POLARIS

METALS PTY LTD

MINING PROPOSAL

CARINA EXTENDED IRON ORE PROJECT

M77/1261 and M77/1244

Yilgarn Region WA

05 November 2012

REV #	*DATE*	*REASON FOR ISSUE*	*PREPARED BY*	*PROJECT APPROVAL*
A	08/2012	Draft	PR	
B	4/09/2012	Draft	MR	
C	31/10/2012	Draft	MR	
Rev 0	05/11/2012	Reviewed By SG, JH, RJ	MR/RJ	

MINING PROPOSAL CHECKLIST

No.	Mining Proposal Checklist	Y/N NA	Page No.	Comments
	Public availability			
1	Are you aware that this Mining Proposal is publicly available?	Y		
2	Is there any information in this Mining Proposal that should not be publicly available?	N		
3	If 'No' to Q2, do you have any problems with the information contained within this Mining Proposal being publicly availability?	N		
4	If 'Yes' to Q2, has confidential information been submitted in a separate document / section?	NA		
5	Has the Mining Proposal been endorsed? See last page Checklist.	Y		
	Mining Proposal details			
6	Have you included the tenement number(s), site name, proposal overview and date in the title page?	Y		
7	Who authored the Mining Proposal?	Monica Russell, Senior Environmental Advisor		
8	State who to contact for enquires about the Mining Proposal?	James Hesford, Environment Manager		
9	How many copies were submitted to DMP?	Hard copies = 2		
		Electronic = 2		
10	Is this Mining Proposal to support lease application?	N		
11	Has a geological resource statement been included (refer **Section 4.3.2** of Mining Proposal Guidelines)	Y		
12	Will more than 10 million tonnes of ore and waste be extracted per year? State total tonnage:	N		
13	Will more than 2 million tonnes or ore be processed per year? State total throughput.	N		
14	Is the Mining Proposal located on pre-1899 Crown Grant lands? (not subject to the Mining Act)	N		
15	Is the Mining Proposal located on reserve land? If 'Yes' state reserve types in space below:	N		Currently UCL
16	Will the Mining Proposal occur within or affect a declared occupied townsite?	N		
17	Is the Mining Proposal within 2 km of the coastline or a Private Conservation Reserve?	N		
18	Is the Mining Proposal wholly or partially within a World Heritage Property, Biosphere Reserve, Heritage Site or Soil Reference Site?	N		

No.	Mining Proposal Checklist	Y/N NA	Page No.	Comments
	Tenement details			
19	Are all mining operations within granted or applied for tenement boundaries?	Y		**Section 2.1**
20	Are you the tenement holder of all tenements?	Y		**Section 2.1**
21	If 'No' at 20, do you have written authorisation from the tenement holder(s) to undertake the Mining Proposal activities? (Refer to **Section 4.2.1** of the Mining Proposal Guidelines)	NA		
22	Is 'Yes' at 21, then is a copy of the authorisation contained within the Mining Proposal?	NA		
23	Have you checked for compliance against tenement conditions?	Y		**Appendix 11**
	Location and site layout plans			
24	Have you included location plans showing tenement boundaries and mining operations?	Y		**Section 2.3**
25	Have you included site layout plans showing all mining operations and infrastructure in relation to tenement boundaries?	Y		**Section 2.3**
26	Have you included Area of Disturbance Tables for all tenements impacted by mining operations?	Y		**Table 24**
	Environmental Protection Act			
27	Does the Mining Proposal require referral under part four or the MOU? If 'Yes' describe why in space below:	N		**Section 3.1.2**
28	Has the EPA set a level of assessment? If yes state:	NA		
29	Is a clearing permit required? If 'No' then explain why in space below?	Y		**Appendix 3**
30	If 'Yes' at Q29 then has a permit been applied for?	Y		**Section 5.1**
31	Is a Works Approval required by the DoE?	N		
32	Has a Works Approval been submitted to the DoE?	NA		
33	**Stakeholder consultation**: Have the following stakeholders been consulted? (use NA if not relevant)			**Section 6.2**
	Shire?	Y		
	Pastoralist?	NA		
	CALM?	Y		
	Main Roads?	NA		
	Environmental assessment and management			
34	Is the Mining Proposal wholly or partially within CALM managed areas?	Y		**Section 2.3**
35	If 'yes' at Q34 has CALM been consulted?	Y		
36	Is the Mining Proposal wholly or partially within a red book area or a bush forever site?	N		

No.	Mining Proposal Checklist	Y/N NA	Page No.	Comments
37	Will the Mining Proposal impact upon a water resource area, water reserve, declared or proposed catchment, groundwater protection area, significant lake or wetland?	N		
38	Is a water or de-watering licence required?	Y		
39	If 'Yes' at Q38 then has the licence(s) been applied for?	N		**Table 25**
40	Does the Mining Proposal includes a new tailings storage or changes to existing tailings storage?	N		
41	Has AMD assessment been undertaken?	Y		**Section 3.3**
42	Have flora and fauna checks been undertaken?	Y		**Sections 3.8, 3.9**
43	Are any rare species present?	Y		**Table 3 and Section 3.8**
44	Has a Preliminary Closure Plan has been included?	Y		**Appendix 12**

I hereby certify that to the best of my knowledge the above checklist accurately reflects the information contained within this Mining Proposal.

Name: James Hesford Signed:  Date: 05/10/2012

Position: Environment Manager

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1. SUMMARY AND COMMITMENTS

Polaris Metals Pty Ltd (Polaris) proposes to develop the Carina Extended iron ore deposit, located approximately 60 kilometres (km) northeast of Koolyanobbing and 100 km northeast of Southern Cross. Carina Extended is a small satellite deposit to the recently developed Carina iron ore project (**Table 1**). Development and operation of the deposit is scheduled to commence from the end of 2012. The project involves the following components;

- open cut mining from one pit: ore haulage 2 km to tie into the existing Carina logistics system consisting of:
    - ore haulage approximately 52 km to a siding on the existing trans Australian railway
    - dry crushing and screening, and
    - train loading at the siding.

Table 1: Comparison of Size and Impact between Carina and Carina Extended

	Carina	Carina Extended
Reserve (Mt)	21.4	1.3
Mining Rate (Mtpa)	4	Up to 1
Individual Priority Flora Species Impacted	Up to 107 individuals (Haul Road) and up to 31 *Daviesia purpurascens* (P4) (Mine).	9 (*Banksia arborea*) (P4) across entire project.
Total Area of Disturbance (ha)	515.95	178.86

The maximum mining rate will not exceed 1Mtpa from a reserve of approximately 1.3Mt. The actual mining rate is likely to be somewhat lower than the maximum depending on the blending requirements. Ore from Carina Extended will be blended with ore from the existing Carina operation to achieve the customer product specification. The maximum mine life is estimated at 5 years, again dependant on the blending requirements.

Carina Extended is located in the Coolgardie 2 Bioregion (COO2 – Southern Cross subregion) as defined by the Interim Biogeographical Regionalisation for Australia (IBRA). The region is east of the wheatbelt and although it has a long history of pastoral, historic woodcutting and mining land uses, remains largely uncleared.

