHIRE CLERK
TELEPHONE: 34 1202, 34 1008
P.O. BOX 61 NORTHAMPTON, W.A. 6535
FAX No. (099) 34 1072

RECEIVED
30 MAY 1995

Our Ref: DT1

Your Ref:

Mr M Ingram
Geologist
GMA Garnet Pty Ltd
P O Box 188
GERALDTON WA 6531

Dear Michael

This is to advise that Council approves of the following for GMA Garnet Pty Ltd.

1. Operate your Port Gregory mine and wet separation plant on Mining Lease M70/204.

2. Draw water from Appatarra Well (Victoria Location 1428, Groundwater Well Licence No. 47201).

3. Transport garnet concentrate and tailings to and from your Geraldton plant via Giacci Bros. Pty Ltd's eight wheel tipper and trailer combinations.

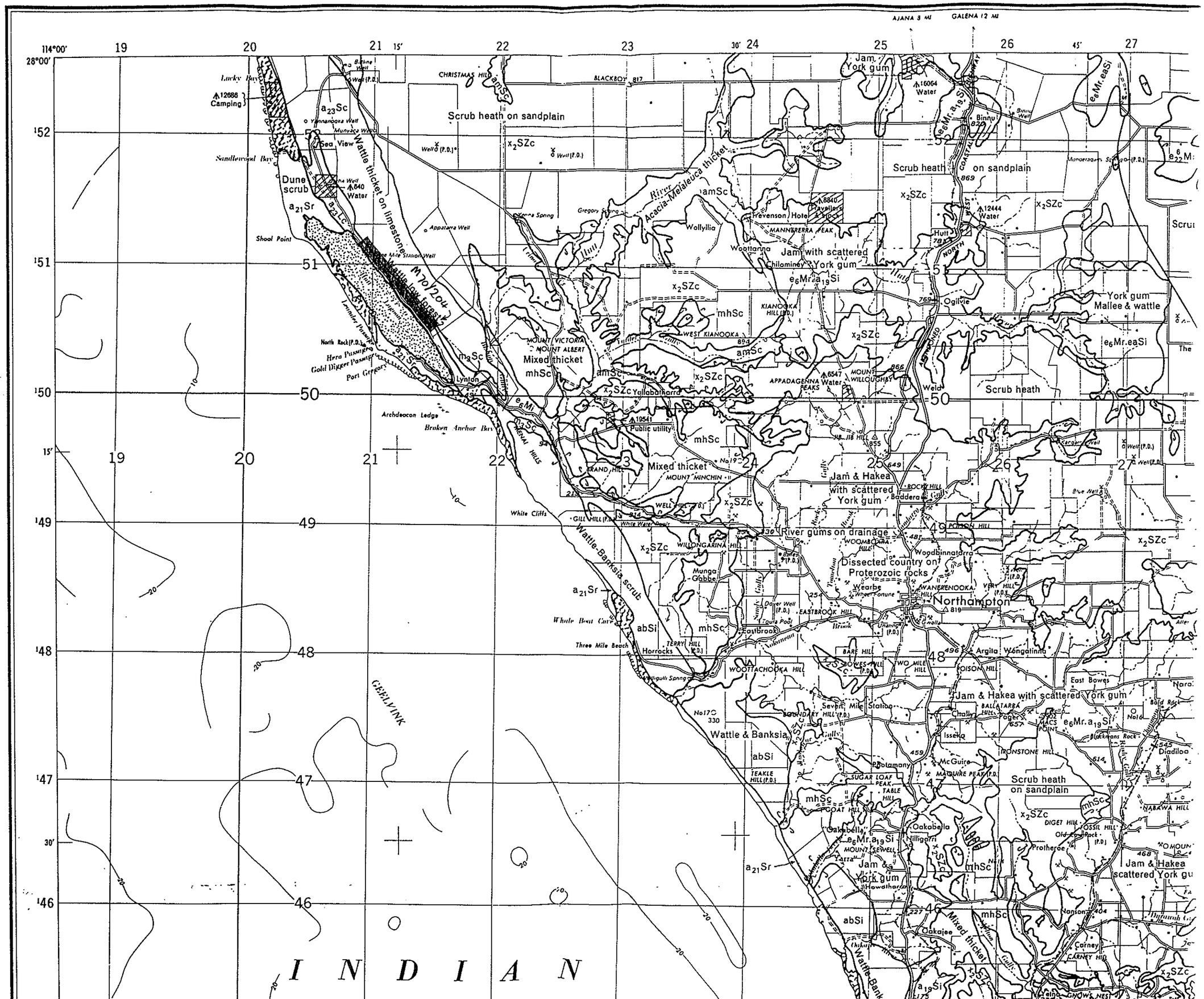
Yours faithfully

Mr C J Perry
SHIRE CLERK

26 May 1995
mcliff/sh/gmagarnet

APPENDIX C

1:250,000 VEGETATION MAP


114°00'
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45'
19
20
21
22
23
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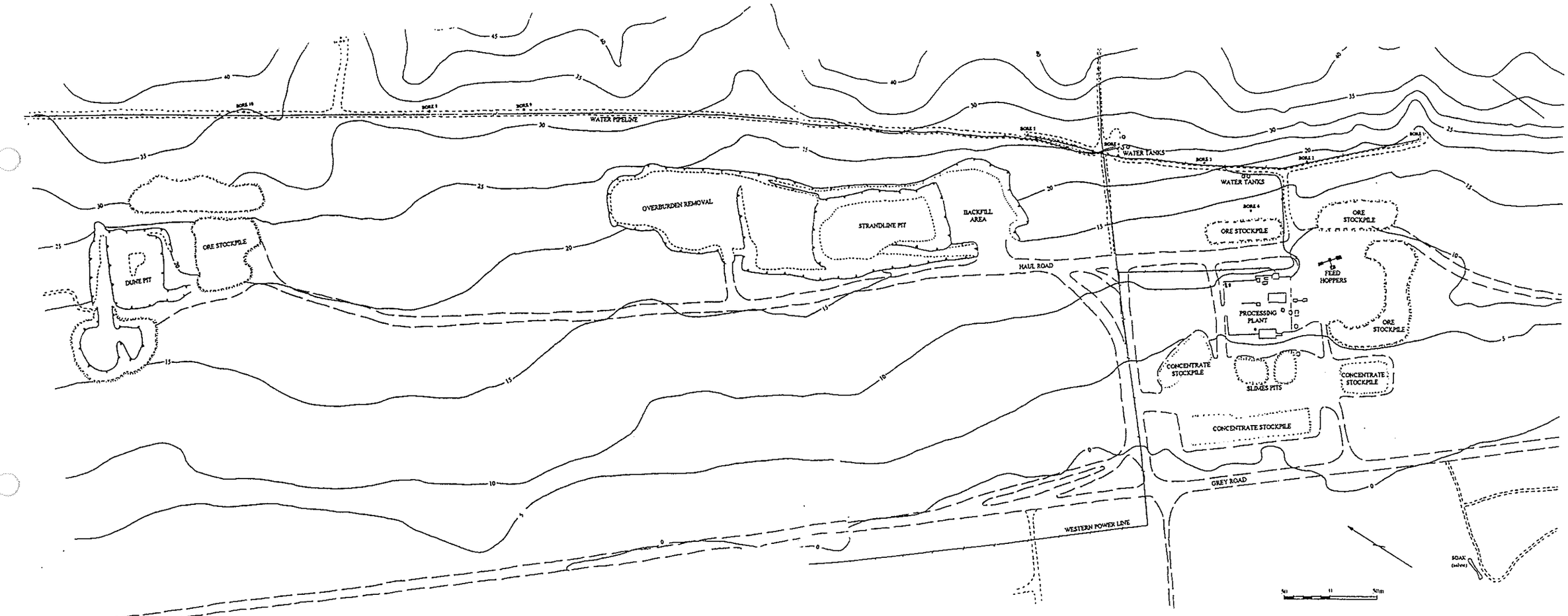
27
52
51
50
49
48
47
46
AJANA 3 MI
GALENA 12 MI
Lucky Bay
Camping
Sandlewood Bay
Shoal Point
Dune scrub
Sea View
Yannanooka Well
Munyaca Well
Wattle thicket on limestone
Low forest
Mollyoch
Scrub heath on sandplain
CHRISTMAS HILL
BLACKBOY
Well (P.D.)
Gregory Spring
Appataira Well
Mount Victoria
Mount Albert
Mixed thicket
Lynton
Archdeacon Ledge
Broken Anchor Bay
Public utility
Grand Hill
Mount Minchin
River Acacia-Melaleuca thicket
Wollyllia
Trevenson Hotel
Mannerrera Peak
Woottanna
Jam with scattered York gum
Chilominey
Kianooka Hill
West Kianooka
Appadagenna Peaks
Mount Willoughby
Weld
Ogilvie
Hull
Binnu
Coastal Highway
North West Coastal Highway
Jam & Hakea with scattered York gum
Rocky Hill
Baddera
White Cliffs
Gill Hill
White Water Gully
Wattle-Banksia scrub
Willongarina Hill
Munga Gabbro
River gums on drainage
Woombourra Hill
Dissected country on Proterozoic rocks
Wearbe
Wheel Fortune
Wanerenooka Hill
Northampton
Dover Well
Eastbrook Hill
Eastbrook
Horrocks
Three Mile Beach
Terry Hill
Bare Hill
Bowes Hill
Two Mile Hill
Poison Hill
Wootiachooka Hill
Argita
Wongatinna
East Bowes
Jam & Hakea with scattered York gum
Seven Mile Station
Boundary Hill
Chally
Issena
Ironstone Hill
McGuire
Potamany
Sugar Loaf Peak
Table Hill
Coat Hill
Scrub heath on sandplain
Wattle & Banksia
Teakle Hill
Oakabella
Nilligorn
Mount Sewell
Jam & York gum
Howatharra
Oakajee
Nanson
Carney
Carney Hill
Crowd's Nest
Protheroe
Fossil Hill
Nabawa Hill
Diadiloo
Ironstone Hill
Mixed thicket
Geelvink
INDIAN

APPENDIX D

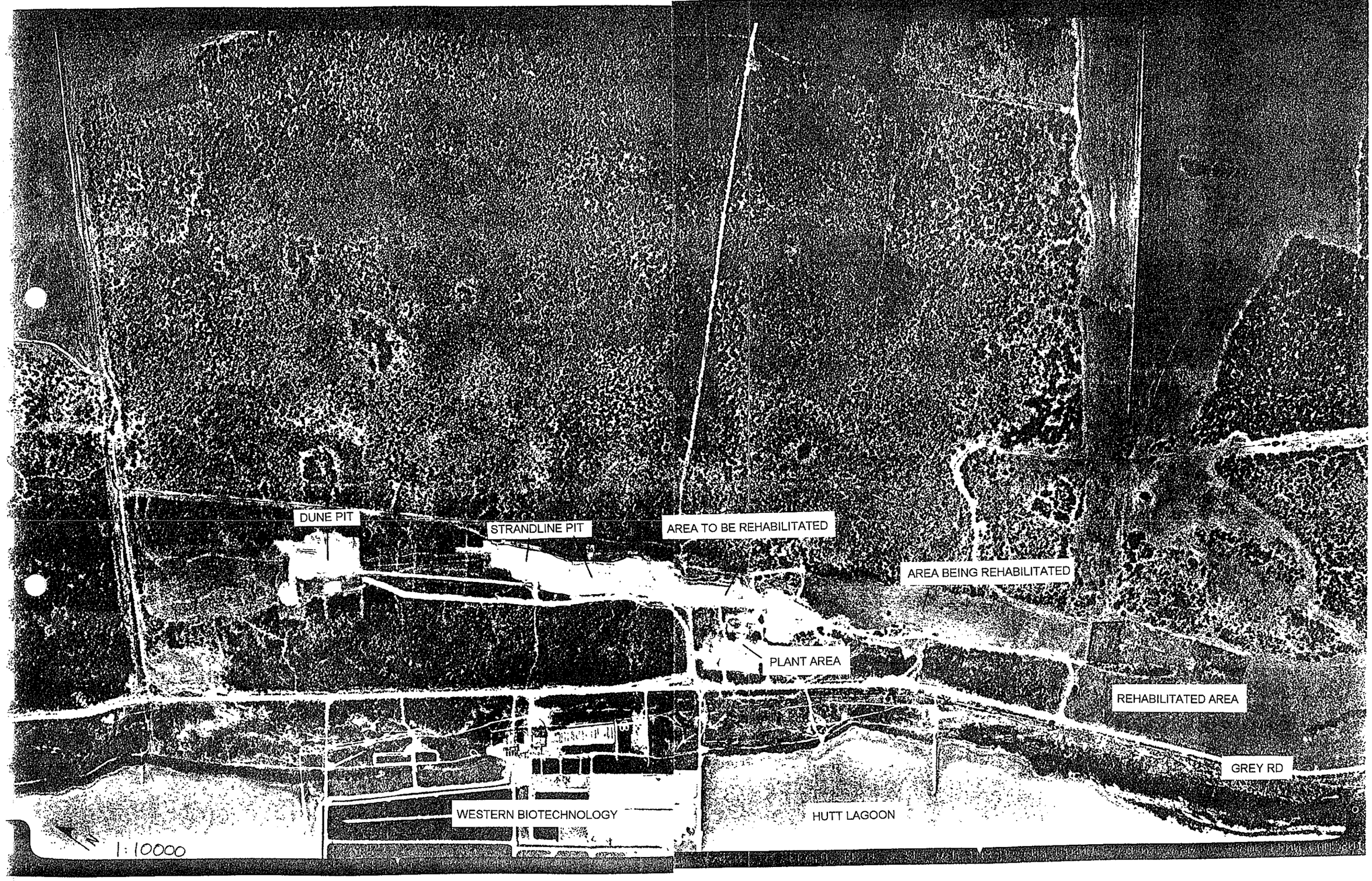
PROCESSING PLANT AND MINE LOCATION PLAN
PROCESSING PLANT AND MINE AERIAL PHOTOGRAPHS



GMA Garnet Pty Ltd. - Port Gregory Mine-Site

PROCESSING PLANT AND MINE LOCATION

10/5/1995


DUNE PIT
STRANDLINE PIT
AREA TO BE REHABILITATED
AREA BEING REHABILITATED
PLANT AREA
REHABILITATED AREA
GREY RD
WESTERN BIOTECHNOLOGY
HUTT LAGOON
1:10000

Appendix C. Rehabilitation

Rehabilitation Management Plan

Rehabilitation monitoring results – 2019

Port Gregory

Rehabilitation Management Plan

Contents

Glossary

Term	Definition
BC Act	*Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
BVA	Beard Vegetation Association
DBCA	Department of Biodiversity, Conservation and Attractions
DMIRS	Department of Mines, Industry Regulation and Safety
DWER	Department of Water and Environmental Regulations
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ha	Hectares
LGA	Local Government Authority
MCP	Mine Closure Plan
MNES	Matters of National Environmental Significance
RMP	Rehabilitation Management Plan
WA	Western Australia

Rehabilitation Management Plan Summary

Description	Summary
Title of Project	Port Gregory Garnet Project
Proponent Name	GMA Garnet Pty Ltd
Mining tenements	G70/171, M70/204, M70/856, M70/926, M70/927, M70/968, M70/1331.
Purpose of the RMP	The intent of this RMP is to provide guidance on management and monitoring actions for rehabilitation of the project.
Local Government Area	Shire of Northampton.
Key mine closure objective	The closure objectives for this project have been determined through internal and external stakeholder consultation. The closure objectives include: • Legal Obligations. • Safe. • Stable/non-pollution. • Sustainable Land Use • Agreed Post-mining Land use. • Landform. • Pollution. • Socio-economic.
Key components in the RMP	Refer to Section 4.

1. Introduction

1.1. Project

GMA currently own and operate two open-cut alluvial garnet mines operated on the Hose Mine (G70/171, M70/856, M70/926 and M70/927) and the Lynton Mine (M70/204, M70/259, M70/968 and M70/1331), which constitute the Port Gregory Garnet Project (the project) (Figure 1). The project is located approximately 100 km north of Geraldton in the Midwest region of Western Australia, near the village of Gregory (Figure 1). The Lynton mine has been in operation since 1981, commencing on M70/204. The Hose mine has been in operation since 1997. Both mines initially included an open pit and a wet gravity separation plant. In 1997, the Lynton mine process plant was decommissioned. Since then, all ore processing is undertaken at the Hose plant on G70/171. The estimated life of the project is 30 years.

Total disturbance and proposed disturbance is 237.3 ha. A breakdown of the footprint is provided in the table below. Approximately 124 ha has been rehabilitated stage 1 (earthworks completed) and stage 2 (vegetation re-establishing), this includes areas returned to agriculture (Figure 2).

1.2. Disturbance and Rehabilitation

The project includes four domains as identified in GMA's Mine Closure Plan and Figure 2. These include:

- Domain 1: Open Pits
- Domain 2: Processing Infrastructure.
- Domain 3: Infrastructure, pipelines, powerlines and borefield.
- Domain 4: Access Roads, Haul Roads

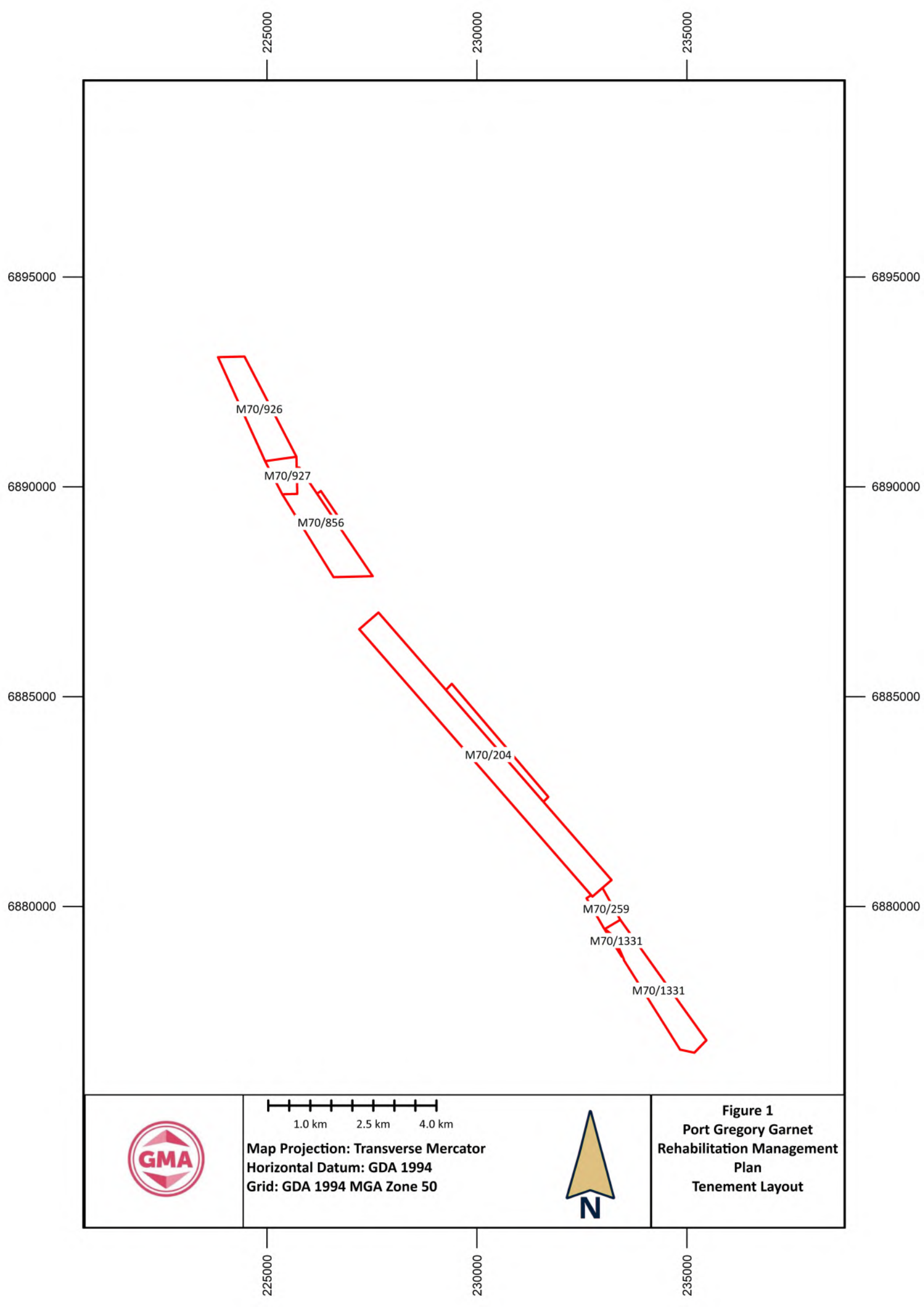
The table below provides a breakdown of current rehabilitation and rehabilitation area requirements.