The project is located approximately 20 km from both the existing Mt Manning Nature Reserve and the Helena and Aurora Conservation Park. It is on the former Jaurdi pastoral station, purchased by CALM in 1989. The portion of the former pastoral station in which Carina Extended is located is proposed to be included in the Mount Manning Area (MMA) reserve system as a Conservation and Mining Reserve.

Carina Extended is intended to be operated as a satellite pit to the existing Carina operation. No new support infrastructure is required as this will be provided from the existing infrastructure at Carina. The existing haul road system on tenements L15/305 and M77/1244 will be extended within two granted mining leases. No additional miscellaneous licence is required.

Botanical surveys have not identified any Declared Rare Flora (DRF) in the entire project footprint area, however two priority species were recorded; *Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155-109) (P3) and *Banksia arborea* (P4).

Based on individual plants identified during surveys, no *Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155-109) (P3) will be disturbed by the project.

A total of 51 *B. arborea* plants were recorded at three locations in the mining tenement M77/1261 (Mattiske Consulting 2011). A forth location consisting of five individuals was recorded outside the north western boundary of the tenement. *B. arborea* was not listed as a priority species in 2008 when many of the other surveys by Mattiske were undertaken in the region, including those for the Carina iron ore project. This species was recorded in other surveys, however specific population counts were not taken at the time. Nine *B. arborea* are located within the open pit area and will need to be removed.

Major waste types have been shown to be non-acid forming (NAF). Because of the relatively shallow depth of the proposed pit, most potential acid forming (PAF) iron pyrite material will remain in situ below the pit floor. Only a very small quantity of PAF waste will be excavated. This will be encapsulated and buried.

Polaris has prepared a Preliminary Mine Closure Plan, consistent with the Australian and New Zealand Minerals and Energy Council / Minerals Council of Australia (ANZMEC/MCA) (2000) document *Strategic Framework for Mine Closure* and the EPA *Guidelines for Preparing Mine Closure Plans* (June 2011).

The open pit will remain as a pit void. Three key factors have been considered on the possible long term impacts from the final mine void at Carina Extended. These are:

1. **No other local beneficial uses**. Natural groundwater quality at Carina Extended is saline, approximating that of sea water. The final pit void is anticipated to act as a groundwater sink, which will increase in salinity over time as a result of evapo-concentration. Such poor quality water is not naturally attractive to animals or for most other beneficial uses without treatment.

2. **Precedent**. There are historic open pit mine voids in the local area (within 20 km). Water quality in these voids is unknown. There is no evidence of increased grazing impacts around these existing open pit as a result of population increase of grazing animals in the local area.

3. **Absence of significant populations of feral animals, with low potential for population increase.** There are few large introduced grazing animals in the local area. Carina Extended is located in the former Jaurdi pastoral lease, which was purchased by CALM in 1989. The station was originally over 320,000 hectares in area. It has been destocked now for 20 years. There are no active pastoral stations abutting the former station area that could be a source of migrating stock.

On the information available, future possible risk of a significant increase in grazing pressure, as a result of sustained concentration of feral animals, is considered unlikely. Polaris will continue to revise and implement the Mine Closure Plan during the life of mine. Post closure monitoring will provide data on the pit void lake.

An earlier draft of this Mining Proposal was submitted to DMP, DEC, DEC (Kalgoorlie) and the Shire of Yilgarn for comment. Input and comments received have been reconciled and included in this document.

Table 26 summarises environmental factors identified for the project, together with proposals for their management. Polaris considers there are only localised impacts from the project and

these can be adequately managed. Under existing policies and procedures the predicted outcome in **Table 26** for all factors is *no significant residual impact*. Furthermore, as the complete design for Carina Extended project has been determined based on optimal financial outcomes, the outermost extent of this design may not be utilised and disturbance may fall well within this proposed boundary.

Table 2 lists commitments made within this Mining Proposal.

Table 2: Commitments in the Mining Proposal

Commitment	Action	Page
Commitment 1	targeted flora surveys for conservation significant species prior to disturbance.	47
Commitment 2	effective site selection of infrastructure to minimise disturbance to the W22 and S6 vegetation types.	47
Commitment 3	to obtain all other required permits and licences to operate Carina Extended.	68
Commitment 4	Clearing of vegetation will be progressive and on an as-needed basis.	77
Commitment 5	to undertake progressive rehabilitation during the life of mine.	89

EPA referral of this project is not required under the existing MOU between OEPA and DMP as the project is currently located on unallocated crown land and none of the 8 criteria in the MOU are satisfied at Carina Extended. This is discussed further in **Section 3.1.2** and **Table 3.**

2. BACKGROUND

2.1 Ownership

Polaris Metals Pty Ltd (Polaris) is a wholly owned subsidiary of Mineral Resources Limited (MRL). MRL provides mining services, infrastructure and operates mines and is listed on the Australian Stock Exchange (ASX). Polaris is the proponent for the Carina Extended iron ore mine.

The company address is:

1 Sleat Road
Applecross, WA 6153

Postal address:

Locked Bag 3
Canning Bridge
Applecross WA 6153

Telephone: (08) 9329 3700

Fax: (08) 9329 3701

Mining lease M77/1261, which covers the Carina Extended mine area, was granted by DMP on 15/5/2012. M77/1244, which covers the haul road, was granted on 7/12/2009.

2.2 Project Objectives

This document is submitted to DMP for the purpose of describing the project's characteristics, environmental impacts and proposed management measures, in sufficient detail for the Department to assess the project under the *Mining Act 1978*. Preparation of this document has been undertaken according to the *Guidelines for Preparing a Mining Proposal in WA* (DoIR 2006).

A summary of key project dates is as follows:

i.	Grant of mining lease M77/1261	May 2012
ii.	Draft Mining Proposal submitted to stakeholders for comment	August 2012
iii.	Final Mining Proposal submitted to DMP	November 2012
iv.	Approval to commence mining	December 2012
v.	Mining completed	December 2017
vi.	Rehabilitation completed	December 2018

2.3 Location and Site Layout

The Carina Extended project is located in the western section of the Goldfields, approximately 60 km northeast of Koolyanobbing and 100 km northeast of the town of Southern Cross (**Figure 1**). It is located in the Shire of Yilgarn.

The project is located on Mining lease M77/1261. The tenement is 491.36 ha in area and was granted on 15/5/2012. M77/1244, which is 999.5 ha in area was granted on 7/12/2009.

Carina Extended is located approximately 2 km north west of the existing Carina iron ore mine (Mining Proposal ID 28616), located on M77/1244 (**Figure 2**). Carina Extended is to operate as a satellite open pit to the Carina operation. All supporting infrastructure and workforce for Carina Extended will be supplied from the existing Carina operation. No additional support infrastructure will be required.

Ore from the Carina Extended open pit will be hauled in off highway dump trucks to a ROM pad adjacent to the open pit. Here it will be loaded into off highway road train trucks and transported on dedicated mine haul roads to the existing crushing plant, ore stockpile and rail load-out facility. This facility is located on G15/21 and Department of Regional Development and Lands (DRDL) lease Lot 500 on Deposited Plan 68972 (Lot 500).