Domain	Current Disturbance Footprint	Proposed Additional Disturbance Footprint	Current Rehabilitation	Post mining land use
Domain 1				
Hose Pit	0	0	74 ha	Agriculture
Utcha Pit	29.9 ha	0	20.2 ha	Native Vegetation
Brealey Pit	60 ha	5 ha	0	Agriculture
Lynton Pit	65 ha	N/A	20 ha	Native Vegetation
Domain 2				
Hose Wet Plant	1.60 ha	0.06 ha	0	Agriculture
Tailings Ponds and Water Dams	1.60 ha	6.85 ha	0	Agriculture
Old Lynton Plant	0.9 ha	0.9 ha	0	Native Vegetation
Run-of-Mine-Pads/Low Grade Ore Stockpiles (M70/204)	1.61 ha	N/A	0	Native Vegetation
Run-of-Mine-Pads/Low Grade Ore	6.6 ha	0	0	Agriculture

Domain	Current Disturbance Footprint	Proposed Additional Disturbance Footprint	Current Rehabilitation	Post mining land use
Stockpiles (M70/856 and G70/171)				
Domain 3				
Admin Buildings	0.08 ha	0.08 ha	0	Agriculture
Powerline corridor (M70/856, G70/171, M70/926)	2.84 ha	0	0	Agriculture
Lynton Borefield (M70/204)	0.1 ha	0	0	Native Vegetation
Workshop and washdown bay	0.929 ha	0	0.929 ha	Agriculture
Laydown areas	1.24 ha	0	1.24 ha	Agriculture
Bioremediation Facility	0	0.82 ha	0	Agriculture
Domain 4				
Firebreaks	1.1 ha	0	0	Agriculture
Hose Haul/Access Roads	29.91 ha	0	0	Agriculture
Utcha Access Roads	1.11 ha	0	0	Native Vegetation
Lynton Haul Road (M70/204)	18.4 ha	0	0	Native Vegetation
Lynton Haul Road (M70/259)	0.49 ha	0	0	Native Vegetation
Lynton Haul Road (M70/968)	0.4 ha	0	0	Native Vegetation

1.3. Closure Objectives

The RMP outlines the progressive rehabilitation work that will be undertaken for this project to achieve the closure objectives that are realistic and achievable. GMA has adopted the principles of the DMIRS (2020) Guidelines for Preparing Mine Closure Plans and aims to re-establish the pre-mining land-use.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M70/926
M70/927
M70/856
M70/204
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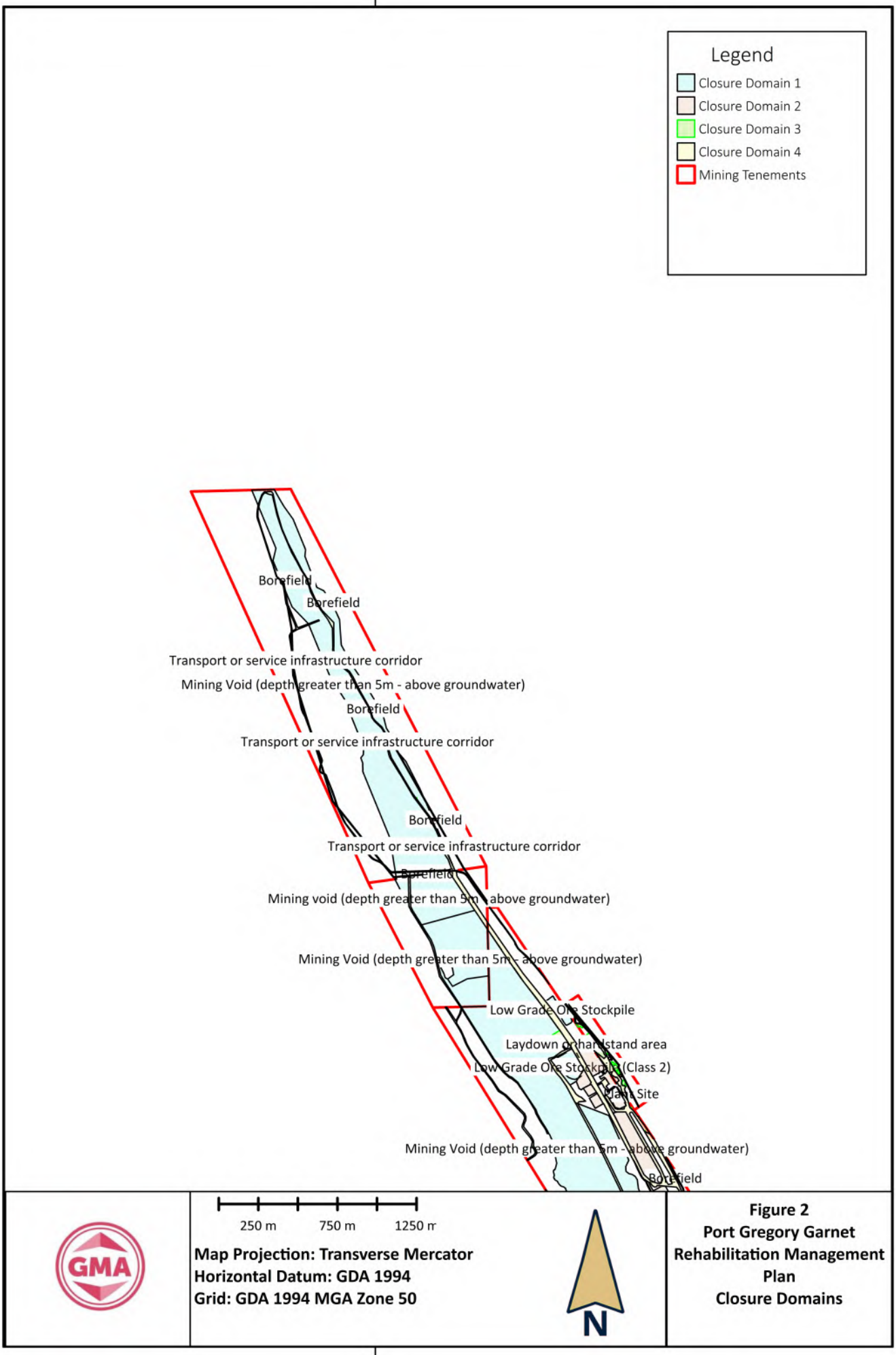
M70/1331
M70/1331
1.0 km
2.5 km
4.0 km
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
N
Figure 1
Port Gregory Garnet
Rehabilitation Management
Plan
Tenement Layout

225000



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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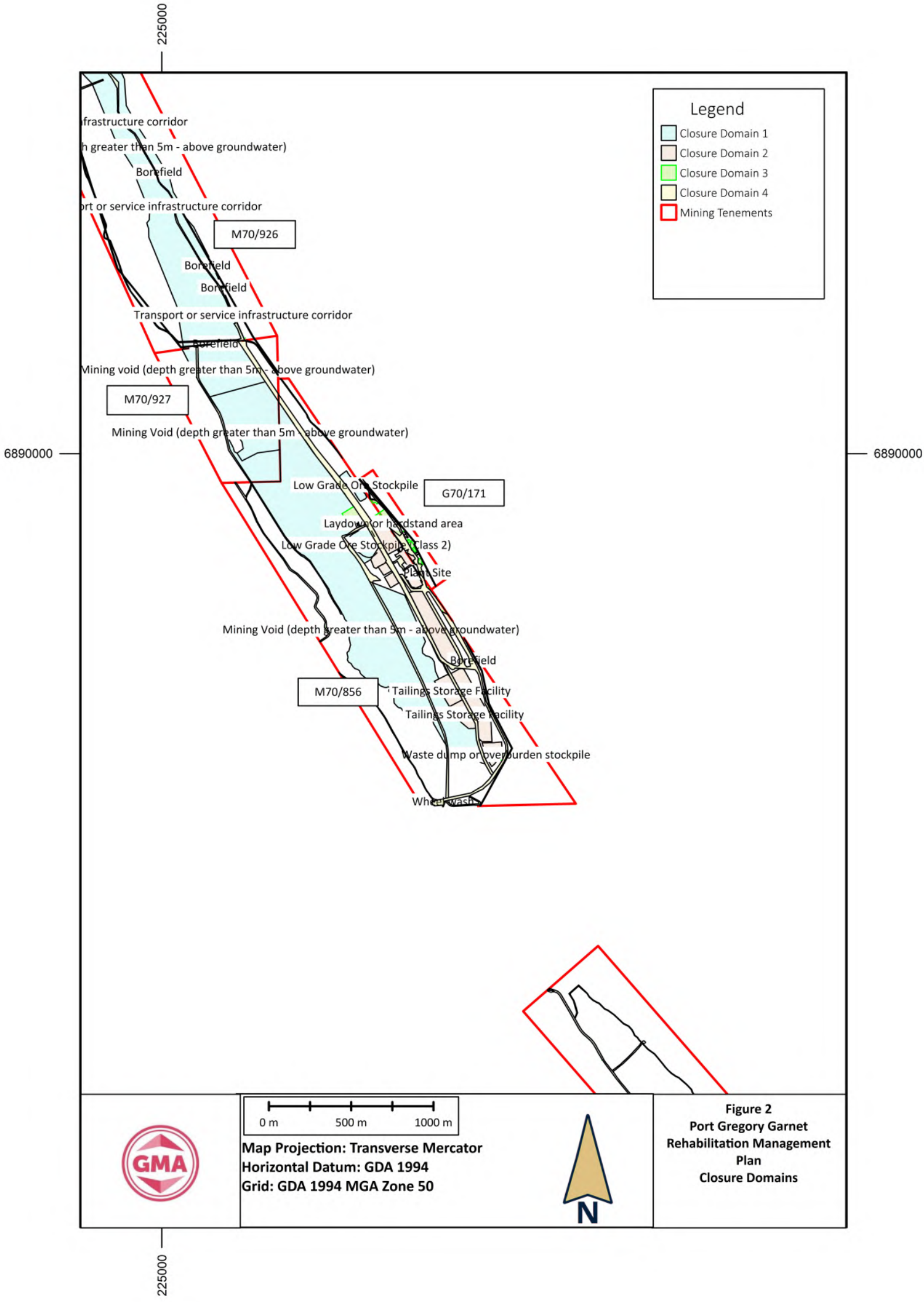
Figure 2
Port Gregory Garnet Rehabilitation Management Plan
Closure Domains

225000


225000
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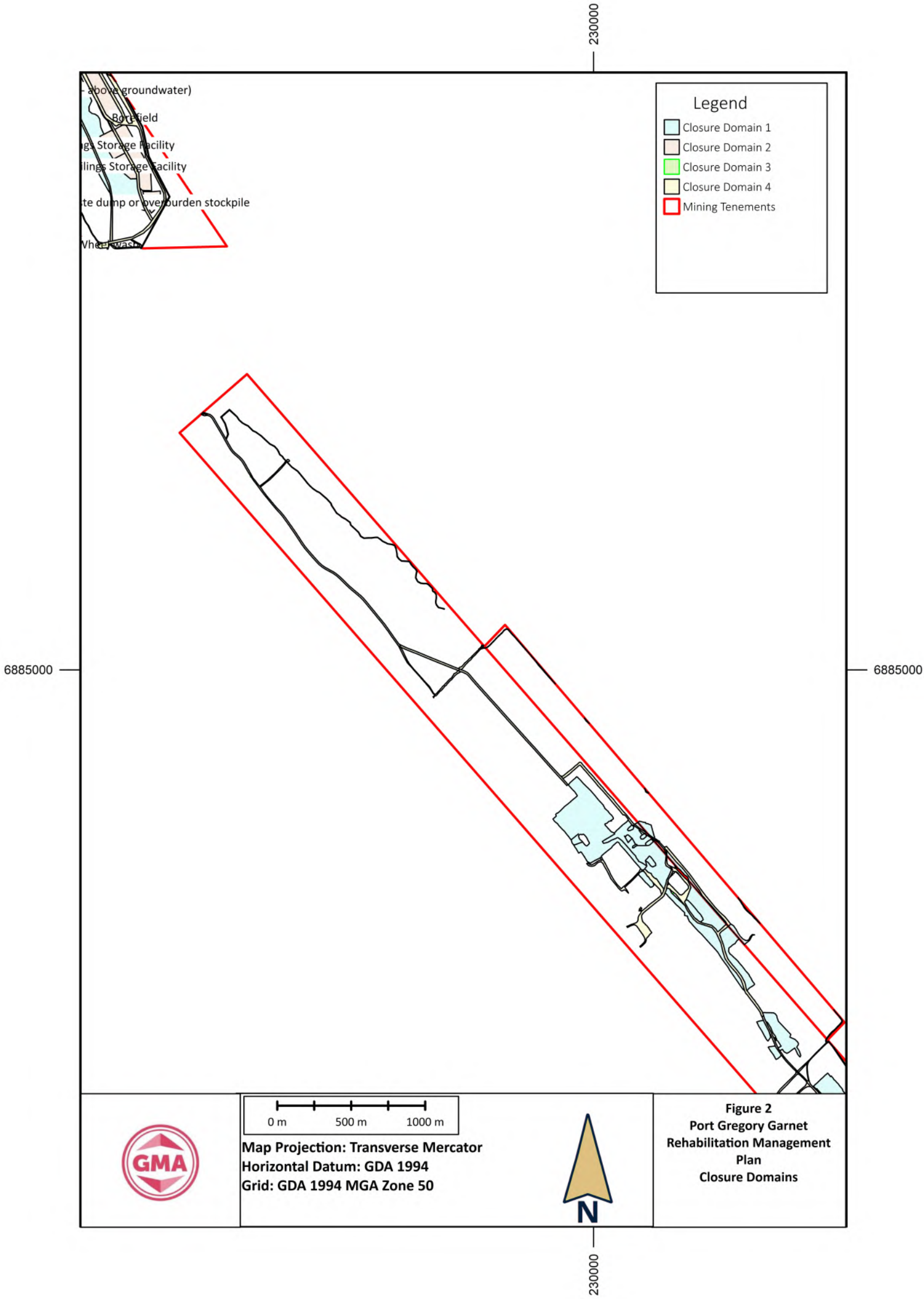
Legend
Closure Domain 1
Closure Domain 2
Closure Domain 3
Closure Domain 4
Mining Tenements
ıfrastructure corridor
h greater than 5m - above groundwater)
Borefield
ort or service infrastructure corridor
M70/926
Borefield
Borefield
Transport or service infrastructure corridor
Borefield
Mining void (depth greater than 5m - above groundwater)
M70/927
Mining Void (depth greater than 5m - above groundwater)
Low Grade Ore Stockpile
G70/171
Laydown or hardstand area
Low Grade Ore Stockpile (Class 2)
Plant Site
Mining Void (depth greater than 5m - above groundwater)
Borefield
M70/856
Tailings Storage Facility
Tailings Storage Facility
Waste dump or overburden stockpile
Wheel wash
0 m
500 m
1000 m
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
N
Figure 2
Port Gregory Garnet
Rehabilitation Management
Plan
Closure Domains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Closure Domain 1
Closure Domain 2
Closure Domain 3
Closure Domain 4
Mining Tenements
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1000 m
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
N
GMA
Figure 2
Port Gregory Garnet
Rehabilitation Management
Plan
Closure Domains

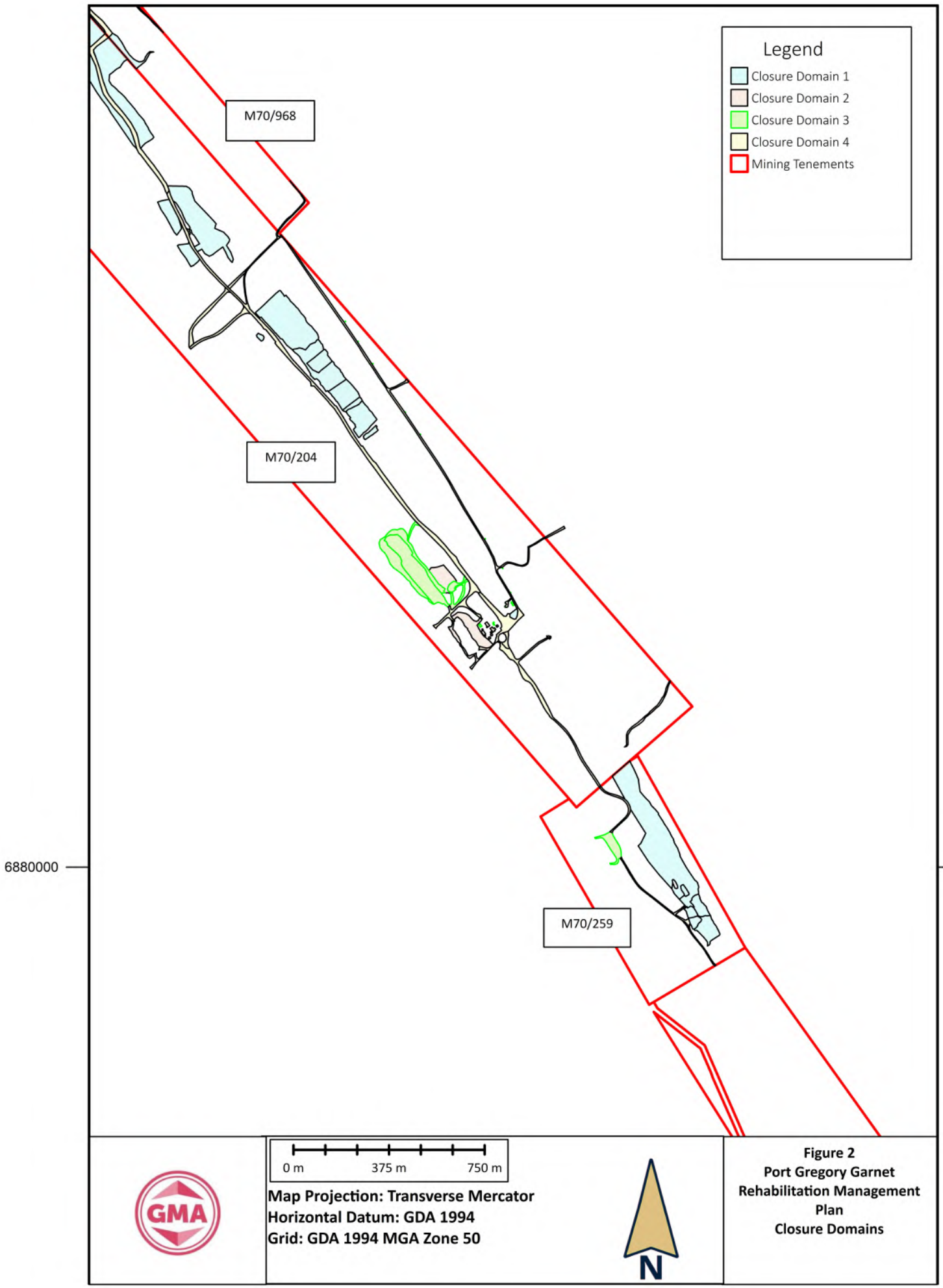


Figure 2
Port Gregory Garnet Rehabilitation Management Plan
Closure Domains

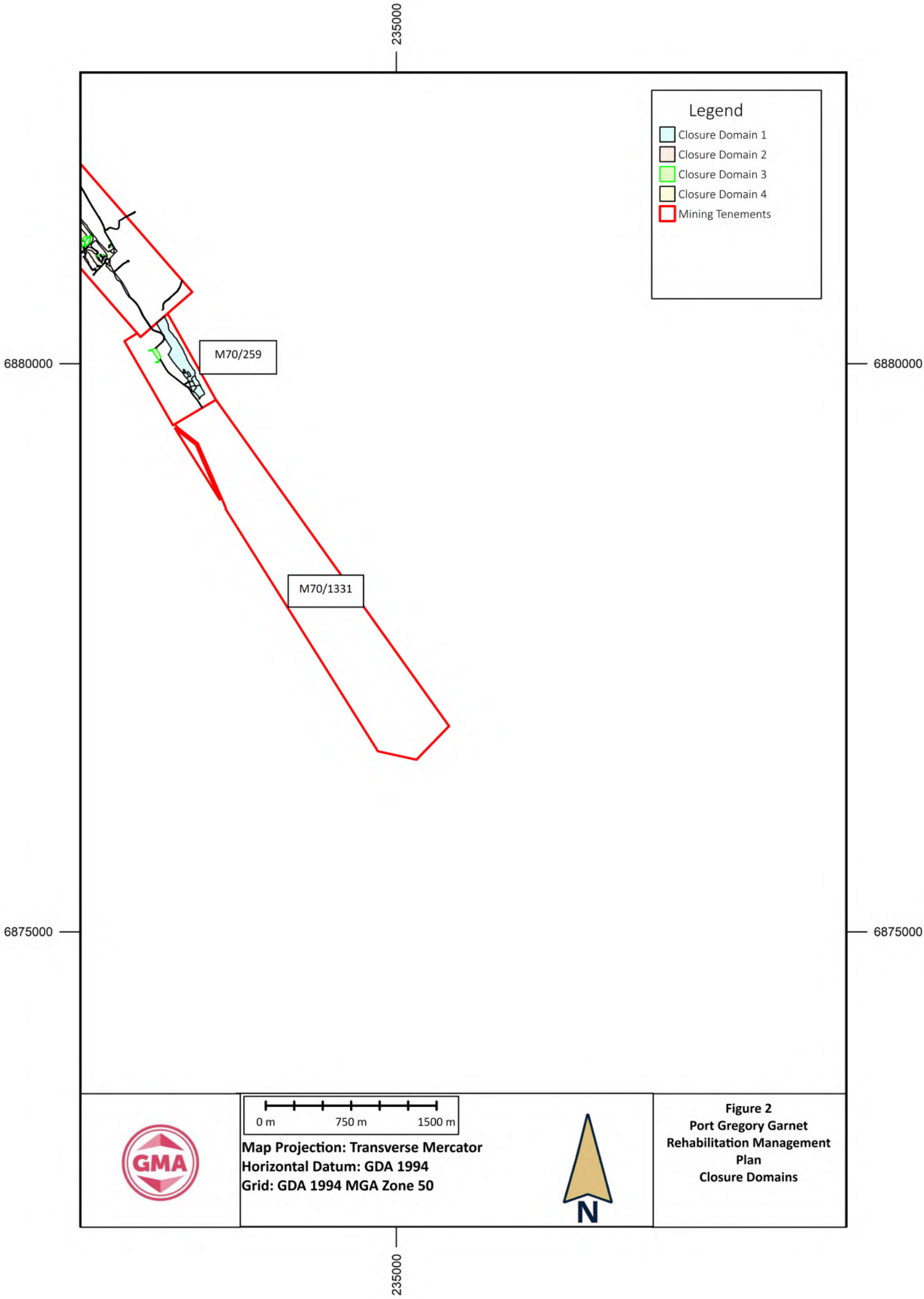


Figure 2
Port Gregory Garnet Rehabilitation Management Plan
Closure Domains

Adopted Closure Objectives

Aspect	Objective
Legal Obligations	Ensure all legal obligations relating to closure of the Port Gregory Garnet Mine Site are met. Infrastructure required to be retained by the key stakeholder will be established through a sequential agreement.
Safe	Leave the site in a condition where the risk of adverse effects to people, livestock and other fauna, and the environment, has been reduced to a level acceptable to stakeholder.
Stable/non-pollution	Rehabilitated landforms and landscapes are stable and non-polluting that minimises long-term environmental impacts.
Sustainable Land Use	Reinstate and maintain areas within the project for pasture and minimise any impacts on surrounding land uses.
	Return the soil profile and landform similar to pre-mining conditions.
	Develop final landforms that are compatible with the surrounding landscape and that meet the final land use.
	Rehabilitate the project with local provenance vegetation, where possible, to meet the agreed completion criteria
Agreed Post-mining land use	Revegetate the project with local native species (where possible), to achieve the agreed completion criteria.
	Ensure stakeholders have been consulted during the mine closure process.
Landform	The final landforms are visually compatible with the surrounding Area.
Pollution	Achieve a condition where contaminants at the site are at or below agreed criteria and that is suitable for final land use.
Socio-economic	The closure process occurs in an orderly manner, cost-efficient, and in a timely fashion. Ensure that the cost of closure is adequately accounted for by GMA and the community is not left with a liability

The RMP has been prepared with consideration the DMIRS closure objective.

RMP Guidance Requirements	RMP Section
Assess environmental significance of land	Section 2.3
Identify major limitation to rehabilitation	Sections 2.3, 4.1, 5.0
Set rehabilitation objectives and definitions	Section 4.0

1.4. Previous experience with rehabilitation

The table below summarises GMA previous experience with rehabilitation.

Previous Rehabilitation Experience

Tenement	Summary of findings
M70/204	• Revegetation quadrats in the six year old revegetation comprised 43% of the species recorded at the reference sites • The nine year old revegetation (Q12) exceeded the reference site species diversity and meets the completion criteria for diversity

Tenement	Summary of findings
	• The key flora taxa that define the remnant vegetation type were dominant within all ages of revegetation • The upper stratum within the revegetation sites have yet to establish and the middle stratum largely dominated the area, however as the key upper stratum species are present it is expected that with time the upper stratum will develop
M70/856	• Re-establishment of pastoral grasses, compatible for sheep grazing.
M70/927	• Revegetation area on the slope has low flora diversity and native vegetation foliage cover, with weeds dominating the groundcover (Q01 and Q02) • Soil erosion was notably evident along the slope (i.e Q01) • The re-establishment of a vegetation with the lower elevated portion of the Site appeared to be more successful, with similar diversity to reference sites and higher percent foliage cover of native flora in contrast to Q01 and Q02 • The topography appears to have an influence for the success of re-establishment of native vegetation
M70/968	• Revegetation is currently in the preliminary stage (i.e. ripping of the topsoil has not occurred) • The revegetation areas comprise both low native flora diversity and cover (two flora taxa and less than 2% cover) • The soils within the revegetation area are sandy soils, which are susceptible to wind and water erosion, and soil erosion was noted • Weed cover ranged from 36% to 62%, and dominated the ground layer

1.4.1. Rehabilitation Trials

Rehabilitation contractors generally collect seeds before clearing native vegetation with heavy mobile equipment. The seeds collected by a rehabilitation contractor are used as part of the mine rehabilitation process, either spread across the landform or retained to grow tube stock. The seeds collected will also be used as part of trials and this includes testing the species' application rate.

As part of rehabilitation in 2020, the following were undertaken:

1. Field trials utilising vegetation brush and seed
2. Field trials using vegetation brush (only).
3. Field trials utilising seed (only).

2. Approach to Rehabilitation

2.1. Closure Objectives

Rehabilitation is required for the Project mine closure. Effective rehabilitation will manage potential impacts from:

- Direct loss of clearing native vegetation
- Direct loss of fauna habitat from clearing
- Injury or mortality of individuals from vehicle or machinery interaction
- Introduction and spread of weeds because of disturbances and vehicle or machinery movement.
- Unstable and polluting landforms
- Unsafe site conditions which may pose a risk to people, livestock and other fauna.