Carina Extended lies within the former Jaurdi pastoral lease. The pastoral lease was purchased by the Department of Conservation and Land Management (CALM), now Department of Environment and Conservation (DEC), in 1989. The former Jaurdi pastoral lease and adjacent group of existing and proposed conservation areas are collectively referred to as the Mount Manning Area (MMA) proposed parks. These are shown in **Figure 2**.

On 1 September 2010 the WA State Government announced its policy for the MMA. This includes a portion of the former Jaurdi pastoral lease proposed as a Conservation and Mining Reserve (blue zone in **Figure 2**). Both the proposed Carina Extended and existing Carina open pits are within this zone. This reserve has not yet been formally created.

Carina Extended is located approximately 20 km from both the existing Mt Manning Nature Reserve and the Helena and Aurora Conservation Park (**Figure 2**). These conservation reserves are located to the north and west. These existing reserves are the nearest Environmentally Sensitive Area (ESA) or Schedule 1 Area, as described in Regulation 6 and Schedule 1, clause 4 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Figure 3 shows the local location of the Carina Extended project. **Figure 4** and **Figure 5** show the layout of project components.

Figure 1: Project Location

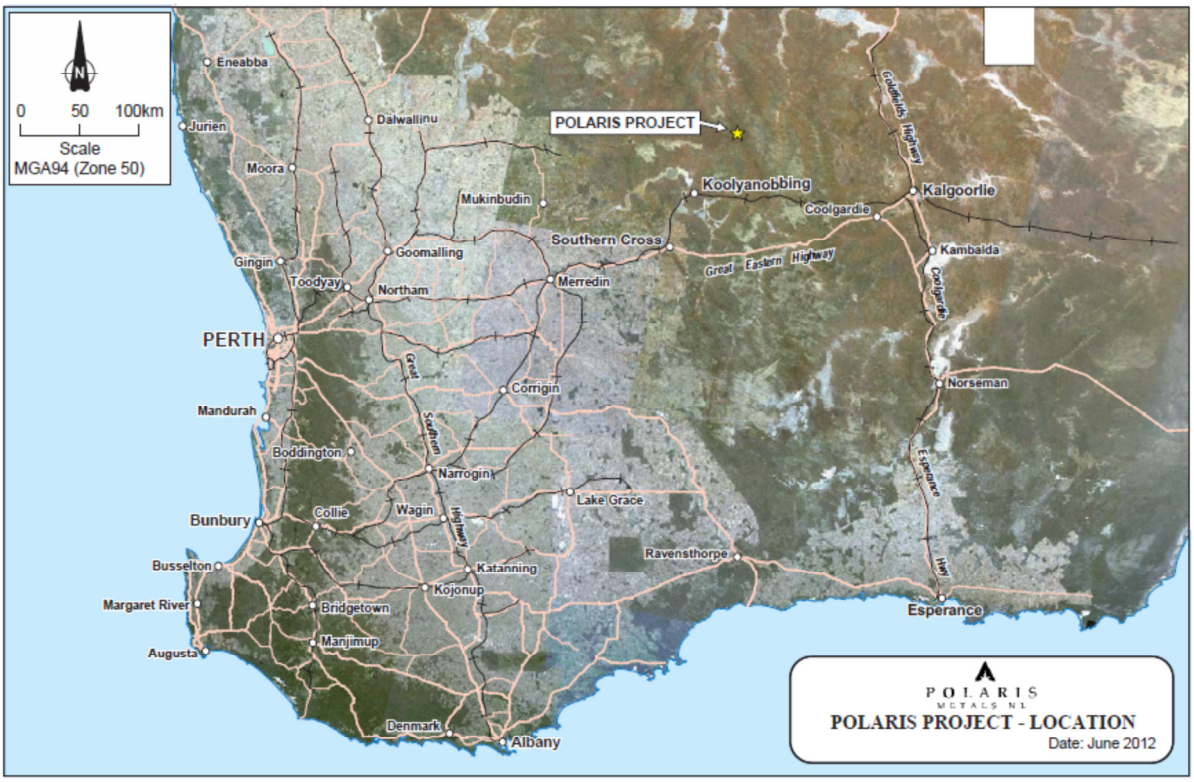


Figure 2: Proposed Tenure in the Mount Manning Area

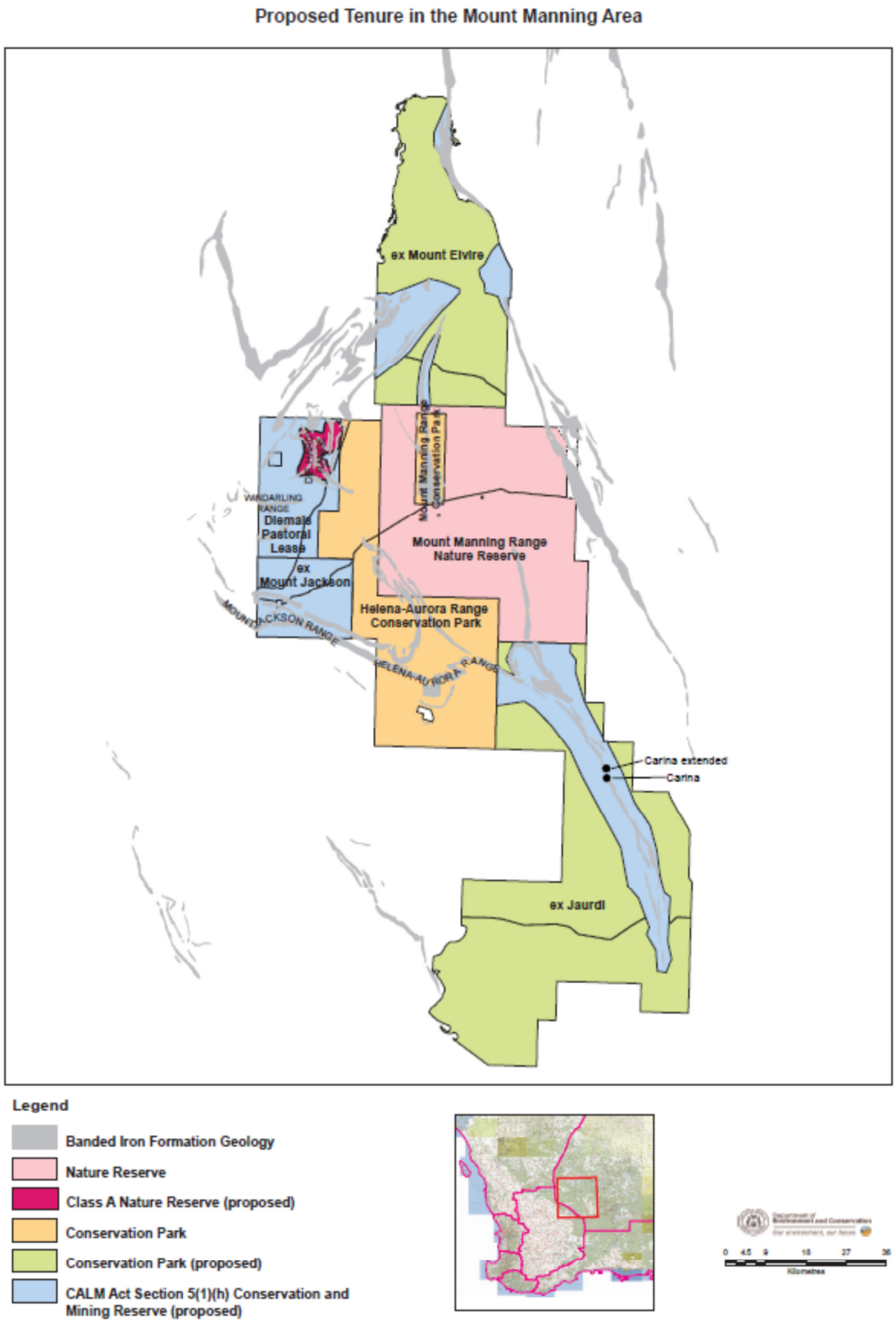