- Unsustainable land use (vegetation is not self-sustaining).
- Incompatible vegetation communities (i.e. establishment of native vegetation, when it should be pasture grass).
- Incompatible landforms (i.e. establishment of a hill when it was a plain).
- Failure to achieve legal obligations.

Managed through GMA's procedures and guidelines. However, certain factors are beyond GMA's control and could potentially impact the rehabilitation outcomes, including climate change, floods, drought, and fire. These factors represent a threat to successful rehabilitation and are further detailed below.

Monitoring at both rehabilitation and analogue (reference) sites will be undertaken to determine progress towards achieving the RMP objectives and targets. The data gathered will also inform where contingency actions need to be implemented to manage any risks to the rehabilitation outcomes.

2.2. Post-mining Land use

The general approach for post-mining land-use (PMLU) is to return each tenement to its pre-mining land-use. Achievable PMLU agreed with key stakeholders is a fundamental closure consideration:

- Acceptable to key stakeholders
- Relevant and compatible with the local environment
- Realistic and achievable to deliver the target outcomes.

Following closure, no aboveground waste landforms or open pits will be left at the site.

The PMLU will be agriculture (cropping and pastoral) and native vegetation. Land contained within tenements G70/171 and M70/856 is to be returned to the landowners in a condition suitable for cropping and livestock grazing. M70/926 and M70/1331 is to be restored to a condition ideal for pastoral use.

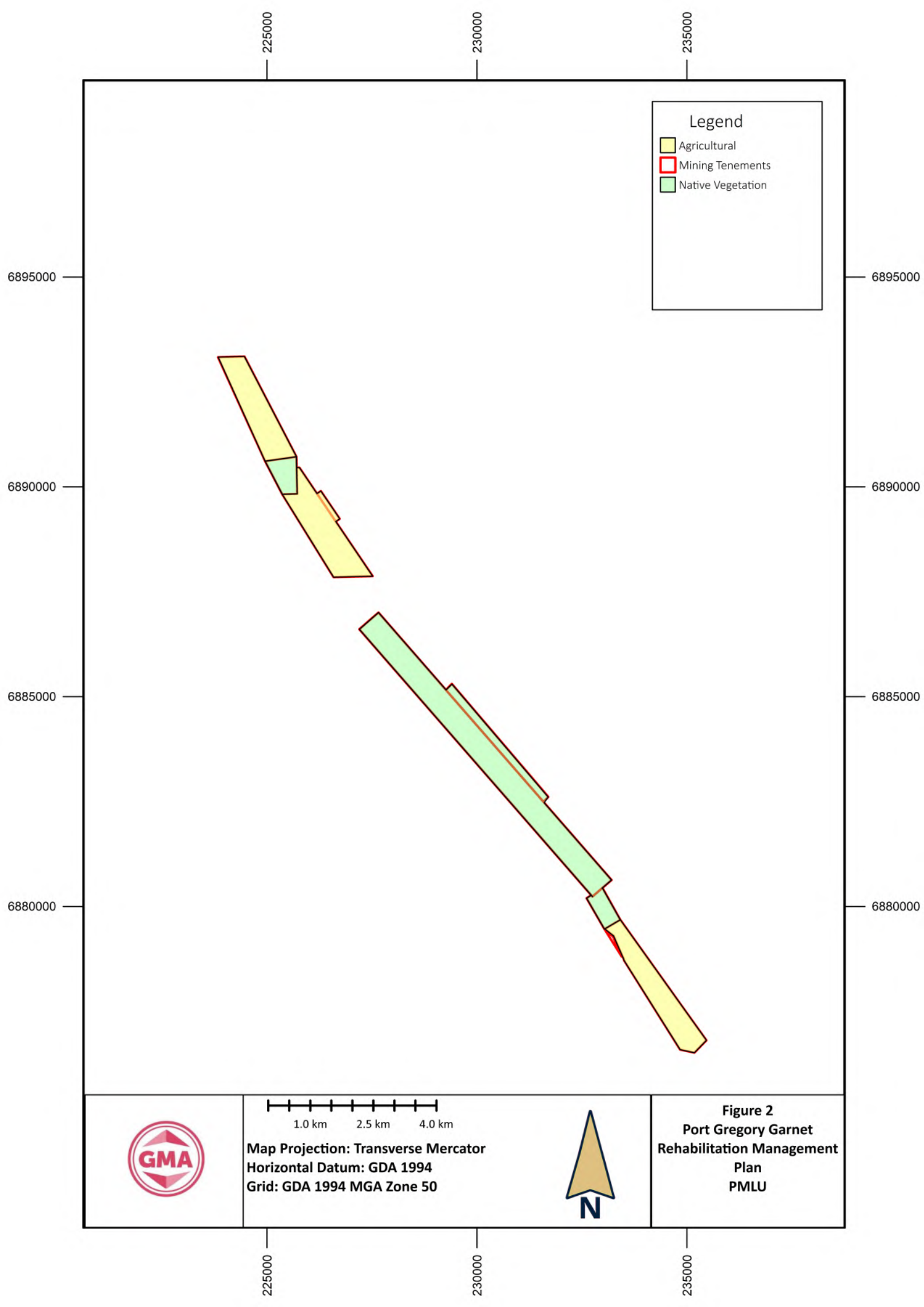
Land contained within M70/927 is to be restored to natural vegetation as per the Clearing Offset Proposal agreement conditions. The site will be rehabilitated with species representative of established analogue sites representing the pre-mining vegetation community.

M70/204, M70/968, and M70/259 are progressively rehabilitated and returned to the pre-mining vegetation community.

PMLU following closure is presented in Figure 3 and summarised in the table below.

Summary of pre-mining and post-mining land-use for mining tenement

Tenement	Pre-mining land-use	Post-mining Land-use
G70/171	Agricultural	Agricultural
M70/856	Agricultural	Agricultural
M70/926	Agricultural	Agricultural
M70/1331	Agricultural	Agricultural
M70/927	Remnant native vegetation	Native vegetation
M70/204	Remnant native vegetation	Native vegetation
M70/968	Remnant native vegetation	Native vegetation
M70/259	Remnant native vegetation	Native vegetation


225000
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Agricultural
Mining Tenements
Native Vegetation
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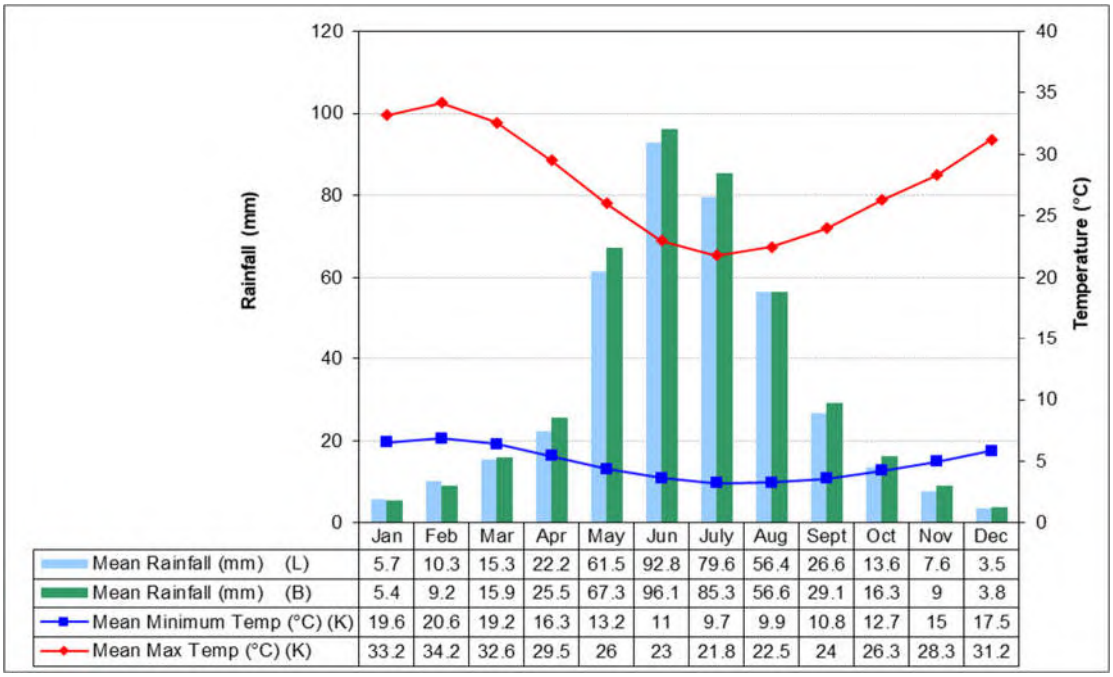
1.0 km
2.5 km
4.0 km
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
N
Figure 2
Port Gregory Garnet
Rehabilitation Management
Plan
PMLU

2.3. Baseline Data

2.3.1. Local Climatic Conditions

The project is located within the Mid-West Region of Western Australia. The climate of Mid-West is considered warm semi-arid to Mediterranean climate with 400 to 500 mm of rainfall per annum (Desmond and Chant, 2002). The region experiences short, mild, wet winter and the remainder of the year is warm to hot, dry to windy. Weather recording stations are located at Lynton (Station 008075), Balline (008004) and Kalbarri, Western Australia. Rainfall data was available at Lynton and Balline, and temperature data was available from Kalbarri. The average annual rainfall is 400.4 mm at Balline and 425.4 mm at Lynton. Prevailing winds are from the south-south-west during summer and variable during winter. The rainfall and temperature data are summarised in the chart below. The Annual Evaporation rate in the area is around 2, 500 mm.



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Mean Rainfall (mm) (L)	5.7	10.3	15.3	22.2	61.5	92.8	79.6	56.4	26.6	13.6	7.6	3.5
Mean Rainfall (mm) (B)	5.4	9.2	15.9	25.5	67.3	96.1	85.3	56.6	29.1	16.3	9	3.8
Mean Minimum Temp (°C) (K)	19.6	20.6	19.2	16.3	13.2	11	9.7	9.9	10.8	12.7	15	17.5
Mean Max Temp (°C) (K)	33.2	34.2	32.6	29.5	26	23	21.8	22.5	24	26.3	28.3	31.2

Climate Data for Balline, Lynton and Kalbarri (BoM 2021)

The annual wind rose for the Geraldton 2007 meteorological file indicates the dominant wind blows from the south and south-east direction, with a secondary dominant wind from the north-east. Wind speeds from 2 up to 6 metres per second (m/s) are often observed, with wind speeds reaching 8 m/s from the south-eastern direction (GHD, 2020c).

2.3.1.1. Climate Change

The Batavia Regional Organisation of Councils (BROC), consisting of the City of Greater Geraldton, Shires of Irwin, Northampton, and Chapman Valley conducted a workshop focusing on identifying risks, opportunities and developing an adaption plan concerning higher temperatures, reduced rainfall and sea-level rise (BROC 2010). The risk assessment workshop evaluated the risks to the operations of BROC on climate projects for 2030 and 2070. The climate change projections used as part of the risk assessment are provided in the table below.

Climate Change Projections

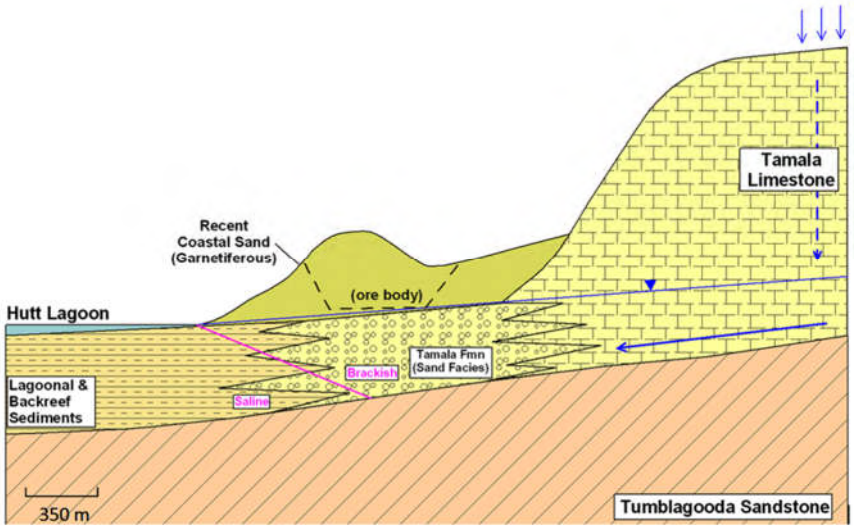
Climate Change	Specific Climate variable	Current Condition	Projections for 2030	Projection for 2070
Increased Temperatures	Average Temperature	19.8 °C	+1.4oC (21.2°C)	+6.4oC (26.2°C)
	Days over 35oC per year	38 days	+6 days (44 days)	+26 days (64 days)
Reduced Rainfall	Average rainfall*	449 mm	-9.5% (406 mm)	-43.7% (252.8 mm)
	Annual dry days (days with <1mm)	324.1 days	+2.9 days (327 days)	+13.4 days (337.5 days)
	Sea level rise		+0.2 metres	+0.7 metres
Sea Level Rise	Extreme sea level events (storm surge)	Factor of four increase in frequency for every 0.1 metre of mean sea level rise.		

As indicated in BROC (2010), climate change will impact flora and vegetation communities in the area. Therefore, it is necessary to identify natural changes to vegetation structure to ensure rehabilitation criteria are achievable. The establishment and monitoring of analogue sites within remnant vegetation will assist with understanding potential external factors such as climatic events (i.e. droughts) that may influence revegetation progress. The monitoring program's findings will help determine whether practical completion has been met or if it is achievable (i.e. certain flora species become extinct from the effects of climate change).

2.4. Landforms

The ore body is composed of poorly cemented quartz and shell sand deposits that contain a high concentration of heavy minerals, dominantly garnet. These deposits form a dune approximately 750 m wide that runs north-south through tenements M70/927 and M70/926 at the Hose Mine and through M70/204 and M70/968 at the Lynton Mine. Ground levels vary from approximately 1 m to 48 m AHD. The ore body is abutted by an escarpment of Tamala limestone that runs roughly parallel to the east of the orebody and exceeds 60 m AHD. The ore body and associated beach sands are underlain by Tamala Formation, as indicated below.

The garnet sand is derived from the Precambrian granulite rocks of the Northampton Shield. It is understood that the Hutt River carried garnet to the coast during wetter climatic periods coinciding with a raised sea level (four to six metres above current sea level). Longshore currents, wave action and winds have concentrated the garnet and other heavy minerals along the base of the Tamala Limestone escarpment. Marine erosion of Tamala Limestone has most likely added to the accumulation of garnet. Heavy minerals comprise approximately 20% of the ore body, of which approximately 94% is garnet.



Geology and Sub-surface Flow

2.4.1. Flora, Fauna and Vegetation Studies

Previous biological and rehabilitation surveys have described ten vegetation types across the project. The northern and middle portions of the project are primarily mapped as *Acacia rostellifera* shrublands/ forests and the southern part is dominated by heath. The vegetation condition of the project was generally rated from Good to Degraded. Agricultural weeds (i.e. **Avena barbata*) dominated the groundcover within degraded areas of the project.

A summary of the previous fauna, vegetation and flora studies were undertaken within the project is provided in below. GHD (2013 and 2016) studies were a Level 1 flora and vegetation study undertaken in Spring across mining leases M70/926, M70/927 and M70/968. The studies delineated key flora, fauna and vegetation constraints, and supported the native clearing permit application. Vegetation delineated from the project at a sub-association level are provided in the mapped vegetation description table.

Searches of the EPBC Act Protected Matters database and DBCA databases confirmed that there are no Federal or State listed Threatened Ecological Communities (TECs) or no State listed Priority Ecological Communities (PECs) within a 10 km radius of the project. The previous studies did not identify any TECs or PECs represented within the project.

Fauna and Vegetation, Flora Surveys within the Project

Reference	Tenements	Key Findings
BSD Consulting (1997) Vegetation survey of the Hose Prospect M70/856	M70/856	The vegetation assessment completed in Spring 1997 delineated key flora and vegetation constraints to support the Notice of Intent for M70/856. The survey delineated two vegetation communities, including *Acacia rostellifera* thickets and grasslands plains (**Avena barbata and *Hordeum leporinum*).
GHD (2013) GMA Port Gregory Mine Tenement M70/968 Vegetation, Flora and Fauna Assessment. GHD (2014) Report for Port Gregory Mine Targeted Flora Survey	M70/968	Level 1 survey (according to EPA Guidance Statement No. 51) identified four vegetation types, with the most dominant being Mixed Open Heath on Sandy Limestone Ridge and Low Heath. The vegetation was predominantly Good to Very Good with areas of degradation due to grazing, firebreaks and historical mining activities. Seventy-five flora taxa from 39 families were recorded, including 12 introduced/weed flora taxa.

Reference	Tenements	Key Findings
GHD (2019b) Port Gregory Mining Tenement M70/968 Revegetation Monitoring.		A targeted flora survey for EPBC Act/BC Act listed *Caladenia bryceana* subsp. *cracens* and habitat. The species was not recorded however marginal habitat was mapped. Two DBCA Priority-listed species were recorded including 23 individual plants of *Melaleuca huttensis* (Priority 1) and 54 individual plants of *Anthocercis intricata* (Priority 3). A Level 1 fauna survey was undertaken and a total of five birds and two mammals were recorded. Of these, one introduced fauna was recorded. No Threatened fauna or habitat listed under the EPBC Act, BC Act or DBCA listed fauna were recorded.
GHD (2016a) Mining Lease M70/926 Biological Survey.	M70/926	Level 1 survey (in accordance with EPA Guidance Statement No. 51 and EPA and DPaW 2015 Technical Guidance). Three vegetation types (excluding Cleared/Degraded) were recorded. The vegetation was predominantly Good to Degraded with large areas considered to be Completely Degraded in locations due to grazing, firebreaks and historical exploration activities. Sixty flora taxa from 28 families were recorded including Twenty-five introduced/weed flora taxa and one planted taxon. No EPBC Act or BC Act or DBCA listed flora species were recorded.
GHD (2011) Port Gregory Minesite Offset Area Rehabilitation Management Plan GHD (2019c) Port Gregory Mining Tenement M70/927 Revegetation Monitoring	M70/927	GHD (2011) conducted a reconnaissance flora survey. GHD (2019c) completed revegetation monitoring within the tenement. Two vegetation types were recorded from M70/927. The vegetation recorded was predominantly Good to Degraded. Forty-nine flora taxa from 25 families were recorded including 13 weed and introduced species. No EPBC Act or BC Act or DBCA listed flora species were recorded from M70/927.
GHD (2019d) Port Gregory Mining Tenement M70/204 Revegetation Monitoring.	M70/204	GHD (2019b) completed revegetation monitoring within the tenement and as part of the works reference sites were established within remnant vegetation. Two vegetation types were recorded and rated as predominantly Good to Degraded, with large areas considered Completely Degraded. Eighteen flora taxa from eight families were recorded from three quadrats established within M70/204, this total included nine introduced flora taxa. No EPBC Act or BC Act or DBCA listed flora species were recorded from M70/204.
GHD (2020a) Lynton Mine Expansion, Biological Survey	M70/204, M70/259	GHD (2020a) completed a detailed (single-season) flora and vegetation survey, and a Level 1 Fauna survey (reconnaissance survey) of M70/204 and M70/259. Three vegetation types were identified from the survey (excluding cleared and degraded). The vegetation was predominately rated Good to Completely Degraded. Sixty-four flora taxa (including subspecies) representing 26 families and 50 genera were recorded from the survey. No EPBC Act or BC Act or DBCA listed flora species were recorded; however potential habitat for *Caladenia bryceana* subsp. *cracens* was recorded. Five broad fauna habitats were mapped from the survey. Thirty-one fauna species were recorded including 21 birds, eight mammals and two reptiles. Of these, 24 are native and

Reference	Tenements	Key Findings
		seven are introduced. No Threatened fauna listed under the EPBC Act, BC Act or DBCA listed fauna were recorded. One Migratory and Marine listed fauna (Eastern Osprey – *Pandion cristatus)* was recorded during the survey.
GHD (2020b) Targeted *Caladenia bryceana* subsp. *cracens* survey and conservation listed flora survey of proposed haul road	M70/204	GHD (2020b) completed a targeted orchid survey of M70/204. No individuals of *Caladenia bryceana* subsp. *cracens* were recorded.
Earthstewardship (2020) Hose Mining Operations – Vegetation Survey	G70/171, M70/856	Earthstewardship (2020) completed a Level 1 vegetation survey of G70/171 and M70/856 to support application for a clearing permit. Seven vegetation types (including clearing and degraded) were recorded. Vegetation condition was rated Degraded to Completely Degraded, with a large area of M70/856 covered by Open Paddock. Seventy-three flora taxa from 35 families were recorded from the survey. Of this total, 29 were weeds and introduced flora. No EPBC Act or BC Act or DBCA listed flora were recorded during the survey.

2.4.1.1. Vegetation Mapping

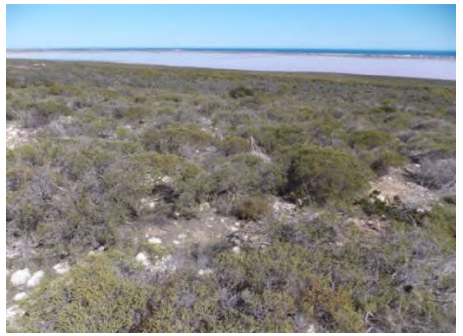
The vegetation types identified within each tenement are described in the table below. The vegetation types for each closure domain is mapped in Figure 4.

Mapped Vegetation Types within Active Mining Tenements

Sub-association Level	Description	Location	Condition	Representative photograph
***Acacia rostellifera* open woodland to woodland**	*Acacia rostellifera* open woodland to woodland over *Rhagodia preissii* subsp. *obovata, Pimelea microcephala* subsp. *microcephala*, *Olearia* sp. Kennedy Range (G. Byrne 66) and *Stylobasium spathulatum* open shrubland over *Austrostipa elegantissima* and **Ehrhrata longiflora* open grassland to grassland. Other common species include *Alyogyne hakeifolia, Roepera fruticulosa*, *Commicarpus australis* and *Euphorbia boophthona.*	M70/204	Degraded to Good	
***Melaleuca cardiophylla* shrubland to open shrubland *Melaleuca cardiophylla* shrubland to open shrubland**	*Melaleuca cardiophylla* shrubland to open shrubland over *Alyogyne hakeifolia*, *Pimelea microcephala* subsp. *microcephala* and *Rhagodia preissii* subsp. *obovata* open shrubland over *Ptilotus divaricatus* scattered forbland. Other common species include *Roepera fruticulosa, Pimelea gilgiana* and **Bromus diandrus*. In areas that contain deeper soils *Acacia rostellifera* was also recorded. Occurs on upper mid slopes on white-brown sand with limestone outcropping. Disturbances include high grazing impacts from feral pigs and other native species (kangaroo).	M70/204	Degraded to Good	
***Acacia rostellifera* Low Forest**	Low woodland to open forest of *Acacia rostellifera* over scattered shrubs of *Rhagodia preissii* subsp. *obovata, Stylobasium spathulatum, Pimelea microcephala* with *Commicarpus australis, Zygophyllum fruticulosum, Tetragonia implexicoma* over Open tussock grassland of **Bromus diandrus*, **Avena barbata, *Ehrharta longiflora* over scattered herbs of **Urospermum picroides, *Sonchus oleraceus, *Lysimachia arvensis*, **Arctotheca calendula, *Trifolium* spp. on sandy soils.	M70/926	Very Good to Completely Degraded	

Sub-association Level	Description	Location	Condition	Representative photograph
***Acacia rostellifera* Tall Open Shrubland**	Tall open shrubland of *Acacia rostellifera* over scattered shrubs of *Rhagodia preissii* subsp. *obovata*, with *Commicarpus australis*, *Enchylaena tomentosa, Tetragonia implexicoma*, **Solanum nigrum* over Open Tussock Grassland of **Bromus diandrus*, **Avena barbata, *Ehrharta longiflora* over Mixed Herbs of **Urospermum picroides, *Sonchus oleraceus, *Lysimachia arvensis*, **Arctotheca calendula, *Trifolium* spp. on sandy soils.	M70/926	Good to Completely Degraded	
***Acacia rostellifera* Low Shrubland on Shallow Soils**	Shrubland of *Acacia rostellifera* over Low Open Shrubland of *Scaevola tomentosa*, *Enchylaena tomentosa, Rhagodia* spp., with *Acanthocarpus preissii, Pimelea microcephala* over Open Tussock Grassland of **Bromus diandrus, *Avena barbata, *Ehrharta longiflora* over Mixed Herbs of **Urospermum picroides, *Sonchus oleraceus, *Lysimachia arvensis*, **Arctotheca calendula, *Hypochaeris* glabra on shallow sandy and limestone soils.	M70/926	Very Good to Good	
***Acacia rostellifera* Tall Open Shrubland**	Tall open shrubland of *Acacia rostellifera* over scattered shrubs of *Rhagodia preissii* subsp. *obovata,* with *Enchylaena tomentosa, Tetragonia implexicoma* over open tussock grassland of **Bromus diandrus, *Avena barbata, *Ehrharta longiflora* over mixed herbs of **Urospermum picroides, *Sonchus oleraceus, *Lysimachia arvensis, *Arctotheca calendula, *Trifolium* spp. on sandy soils.	M70/927	Good to Degraded	

Sub-association Level	Description	Location	Condition	Representative photograph
***Acacia rostellifera* Low to open Forest**	*Acacia rostellifera* low to open forest over scattered shrubs of *Rhagodia preissii* subsp. *obovata, Tetragonia implexicoma, Alyxia buxifolia, Pimelea microcephala* over tussock grassland of **Ehrharta longiflora* over scattered herbs **Lysimachia arvensis, *Leontodon rhagodioides, *Richardia tingitana*.	M70/927	Good to Degraded	
Mixed Open Heath on Sandy Limestone Ridge	High open shrubland of *Acacia rostellifera, Melaleuca cardiophylla, Grevillea argyrophylla*, over shrubland of *Olearia* sp. Kennedy Range, *Hibiscus huegelii*, over low shrubland of *Pimelea angustifolia*, *Diplopeltis petiolaris, Acanthocarpus preissii* over Scattered Grasses of **Avena barbata, Austrostipa* spp., over mixed herbs of **Lysimachia arvensis*, *Goodenia beardiana*, *Erodium* sp. with Scattered Climbers of **Cuscuta* sp., *Dioscorea hastifolia, Commicarpus australis.*	M70/968	Good	
***Acacia rostellifera* Scrub**	High shrubland to open scrub of *Acacia rostellifera* over shrubland of *Rhagodia latifolia, Stylobasium spathulatum*, *Olearia* sp. Kennedy Range over low shrubs of *Tetragonia implexicoma* over grasses of **Ehrharta longiflora*, **Avena barbata, Austrostipa* spp., over mixed herbs of **Lysimachia arvensis, Erodium* sp. over with scattered climbers of **Cuscuta* sp., *Dioscorea hastifolia, Commicarpus australis*.	M70/968	Degraded	

Sub-association Level	Description	Location	Condition	Representative photograph
Low Heath	Low open heath to low heath of *Melaleuca cardiophylla, Diplopeltis petiolaris, Bossiaea spinescens, Pimelea angustifolia, Opercularia vaginata*, over scattered grasses of **Avena barbata, Austrostipa* spp., over mixed herbs of **Sisymbrium irio, Roepera billardierei* with scattered climbers of Dioscorea hastifolia, with open rushes of Desmocladus asper.	M70/968	Very Good	
***Melaleuca* Thickets**	Closed scrub of *Melaleuca cardiophylla* with mallee of *Eucalyptus* spp. over low shrubs of *Rhagodia latifolia, Lasiopetalum angustifolium* with scattered climbers of *Aphanopetalum clematideum, Dioscorea hastifolia.*	M70/968	Very Good	

M70/926

M70/927

Legend

Vegetation Types M70/926 (GHD, 2016)

- Acacia rostellifera Low Forest
- Acacia rostellifera Shrublands on Shallow Soils
- Acacia rostellifera Tall Open Shrublands
- Cleared / Degraded

Vegetation Types M70/927 (GHD, 2011)

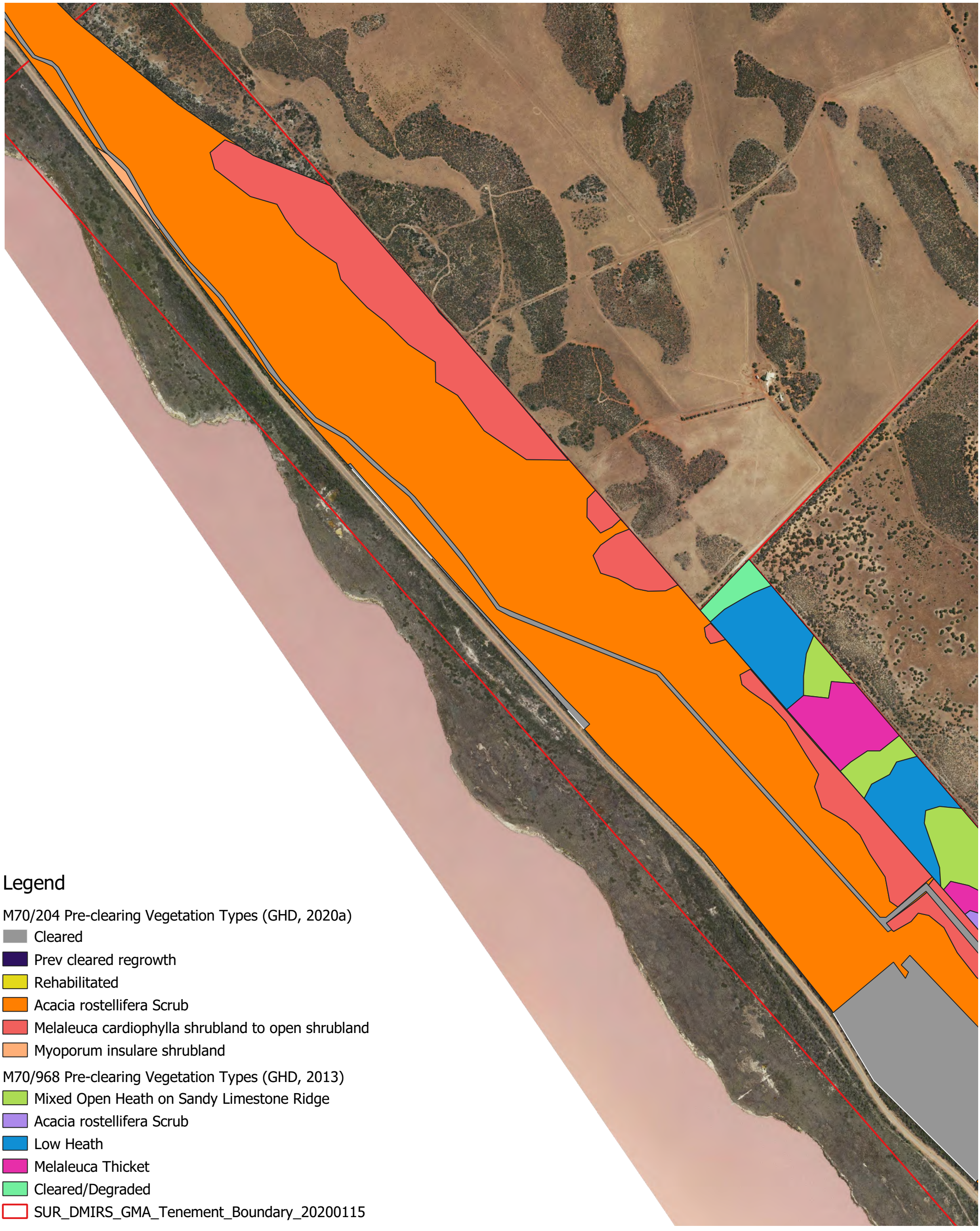
- Acacia rostellifera low Forest to Open Low Shrubland
- Cleared/Degraded,Cleared and Degraded
- RMP Mining Tenements

0 250 500 m

Map Project: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
Imagery: GMA Survey 2019-2020, Landgate 2017
Data Source: GHD (2011), GHD (2016)

N

Figure 4
GMA Garnet Pty Ltd
Rehabilitation Management Plan
Previously Mapped Vegetation Types



0 250 500 m

Map Project: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
Imagery: GMA Survey 2019-2020, Landgate 2017

N

Figure 4
GMA Garnet Pty Ltd
Rehabilitation Management Plan
Previously Mapped
Vegetation Types

M70/204 Pre-clearing Vegetation Types (GHD, 2020a)

- Cleared
- Prev cleared regrowth
- Rehabilitated
- Acacia rostellifera Scrub
- Melaleuca cardiophylla shrubland to open shrubland
- Myoporum insulare shrubland

M70/968 Pre-clearing Vegetation Types

- Mixed Open Heath on Sandy Limestone Ridge
- Acacia rostellifera Scrub
- Low Heath
- Melaleuca Thicket
- Cleared/Degraded
- Tenement Boundary

0 250 500 m

Map Project: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50
Imagery: GMA Survey 2019-2020, Landgate 2017

N

Figure 4
GMA Garnet Pty Ltd
Rehabilitation Management Plan
Previously Mapped Vegetation Types

M70/204 Pre-clearing Vegetation Types (GHD, 2020a)
- Cleared
- Prev cleared regrowth
- Rehabilitated
- Acacia rostellifera Scrub
- Melaleuca cardiophylla shrubland to open shrubland
- Myoporum insulare shrubland

M70/968 Pre-clearing Vegetation Types
- Mixed Open Heath on Sandy Limestone Ridge
- Acacia rostellifera Scrub
- Low Heath
- Melaleuca Thicket
- Cleared/Degraded
- Tenement Boundary

0 250 500 m

Map Project: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

Figure 4
GMA Garnet Pty Ltd
Rehabilitation Management Plan
Previously Mapped Vegetation Types

2.5. Soil units

The project is located within the Soil Landscape Mapping Zone of Port Gregory. The Port Gregory zone is characterised by Coastal dunes, calcareous in place with undulating sandplain on limestone. Two Soil Landscape System intersects the Project including Tamala North System (231Ta) and the Grey System (231Gy) (NRM Info). Two Soil Landscape Subsystems fall within the project as described below.

Soil Landscape Systems

System	Subsystem	Landform	Soils	Geology
Tamala North	Tamala North 1 (231Ta_1)	Undulating rises and swales associated with coastal parabolic dunes, featuring some limestone outcrop.	Brown and grey Calcareous deep sand.	Tamala Limestone
	Tamala North 2 (231Ta_2)	Dune crests and coastal hills with plains and gentle hillslopes	Brown Calcareous shallow sand and Red shallow sand	Tamala Limestone
Grey System	No subsystem	River beds, terraces and alluvial flats, includes dissected margins of relic alluvial plains.	Yellow/brown shallow sandy duplexes, Red loamy earth, hard cracking clay.	Tamala Limestone

A visually distinct topsoil layer exists at the Site. The topsoil has been formed from long-term changes to in-situ dune sand. Vegetation growth and deposition have formed a layer of humus-stained dark grey sand at the surface, typically 150 mm in depth. The colouration fades with depth and generally does not extend to a depth beyond one metre below surface level. The topsoil and subsoil typically overlie a layer of limestone nodules.

Soil samples were collected from the two soil-landscape subsystems within the footprint of the M70/926 proposed mining boundary disturbance area for laboratory analysis. The laboratory results indicate topsoil pH within the project ranged from 8.5 and 8.8, which is considered slightly alkaline with a low organic content of less than 2%. The exchangeable sodium percentage (ESP) was 0.6% and 0.3%, indicating non-sodic soils are present within the project. Based on the low ESP these soils are not considered to be dispersive. The conductivity ranges from 0.067 to 0.11 ds/cm and is deemed suitable for topsoil growth medium. However, the topsoil is deemed to have a high wind erodibility and is prone to water erosion due to the material being high in medium to very fine sand (0.6 mm to 0.075 mm), and low organic matter levels (DMIRS, 2016). As such, both topsoil stripping and application is scheduled to avoid periods of high winds resulting in topsoil loss.

Baseline soil nutrient testing was undertaken across six sites within pasture areas of the project in 1997, prior to mining. A summary of the results is provided in the table below. Organic carbon levels were low at some sites and all the samples are mildly alkaline. Based on the results, some amelioration may be required. The soils typically have a low clay fraction, are prone to non-wetting and have low water retention properties. The soils are prone to aeolian erosion when not vegetated.

Table 1 Topsoil chemistry

Parameter	Unit	Range	Status[1]	Suitability for legume pasture[2]
Nitrate	mg/kg	7 – 11		
Ammonia	mg/kg	1 – 4		
Total Nitrogen	mg/kg	8-14	Very low	Very low – Low
Phosphorous	mg/kg	18 – 22	Moderate – High	Very good - High
Potassium	mg/kg	53 – 73		Fair - Good
Sulphur	mg/kg	4-7		
Org C	%	0.7 – 1.1	Low - Mod	V. Low – Low
Reactive Iron	mg/kg	76 – 95		Very Low
EC	dS/m	0.09 – 0.13	Non-saline	Very Low
pH	N/A	7.4 – 7.6	Mildly Alkaline	Very High

2.6. Key assumptions and uncertainty

Several environmental influences represent a risk to this RMP, as described below. GMA's rehabilitation objectives, management targets and actions, and corrective actions were developed to minimise these risks wherever possible. As well as several internal procedures were developed and implemented to minimise risks to rehabilitation, refer to the MCP. Risks include:

- Increase in weed cover and density: The Project is in agricultural regions and has also been historically utilised for agricultural purposes. Weeds spread can result from wind spreading seed, animals, vehicles and equipment. New weed species can be introduced, or existing weed infestation spread beyond the current footprint. Weeds can impact the success of re-establishing native vegetation in rehabilitation areas.
- Extreme weather: unexpected or severe weather events, including flooding, can wash away topsoil and impact rehabilitation landforms through erosion. Drought can contribute to the risk of wind erosion due to dry conditions and prevent seed germination from lack of rainfall.
- Fire: hot or out of control fires, have the potential to burn new growth, thus preventing the success of rehabilitation.
- Introduced fauna: feral animals and grazing sheep could impact new growth and impact of regeneration of native vegetation. Feral animals such as cats and foxes can affect the re-establishment of native fauna within the rehabilitation areas.

GMA is responsible for ensuring successful Project rehabilitation and meeting specific completion criteria outlined in this RMP.

3. Progressive Rehabilitative Processes and Planning

The crucial first step to ensuring successful rehabilitation of the project is the planning stage. Maximising planning can reduce the overall disturbance and ensure material such as topsoil is close to its final location. This may involve analysing environmental baseline data and essential information for closure stage such agreed post mining land use (PMLU). Section 2.2 provides details on PMLU. The rehabilitation processes are detailed in the below subsections.

3.1. Rehabilitative Processes

The table below presents the current rehabilitation processes adopted by GMA.

Rehabilitation Processes

Stage	Task	Action	Objective
1	Contour Survey	Topographical survey of location before vegetation clearing	Completed pits are backfilled with mine waste and shaped to blend in with adjacent natural contours.
2	Seed Collection	Collection of seed of native species within Mine Site before vegetation clearing	Retain genetic suite of remnant vegetation in Mine Site
3	Vegetation Removal	100 m corridor removed per year within the mining lease.	Sequential clearing methodology minimising disturbances to fauna movement. Biological matter retained
4	Topsoil removal	Standing remnant vegetation to be pushed into windrows for stockpiling for later respreading on areas rehabilitated	Maximum retention of soil fertility and existing seed bank. Retention of biological material in topsoil. Reduction in change in the physical structure of the topsoil because of compaction and change in moisture content. Retention of preferred growth media to support plant growth in rehabilitated areas
5	Overburden removal	Overburden (where present) to be progressively removed and stockpiled or placed directly over tailings during pit excavations	Minimisation of open area of pit
6	Tailings storage	Tailings to be progressively returned to the trailing edge of the excavated mine pit	Storage of tailings within landform profile
7	Overburden return	Stockpiled overburden to be returned to the trailing edge of the excavated mine pit and over tailings as soon as practicable	Construction of post-mining landform Minimise storage time of overburden
8	Landform construction	Contouring of completed mining area to natural	Construction of post-mining landform to blend in with surrounding landforms.

Stage	Task	Action	Objective
		contours to be achieved by earthmoving machinery	Height and footprint ensure that the rehabilitated area blends in with surrounding landscape. New landform does not restrict the existing hydrological regime present in the area.
9	Topsoil return	Topsoil is placed over subsoil (overburden, tails) to a minimum depth of 150 mm	Construction of post-mining landform to match pre-mining landform
10	Soil treatment (as required)	Addition of fertilisers suitable for native plant growth (as required)	Create conditions suitable for native plant growth, but minimising weed growth (stage may not be required)
11	Integration of topsoil and landform	Deep ripping of constructed landform to ensure integration of topsoil and subsoil	Minimise risk of erosion by wind and water
12	Return of larger vegetative material	Spreading across landscape of stockpiled logs, branches, and other vegetative material pushed up into windrows	Increase microhabitat. Minimise risk of erosion by wind and water
13	Seeding	Direct seeding of reconstructed landform with seeds collected from the Site.	Minimise risk of erosion by wind and water
14	Monitoring	Establishment of long-term monitoring sites.	Increase microhabitat
15	Weed management	Ongoing weed management via a regular treatment program.	Increase seed retention areas for growth

3.1.1. Erosion Control – Early Revegetation

Progressive rehabilitation will occur as soon as possible after being backfilled. The vegetative matter shall be returned to the Site and strategically placed in windrows to help mitigate wind erosion and enhance the establishment of new native vegetation. If required, wind fencing will be established to mitigate wind erosion. If required, instate earthen bunds to protect topsoil area.

3.1.2. Return of Local Native Species

The use of seed for rehabilitation must be obtained from the local area and appropriate for the targeted vegetation type. Seeds should be collected from vegetation within the Site, so that genetic diversity of the Site is retained and returned.

The flora species considered for potential use in revegetation are provided in Appendix B and are found within the Site. The flora species was determined from quadrats established for each vegetation type is provided in Appendix B.

Weeds are problematic for the Site and it is recommended that revegetation efforts focus on fast-growing plants (i.e. Some *Acacia*, Eucalypts and *Melaleuca*) rather than herbs in the initial years. It should be noted that the species list is not exhaustive, and a detailed list of species recorded in each vegetation type are detailed in relevant reports.

A list of propagation methods for select species is provided in Appendix B.

3.1.3. Revegetation Treatments

The topsoil shall be respread across the area at an optimal depth of 150 mm or greater (or topsoil pre-clearing survey results) and vegetative matter strategically placed in windrows to establish fauna habitat and windbreaks.

Direct seeding of the reconstructed post-mining landform is the most suitable method of developing the vegetation community. Seeds will be sourced locally from the Site and collected before vegetation is cleared, to preserve the genetic diversity.

Direct seeding shall be supplemented with additional planting of locally sourced native flora species. This will be undertaken to enhance biodiversity on-site where quick-growing colonisers may outcompete slower-growing or recalcitrant species or where monitoring demonstrates a lack of species diversity in comparison to the biodiversity target criteria.

Direct planting can also be used in conjunction with the direct seed of the reconstructed post-mining landform to enhance soil stabilisation.

3.1.4. Signage

Revegetated areas should be marked every 100 m along any boundary where access is available with sturdy, wooden or metal signs. To reduce the risk of accidental damage, staff/contractors will be made aware of signage and protocols for entering revegetated areas.

3.1.5. Supporting Information

Supporting infrastructure to be implemented on an as needs basis includes:

- Installation of wind fence along the outer edge of the rehabilitated area to minimise loss of topsoil and seeds
- Installation of tracks (preferably) and maintenance of existing tracks to allow sufficient access for management
- Installation of firebreaks, as per Shire of Northampton's requirements.

3.1.6. Schedule and Timeline

Due to the relatively short rainfall season and the drying effects of wind on sandy soils, timing of revegetation activities will be critical for the success of the work. Seeding needs to be undertaken early in the rainfall season for seedlings to become sufficiently stablished prior to soils drying out and hot weather commencing. Planting should be conducted following either a large rainfall event or consecutive rainfall days of 30 mm or greater precipitation.

Once seeding has occurred, there is a need to undertake initial monitoring to ensure that the physical controls such as fencing and weed mats are in place and that damage has not occurred. Revegetation monitoring shall be undertaken at two-yearly intervals following year one monitoring.

A recommended timeline is shown in the table below.

Timeline

Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Seed Collection (species dependent)	X					X	X				X	X
Topsoil spread (if required application of gluon)	X	X	X	X	X	X	X	X	X	X	X	X
Ripping of topsoil				X	X	X						
Strategically place vegetative matter in windrows					X							
Fencing contract (if required)												
Planting contract (weather dependent)							X	X	X			
Weed control (before and after planting)						X			X			
Seeding (weather dependent)					X	X	X					
Establish photo points											X	
Implement monitoring plan - six months post seeding/planting									X			
Monitoring (to check for erosion or unauthorised access/damage)						X			X			X
Year 1 monitoring									X			
Year 3 monitoring									X			
Year 5 monitoring									X			
Year 7 monitoring and beyond (2 yearly intervals thereafter until completion criteria is met)									X			

3.2. Rehabilitation Planning Requirements for Each Domain

3.2.1. Domain 1: Open Pits

The key performance indicators for the closure of the backfilled pits are:

- Successful backfilling of the pit to match the adjacent site topography, with no subsidence issues
- Rehabilitated vegetation (for M70/927, M70/204, M70/968, M70/259) or pasture (M70/856, M70/926, M70/1331, G70/171) is performing adequately
- Weed management strategies applied to prevent the spread of weeds through the rehabilitated areas are effective and weed infestation does not occur.

The mining pit has progressed from the south-east to the north-west of the mining area in the Hose tenements. Lynton mining activities started in lower M70/204 and progressed south into M70/259 and then into M70/1331. Mining has also resumed in M70/204 and is moving northwards.

Mining operations are conducted using conventional (dry mining) earthmoving methods. This mining method is amenable to progressive rehabilitation as backfilling and progressive rehabilitation can occur at the trailing edge of the pit. While, mining activities continue at the leading edge, progressing northwards. Backfilling of the trailing edge of the pit operates continuously in conjunction with excavation at the leading edge of the pit (Plate below). Excavations are conducted in benches of 3 to 5m.

Topsoil is added annually following the first winter rains. Following application, the topsoil is deep-ripped before seeding and fertilisation (where necessary).

The pit disturbance area is composed of:

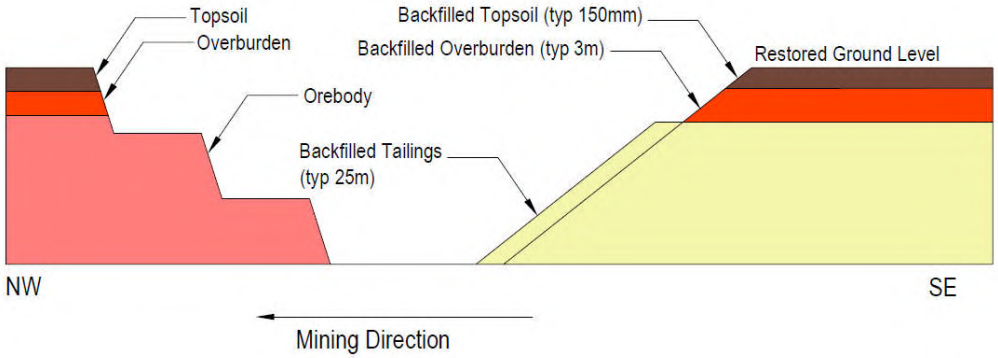
- A rehabilitated zone behind the trailing edge of the pit.
- A backfilled zone awaiting annual surface rehabilitation.
- Working pit area
- Pre-stripped zone ahead of the leading edge of the pit.