Figure 3: Local Location

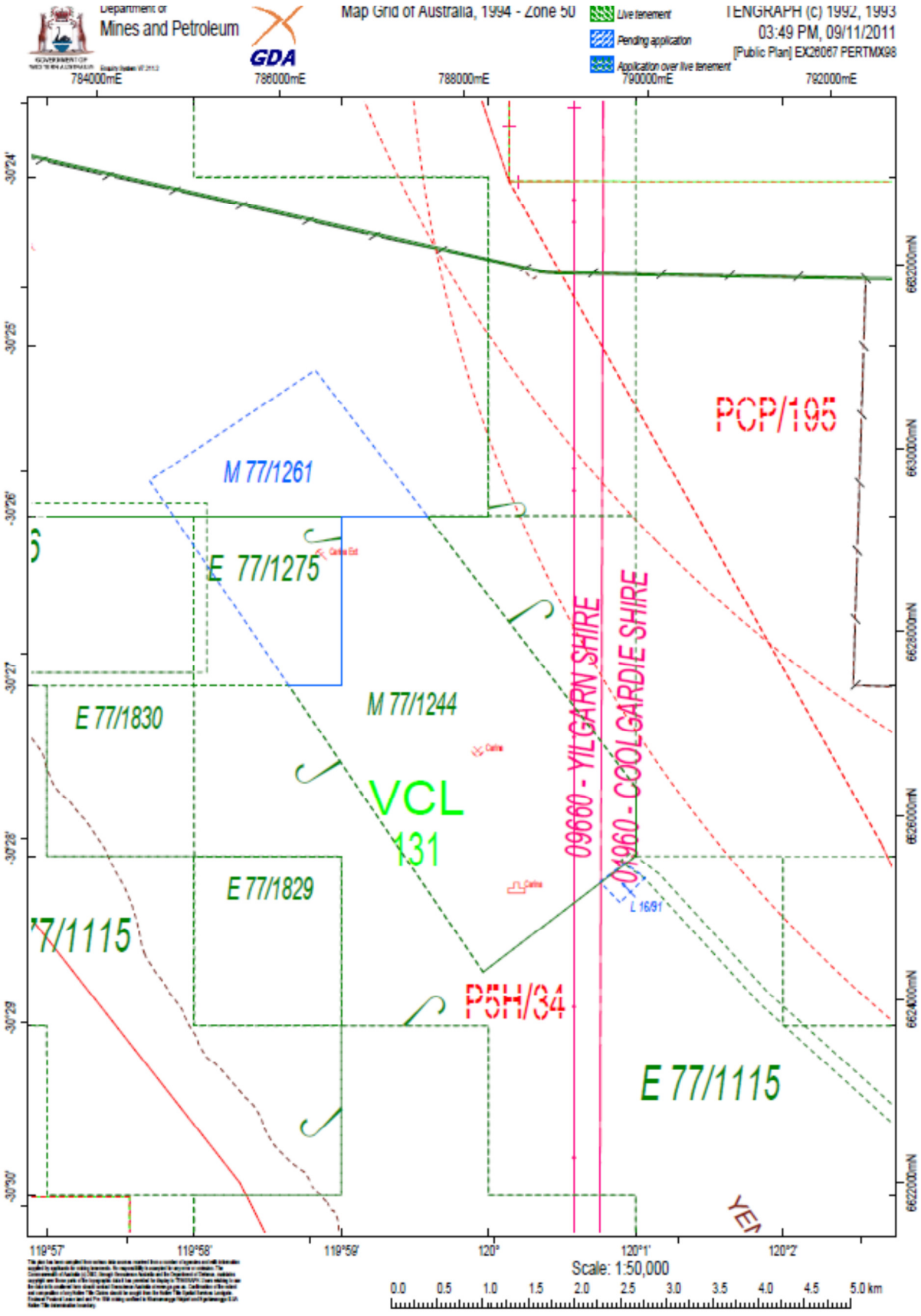


Figure 4: Carina Extended Layout

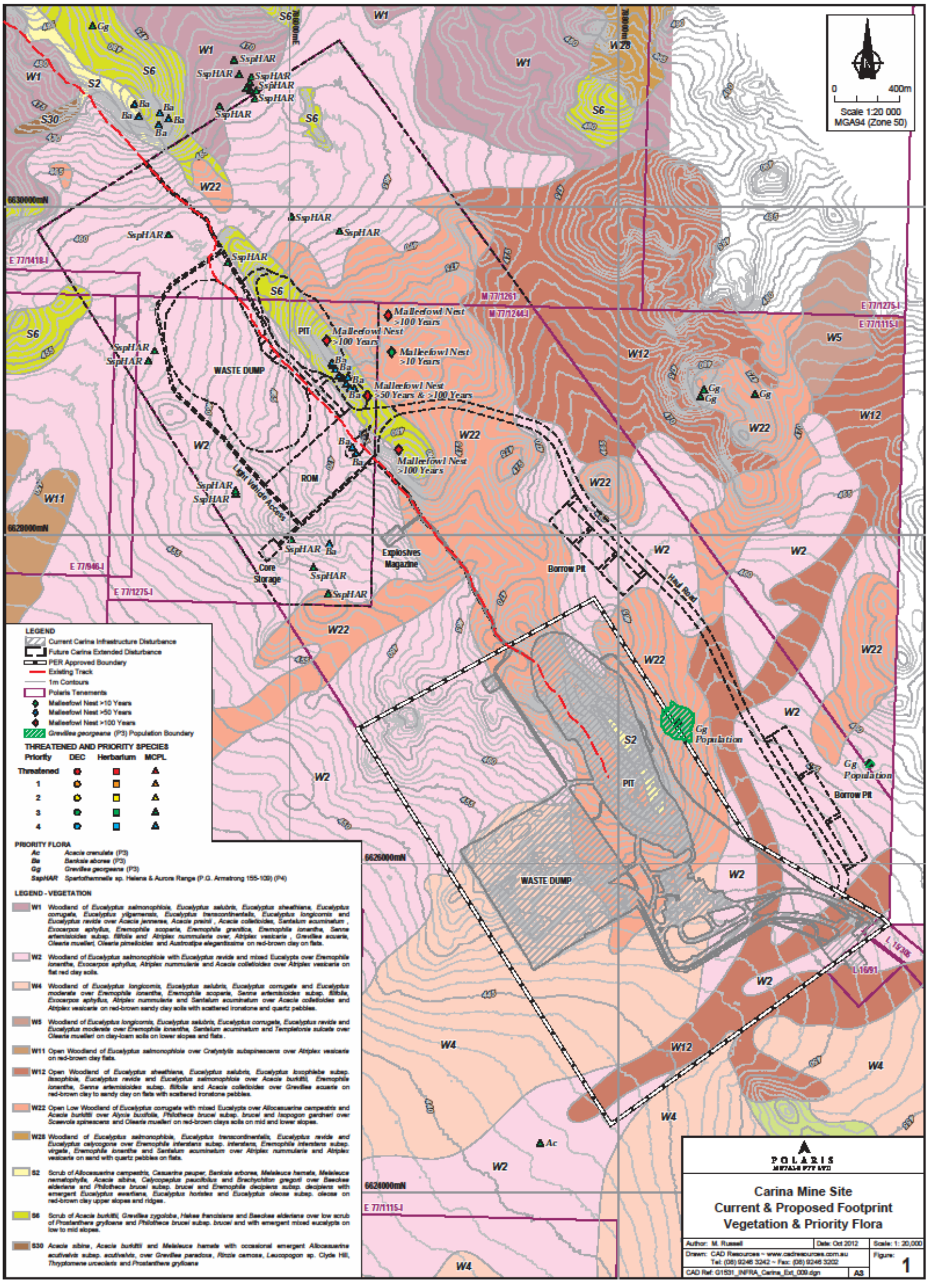
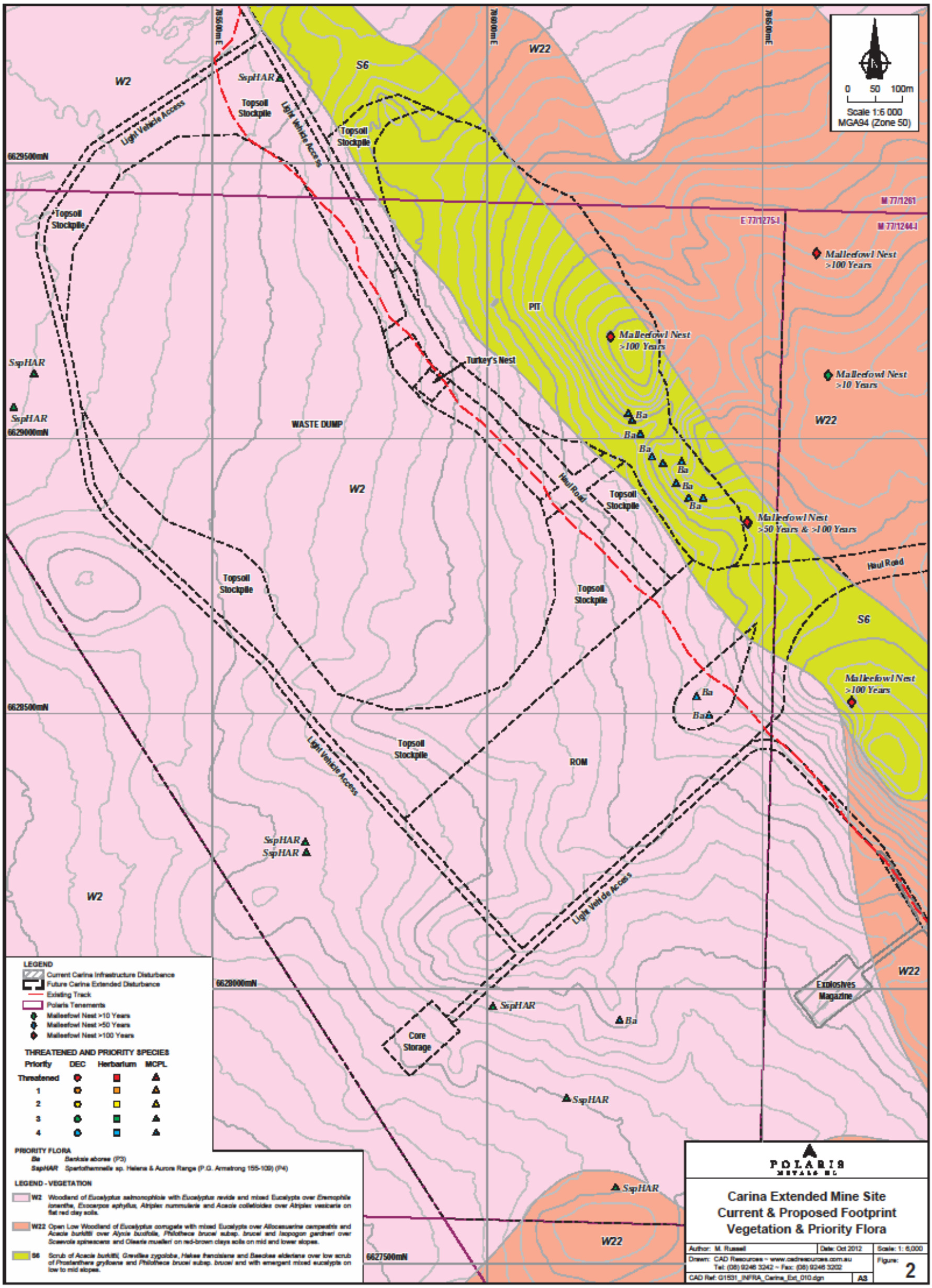


Figure 5: Carina Extended Layout – Mine Detail



2.4 History

Carina Extended is a green field project. Exploration activity has occurred to define the deposit. Approximately 5.2 ha of clearing have been approved in POW's over the project area from 2009 for access tracks, drill lines and pads.

2.5 Existing Facilities

There are no existing facilities on M77/1261. All supporting infrastructure and workforce will be supplied from the operating Carina mine.

2.5.1 Carina iron ore mine

The nearby Carina iron ore mine received approval from the Minister for the Environment in January 2011 (Ministerial Statement (MS) 852). DMP approved the Carina Mining Proposal on 21 February 2011 and the State Mining Engineer approved the Project Management Plan on 16 February 2011.

The Carina Extended project will not require any change to MS 852 for Carina. The addition of another pit allows greater flexibility in mine scheduling and ore blending. The approved mine life of up to 10 years remains a sufficient period to complete mining at Carina. The approved mining rate of up to 4 Mtpa from the Carina pit is not affected by this proposal. Mining at the Carina Extended pit is in addition to that approved at Carina.

3. EXISTING ENVIRONMENT

3.1 Regional Setting