Backfilling of mining pits to pre-mining ground level has several positive closure outcomes. Disturbance areas can be progressively rehabilitated more quickly, safety risks are mitigated, and the project is typically more capable of satisfying the post-mining land use. Backfilling allows for rehabilitation trials, avoids aboveground waste landforms, and means that an open pit is not left at closure.

Mining rates are linked to market conditions but are expected to continue at the rate of approximately 1.7 million tonnes of ore a year in Hose Mine and 0.5 to 1 million tonnes per year in Lynton Mine. The disturbance rates are expected to continue at approximately 6 ha per year for Hose and 4 to 8 ha per year for Lynton. Depth of mining below pre-mining ground level is expected to be between 4 m and 40 m at both mine sites.

The total area planned to undergo disturbance is estimated to be approximately 180 ha for Hose Mine and 400 ha for Lynton Mine. The current disturbance area within the Hose and Lynton Mine as of 31 October 2021 was estimated to be 297 ha (includes active mining, backfilling, and contouring) with a further 116 ha rehabilitated. Backfilling at the trailing pit edge with tailings and overburden is conducted continuously. After the first winter rains, the application of topsoil and seeding of backfilled areas is conducted annually.

Progressive rehabilitation has been used since mining operations started in 1981. Some of the early mine areas have been re-mined to recover remnant ore and heavy minerals from tailings in recent years. Losses of topsoil and dust emissions have been minimised by managing topsoil or other backfilled materials and avoiding long-term stockpiling wherever possible.



Pit Backfilling Concept Plan

Backfilling will be done using damp tailings material that is deposited in benches, and traffic compacted. Following the deposition of the tailings material, the overburden material (if available) is deposited on top and shaped to fit the surrounding topography. Topsoil material is placed on the overburden annually following the first winter rains to reduce wind erosion potential and aid rehabilitation.

Following the application of topsoil, the tenements returned for agriculture will be managed using standard pastoral practices for the area.

Subsidence has occurred in one previously rehabilitated area on the project site due to the consolidation of material. To achieve ground level, the removal of topsoil, further deposition of tailings and overburden, and reapplication of topsoil was required. Since this event, tailings and overburden are heaped to above ground level while backfilling, tailings are deposited when wet where possible and benched to enable some vehicle compaction. Since these measures have been implemented, no problems associated with subsidence have been identified.

Closure works are ongoing. Backfilling would be expected to be completed within 12 months of completing mining activities (the year 2034), based upon the current projected life of the project.

Plate 1 Mine Pit Undergoing Backfilling (Hose Mine)

Table 2 Open Pit and Stockpiles Task List

Sub-domain	Task	Monitoring and Verification
Open Pits	• Progressively backfill open pits with mine waste and shaped to blend in with adjacent natural contours. • Conduct a radiation survey of the backfill area. • Revegetate area in accordance with the Rehabilitation Management Plan.	• Comparison of pre-mining and post-rehabilitation survey of the backfilled pit to verify correct height and correct landform returned. • Vegetation density, height and diversity comparable with the analogue site. • Pre-mining vegetation community returned. • Radiation levels are either equal to or below background levels.
Topsoil Stockpiles	• Respread across backfill area. • Revegetate area in accordance with the Rehabilitation Management Plan.	• Vegetation density, height and diversity comparable with the analogue site • Pre-mining vegetation community returned. • For agricultural areas, pasture has been re-established.
Low grade ore stockpile	• Low grade ore to be either processed or backfill into mining voids depending on viability. • Conduct a radiation survey of the backfill area. • Revegetate area in accordance with the Rehabilitation Management Plan.	• Pasture has been re-established. Undertake post-rehabilitation audit.

3.2.2. Domain 2: Processing and Supporting Infrastructure

The processing area on G70/171 and M70/856 includes the wet processing plant, ROM stockpile areas, pipelines, transfer tank and process water pond. All infrastructure will be removed from the site at mine closure unless it is subject to a signed sequential use agreement. No final sequential land use agreement is currently in place. Closure works are predicted to commence in 2033 and to be completed within 12 months.

The sub-domains for domain 2 detail the necessary tasks for decommissioning and monitoring/verification requirements.

Table 3 Domain 2 Task List

Sub-domain	Task	Monitoring and Verification
Wet Plant and associated infrastructure	• Remove all infrastructure and concrete pad. • Backfill and contour area to blend in with surrounding landscape. • Spread topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use • Implement post-mining monitoring.	• Site audit of the removal of all material. • Pasture has been re-established. Undertake post-rehabilitation audit. • Where the native vegetation has re-established. • Vegetation density, height and diversity comparable with the analogue site. • The pre-mining vegetation community returned.
Solar Drying Ponds and associated infrastructure	• All sediment removed from the solar drying ponds, and disposed of into the open pit. • Backfill with stockpiled overburden material and contour area to blend in with surrounding landscape. • Spread stockpile topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use. • Implement post-mining monitoring.	

Sub-domain	Task	Monitoring and Verification
Run-of-mine Pads	• Backfill and contour area to blend in with surrounding landscape. • Spread topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use. • Implement post-mining monitoring.	
Geraldton Reprocess	• Backfill and contour area to blend in with surrounding landscape. • Radiation Survey • Spread topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use. • Implement post-mining monitoring	

3.2.3. Domain 3: Administration Infrastructure, Pipelines, Powerlines and Borefields

Site power is supplied from the SW grid and BESS. Process water supply from the bore fields is piped through a HDPE underground pipe. The bore field on Hose mine is comprised of 16 bores. The bore field on Lynton mine is comprised of 12 bores. Only three of the Lynton bores are required for current operation.

The Hose administration building, and parking area is located east of the Wet Plant. The parking area is unsealed.

The existing diesel storage facility is contained in a bunded area, and this will be decommissioned upon commissioning of the self-bunded containment structure. The workshop and washdown bay are located immediately south of the diesel storage facility.

The sub-domains for domain 3 detail the required tasks for decommissioning and monitoring/verification requirements (refer to the table below).

Domain 3 Task List

Sub-domain	Tasks	Monitoring and Verification
Hose Administration building and parking area.	• Remove all infrastructure and concrete pad. • Backfill and contour area to blend in with surrounding landscape. • Spread topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use • Some of the infrastructure may be retained by the landholder.	• Site inspection to confirm all infrastructure removed • Pasture has been re-established. Undertake post-rehabilitation audit.
Workshop and washdown bay	• Remove all infrastructure and concrete pad. • Any hydrocarbon contaminated soil to be remediated. • Backfill and contour area to blend in with surrounding landscape. • Spread topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use.	
Diesel Fuel storage	• Remove all infrastructure and concrete pad. • Any hydrocarbon contaminated soil to be remediated. • Backfill and contour area to blend in with surrounding landscape. • Spread topsoil over contoured area. • Return land-use to pasture, consistent with pre-mining use.	

Sub-domain	Tasks	Monitoring and Verification
Borefield and pipelines, powerlines	• Any bores to be decommissioned, undertaken in accordance with the Minimum construction requirements for water bores in Australia. • Pipelines remove and disposed of/recycled/re-used. • Some of the infrastructure may be retained by the landholder. • Topsoil application. • Return to pre-mining land-use. • Where native vegetation is return, undertake in accordance with the Rehabilitation Management Plan.	• The pre-mining land-use has been returned. Pasture has been re-established. Undertake post-rehabilitation audit. • Where native vegetation has re-established. • Vegetation density, height and diversity comparable with the analogue site. • Pre-mining vegetation community returned.
Laydown areas	• Backfill and contour the area to blend in with the surrounding landscape. • Spread topsoil over a contoured area. • Return land use to pasture, consistent with pre-mining use. • Implement post-mining monitoring.	• Pasture has been re-established. Undertake post-rehabilitation audit.
Bioremediation Facility	• All remediated contaminated soil was removed and backfilled. • Test and dispose of the water per legal requirements contained in a stormwater catchment, as required. • Removal and disposal of the marker layer in accordance with legal requirements. • Removal and disposal of the liner. • Backfill and contour the area to blend in with the surrounding landscape. • Spread topsoil over a contoured area. • Return land-use to pasture, consistent with pre-mining use. • Implement post-mining monitoring.	• Pasture has been re-established. Undertake post-rehabilitation audit.

3.2.4. Domain 4: Access Roads

The project comprises several types of access roads:

- Firebreak access tracks.
- Access tracks to monitoring bore sites and rehabilitation sites
- Hose access road.
- Hose single-lane access road.
- Lynton Access road.

Several of the access roads also serve as a firebreak and as agreed with post-mining landholders, some access roads will be retained.

The table below summarises the tasks required for decommissioning of the access roads.

Domain 4 Task List

Sub-domain	Tasks	Monitoring and Verification
Access Roads	• Some of the access roads are to be retained and handed over to the landowner as part of the sequential use agreement. • All other access roads were ripped and topsoil spread on ripped surface. • Return to pre-mining land-use.	• Pasture has been re-established. Undertake post-rehabilitation audit. • Where native vegetation requires to be returned. Vegetation density, height, and diversity comparable with the analogue site.

Sub-domain	Tasks	Monitoring and Verification
		• Pre-mining vegetation community returned.

4. Rehabilitation Management Plan Provisions

4.1. Management Actions

The appropriateness of these objectives will be continually reviewed throughout the life of the mine, based on the outcome of adaptive measures outlined in Section 5.

Objective	Management Target	Management Action	Monitoring	Timing/Frequency	Responsibility Reporting
Ensure all legal obligation to closure of Port Gregory are met.	• All clearing permit conditions met. • Tenement relinquishment completed. • Offset requirements achieved. • PMLU achieved	• Progressive rehabilitation as per the clearing permit condition requirements. • Rehabilitation Management procedure. • Relinquishment inspection.	• Rehabilitation monitoring sites and analogue sites (remnant native vegetation to be established for each year of rehabilitation. • Annual photo monitoring points to track how rehabilitation is progressing.	• Monitoring will be undertaken in year 1, year 3, year 5, year 7 and after 7 years at 2 yearly intervals until practical completion criteria is met. The vegetation monitoring aspects are discussed further in Section 4.2.	• Environmental Department. • Annual Clearing Permit Report • DMIRS Annual Environmental Report
Safe, stable and non-pollution landforms.	• All legacy contaminated sites remediated. • Establishment of stable and safe landforms.	• Maintain contaminated sites register. • Establish site management plans for contaminated sites. • No subsidence of landforms.	• Monitor all hydrocarbon spill incidents and remedial actions undertaken. • Review and update contaminated sites register as required. • Monitor for subsidence of landforms.	• Ongoing monitoring required.	• Environmental Department. • Supervisors and Superintendents. • Skytrust.
To re-establish vegetation in line with practical completion and is self-sustaining.	The practical completion criteria for native revegetation: • An average of 75% species diversity of adjacent reference sites, +/- 5%, for five years. • An average of 50% plant cover in the ground and mid layers of adjacent reference sites, +/- 5%, for five years. The key upper storey species recorded in the vegetation type / adjacent reference site are present and likely to	• Progressive rehabilitation to minimise the open areas. • Clearing and ground disturbance procedure. • Dust management procedure. • Rehabilitation Management procedure. • Topsoil to be spread over contour surface and vegetation matter spread in windrows. • Fire management requirements. • Use seed obtained from the local area, to maintain	• Rehabilitation monitoring sites and analogue sites (remnant native vegetation to be established for each year of rehabilitation. • Annual photo monitoring points to track how rehabilitation is progressing. • Annual inspections of fire breaks by the Shire of Northampton Fire Control Officer. • Engage rehabilitation contractors to undertake seed collection.	• Monitoring will be undertaken in year 1, year 3, year 5, year 7 and after 7 years at 2 yearly intervals until practical completion criteria is met. The vegetation monitoring aspects are discussed further in Section 4.2. • Annual inspection of firebreaks by Northampton Fire Control Officer. • Annual seed collection program.	• Environmental Department. • Annual Clearing Permit Report • DMIRS Annual Environmental Report

Objective	Management Target	Management Action	Monitoring	Timing/Frequency	Responsibility Reporting
	form an upper storey over time. Background information regarding development of the vegetation completion is provided in Appendix A.	genetic diversity for the site (refer to Appendix B). Restrictions established to minimise disturbance.			
Agreed post-mining land use	Agree post mining land-use re-established as per Section 2.2	• Ongoing Stakeholder Consultation. • Review/update rehabilitation management plan.	• Stakeholder Consultation Register. • Conduct annual review.	• Stakeholder Consultation will be as required. • Annual review of the rehabilitation management	• Environmental Department. • Mine Manager • Resource Manager
	Land use for M70/856 is compatible for pasture.	• Maintain native regrowth (mechanical and chemical control).	• Conduct annual monitoring.	• Annually	• Environmental Department. • Supervisors and Superintendents.

4.2. *Vegetation Monitoring Aspects*

This RMP has been designed to:

- Assess the progressive establishment of revegetated areas
- Identify areas that require further revegetation works such as weed control or infill planting
- Determine trends in revegetation.

The RMP is recommended to be implemented until practical completion, whereby the revegetation fulfils the relevant requirements (i.e. clearing permit conditions). An environmental specialist (botanist) who can recognise juvenile plants, weed types and other impacts should undertake the monitoring aspect of the monitoring plan.

4.2.1. *Site Establishment*

At each mining tenement where revegetation is being undertaken, a minimum of one permanent quadrats (10 x 10 m) will be established within both remnant vegetation and rehabilitation areas for each revegetation year to provide sufficient monitoring data.

The analogue quadrats (reference sites) established within the remnant vegetation will assist with measuring revegetation progress and be used to determine whether practical completion has been met.

A galvanised steel post will be installed in each corner of the quadrat, and each corner will be geo-referenced.

4.2.2. *Data Collection*

Site data collected from each quadrat will be recorded on pro-forma data sheets and will include the parameters described in the table below.

Example of Data Collection Parameters

Parameters	Measurements
Collection attributes	Personnel/recorder, date, quadrat dimensions, GPS coordinates of all corners and photographs from each corner of the quadrat.
Rehabilitation details	Rehabilitation year and works
Physical attributes	Landform, drainage, soil, litter type and cover
Disturbances	Nature of disturbances, fire age
Vegetation	Structure: overall projected foliar cover of upper, mid- and ground stratums (based on cover classes of: 1-100%)
Flora	Composition (species diversity): list of all flora species and stratum abundance
Weeds and Declared Pests	Overall foliar cover of all weed species combined based on cover class of: 1 to 100%

4.2.3. *Flora Identification*

Vascular flora taxa will either be identified in the field or collected for identification using local regional flora keys compared with the named species held by the regional herbarium. Flora taxa collection requirements must be consistent with the methodology outlined in the Western Australian Herbarium (2008) How to Collect Herbarium Specimens.

Juvenile flora forms may be identified to a genus level. The nomenclature used for reporting is required to follow that used by the Western Australian Herbarium reported on FloraBase (WA Herbarium, 1998-).

4.2.4. Data Analysis

Vegetation data will be analysed using Excel's Data Analysis Tool and include the use of Descriptive Statistics function for density and composition measures.

4.2.5. Reporting

The results of the monitoring, including data collected from the monitoring event, photos and statistical analysis comparing results against previous monitoring results and completion criteria shall be compiled in a concise report. The report should contain recommendations for any remediation works.

5. Adaptive Management and Review

5.1. Management Plan Review

GMA operate an ISO 14001 Certified Environmental Management System (EMS) and an ISO 9000 Quality Management System. The EMS provides the framework for environmental management for the project, to ensure compliance with relevant permit and licences, detail the relationship and interaction between various operational and environmental components, to assist GMA employees and contractors in administering their responsibilities regarding management. The RMP forms part of annual review process and as a result objective management may be adapted in response to the outcomes of:

- Changes to the conservation status of vegetation communities and flora.
- Rehabilitation monitoring or contingency actions.
- Improved methods obtained through rehabilitation trials.
- Increased knowledge through vegetation surveys or government advice.

Ongoing review of the appropriateness of the practical completion criteria and management targets for rehabilitation not being achieved, or are unlikely to be achieved within three to five years, contingencies and corrective actions will be enacted as per the table below.

Contingency and Corrective Actions

Trigger	Action
Monitoring demonstrates increase in weed populations and also greater than the analogue site.	Weed management should be undertaken at the sites whenever the completion criteria for weeds are not met (i.e. target weed control) and should continue for three years following the commencement of rehabilitation works. Weed management shall comprise the following activities: • Weed monitoring to determine weed species present and observed percentage cover of weeds. • As necessary, manual (hand removal) or chemical (herbicide application) removal of key weed species within the sites. Optimal removal times may vary for weed species, however, at a minimum weed control should occur annually prior to seed set. It is important to ensure that appropriately experienced personnel undertake weed management to provide native plants are not damaged or destroyed. The Pest and Weed Management Guideline (HSE-174-001) and the Pest and Weed Management procedure (HSE-174-002) outlines weed management requirements.
Monitoring demonstrates the completion criteria after two years for species diversity is not met.	Infill/extra planting of species to increase diversity.
Monitoring indicates erosion of soil in the rehabilitation area.	Erosion control e.g. brushing/mulching and/or topsoil replacement if erosion is noted during monitoring as a potential issue. Possible options may include mulching with clean woodchips around planted areas and inner edge of the grazing/wind proof fence. The semi-permanent shade cloth fence and posts should be removed at the project's cessation or when the completion criteria are met.
Evidence of subsidence	If necessary, remediate the area of subsidence.

Contingency and corrective actions will be implemented throughout the project, as required, until closure objectives have been achieved. A review is expected to be undertaken with new information, as development continues, changes occur and/or additional studies are undertaken. If the contingency and actions fail to meet the mine closure objectives, an alternative approach will be conducted in agreeance with all relevant stakeholders.

6. Supporting Documents

Document No.	Document Title or Information Source
	Rehabilitation Management Procedure

7. Related Documents

Document No.	Document Title or Information Source
HSE-172	Clearing and Ground Disturbance
	Clearing and Topsoil Management
HSE-174 - 001	Pest and Weed Management Guideline
HSE-174 - 002	Pest and Weed Management Procedure
	Fauna Management
	Dust Management
	Port Gregory Mine Closure Plan (revision 5)

8. References

Document No.	Document Title or Information Source
	Department of Water and Environmental Regulation (DWER) (2016) A Guide to Preparing Revegetation Plans for Clearing Permits. Draft v0-3, October 2016
	Department of Mines, Industry Regulations and Safety (DMIRS) (2015) Guidelines for Preparing Mine Closure Plans. May 2015.
	GHD (2011) Port Gregory Minesite Offset Area Rehabilitation Management Plan. June 2012
	GHD (2013) GMA Port Gregory Mine Tenement M70/968 Vegetation, Flora and Fauna Assessment. October 2013.
	GHD (2013) GMA Port Gregory Mine Tenement M70/968 Vegetation, Flora and Fauna Assessment
	GHD (2014) GMA Garnet Port Gregory Mine Targeted Flora Survey
	GHD (2016) Mining Lease M70/926 Biological Survey
	GHD (2016) Mining Lease M70/926 Biological Survey. October, 2016.
	GHD (2019a) Port Gregory Mining Tenement M70/204 Revegetation Monitoring
	GHD (2019b) Port Gregory Mining Tenement M70/927 Revegetation Monitoring
	GHD (2019c) Port Gregory Mining Tenement M70/968 Revegetation Monitoring.
	GHD (2020a) Lynton Mine Expansion Biological Survey. February, 2020.

Document No.	Document Title or Information Source
	GHD (2020b) GMA Garnet Dust and Noise Modelling. Air Quality Assessment.

9. Revisions

Date	Revision	Created/ Amended By	Amendment	Approved By (Document Owner)
15/10/2019	A	GHD	Update based on GMA comments	Thomas Southwell
12/11/2019	B	GHD	Update based on GMA comments	Thomas Southwell
24/01/2020	C	GHD	Update based on GMA comments	Thomas Southwell
24/11/2020	0	Steven Petts	Convert to GMA Management Template, update document name and update/review vegetation descriptions and rehabilitation processes.	Sean Dowley
21/02/2022	1	Steven Petts	Update RMP with reference to the current guideline requirements.	Sean Dowley

Appendix A. Background of Vegetation Establishment

The baseline return for vegetation establishment is based on previous vegetation and flora surveys, and revegetation monitoring is undertaken within active mining tenements.

Baseline return measures native foliage percent cover in each stratum (upper, middle and groundcover), weed foliage percent cover and flora species diversity. The baseline return for revegetation is derived from an average of the quadrats mapped within each vegetation type.

Mining Tenement M70/204

GHD (2020) has mapped three vegetation types and two by GHD (2019a) mapped within the M70/204.

GHD (2019) recorded the following two vegetation types:

- *Acacia rostellifera* Low Open Forest (VT01)
- *Acacia rostellifera* Tall Open Shrubland (VT02)

GHD (2020) recorded the following three vegetation types:

- *Acacia rostellifera* open woodland to woodland (VT01).
- *Melaleuca cardiophylla* shrubland to open shrubland (VT02).
- Myoporum insulare shrubland (VT03).

Vegetation type 3 has been excluded from the vegetation establishment criteria, as the mining resource fall outside this vegetation type. For rehabilitation VT01 and VT02 recorded by GHD (2019) were grouped with VT01 recorded by GHD (2020), due to their similarities in species diversity, structure, soil type and landforms (herein referred to as VT01 – *Acacia rostellifera* open woodland to woodland). Background for vegetation re-establishment was develop for vegetation types VT01 and VT02 as shown in the tables below. Groundcover was dominated by introduced flora. Further details of dominant native flora taxa for this vegetation type is provided in Appendix B.

Background Quadrat Data for VT01 (GHD, 2020a and GHD, 2019a)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Lyn04	-	24.5%	31.7%	30.1%	3	11
Lyn05	-	32.0%	40.4%	28.2%	6	14
Lyn07	31%	41%	1.60%	60.6%	4	11
Lyn08	20%	71%	12.20%	23.1%	4	7
Lyn09	30%	66%	39.40%	30.1%	2	7
Lyn17	50%	78%	1.00%	0.5%	1	9
Lyn19	30%	15%	6.00%	78.1%	4	13
Lyn20	60%	17.5%	26.50%	77.1%	4	10
Lyn23	-	54%	11.20%	10%	2	6
Lyn25	-	50.5%	17.10%	1.1%	2	16
Lyn26	-	62.5%	3.00%	65.2%	4	9
Lyn27	-	97%	6.10%	75%	1	9
Q7	70%	41%	-	87%	4	8
Q8	20%	29%	-	50%	7	7
Q9	-	65%	-	75%	2	5
Av.	39%	50%	11.4%	46%	3	9.5

Background Quadrat Data for VT02 (GHD, 2020a)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Lyn01	-	21.6%	6.60%	52.6%	4	17
Lyn02	-	31.1%	25.40%	0.1%	1	18
Lyn10	-	49.5%	12.10%	33%	3	15
Lyn11	-	48.5%	21.10%	65.1%	3	10
Lyn18	20%	19%	6.50%	90%	2	14
Av.	5%	34%	14%	48%	3	15

Mining Tenement M70/926

Three vegetation types (excluding cleared and degraded) were mapped within this mining tenement by GHD (2016). The vegetation types included:

- *Acacia rostellifera* Low Forest (VT01)
- *Acacia rostellifera* Tall Open Shrubland (VT02)
- *Acacia rostellifera* Low Shrubland on Shallow Soils (VT03).

Vegetation type 1 and 2 were grouped together due the similarities in species diversity, structure, soil type and landforms for revegetation purposes. Background for vegetation re-establishment was develop for the identified vegetation types in the tables below. Groundcover was dominated by introduced flora. Further details of dominant native flora taxa for this vegetation type is provided in Appendix B.