S. F. Chen and S. Wyche (2003) describe the regional geology of the Bungalbin 1:100,000 map sheet as follows:

> The Bungalbin 1:100,000 sheet is situated in the central Southern Cross Granite–Greenstone Terrane of the Yilgarn Craton. It covers the southeastern part of the Marda–Diemals greenstone belt, the northern part of the Hunt Range greenstone belt, the southern end of the Mount Manning greenstone belt, and a small part of the Yerilgee greenstone belt. These greenstone belts are separated by large areas of granitoid rocks of mainly monzogranitic composition.
>
> On Bungalbin the Marda–Diemals greenstone belt consists of a 3 Ga mafic-dominated lower greenstone succession that is subdivided into three lithostratigraphic associations. The lower association is dominated by tholeiitic basalt, with subordinate ultramafic rocks in its lower part, and thin units of banded iron-formation and chert in its upper part. The middle association is composed of a major banded iron-formation and chert unit, up to 800 m thick, with intercalated lenticular quartzites. The upper association comprises a variety of rock types, including tholeiitic and high-Mg basalts, a number of banded iron-formation and chert units, and minor siltstone and shale. The lower greenstone succession is unconformably overlain by a c. 2.73 Ga upper greenstone succession that consists of felsic volcanic and volcaniclastic sedimentary rocks of the Marda Complex. In other greenstone belts on Bungalbin, only the lower greenstone succession is recognized.