Background Quadrat Data for VT01 and VT02 (GHD, 2016)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Q1	80%	2%	-	20%	4	3
Q2	80%	25%	-	29%	6	5
Av,	**80%**	**13%**	**-**	**15%**	**5**	**4**

Background Quadrat Data for VT03 (GHD, 2016)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Q1	80%	2%	-	20%	4	3

Mining Tenements M70/927

Two vegetation type (excluding cleared and degraded) were mapped within this mining tenement by GHD (2019b). The vegetation types included:

- *Acacia rostellifera* Low Open Forest (VT01)
- *Acacia rostellifera* Tall Open Shrubland (VT02).

Both vegetation types were grouped together due their similarities in species diversity, structure, soil type and landforms for revegetation purposes. A background for vegetation re-establishment was develop for the identified vegetation type in the table below. Groundcover was dominated by introduced flora. Further details of dominant native flora taxa for this vegetation type is provided in Appendix B.

Background Quadrat Data for VT01 and VT02 (GHD, 2019b)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Q4	-	96%	-	35%	2	7
Q5	70%	35%	2%	79%	3	7
Q6	80%	32%	-	77%	3	7
Av.	**75%**	**54%**	**2%**	**64%**	**3**	**7**

Mining Tenement M70/968

Four vegetation types (excluding cleared and degraded) were mapped within this mining tenement. The vegetation types included:

- Mixed Open Heath on Sandy Limestone Ridge (VT01)
- *Acacia rostellifera* Scrub (VT02)
- Low Heath (VT03)
- *Melaleuca* Thickets (VT04).

Background for vegetation re-establishment was develop for the identified vegetation types as shown in the tables below. It understood that the *Acacia rostellifera* Scrub (VT02) was excluded from the mining footprint and therefore completion criteria were not required for this vegetation type. Groundcover was dominated by introduced flora. Further details of dominant native flora taxa for this vegetation type is provided in the tables below.

Background Quadrat Data for VT01 (GHD, 2013 and GHD, 2019c)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Q1	-	82%	10%	25%	4	21
Q17	-	87%	9%	12%	2	19
Q18	-	83%	11%	25%	4	21
Av.	-	**84%**	**10%**	**21%**	**3**	**20**

Background Quadrat Data for VT03 (GHD, 2013)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Q4	-	79%	26%	8%	3	16

Background Quadrat Data for VT04 (GHD, 2013 and GHD, 2019c)

Quadrat No.	Native Flora Cover			Weed Cover	Weed Species Count	Native Species Count
	Upper stratum – tree	Middle – stratum – shrub	Groundcover stratum – grasses, herbs			
Q2	5%	74%	3%	1%	1	9
Q3	-	63%	60%	9%	4	10
Q16	50%	84%	2%	15%	2	16
Av.	**18%**	**67%**	**22%**	**8%**	**2**	**12**

M70/204					
Vegetation Type 1					
Stratum	**Background**	**6 months**	**1 years**	**5 years**	**10+ years**
Upper Stratum	39%	-	-	>10%	>25%
Middle Stratum	50%	-	>2%	>25%	>50%
Groundcover	11%	-	-	5%	≥11%
Mean Weed Foliage Cover (%)	<46%	<46%	<46%	<46%	<46%
Declared Pest	0	0	0	0	0
Weed Species Count	≤3	≤3	≤3	≤3	≤3
Flora Diversity Species Count (native flora)	≥9	≥2	≥4	≥7	≥9
Vegetation Type 2					
Stratum					
Upper Stratum	5%	-	-	>2%	5%
Middle Stratum	34%	-	5%	>20%	34%
Groundcover	4%	-	-	2%	4%
Mean Weed Foliage Cover (%)	<48%	<48%	<48%	<48%	<48%
Declared Pest	0	0	0	0	0
Weed Species Count	≤3	≤3	≤3	≤3	≤3
Flora Diversity Species Count (native flora)	≥15	≥2	≥2	≥8	≥15
M70/926					
Vegetation Type 3					
Stratum	**Background**	**6 months**	**1 years**	**5 years**	**10+ years**
Upper stratum	5%	-	-	>1%	>5%
Middle stratum	25%	-	>2%	10%	>25%
Groundcover	1%	-	>1%	>1%	>1%
Mean weed foliage cover (%)	<77%	<77%	<77%	<77%	<77%
Declare Pests	0	0	0	0	0
Weed species count	≤3	≤3	≤3	≤3	≤3
Flora diversity species count (native flora)	≥9	≥2	≥4	≥9	≥9
M70/926					
Vegetation Type 1 and 2					
Stratum	**Background**	**6 months**	**1 year**	**5 years**	**10+ years**
Upper stratum	5%	-	-	>1%	>5%

Middle stratum	25%	-	>2%	10%	>25%
Groundcover	1%	-	>1%	>1%	>1%
Mean weed foliage cover (%)	<77%	<77%	<77%	<77%	<77%
Declare Pests	0	0	0	0	0
Weed species count	≤3	≤3	≤3	≤3	≤3
Flora diversity species count (native flora)	≥9	≥2	≥4	≥9	≥9
Vegetation Type 3					
Stratum	**Background**	**6 months**	**1 year**	**5 years**	**10 + years**
Upper stratum	5%	-	-	>1%	>5%
Middle stratum	25%	-	>2%	10%	>25%
Groundcover	1%	-	>1%	>1%	>1%
Mean weed foliage cover (%)	<77%	<77%	<77%	<77%	<77%
Declare Pests	0	0	0	0	0
Weed species count	≤3	≤3	≤3	≤3	≤3
Flora diversity species count (native flora)	≥9	≥2	≥4	≥9	≥9
M70/968					
Vegetation type 1					
Stratum	**Background**	**6 months**	**1 year**	**5 years**	**10+ years**
Middle stratum	84%	-	>2%	>50%	>84%
Groundcover	10%	-	>2%	>5%	>10%
Mean weed foliage cover (%)	<21%	<50%	<21%	<21%	<21%
Declare Pests	0	0	0	0	0
Weed species count	≤3	≤3	≤3	≤3	≤3
Flora diversity species count (native flora)	≥20	≥4	≥6	≥10	≥20
Vegetation type 3					
Stratum	**Background**	**6 months**	**1 year**	**5 years**	**10+ years**
Middle stratum	79%	-	>2%	>50%	>79%
Groundcover	26%	-	>2%	>10%	>26%
Mean weed foliage cover (%)	<5%	<50%	<25%	<5%	<5%
Declare Pests	0	0	0	0	0
Weed species count	≤3	≤3	≤3	≤3	≤3
Flora diversity species count (native flora)	≥16	≥4	≥4	≥8	≥16
Vegetation Type 4					

Stratum	Background	6 months	1 year	5 years	10+ years
Upper stratum	18%	-	-	>5%	>18%
Middle stratum	67%	-	>2%	>30%	>67%
Groundcover	22%	-	>2%	>15%	>22%
Mean weed foliage cover (%)	<8%	<50%	<25%	<8%	<8%
Declare Pests	0	0	0	0	0
Weed species count	≤1	≤1	≤1	≤1	≤1
Flora diversity species count (native flora)	≥12	≥3	≥6	≥12	≥12

Appendix B. Vegetation Types Dominant Species List and Species Selection

Tenement	**M70/204**		
Vegetation type	***Acacia rostellifera* open woodland to woodland**		
Species	**Stratum**		
	Upper	**Middle**	**Groundcover**
Acacia rostellifera	17%	24%	
Threlkedia diffusa		2%	
Enchylaena tomentosa		2%	
Olearia sp. Kennedy range			
Pimelea microcephala			
Rhagodia preissii subsp. *obovata*		22%	
Rhagodia latifolia		7%	
Scaevola tomentosa			
Stylobasium spathulatum		8%	
Pimelea microcephala		4%	
Austrostipa elegantissima			3%
Stylobasium spathulatum		5%	
Roepera fruticulosa			7%
Vegetation Type	***Melaleuca cardiophylla* shrubland to open shrubland**		
Species	**Stratum**		
	Upper	**Middle**	**Groundcover**
Acacia rostellifera	20%	3%	
Acanthocarpus canaliculatus			20%
Alyogyne hakeifolia			3%
Austrostipa elegantissima			2%
Melaleuca cardiophylla		12%	
Pimelea microcephela		3%	
Rhagodia preissii subsp. *obovata*		6%	8%
Roepra fruticulose			6%
Templetonia retusa		5%	
Tenement	**M70/926**		
Vegetation type	***Acacia rostellifera* tall open shrubland to low forest**		
Species	**Stratum**		
	Upper	**Middle**	**Groundcover**
Acacia rostellifera	80%		
Rhagodia preissii subsp. *obovata*		1%	

Stylobasium spathulatum		1%	
Acacia rostellifera		3%	
Tetragonia implexicoma		15%	
Enchylaena tomentosa		1%	
Ptilotus drummondii		1%	
Tenement	**M70/926**		
Vegetation type	***Acacia rostellifera* low shrubland on shallow soils**		
Species	**Stratum**		
	Upper	**Middle**	**Groundcover**
Eucalyptus mannensis subsp. *vespertina*	5%		
Acacia rostellifera		15%	
Scaevola tomentosa		1%	
Rhagodia latifolia		1%	
Alyxia buxifolia		1%	
Scaevola tomentosa		5%	
Erodium cygnorum			1%
Enchylaena tomentosa		1%	
Pimelea microcephala		1%	
Tenement	**M70/968**		
Vegetation type	**Mixed Open Heath on Sandy Limestone Ridge**		
Species	**Stratum**		
	Upper	**Middle**	**Groundcover**
Acacia rostellifera		30%	
Acanthocarpus preissii		1%	
Alyogyne huegelii		3%	
Austrostipa elegantissima			1%
Austrostipa tenuifolia			2%
Calandrinia remota			2%
Commicarpus australis			1%
Convolvulus remotus			1%
Dioscorea hastifolia			7%
Diplopeltis petiolaris		1%	
Enchylaena tomentosa		1%	
Eremophila glabra subsp. *carnosa*		5%	
Erodium sp. (insufficient material)			5%
Euphorbia tannensis		2%	

Glycine canescens			2%
Goodenia berardiana			1%
Grevillea argyrophylla		5%	
Melaleuca cardiophylla		8%	
Olearia sp. Kennedy Range (G. Byrne 66)		4%	
Phyllanthus calycinus		1%	
Pimelea angustifolia		6%	
Pimelea microcephala		1%	
Pittosporum angustifolium		1%	
Rhagodia latifolia		2%	
Rhagodia preissii subsp. *preissii*		5%	
Rhodanthe chlorocephala subsp. *rosea*			2%
Reopera fruticulosa		2%	
Solanum oldfieldii		1%	
Templetonia retusa		5%	
Tetragonia implexicoma		10%	
Thysanotus manglesianus			1%
Waitzia podolepis			2%
Tenement	**M70/968**		
Vegetation type	**Low Heath**		
Species	**Stratum**		
	Upper	**Middle**	**Groundcover**
Melaleuca cardiophylla		50%	
Calandrinia polyandra			2%
Diplopeltis petiolaris		10%	
Bossiaea spinescens		5%	
Opercularia vaginata		5%	
Desmocladus asper			15%
Dichopogon fimbriatus		1%	
Avena barbata			5%
Sisymbrium irio			2%
Dioscorea hastifolia			5%
Acanthocarpus preissii		1%	
Pimelea angustifolia		5%	
Waitzia podolepis			1%
Phalaris minor			1%

Goodenia beardiana			1%
Phyllanthus calycinus			1%
Melaleuca campanae		1%	
Olearia sp. Kennedy Range (G. Byrne 66)		1%	
Clematicissus angustissima			1%
Tenement	**M70/968**		
Vegetation type	**Melaleuca Thickets**		
Species	**Upper**	**Middle**	**Groundcover**
Acacia rostellifera		5%	
Alyogyne huegelii		1%	
Aphanopetalum clematideum			1%
Calandrinia polyandra			1%
Calandrinia remota			2%
Clematis linearifolia			2%
Dioscorea hastifolia			50%
Eucalyptus fruticosa	28%		
Euphorbia boophthona		5%	
Goodenia beardiana			1%
Lasiopetalum angustifolium		1%	
Melaleuca cardiophylla		33%	
Olearia sp. Kennedy Range (G. Byrne 66)		5%	
Parietaria debilis			1%
Pimelea angustifolia		3%	
Pimelea microcephala		2%	
Pittosporum angustifolium		1%	
Ptilotus eriotrichus		5%	
Rhagodia preissii subsp. *obovata*		5%	
Rhagodia latifolia		5%	
Scaevola tomentosus		5%	
Templetonia retusa		4%	
Tetragonia implexa		13%	
Waitzia podolepis			1%
Zygophyllum billardierei			5%

Appendix C. Example of Monitoring Data Sheet

Plan Approvals

Approval Authority	Name	Signature	Date
Mine Manager	Sean Dowley		19/12/2020

12 November 2019

Mr Tom Southwell
Global Resource Manager
GMA Garnet Pty Ltd
122 Goulds Road
Narngulu WA 6530

Our ref: 6138125-79455
Your ref:

Dear Tom

Port Gregory Mine M70/204 Revegetation Monitoring Assessment 2019

1 Introduction

GMA Garnet Pty Ltd (GMA) commissioned GHD Pty Ltd (GHD) to undertake revegetation monitoring at mining tenement M70/204 (the Site). The monitoring methodology was consistent with the revegetation monitoring plan (RMP) (GHD 2019) for the Port Gregory mine which includes the Site. The purpose of the RMP was to address the requirements of revegetation and monitoring for all GMA active mining leases (GHD 2019).

As indicated in Mining Lease 204 Notice of Intent, mining commenced on the Site in 1995, with 87.53 ha of revegetation undertaken from 1996 to 2019, with revegetation areas ranging in age from one to 23 years old.

This letter report provides the results of the first year of revegetation monitoring and is subject to the limitations provided in Attachment A.

2 Scope of works

The GHD scope of works was to undertake revegetation monitoring at the Site in accordance with the RMP (GHD 2019), including:

- Establishment of permanent quadrats within the revegetation area and within remnant vegetation to record vegetation structure, condition and to measure flora diversity and cover
- Preparation of this letter report detailing both survey methods and results.

3 Background

Mining operations use standard open-cut sand mining methods. Mobile earthmoving equipment, including front-end loaders, excavators and dump trucks are used for pit excavation and backfilling. Soil and overburden if present are removed ahead of ore excavation and are replaced in their original stratigraphic order over the backfill tailings. There is no waste or tailing dumps due to the continuous process of backfill and restoration.

3.1 Existing vegetation and floristics

As part of revegetation monitoring at the Site, reference sites (3) were established within remnant vegetation. At each reference site the vegetation structure, type and vegetation condition was recorded.

Vegetation types and condition

Two vegetation types were recorded within remnant vegetation from the Site. These included *Acacia rostellifera* Low Open Forest and Open *Acacia* Tall Shrubland. Both vegetation types comprised similar density and species composition influenced by topography and underlying geology.

The vegetation condition of the Site was rated during the field survey using the Vegetation Condition Scale (after Environmental Protection Act (EPA) and Department of Parks and Wildlife (DPaW), 2015). The vegetation at the Site was predominantly *Good* to *Degraded* with large areas considered to be *Completely Degraded* in locations due to grazing, firebreaks and historical exploration activities.

Flora diversity

Eighteen flora taxa from eight families were recorded from three quadrats established within the Site, this total included nine introduced flora taxa.

No *Environmental Protection Biodiversity and Conservation Act 1999* (EPBC) Act or *Biodiversity Conservation Act 2017* (BC Act) or Department of Biodiversity, Conservation and Attractions (DBCA) listed flora species were recorded from the Site.

3.2 Objective and completion criteria

A baseline for the re-establishment of vegetation was developed to initially guide revegetation and monitor the success of the works. Indicative values for foliage cover and flora species diversity at set intervals were provided to guide the progress of native flora taxa within each stratum and weed species until practical completion. The two vegetation types described within the Site were grouped together due the similarities in species diversity, structure, soil type and landforms for revegetation purposes.

The success of revegetation can be affected by a range of issues, which may be out of the control of GMA, such as lack of rainfall, storm events, insect attack and vandalism, but other success factors, such as weeds, grazing, and care of planting can be managed. The overarching outcome for revegetation is:

- To achieve similar species composition, structure and diversity to what was present prior to vegetation clearing. Small-scale vegetation structure and species combinations may vary

Practical completion is as per GHD (2019) and is achieved when:

- An average of 75% species diversity of adjacent reference sites, +/- 5%, for a five year period
- An average 50% plant cover of adjacent reference sites, +/- 5%, for a five year period.

4 Methodology

4.1 Data collection

Six permanent quadrats were installed, including three within revegetation sites and remnant vegetation (reference sites). Each monitoring quadrat was 10 x 10 m in size (100 m^2 area) and each corner was permanently marked with a metal stake. Field data collected at each quadrat was recorded on a pro-forma data sheet and included following parameters:

- Collection attributes
- Rehabilitation year and works
- Physical attributes: landform, drainage, soil, little type and cover
- Disturbances
- Vegetation structure including overall foliage cover
- Flora species diversity and stratum abundances
- Weeds and declared pests overall foliage cover.

4.1.1 Summary of quadrat locations

A description of the three quadrat sites established in revegetated areas of the Site are as follows:

- Q10 and Q11 are located within six years old revegetation
- Q12 located within nine years old revegetation.

Three quadrats were established within remnant vegetation within the Site:

- Q07 to Q09 located within remnant vegetation in the northern portion of the Site.

The quadrat locations are mapped in Figure 1, Attachment B and the pro-forma datasheets are provided in Attachment C.

4.2 Flora Identification

Vascular flora taxa were identified in the field or collected, and identified using local and regional flora keys. A small number of flora taxa were not able to be adequately identified to species level due to many still occurring in juvenile forms and not having adequate material for identification purposes.

4.3 Data analysis

Data analysis was not undertaken for the 2019 revegetation assessment as it is the first year of monitoring as there is no comparable data available.

4.4 Survey timing

GHD ecologist Steven Petts undertook revegetation monitoring from 3 to 5 September 2019. The monitoring was undertaken in spring, which is optimal flowering time for flora species within the mid-west region.

5 Results

5.1 Climate

The Port Gregory region experiences a Mediterranean type climate, characterised by warm to hot dry summers and mild wet winters. The closest Bureau of Meteorology (BoM) weather station that provides continuous reliable data to the Site is located a Kalbarri (Site Number 8251). The average annual rainfall measured at Lynton (Site number 008075) is 396.9 mm. In the three months (June, July and August) preceding the revegetation monitoring assessment Lynton station received 258 mm of rainfall, which is greater than the long-term average (226.1 mm) for the same three months (Chart 1).

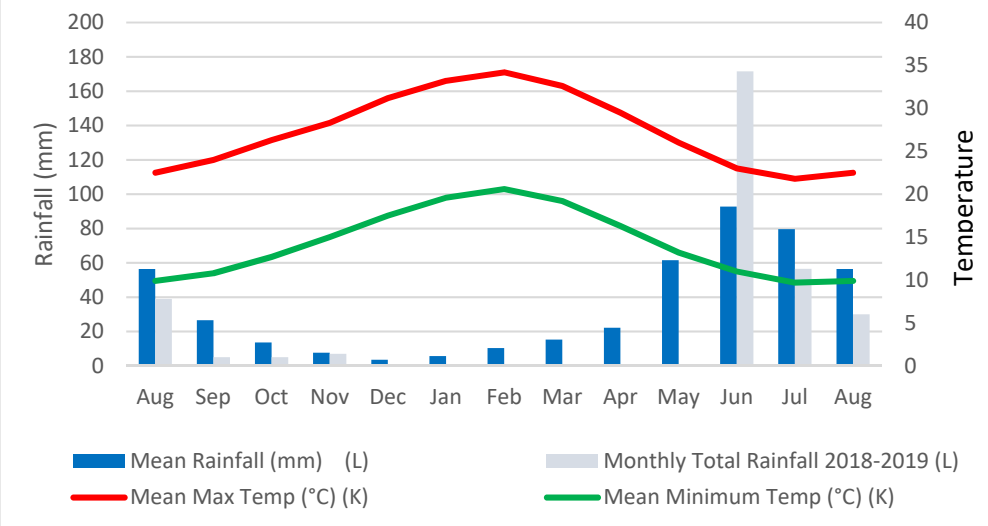


Chart 1 Climate summary for Kalbarri and Lynton weather stations

5.2 General site conditions

The Site is generally flat (20 mAHD) with the limestone escarpment intersecting the eastern boundary. Mining activities are currently underway in the middle portion of the tenement and progressing in a northerly direction. Revegetation efforts have focussed on the southern portion of the tenement and these areas have naturally re-established (i.e. no seeding or tube stock). The soils within the revegetation area comprised shallow beige sandy soils on limestone and the ground was generally bare (Plate 1).

Plate 1 Revegetation site (Q08)

5.3 Species diversity

A summary of the individual quadrat diversity for reference site established within remnant vegetation is provided in Table 1. Table 1 indicates that quadrats contained an average of seven native flora taxa and three weed species. Dominant native species included *Acacia rostellifera, Rhagodia preissii* subsp. *obovata, Rhagodia latifolia* and *Pimelea microcephala.*

Table 1 Reference sites – flora diversity

Quadrats	Year of establishment	No. native taxa	No weed taxa
Q07 (Reference)	2019	8	4
Q08 (Reference)	2019	7	7
Q09(Reference)	2019	5	2
Average	-	**7**	**4**

Quadrats established within the revegetation area of the Site indicate that Q12 is greater than the reference site (114% of the average diversity), however Q10 and Q11 are less than the average (43% of the average diversity) (Table 2). Similar dominant native species to the reference sites were recorded within the revegetation area including *Acacia rostellifera, Pimelea microcephala, Rhagodia preissii* subsp. *obovata* and *Rhagodia latifolia.* The dominant recorded flora taxa are key flora species that define the vegetation type and were also recorded within remnant vegetation.

Table 2 Revegetation assessment 2019 Flora diversity

Quadrat	Age and year of revegetation	No. Native taxa	No. Weed taxa	% diversity of reference site
Q10	6 years and 2013	3	2	43%
Q11	6 years and 2013	3	3	43%
Q12	9 years and 2010	8	3	114%

5.4 Percent cover

A summary of the individual quadrat structural cover for reference sites established within remnant vegetation is provided in Table 3. Table 3 indicates that quadrats contained an average of 45% cover in the upper stratum, 23% cover in the middle stratum and total groundcover is 45% with 2% native groundcover.

Table 3 Reference site – percent cover

Quadrat	Upper stratum	Middle stratum	Native groundcover	Weed cover
Q07	70%	41%	2%	70%
Q08	20%	29%	2%	20%
Q09	-	65%	-	-
Average	**45%**	**23%**	**2%**	**45%**

Table 4 provides an overview of the recorded vegetation cover within the upper, middle and groundcover strata for revegetated areas. The following key findings include:

- Revegetation sites were largely dominated by middle stratum
- Upper stratum has not been established due these species (*Acacia rostellifera)* yet to develop to their mature height
- Both the middle and groundcover stratum meets the completion criteria for Q12
- Native groundcover percent was similar to the reference sites
- Weed cover within the revegetated area was less than the reference sites.

Table 4 Revegetation assessment 2019 percent cover (native flora)

Quadrat	Upper stratum	Middle stratum	Groundcover	Weed cover
Q10	-	18%	2%	7%
Q11	-	54%	5%	12%
Q12	-	76%	2%	32%

5.5 Weeds

Weed species recorded within the revegetation monitoring sites and reference site were typically grasses and herbs that are not listed as a *Weed of National Significance* or under the *Biosecurity and Agriculture management Act 2007.* The weeds recorded are considered to be a reflection of the surrounding land use (agriculture). Weed species dominated much of the groundcover across both reference (average cover 45%) and revegetation monitoring sites (7 to 32% cover).