Figure 6 is an extract from the Bungalbin 1:100,000 series map. The project area is located on a colluvial unit (Cf) of ferruginous gravel and laterite. It is situated on a low rise which is part of a broken chain of ridges mapped as Ac - banded chert and ferruginous banded chert; includes banded iron formation and minor quartzite; metamorphosed. The open pit location is mapped as Cf - Ferruginous gravel and reworked laterite. The waste landform location includes both Cf and Wf (Sheetwash units with ferruginous gravel) units.

3.1.1 Government policy

Government released its policy on proposed reserve tenure in the MMA in September 2010 (**Figure 2**). The Carina Extended project is within a portion of the former Jaurdi pastoral station proposed as a Conservation and Mining Reserve. This tenure has not yet been finalised. The proposed tenure establishes mining as a permitted purpose in the reserve.

3.1.2 DMP-EPA MOU

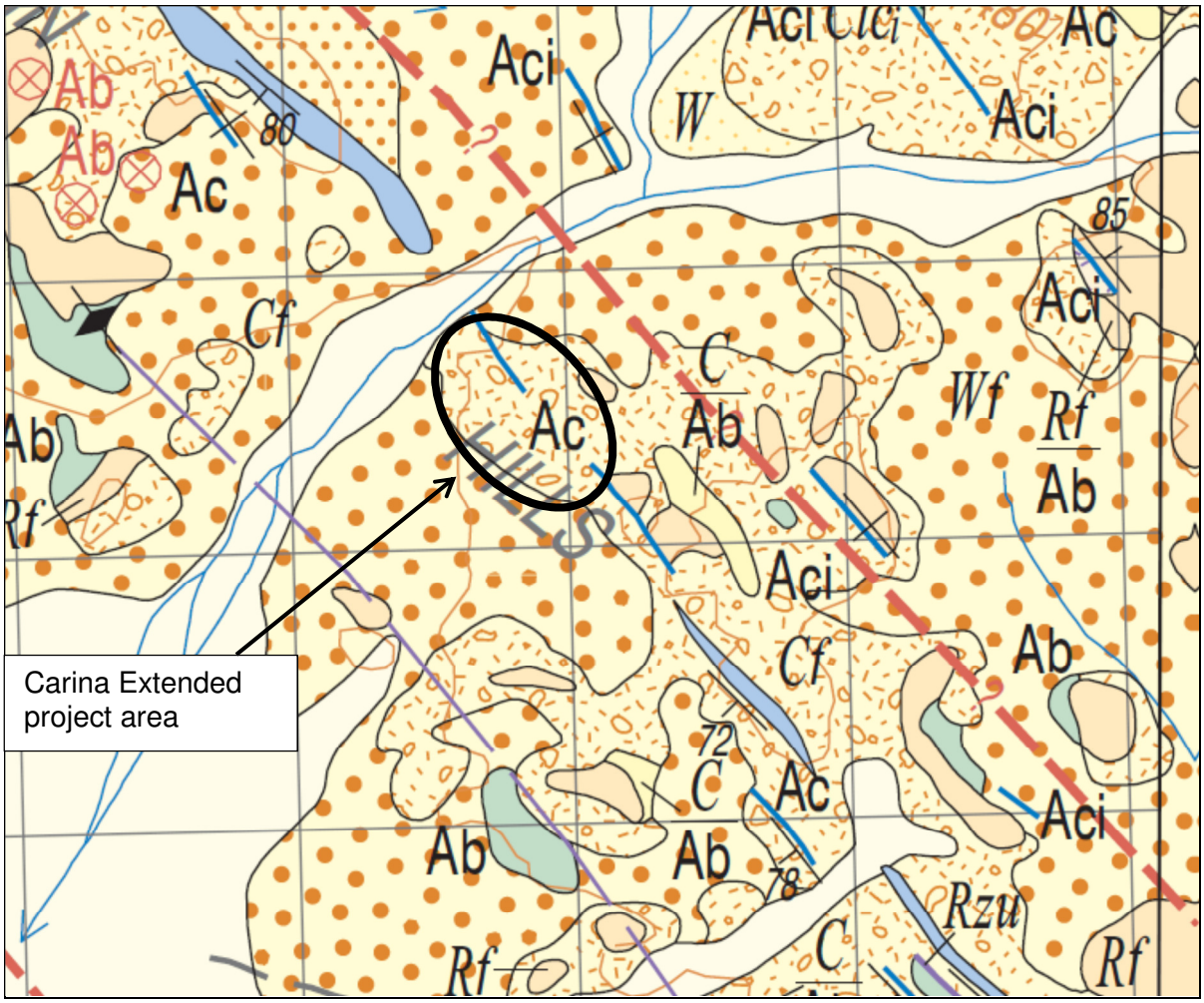
Table 3 shows referral categories in Schedule 1 of the Memorandum of Understanding (MOU) between the Department of Mines and Petroleum (DMP) and Environmental Protection Authority (EPA).

Carina Extended does not trigger any of the MOU referral categories; consequently DMP can assess the Mining Proposal without referral to the EPA.

Table 3: DMP-EPA MOU

		Development, productive mining, excess tonnage applications and construction proposals	Outcome
1	Wholly or partly within pre-1899 Crown Grant and consequently not subject to the Mining *Act 1978*		NA- referral not required
2	Wholly or partly within areas identified as protected under statute; i. National Park ii. Nature Reserve iii. Conservation Park iv. State Forest and Timber Reserves v. Threatened Ecological Communities	DMP will refer the Proposal to the EPA in accordance with S38(5) of the EP Act 1986	Currently in UCL. In proposed conservation and mining reserve – not yet gazetted. - referral not required
3	Wholly or partly within the following areas: • World Heritage Property; • Biosphere Reserve, • Soil reference site, • Ramsar wetlands; • ANCA wetlands, • Sites visited by species listed under JAMBA or CAMBA.		See **Table 4**. No significant impact - referral not required
4	Having a direct or indirect effect upon environmentally significant lakes and wetlands including: 1. EPP lakes and wetlands; and 2. Conservation category wetlands.	DMP will liaise with the OEPA on the Proposal	NA- referral not required
5	Wholly or partly within 2km of the coastline		NA- referral not required
6	Likely to impact on a water resource area, including a water reserve, a declared or proposed water supply catchment area or Groundwater protection area.		NA- referral not required
7	Area currently subject to formal assessment by the EPA.		NA- referral not required
8	Wholly or partly within 2km of a declared occupied townsite	DMP will refer the Proposal to the EPA in accordance with S38(5) of the EP Act 1986	NA- referral not required

Figure 6: Regional Geology



Source: DMP (2003), Bungalbin 1:100,000 map sheet 2837.