Common weeds recorded across the Site include

- **Leontodon rhagadioloides*
- **Ehrharta longiflora*
- **Lysimachia arvensis.*

6 Summary of findings and recommendation

In summary, revegetation quadrats in the six year old revegetation comprised 43 % of the species recorded at the reference sites. The nine year old revegetation (Q12) exceeded the reference site species diversity and meets the completion criteria for diversity. The key flora taxa that define the remnant vegetation type were dominant within all ages of revegetation. The upper stratum within the revegetation sites have yet to establish and the middle stratum largely dominated the area, however as the key upper stratum species are present it is expected that with time the upper stratum will develop.

Based on the results of the revegetation assessment the following recommendations have been identified:

- Infill planting utilising tube stock and seeds to enhance native success of establishment of revegetation and flora diversity for six year old revegetation.
- Ongoing weed management across the Site
- Continue establishing permanent quadrats across revegetation areas to achieve a minimum of one quadrat per revegetation year
- Continue monitoring revegetated areas every two years.

Sincerely
GHD

Meranda Toner
Senior Environmental Scientist
+61 8 9840 5103

Attachment A – Limitations

Attachment B – Figure

Attachment C- Revegetation Monitoring Datasheets

Attachment A

Limitations

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This report has been prepared by GHD for GMA Garnet and may only be used and relied on by GMA Garnet for the purpose agreed between GHD and GMA Garnet as set out in section 2 of this report.

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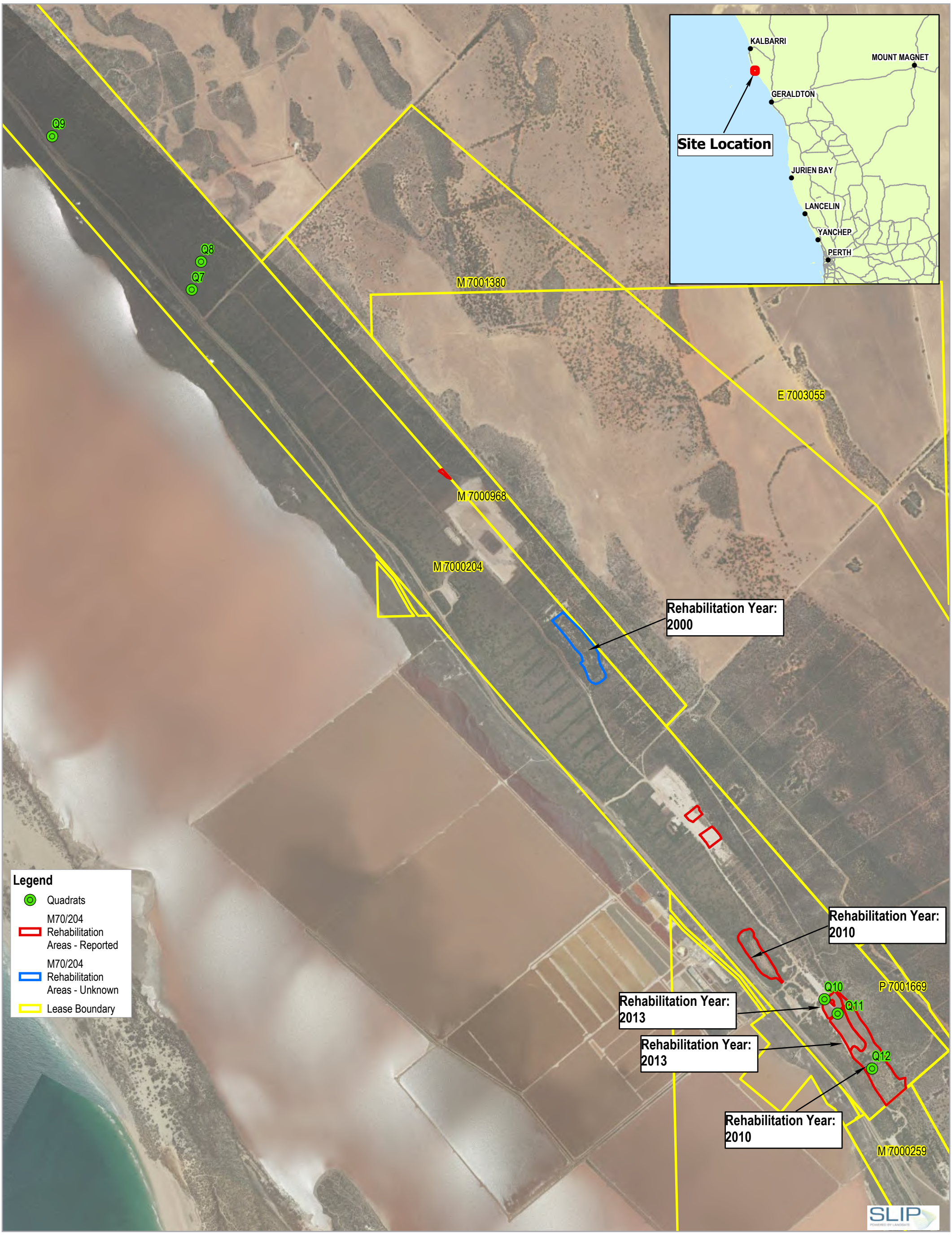
Attachment B

Figure



Paper Size ISO A3

0 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

GMA Garnet Pty Ltd
Revegetation and Monitoring Plan

M70/204 Revegetation Monitoring Assessment 2019

Project No. **61-38125-01**
Revision No. **0**
Date **1/11/2019**

FIGURE 1

G:\61\38125\GIS\Maps\Working\613812501\613812501_Working\613812501_Working.aprx\613812501_M70-204-RevegetationMonitoringAssessment_RevA
Print date: 01 Nov 2019 - 14:37

Data source: DMIRS: Lease Boundary - 20190322; GMA: Rehabilitation Areas - 20191030; WANow: Landgate / SLIP. Created by: bmorgan

Attachment C

Revegetation Monitoring Datasheets

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Vegetation Site Sheet: habitat information					Date:	04-09-19	Site#:	Q07
Survey:	Reveg Monitoring	Field Veg:	Acacia rostellifera Low Open Forrest					
Observers:	SP AS							
Location:	M70/204 - North-western area - Reference Site							
MGA Zone:		Easting:			Northing:			
Site Type:	Quadrat	Dimensions:	10 x 10	Camera:		From:		
Site Disturbance	Frequency		Water or Wind Erosion Evidence					
Animal	Current Disturbance	rabbit, roos	No					
		pigs						
			Climate		Vegetation Condition		Litter	
			Recent rain, no impact on veg			Good		
			Site Drainage			Degraded	Leaf Litter:	
		weeds	Good Drain				Moderate	
			Fire Frequency		Fire Intensity		Wood Litter:	
			Nil				Moderate	

No Picture Available

North-eastern Corner	Easting:	Northing:	South-eastern Corner	Easting:	Northing:

No Picture Available

No Picture Available

South-western Corner	Easting:	Northing:	North-western Corner	Easting:	Northing:
Cracked Clay					
Fine Rocks (2-6mm)			Minor	Slope	
Medium gravel/pebbles (6-20mm)			Sandy	Gentle	
Coarse gravel/pebbles (20-60mm)					
Cobbly Cobbles (60-200mm)			Soil Colour	Slope Aspect	
Stony/stones (200-600mm)			Brown		
Surface Plates/boulders (>600mm)				West	

Growth Form Table								
Tree >10m		Tree 2-10m	Upper	Tree <2m			Tree Mallee	
Palm		Shrub >2m		Shrub 1-2m	Middle		Shrub >1m	Middle
Cycads		Tussock Grass	Groundcover	Hummock Grass			Sedge	
Vine		Herbs	Groundcover	Other			Mallee Shrub	
Heath Shrub		Samphire Shrub		Chenopod			Rush	
Grass Tree		Other						
Stratum	Upper stratum			Middle stratum			Groundcover	
%Cover	70%			61%			87%	
Ht range (m)	5-6			0.2-2.0			0.05-0.5	
Av ht (m)	5.5			0.5			0.2	

Family	Genus	Species	Status	Stratum	Height (m)	Cover (%)	Photo	Count
Chenopodiaceae	Rhagodia	preissii subsp. obovata		Middle	0.3-2	30%		
Fabaceae	Acacia	rostellifera		Upper	5-6	70%		
Poaceae	Ehrharta	longiflora	*	Groundcover	0.05-0.5	60%		
Chenopodiaceae	Rhagodia	latifolia		Middle	1.4	5%		
Poaceae	Austrostipa	elongatisma		Groundcover	0.8	2%		
Fabaceae	Trifolium	hirtum	*	Groundcover	0.05-0.2	5%		
Thymelaeaeceae	Pimelea	microcephala		Middle	0.5 - 1.3	4%		
Poaceae	Avena	barbata	*	Groundcover	0.8	20%		
Brassicaceae	Raphanus	raphanistrum	*	Groundcover	0.5	2%		
Goodeniaceae	Scaevola	tomentosa		Middle	0.5	2%		

Vegetation Site Sheet: habitat information					Date:	05-09-19	Site#:	Q08
Survey:	Reveg Montioring	Field Veg:	Acacia rostellifera Low Open Forest					
Observers:	SP AS							
Location:	M70/204 - Northern Portion - Reference Site							
MGA Zone:	50	Easting:			Northing:			
Site Type:	Quadrat	Dimensions:	10 x 10	Camera:		From:		
Site Disturbance	Frequency		Water or Wind Erosion Evidence					
Animal	Current Disturbance	rabbit, roos	No					
			Climate		Vegetation Condition		Litter	
		goats	Recent rain, no impact on veg			Good		
			Site Drainage			Degraded	Leaf Litter:	
		weeds	Good Drain				Moderate	
			Fire Frequency		Fire Intensity		Wood Litter:	
			Nil				Moderate	

North-eastern Corner	Easting:	Northing:	South-eastern Corner	Easting:	Northing:

South-western Corner	Easting:	Northing:	North-western Corner	Easting:	Northing:

Surface Components	Cover (if needed)		Soil		Landform	
Loose Soil	sandy	3%	Major Component		Slope-Middle	
Humus/Litter	30%	humus litter	Sand			
Cracked Clay						
Fine Rocks (2-6mm)			Minor		Slope	
Medium gravel/pebbles (6-20mm)			Sandy		Gentle	
Coarse gravel/pebbles (20-60mm)						
Cobbly Cobbles (60-200mm)			Soil Colour		Slope Aspect	
Stony/stones (200-600mm)			Brown		West	
Surface Plates/boulders (>600mm)						

Growth Form Table								
Tree >10m		Tree 2-10m	Upper	Tree <2m			Tree Mallee	
Palm		Shrub >2m		Shrub 1-2m	Middle		Shrub >1m	Middle
Cycads		Tussock Grass	Groundcover	Hummock Grass			Sedge	
Vine		Herbs	Groundcover	Other			Mallee Shrub	
Heath Shrub		Samphire Shrub		Chenopod			Rush	
Grass Tree		Other						
Stratum	Upper stratum			Middle stratum			Groundcover	
%Cover	20%			29%			52%	
Ht range (m)	5.0 - 6.0			0.2-2.0			0.1-0.3	
Av ht (m)	5			1.3			0.2	

Family	Genus	Species	Status	Stratum	Height (m)	Cover (%)	Photo	Count
Fabaceae	Acacia	rostellifera		Upper	5-6	20%		
Chenopodiaceae	Rhagodia	preissii subsp. obovata		Middle	1.3-1.5	15%		
Primulaceae	Lysimachia	arvensis	*	Groundcover	prostrate	2%		
Poaceae	Ehrharta	longiflora	*	Groundcover	0.1-0.3	30%		
Asteraceae	Hedypnois	rhagalioides	*	Groundcover	0.05	5%		
Brassicaceae	Raphanus	raphanistrum	*	Groundcover	0.1-0.4	2%		
Chenopodiaceae	Enchyleana	tomentosa		Middle	0.7-0.9	5%		
Poaceae	Avena	barbata	*	Groundcover	0.1	5%		
Goodeniaceae	Scaevola	tomentosa		Middle	1.0	5%		
Chenopodiaceae	Rhagodia	latifolia		Middle	0.8	2%		
Asteraceae	Monoculus	monstrosus	*	Groundcover	0.05	2%		
Asteraceae	Olearia	sp. Kennedy range		Middle	0.8	2%		
Poaceae	Austrostipa	elegantissima		Groundcover	0.8	2%		
Fabaceae	Medicago	polymorpha	*	Groundcover	0.05	4%		

Vegetation Site Sheet: habitat information					Date:	05-09-19	Site#:	Q09
Survey:	Reveg Montioring	Field Veg:	Open Acacia Shrubland		1			
Observers:	SP AS							
Location:	M70/204 - Northern Portion - Reference Site							
MGA Zone:	50	Easting:			Northing:			
Site Type:	Quadrat	Dimensions:	10 x 10	Camera:		From:		
Site Disturbance	Frequency		Water or Wind Erosion Evidence					
Animal	Current Disturbance	rabbit, roos	No					
Exotic Weeds	Current Disturbance							
			Climate		Vegetation Condition		Litter	
			Recent rain, no impact on veg		Good			
			Site Drainage		Degraded		Leaf Litter:	
			Good Drain				Moderate	
			Fire Frequency		Fire Intensity		Wood Litter:	
			Nil				Moderate	

North-eastern Corner	Easting:	Northing:	South-eastern Corner	Easting:	Northing:

South-western Corner	Easting:	Northing:	North-western Corner	Easting:	Northing:

Surface Components	Cover (if needed)		Soil		Landform	
Loose Soil	5%	sandy	Major Component		Slope-Middle	
Humus/Litter	50%	humus litter	Sand			
Cracked Clay						
Fine Rocks (2-6mm)			Minor		Slope	
Medium gravel/pebbles (6-20mm)			Sandy		Gentle	
Coarse gravel/pebbles (20-60mm)						
Cobbly Cobbles (60-200mm)			Soil Colour		Slope Aspect	
Stony/stones (200-600mm)			Brown		West	
Surface Plates/boulders (>600mm)						

Growth Form Table								
Tree >10m		Tree 2-10m		Tree <2m			Tree Mallee	
Palm		Shrub >2m	Middle	Shrub 1-2m	Middle		Shrub >1m	
Cycads		Tussock Grass	Groundcover	Hummock Grass			Sedge	
Vine		Herbs	Groundcover	Other			Mallee Shrub	
Heath Shrub		Samphire Shrub		Chenopod			Rush	
Grass Tree		Other						
Stratum	Upper stratum			Middle stratum			Groundcover	
%Cover				65%			75%	
Ht range (m)				1.2 - 3.2			0.05 - 0.7	
Av ht (m)				1.5			0.7	

Family	Genus	Species	Status	Stratum	Height (m)	Cover (%)	Photo	Count
Fabaceae	Acacia	rostellifera		Middle	3.2	10%		
Fabaceae	Acacia	rostellifera		Middle	1.8	10%		
Thymelaeceae	Pimelea	microcephela		Middle	2.2	5%		
Chenopodiaceae	Rhagodia	preissii subsp. obovata		Middle	1.5-1.6	20%		
Chenopodiaceae	Rhagodia	latifolia		Middle	1.5-1.6	20%		
Poaceae	Ehrharta	longiflora	*	Groundcover	0.3-0.7	70%		
Asteraceae	Leontodon	rhagadioloides	*	Groundcover	0.05-0.1	5%		

Vegetation Site Sheet: habitat information					Date:	05-09-19	Site#:	Q10
Survey:	Reveg Monitoring	Field Veg:	Reveg Site					
Observers:	SP AS							
Location:	M70/204 - south of Lynton							
MGA Zone:	50	Easting:			Northing:			
Site Type:	Quadrat	Dimensions:	10 x 10	Revegetation stage:		Year 6		
Site Disturbance	Frequency		Water or Wind Erosion Evidence					
Animal	Current Disturbance	rabbit, roos	No					
Exotic Weeds	Current Disturbance							
			Climate		Vegetation Condition		Litter	
			Dry, plants not stress		Good			
			Site Drainage		Degraded		Leaf Litter:	
			Good Drain				Sparse	
			Fire Frequency		Fire Intensity		Wood Litter:	
			Nil					Sparse

North-eastern Corner	Easting:	Northing:	South-eastern Corner	Easting:	Northing:

South-western Corner	Easting:	Northing:	North-western Corner	Easting:	Northing:

Surface Components	Cover (if needed)		Soil		Landform	
Loose Soil	pale Brown	50%	Major Component		Slope-Lower	
Humus/Litter	10%	litter	Sand			
Cracked Clay						
Fine Rocks (2-6mm)			Minor		Slope	
Medium gravel/pebbles (6-20mm)			Sandy		Gentle	
Coarse gravel/pebbles (20-60mm)						
Cobbly Cobbles (60-200mm)	limestone	5%	Soil Colour		Slope Aspect	
Stony/stones (200-600mm)					West	
Surface Plates/boulders (>600mm)			Brown			

Growth Form Table								
Tree >10m		Tree 2-10m		Tree <2m			Tree Mallee	
Palm		Shrub >2m	Middle	Shrub 1-2m	Middle		Shrub >1m	Middle
Cycads		Tussock Grass		Hummock Grass			Sedge	
Vine		Herbs	Groundcover	Other			Mallee Shrub	
Heath Shrub		Samphire Shrub		Chenopod			Rush	
Grass Tree		Other						

Stratum	Upper stratum			Middle stratum			Groundcover	
%Cover				18%			9%	
Ht range (m)				1.2-2.3			0.02-0.05	
Av ht (m)				2.1			0.05	

Family	Genus	Species	Status	Stratum	Height (m)	Cover (%)	Photo	Count
Fabaceae	Acacia	rostellifera		Middle	2-2.3	5%		
Malvaceae	Alyogyne	huegelii		Middle	2-2.3	5%		
Fabaceae	Acacia	rostellifera		Middle	1.6-1.8	5%		
Malvaceae	Alyogyne	huegelii		Middle	1.5	2%		
Primulaceae	Lysimachia	arvensis	*	Groundcover	0.02-0.03	5%		
Crassulaceae	Crassula	colorata		Groundcover	0.05	1%		
Asparagaceae	Thysanotus	manglesianus		Groundcover	climber	1%		
Asteraceae	Leontodon	rhagadioloides	*	Groundcover	0.05	2%		
Thymelaeceae	?Pimelea	sp. Insufficient		Middle	0.1	1%		

Vegetation Site Sheet: habitat information					Date:	04-09-19	Site#:	Q11
Survey:	Reveg Monitoring	Field Veg:	Revegetation					
Observers:	SP AS							
Location:	M70/204 - south of Lynton							
MGA Zone:	50	Easting:			Northing:			
Site Type:	Quadrat	Dimensions:	10 x 10	Revegetation stage:		Year 6		
Site Disturbance	Frequency		Water or Wind Erosion Evidence					
Animal	Current Disturbance	rabbit, roos	No					
			Climate		Vegetation Condition		Litter	
			Dry, plants not stress			Good		
			Site Drainage			Degraded	Leaf Litter:	
		weeds	Good Drain				Sparse	
			Fire Frequency		Fire Intensity		Wood Litter:	
			Nil					Sparse

No Picture Available

North-eastern Corner	Easting:	Northing:	South-eastern Corner	Easting:	Northing:

No Picture Available

No Picture Available

South-western Corner	Easting:		Northing:	North-western Corner		Easting:	Northing:
Cracked Clay							
Fine Rocks (2-6mm)				Minor		Slope	
Medium gravel/pebbles (6-20mm)				Sandy		Negligible	
Coarse gravel/pebbles (20-60mm)							
Cobbly Cobbles (60-200mm)		5%	limestone	Soil Colour		Slope Aspect	
Stony/stones (200-600mm)						West	
Surface Plates/boulders (>600mm)				Brown			

Growth Form Table							
Tree >10m		Tree 2-10m		Tree <2m			Tree Mallee
Palm		Shrub >2m	Middle	Shrub 1-2m	Middle		Shrub >1m
Cycads		Tussock Grass		Hummock Grass			Sedge
Vine		Herbs	Groundcover	Other			Mallee Shrub
Heath Shrub		Samphire Shrub		Chenopod			Rush
Grass Tree		Other					

Stratum	Upper stratum			Middle stratum			Groundcover	
%Cover				54%			17%	
Ht range (m)				2-2.5			0.02-0.1	
Av ht (m)				2.2			0.05	

Family	Genus	Species	Status	Stratum	Height (m)	Cover (%)	Photo	Count
Fabaceae	Acacia	rostellifera		Middle	2-2.5	50%		
Malvaceae	Alyogyne	huegelii		Middle	1.8	2%		
Malvaceae	Alyogyne	huegelii		Middle	2.2	2%		
Montiaceae	Calandrinia	remota		Groundcover	0.02-0.07	5%		
Primulaceae	Lysimachia	arvensis	*	Groundcover	0.02-0.05	5%		
Asteraceae	?Leontodon	rhagadioloides	*	Groundcover	0.02-0.05	5%		
Poaceae	Ehrharta	longiflora	*	Groundcover	0.05-0.1	2%		

Vegetation Site Sheet: habitat information					Date:	04-09-19	Site#:	Q11
Survey:	Reveg Monitoring	Field Veg:	Revegetation					
Observers:	SP AS							
Location:	M70/204 - south of Lynton							
MGA Zone:	50	Easting:			Northing:			
Site Type:	Quadrat	Dimensions:	10 x 10	Revegetation stage:		Year 9		
Site Disturbance	Frequency		Water or Wind Erosion Evidence					
Animal	Current Disturbance	rabbit, roos	No					
			Climate		Vegetation Condition		Litter	
			Recent rain, no impact on veg		Good			
			Site Drainage				Leaf Litter:	
		weeds	Good Drain					Moderate
			Fire Frequency		Fire Intensity		Wood Litter:	
			Nil					Sparse

North-eastern Corner	Easting:	Northing:	South-eastern Corner	Easting:	Northing:

South-western Corner	Easting:	Northing:	North-western Corner	Easting:	Northing:
Cracked Clay					
Fine Rocks (2-6mm)			Minor	Slope	
Medium gravel/pebbles (6-20mm)			Sandy	Negligible	
Coarse gravel/pebbles (20-60mm)	2%	limestone			
Cobbly Cobbles (60-200mm)			Soil Colour	Slope Aspect	
Stony/stones (200-600mm)			Brown		
Surface Plates/boulders (>600mm)				West	

Growth Form Table							
Tree >10m		Tree 2-10m		Tree <2m			Tree Mallee
Palm		Shrub >2m	Middle	Shrub 1-2m	Middle		Shrub >1m
Cycads		Tussock Grass	Groundcover	Hummock Grass			Sedge
Vine		Herbs	Groundcover	Other			Mallee Shrub
Heath Shrub		Samphire Shrub		Chenopod			Rush
Grass Tree		Other					

Stratum	Upper stratum			Middle stratum			Groundcover	
%Cover				76%			34%	
Ht range (m)				2.0 - 3.0			0.03 - 0.1	
Av ht (m)				2.5			0.05	

Family	Genus	Species	Status	Stratum	Height (m)	Cover (%)	Photo	Count
Fabaceae	Acacia	rostellifera		Middle	2.0 - 3.0	50%		
Proteaceae	Grevillea	argryophylla		Middle	2.1	5%		
Malvaceae	Alyogyne	huegelii		Middle	2-2.1	5%		
Goodiaceae	Scaevola	crassifolia		Middle	1.7	5%		
Asteraceae	Olearia	sp. Kennedy range		Middle	1.7	10%		
Poaceae	Ehrharta	longiflora	*	Groundcover	0.05-0.1	30%		
Asteraceae	?Leontodon	rhagadioloides	*	Groundcover	0.05	1%		
Chenopodiaceae	Rhagodia	sp. insufficient		Middle	1.3	1%		
Fabaceae	Medicago	polymorpha	*	Groundcover	0.03	1%		
Asteraceae	Rhodanthe	chlorocephala subsp. rosea		Groundcover	0.04	1%		
Montiaceae	Calandrinia	remota		Groundcover	0.03	1%		

Appendix D. GMA Dust and Management Plan

Dust Management

Mining Australia Procedure

Contents

1. Purpose and Scope

Dust can be generated through activities undertaken by GMA Garnet Pty Ltd (GMA). Dust Management provides guidance to successfully manage dust to ensure the impact on the environment and communities in which we operate is minimised.