Map legend

Colluvial units
C Mixed gravel and debris as proximal talus; includes sand and silt; locally ferruginous
Cf Ferruginous gravel and reworked laterite
Sheetwash units
W Clay, silt and sand; locally ferruginous
Wf Sheetwash units with ferruginous gravel
Residual units
Rf Lateritic duricrust; includes lateritic nodules
Rzu Silica caprock over ultramafic rock
Marda Complex
Ac Banded chert and ferruginous banded chert; includes banded iron formation and minor quartzite; metamorphosed.
Aci Banded iron formation and local jaspilite; includes minor banded chert; metamorphosed
Ab Fine grained mafic rock, mainly basalt; metamorphosed; typically deeply weathered.
Notations
Ab x Subsurface data from drillhole, costean, shallow shaft or pit.

3.1.3 Commonwealth referral

Matters of National Environmental Significance (MNES) are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The eight MNES protected under the EPBC Act are:

1. world heritage properties
2. national heritage places
3. wetlands of international importance (listed under the Ramsar Convention)
4. the Great Barrier Reef Marine Park
5. Commonwealth marine areas
6. listed threatened species and ecological communities
7. migratory species protected under international agreements
8. nuclear actions (including uranium mines).

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a MNES require referral to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) for determination on whether assessment of the project is required.

A search using the EPBC Act Protected Matters Search Tool (PMST) was undertaken. The report is provided in **Appendix 1**. A summary of the report is provided below:

1. World Heritage Properties: None
2. National Heritage Places: None
3. Wetlands of International Significance (Ramsar Wetlands): None
4. Great Barrier Reef Marine Park: None
5. Commonwealth Marine Areas: None

6a. Threatened Ecological Communities: None

6b. Listed threatened species and ecological communities: see **Table 4**

7. Migratory species protected under international agreements : see **Table 4**
8. Nuclear actions (including uranium mines): None

The Mount Manning Range (WA) was identified as being within the search area as were the following additional species:

- Invasive species:
  - Mammals
    - Goat (*Capra hircus*)
    - Cat (*Felis catus*)
    - Rabbit (*Pryctolagus cuniculus*)
    - Red Fox (*Vulpes vulpes*)
  - Plants
    - Ward's Weed (*Carrichtera annua*)

Table 4 lists the threatened and migratory species that may occur in the area as identified by the EPBC Act PMST. Comments are provided on the known or likely presence of these species and the project's potential impact on them. Polaris concludes the project is not likely to have a significant impact on any Matter of National Environmental Significance. Referral to DSEWPaC is not required.

Table 4: EPBC Act Protected Matters Search Results

Species		Status	Polaris Comment	Outcome
Plants				
Ironstone Beard-heath	*Leucopogon spectabilis*	Critically Endangered	Florabase describes preferred habitat as shallow red-brown loam and ironstone, found in rock crevices on exposed ridges. Found in the Coolgardie region and Southern Cross and Yilgarn Subregions.	Botanical surveys of the site have not identified this species – Referral not required.
Chiddarcooping myriophyllum	*Myriophyllum lapidicola*	Endangered	This aquatic herb is recorded almost 400 km west of the Kalgoorlie and away from the project area.	Referral not required.
NA	*Ricinocarpos brevis*	Endangered	Recorded in Florabase as occurring on "rocky hillslopes, rock outcrops". This habitat type is not present at Carina Extended. See Florabase distribution map below.	Botanical surveys of the site have not identified this species – Referral not required.
Paynter's Tatratheca	*Tetratheca paynterae*	Endangered	Restricted distribution known only from the Windarling area, approximately 70 km northwest of the project area. Habitat restricted to massive ironstone outcrops, which is not present at Carina Extended. See Florabase distribution map below. There are two subspecies of *T. paynterae; T. paynterae* subsp. *cremnobata* and *T. paynterae* Alford subsp. p*aynterae*. However, the distributions of these subspecies are very similar and restricted to the same area, away from the project area. This identified species has been treated and assessed for significant impacts as a species only.	Botanical surveys of the site have not identified this species or its subspecies – Referral not required.
Birds				
Slender-billed Thornbill	*Acanthiza iredalei iredalei* (western)	Vulnerable	This bird is patchily distributed through the southern arid zone of Western Australia. It prefers Chenopod shrublands including samphire, has a preference for *Aluta maisonneuvei* and *Maireana* shrublands, often treeless or very open flatlands (Ninox 2009). These habitats do not occur at Carina Extended. Bamford (2012) did not record this bird in the project area.	Referral not required.

Malleefowl	*Leipoa ocellata*	Vulnerable	The Malleefowl inhabits semi-arid regions of southern Australia (Barrett et al. 2003; Benshemesh 2000; Marchant & Higgins 1993), although its distribution has contracted substantially in all states in which the species occurs (Benshemesh 2000, 2005) but, for the most part, these changes appear to have had a much greater impact on the area of occupancy than the extent of occurrence. Malleefowl preferred habitat: shrublands and low woodlands that are dominated by mallee vegetation. It also occurs in other habitat types including eucalypt or native pine Callitris woodlands, acacia shrublands, Broombush *Melaleuca uncinata* vegetation or coastal heathlands (Benshemesh 2005; Marchant & Higgins 1993; Priddel & Wheeler 1995). Six Malleefowl mounds were recorded at Carina Extended and the species is believed to occur across the area, however five of the six mounds appeared to be inactive. One of these (>100 years old) falls within the pit footprint and will require removal. The remaining 5 mounds are unlikely to be disturbed (see **Figure 4**). This species is widespread across the southern part of Australia. Impacts to this species are deemed not to be significant.	Known to be in the area. No significant impact to the species. Referral not required.
Migratory Species				
Migratory Marine Birds				
Fork-tailed Swift	*Apus pacificus*	Migratory	Not recorded in any of the surveys conducted in the general area. While spending the summer and most of the autumn in Australia, Fork-tailed Swifts are almost entirely aerial. They feed and sleep on the wing, sometimes occurring in extremely large flocks of up to 2,000 individuals (Ninox 2009). Bamford (2012) did not record this bird in the project area.	Potential seasonal presence. Referral not required.
Great Egret, White Egret	*Ardea alba*	Migratory	This large white egret occurs in a range of wetland habitats including floodwaters, rivers, estuaries and inter-tidal mudflats (Ninox 2009). Bamford (2012) did not record this bird in the project area.	Unlikely to be present– Referral not required.