This procedure details management measures to:

- Minimise the emission of dust associated with the operations
- Prevent negative impacts on sensitive receptors (the surrounding environment and local communities)
- Comply with relevant environmental legal and other requirements.

This procedure applies to all personnel employed by GMA and Sites.

2. Roles and Responsibilities

Role	Responsibilities
General Manager	• Accountable for ensuring adequate resources are available for the implementation and management of this procedure
Mine Manager/Production Manager	• Managing the implementation of this procedure for their Site
Supervisors/Superintendent	• Manage the implementation of the requirement of this procedure with their teams and areas of responsibility
Environmental Coordinator	• Providing advice and assistance to the Division with the implementation of this Procedure. • Undertake monitoring of the requirements within this Procedure. • Periodic reporting of results internally and externally as defined under legislative requirements.

3. Definitions

Term	Definition
Aspect	Element of GMA's activities, products or services that can interact with the environment.
BoM	Bureau of Meteorology
Dust	Fine soil/material particles emitted into the atmosphere from mining and other activities.
Dust Exceedance	In the absence of environmental monitoring data, this could be dust above standard operating, that could impact sensitive receptors and that is more than just a once-off occurrence.
DWER	Department of Water and Environmental Regulations
Environment	Living things, their physical, biological and social surroundings, and interactions between these.
Environmental Impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's aspects.
EPA Licence	*Environment Protection Act 1986* Environmental Licence to Operate
Licenced premise	A place that is prescribed under the under the *Environment Protection Act 1986.*

Term	Definition
Risk	The probability (likelihood) of harm or damage occurring from exposure to a hazard, and the likely consequences of that harm or damage.
Sensitive Receptor	Locations, such as residential buildings or other premises, communities, flora, fauna or habitats, where health or property or environmental values may be affected by emissions above background levels.
Shall	The term "Shall" means mandatory.

4. Legal requirements

Port Gregory Site is an *Environmental Protection Act 1986* (EPA) –Licenced premise (L8561/2011/1). The Licence Premises includes Lynton (M70/204, M70/259, M70/968, M70/1330 and M70/1331), Hose (M70/856 and G70/171) and Utcha (M70/926 and M70/927).

Geraldton Site is also an EPA Licenced premise (L6145/1983/11). As a Licenced premise GMA is required to implement dust management measures to minimise dust and impacts to sensitive receptors. The management measures are outline in Section 5.

5. Process

5.1. Document and Communicate Dust Requirements

The requirements of this procedure and any project specific requirements shall be communicated to personnel involved in dust causing activities during the site inductions, pre-start meetings and during toolbox meetings. The Toolbox Topic: Dust can be used to communicate these requirements.

5.2. Plan Activities

Activities involving the generation of dust shall be planned to minimise emissions and impacts to sensitive receptors:

- Areas to be disturbed shall be identified, minimised and disturbance shall be a staged process as per the requirements outlined in Clearing and Ground Disturbance (HSE-172).
- Use hardstand areas to minimise dust emissions where feasible.
- Discuss activities that have the potential to generate high levels of dust at pre-start meetings and agree on reduction methods before undertaking works.
- Monitor daily weather forecasts for temperature and wind speed and communicate the forecast information to persons involved in dust generating and dust suppression activities, where there is a risk of impacting sensitive receptors. At the Port Gregory mine site monitor the wind station.

5.3. Minimise Dust during Operations

During operations dust shall be minimised by:

- Operating proactively subject to weather forecasting over a 24 hour period (refer to Appendix A.2.12).
- Monitoring Port Gregory wind station (refer to Appendix A.2.12).
- Maintaining roads throughout the Site including watering the roads to maintain moisture on the surface of roads/haul routes
- Use of water trucks and/or water cannons to dampen areas identified as being potentially dust generating (sandy soils, soil stockpiles, unsealed access roads etc.). The frequency of dampening shall be determined based on weather conditions and dust emissions (refer to Appendix A.2.12).
- Restricting all vehicles to dedicated roads and tracks

- Depending on the situation reduce speed limits to minimise dust generation.
- Introducing dust suppression additives where required and practicable
- Maintaining dust suppression systems on conveyor belts.
- Operating dust suppression sprinkler system at Geraldton as per SOP-40.
- Covering vehicles transporting soils off-site to minimise dust generation during transport.
- Implementing regular inspections and preventative maintenance strategies for dust control equipment.
- Maintaining adequate spares at the Site for critical items of control equipment, such as water pumps for dust suppression sprays, spray heads etc.
- Undertaking staged vegetation clearing to minimise open areas
- Undertaking vegetation rehabilitation as soon as practicable to reduce open areas
- Scheduling topsoil stripping to avoid periods of high winds from unfavourable directions relative to sensitive receptors (including George Grey Drive and Utcha Well Nature Reserve).
- Cease/suspending topsoil stripping operations during high wind conditions where there is a risk of dust affecting sensitive receptors.
- Dust suppressant applied proactively to overburden/topsoil stockpiles.
- Dust suppressant reapply proactively subject to visual inspection and weather forecasting.
- Cease activity causing visible dust lift-off where dust management measures have not prevented dust lift-off, and there is a risk of dust affecting sensitive receptors.

Alternative dust control measures, e.g. hydro-mulching, wind fencing, hard standing or chemical dust suppressants may be used and shall be investigated on a case by case basis to determine suitability before implementation.

Additional dust management measures for consideration are documented within Appendix A. Additional Dust Control Guidance.

5.3.1. Product Stockpile Management – Narngulu Operations

Release of fugitive from stockpiled material shall be minimised by:

- Operating dust suppression sprinkler system at Geraldton, as per SOP-40
- Keeping stockpile heights to a minimum. A stockpile shall not exceed the height of the top of the cab of the loader (generally 3 m).
- Scheduling of material cartage so that that stockpiling of material can be kept to a minimum
- Shaping stockpiles with a gentle slope to reduce erosion and sedimentation in the surrounding area
- Maintaining surrounding areas so they are kept free of material build up
- Maintaining an even surface around stockpiles, to reduce material spillage from the loader bucket when in operation
- Reducing loader bucket load volume, so that spillage does not occur.

5.3.2. Mid-West Ports GMA Sheds

The following dust management strategies shall be implemented:

- All trucks loads shall be covered, carting material to the Port.
- In the event the product shed is full, the Contractor shall seek authorisation from Mid West Ports Authority to load from outside the shed on commencement of ship loading.
- Sheds that are at capacity shall have the roller doors lowered until ship loading commences.
- Street sweeping contractor shall be engaged by the Contractor to mitigate the garnet outside the shed areas.

5.4. Undertake Monitoring

Monitoring activities and frequencies are summarised in the table below:

Monitoring Activity	Description of Monitoring Activity	Frequency	Responsibility
Report Exceedances	Any evidence of dust exceedances shall be reported to the Supervisor / Superintendent to enable it to be rectified.	Throughout operations	All Personnel
Inspection	Dust produced by work areas shall be inspected, and if dust levels could impact sensitive receptors, mitigation measures shall be put in place to reduce impact.	Daily	Supervisor/ Superintendents
Monitoring	Port Gregory (only) - Superintendent/Supervisors shall monitor the weather station located on the monitor in the lunch room.	Daily	Supervisor/ Superintendents
Monitoring	Monitoring of sensitive receptors	Mining in M70/926 between October and May.	Environmental Coordinator

5.5. Report Incident or Complaint

If an incident occurs, or a complaint is received report, this needs to be reported in skytrust.

6. Training and Competency

Role	Type	Requirement
All Personnel	Awareness	Induction covering the requirements of this procedure.
Supervisors/Superintendents	Awareness	Completed Appendix A "Procedure Acknowledgement Form".

7. Supporting Documents

Document No.	Document Title or Information Source
	Environmental Toolbox Topic: Dust
SOP-40	Dust Suppression Sprinkler System

8. Related Documents

Document No.	Document Title or Information Source
HSE-172	Clearing and Ground Disturbance Procedure

9. References

Document No.	Document Title or Information Source
	Environmental Protection Act 1986
	Environmental Protection National Environmental Protection (Ambient Air Quality) Measure
	Environmental Protection (Unauthorised Discharges) Regulations 2004
	A Guideline for the Development and Implementation of a Dust Management Program (2008) Department of Environment and Conservation
	The dust suppression choice (23 May 2012) Mining Australia
	GHD (2020) GMA Garnet Dust and Noise Modelling. Air Quality Assessment.

10. Revision

Date	Revision	Created/ Amended By	Amendment	Approved By (Document Owner)
1/12/2020	A	Steven Petts	Draft Preliminary – Issued for Review	Ross Avard
15/02/2022	B	Steven Petts	Update plan to include specific management of	

Appendix A. Additional Dust Control Guidance

A.1. Factors Influencing the Levels of Dust and other Air Pollutants

The following factors influence the risk associated with dust and other air pollutants and should be considered when planning and undertaking works.

The soil type and properties of a site will have a considerable impact on the amount of dust generated. In general soils with a dominant particle size corresponding to gravel size or larger have less potential of becoming airborne than finer particles such as fine sand, silt and clay. However, soil may comprise a mixture of different soil particles, for example, fine contaminated dust, such as heavy metals, mixed with coarse particles.

An assessment of soil particle size distribution can help to determine the potential for particles to become airborne. As a general guide, particle sizes of 50µm or more tend not to become airborne.

Soil moisture content is also important. Dry or non-wetting soils are more likely to become air borne. A soil profile will also provide information on the different soil layers and their potential for particle lift off.

Sites with a larger exposed area are identified as having a greater dust generating potential.

The longer the project, the greater the dust risk as the potential for exposure increases.

The proximity of a site to sensitive receptors has a significant influence on the dust risk potential of a site. A site that is located close to sensitive receptors, such as, residential housing, children's day care, schools, hospitals, sports fields etc., will generally require more preventative measures compared to a site in an isolated remote location.

The direction of the prevailing winds can also influence the risk potential of a site for dust and other air pollutants. Suppose the prevailing winds (predominant wind direction) are blowing towards sensitive receptors. In that case, the risk potential increases because the sensitive receptors are more likely to be impacted then if the winds are blowing away from the sensitive receptors. The higher the wind speed, the greater the potential for dust lift. Daily and seasonal variation of wind speed and direction should be considered, refer to Appendix A.2.12.

The nature of works to be conducted will affect the dust levels, for example, land clearing and stockpiling may generate more dust than site levelling.

The topography of the Site may influence wind behaviour at the Site, which could impact the dispersion of dust and other air pollutants from the Site.

A.2. Dust Control Measures

A.2.1. Limit Cleared Areas and Maximise Vegetation

Before the commencement of any works and during the operation, as much vegetation as possible should be retained, including patches and strips to minimise dust. This can be done by implementing the following:

- Before any works commence, identify areas of vegetation cover that need to be retained.
- Protect this vegetation by fencing or blocking off from the rest of operations
- In other areas, maintain the original vegetation cover for as long as possible.
- Avoid clearing the entire area at once, instead clear areas as required in stages of the operation.

Retaining original trees, shrubs and grasses is one of the most efficient and effective ways of minimising dust emissions. Even low or sparse scrub can be very effective at dissipating wind velocity at the ground surface, where dust lift off occurs.

The following should be considered:

- Retain as much existing vegetation as possible

- If an area needs to be cleared, transplant established plants that must be disturbed to areas that need vegetation
- If trees and plants must be removed and it is not possible for them to be replanted, consider chipping and using the material as mulch – the advantage is that reseeding of original vegetation can occur. Where possible, restore vegetation that is native to the area to maximise plant success and improve environmental conditions.

A.2.2. Timing of Development and Development Staging

Activities with high dust-causing potential, such as topsoil stripping, should not be carried out near sensitive receptors during adverse wind conditions. When necessary, topsoil should be stripped in discrete sections, allowing buffer strips (windbreaks) between clearings.

Dust generated by bulk earthworks being performed during the summer months, particularly with sensitive receptors in proximity, can adversely impact the community/environment.

When planning the staging of developments, the impact on personnel including but not limited to the camp, offices, crib rooms and work areas should be taken into account in relation to the cleared areas and the prevailing winds.

A.2.3. Wind Barriers

Having appropriate wind barriers can be an effective measure for the control of dust over short distances. Wind barriers provide a positive visual impact and offer a protection against the movement and impact of dust on nearby land users. Wind barriers should be considered before commencement of works and when it is apparent that one is required during the next phase of the operation. Consider the following options when placing barriers to prevent dust emissions:

- Wind barriers are most effective when placed perpendicular to the direction of the prevailing wind but will have little or no effect when the wind direction is parallel.
- When choosing wind barriers, it has been observed that solid barriers provide significant reductions in wind velocity for relatively short leeward distances, whereas porous barriers provide smaller reductions in velocity for more extended distances.
- Wind barriers should be at least two metres high.

Windbreaks are barriers designed to slow the speed and redirect the flow of wind. These are not widely used but may be useful in some locations. Effective windbreaks do not stop the wind but break its forward movement, to slow it down. Good windbreaks will not create excessive turbulence or wind eddies.

Windbreak materials may include fences, berms and plants. Windbreaks are most useful when designed for specific wind directions. The effective zone of protection created by a windbreak is approximately 25 times its height, although maximum-protection wind reduction occurs in a range of five to eight times the height of the screen.

A.2.4. Earthmoving Management

Earth-moving activities have the potential to generate large amounts of dust. Planning earth-moving activities particularly at the start of an operation can reduce dust emissions by limiting the time the area is exposed. Options for dust control can include the following:

- Plan earth-moving so they are completed just prior to the time they are needed to limit the length of time ground is exposed
- Observe weather conditions and do not commence or continue earth moving if conditions are unsuitable e.g. under conditions of strong winds.
- Reduce off-site hauling via balanced cut and fill operations
- Pre-water areas to be disturbed.

A.2.5. Management of Material Stockpiles

Material stockpiles can generate large amounts of dust. Fine materials stored in stockpiles can be subject to dust pick-up. Materials being loaded onto conveyor belts or into trucks, rail cars or marine vessels are also potential sources of dust emissions. Dust emissions from material stockpiles can be minimised using the following processes:

- Locate stockpiles in sheltered areas where possible. Alternatively, stockpiles may be covered.
- Where stockpiles are located in open areas, limit the height and slope of the stockpiles to reduce wind pick up, orient stockpiles lengthwise into the wind so they offer the minimum cross-sectional area to prevailing winds, install wind barriers on three sides of the stockpile.
- Limit activity to the downwind side of the stockpile
- Limit drop heights from loading facilities and use closed conveyors where possible. Transfer points should also be minimised. Sprinkler systems could also be used on conveyor systems. Alternatively, dust collection systems, such as, cartridge or baghouse systems could be used instead of sprinklers, where moisture is of concern, for example, with mineral concentrates.

A.2.6. Watering Road

Moisture in the surface of dirt roads causes particles to stick together. The moisture content of dirt roads can be increased by watering the road surface. Depending on weather conditions, a single watering may be effective for hours. When water is applied alone, it provides a short-term reduction in dust. Regular, light watering is better than less frequent, heavy watering.

Watering assists with reducing dust lift off from roads and other traffic areas and during earthworks, to controlling dust during movement of materials such as loading/offloading and transportation of materials.

Watering is a very effective short-term measure; however, its efficiency decreases as wind velocity and evaporation rate increase. Dust emissions can be minimised using the following watering processes:

- The surface should be dampened to prevent dust from becoming airborne but should not be wet to the extent of producing run-off. Alternatively, wetting agents could be used, particularly for non-wetting soils.
- Watering is more effective when undertaken prior to strong breezes
- Use watering sprays on materials to be loaded and during loading.

The use of scheme water should be discouraged, and alternative supplies used whenever possible. However, care must be taken to ensure that the quality of water will not have adverse environmental impacts.

Real time automated response systems to turn on water cannon systems in response to dust levels or high wind speeds can be used. These can help save water by only turning on water cannons during the required conditions and help to reduce the possibility of operator error.

A.2.7. Reducing the Traffic and Speed

Vehicles travelling on unpaved roads stir up dust, reducing the number of vehicles or number of vehicle movements can reduce dust. Traffic can be reduced by restricting vehicle weight or type, ensuring vehicles are utilised with maximum passengers (as opposed to one car per person), or by limiting motor vehicle access to dirt roads.

Fast moving vehicles stir up dust. Studies show that particulate matter 10 micrometres or less in diameter (PM10) goes up with vehicle speed. Reducing speed from 65 kilometres per hour (km/h) to 30 km/h reduces dust emissions by 65%. Speed limit signs and enforcement can reduce speeds. Drainage channels across roads and speed bumps can reduce speeds. Speed bumps and drainage will only reduce dust on roadways, not the surrounds.

A.2.8. Improving Road Design

Good road drainage can reduce dust. If a road surface has poor drainage, puddles will form. Water floats the fine particles. With traffic, water and wind spreads the fines as mud or dust. Standing water next to a road may saturate the roadbed, resulting in potholes. When the fines are washed away, or blown away, the larger particles are left unanchored. These larger particles are pushed to the side of the road, resulting in a need for expensive road resurfacing. If a road is treated with a dust suppressant, the performance of the suppressant depends on the road shedding water and having a smooth driving surface.

A.2.9. Hydromulch

Hydromulch is a very effective measure for preventing dust lift-off from areas where bulk earthworks have been completed and little or no further vehicular or traffic is likely. It is a versatile tool, as the constituents of spray mulch can be varied to suit the requirements of the user and the project. The following processes for hydromulch can be utilised to reduce dust emissions:

- Vehicular and pedestrian access to treated areas should be restricted to prevent disturbance to the hydromulch layer
- Wind barriers placed in isolated locations or where long-term effectiveness is required to control access and achieve maximum benefit
- For short-term stabilisation, hydromulch without grass seed should be sufficient stabilisation.
- For longer-term stabilisation, hydromulch with grass seed and fertiliser should be included in the spray. Organic stabiliser can also be added to the mix to provide a more stable base for the germination of seeds.

Recommended application rates for hydromulch should be sought from suppliers to ensure that application rates and the constituents of the mulch are appropriate to the task.

A.2.10. Chemical Stabilisation

Chemical stabilisers provide immediate coverage and protection; they are effective in areas that receive little traffic or disturbance. They provide a longer-term solution compared to watering, although it may be necessary for the chemical ingredients to be evaluated about their environmental effects.

Chemical stabilisers work by binding the soil particles together to create an artificial crust on the soil surface that is less prone to disturbance by wind. The following options should be considered when using chemical stabilisers to reduce dust emissions:

- Physical barriers or other methods of preventing traffic access should be used to protect stabilised areas
- The manufacturer’s instructions should be followed to optimise performance.

These chemicals fall into several groups, such as petroleum-based, organic nonpetroleum, electrochemical stabilisers, and synthetic polymers.

A.2.11. Covering or Sealing Unpaved Surfaces

Applying gravel to a dirt road surface can reduce dust. Gravel provides a hard surface protecting soils from vehicle wheels. Gravel does not reduce the strength of air currents caused by vehicles themselves, so traffic can still blow loose soil particles into the air. Without a good road base of crushed aggregate, traffic will push surface gravel down into the ground, especially when the road is wet. If the road surface does not have enough fine material to cement the surface gravel in place, traffic will push the gravel away from the driving lanes.

To be effective over a long period of time, new gravel must be anchored to the road surface. This is done through incorporating gravel with aggregate mixes or soil adhesives. If gravel is lost by being pressed into soils beneath the road, then the use of geotextile fabrics may be necessary. These fabrics are constructed of

polymer threads with very high tensile strength and are available in designs that either form water barriers or allow water, but not fine soil, to migrate through.

Paving or bituminising is the most effective (and most expensive) method to control dust from unpaved roads. Asphalt and Portland concrete provide durable and effective surfaces that prevent the breakdown of soil surfaces. Paved roads may still accumulate dust as vehicles enter from unpaved roads.

A.2.12. Wind monitoring

Port Gregory Mine Site

Dust modelling undertaken by GHD (2020) shows the Port Gregory Mine Site is prone to dust lift-off when wind speeds exceed 5.5 m/s (30 to 39 km/hr). Under these conditions, wind erosion will be a high risk for dust emissions (GHD 2020). Wind directions that arcs between 45 and 180 degrees are likely to impact sensitive receptors. The display on the monitor located within the lunch room will flash red when the wind speeds exceed 5.5 m/s and wind direction arcs between 45 and 180 degrees.

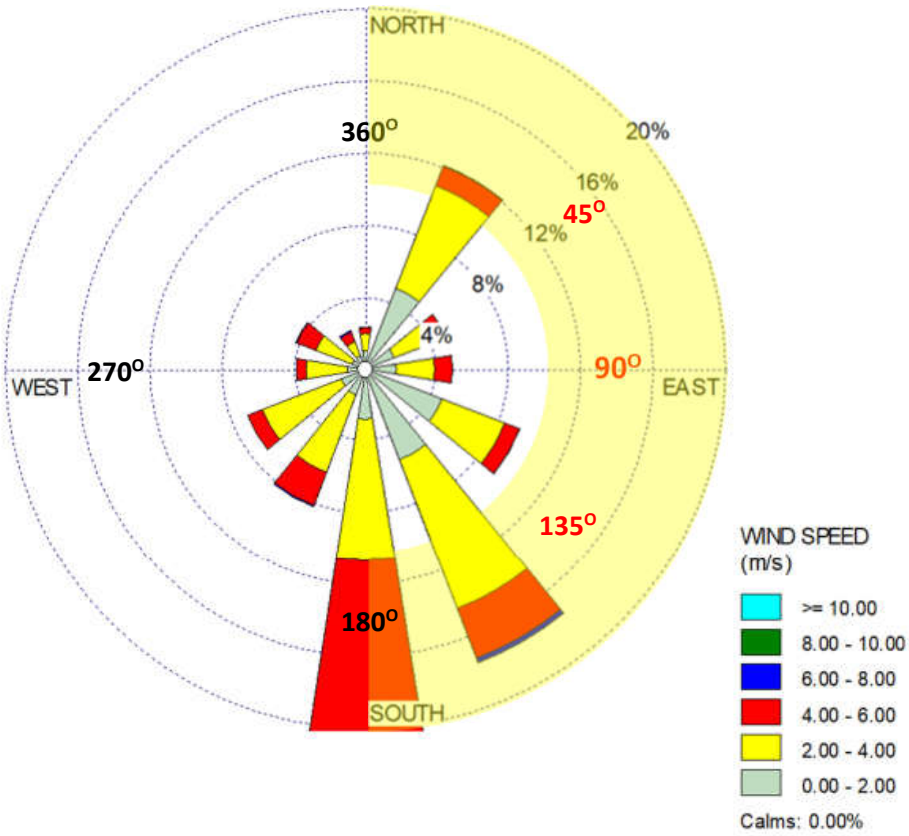

Figure 1 Geraldton Windrose

Geraldton Site

The dust lift-off threshold applicable to the Geraldton Site, are wind speeds greater than 5 to 6 m/s (30 to 39 km/hr). Under these conditions dust is likely to lead to dust breaching the licenced premises boundary.

Appendix B. Procedure Acknowledgement Form

This form shall be completed by personnel who have a responsibility identified in Section 2 Roles and Responsibilities, of this procedure.

I confirm that I have read and am aware of the requirements within this procedure:

PROJECT / FUNCTIONAL AREA	
PROJECT No	

Name	
Signature	
Date	

Return completed form to the Training Department for record keeping.