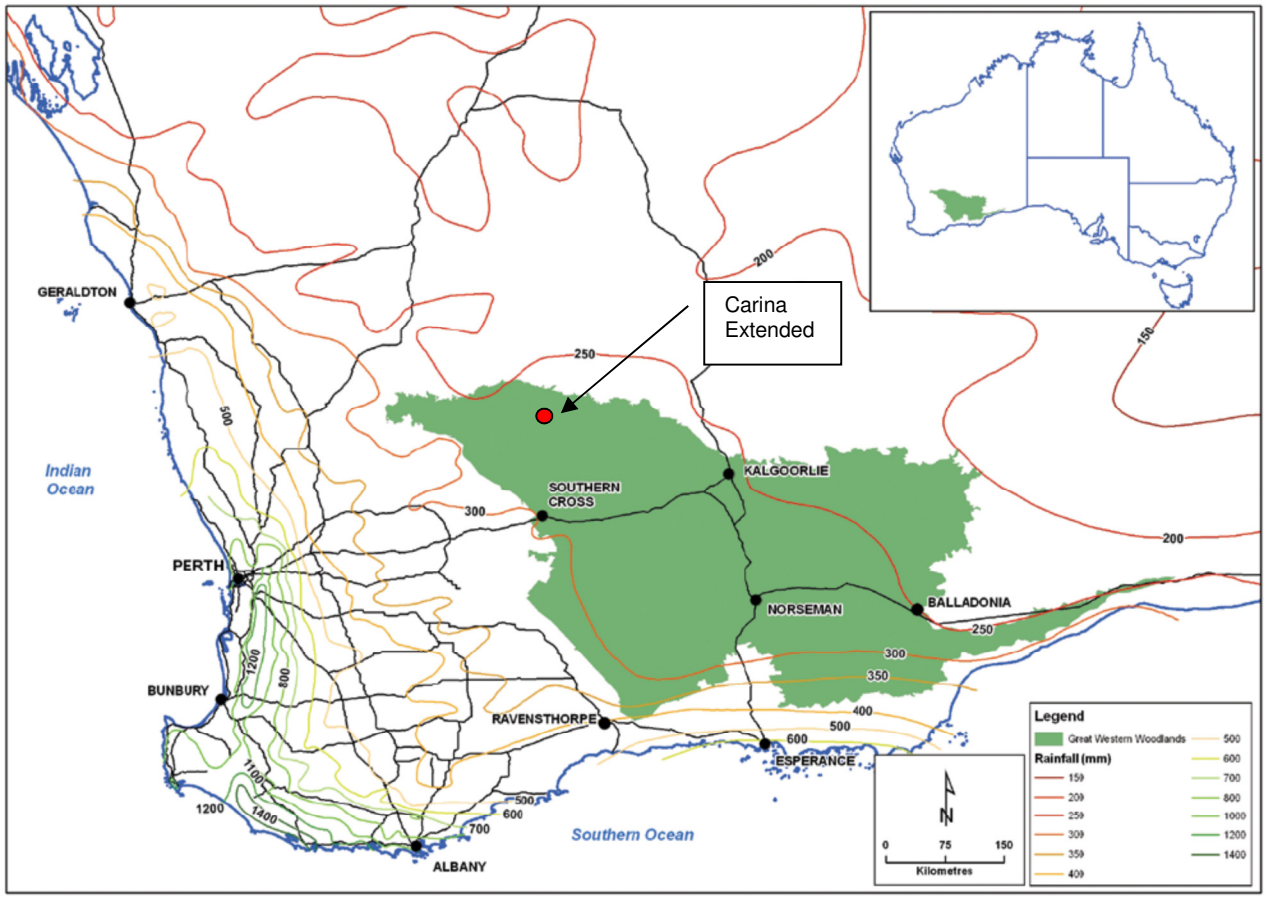
Cattle Egret	*Ardea ibis*	Migratory	A relative newcomer to Australia, this bird has spread from northern Australia into much of the better-watered parts of the country. They prefer areas with short grasses, particularly damp pastures and are usually seen in the company of animals such as cattle and buffalo, mainly feeding on insects that are disturbed by these grazing animals (Ninox 2009). Bamford (2012) did not record this bird in the project area.	Unlikely to be present– Referral not required.
Migratory Terrestrial Species				
Malleefowl	*Leipoa ocellata*	Vulnerable	See above.	Referral not required.
Rainbow Bee-eater	*Merops ornatus*	Migratory	These birds are summer migrants to southern Australia but may be resident in the north. They prefer lightly wooded country, near water and preferably with sandy soils suitable for their breeding burrows, i.e. soils that are easy to excavate but firm enough to support burrows (Ninox 2009). Bamford (2012) did not record this bird in the project area although it was recorded at Chamaeleon, 10 km to the north.	Project is unlikely to have a significant effect on this species Referral not required.
Migratory Wetlands Species				
Great Egret, White Egret	*Ardea alba*	Migratory	See above.	Unlikely to be present– Referral not required.
Cattle Egret	*Ardea ibis*	Migratory	See above.	Unlikely to be present– Referral not required.

3.1.4 Great Western Woodlands

In 2010, the Minister for the Environment released a *Biodiversity and Cultural Conservation Strategy for the Great Western Woodlands* (GWW) (DEC 2010). The GWW is located east of the wheatbelt in Western Australia. It covers an area of almost 16 million hectares, which is approximately twice the size of Tasmania (**Figure 7**).

Given the large size of the GWW, a single mining project is an insignificant proportion of the total GWW area. Potential impact on environmental factors and values at a local scale is a more appropriate method of impact assessment than potential impact on the GWW as a whole. Local impacts and management are addressed in **Section 5**.

Figure 7: Great Western Woodlands



Source: GWW, DEC (2010) Map 1

3.2 Geology

Carina Extended is located in the Yilgarn Craton, a major geological province of the Eastern Goldfields in Western Australia. The Yilgarn Craton consists of greenstone belts and granites of Archaean age (2.4-3.0 billion years old (Ga)). The region is characterised by granite rocky outcrops, low greenstone hills, laterite uplands and broad plains (CNS 2008). There are no major rivers in the region. Numerous salt lakes of varying size occur across the region.

The project area is situated in the south-eastern part of the Marda-Diemals greenstone belt, within the Archaean Yilgarn Block. A craton scale sinistral fault zone, the Mt Dimer Shear Zone, separates

the Marda-Diemals and Hunt Range greenstone belts. The Marda-Diemals belt can be divided into two greenstone successions. The lower 3.0 Ga greenstone succession is characterised by mafic volcanics and BIF and is subdivided into a lower sequence of basalt and ultramafic rocks overlain by a relatively thick BIF/chert unit, which is then overlain by dominantly mafic volcanics. The upper 2.73 Ga greenstone succession unconformably overlays the lower succession and consists of felsic to intermediate volcanic rocks and clastic sedimentary rocks (CNS 2008).

The Kalgoorlie Province (Tille 2006) occupies about 148,400 km^2 (5.9 % of WA). It is based on the Kalgoorlie Province of Bettenay (1983) and correlates with the bulk of the Coolgardie Botanical District of Beard (1990) and the Coolgardie IBRA region of Environment Australia (2000), the south-east of the Yilgarn Craton tectonic unit of Tyler and Hocking (2001), and the south-east of the Yilgarn Plateau Province of Jennings and Mabbutt (1977).

Tille (2006) describes landforms of the Kalgoorlie Province as consisting of an extensive plateau of low relief. This includes:

- Flat to undulating plains with small valleys (occasionally broken by low narrow rocky hills, ridges, tors and bosses) are most commonly found on granitic terrain. On these plains may be found some silcrete duricrust, claypans, salt lakes with dunes and lunettes, gilgai areas, small remnants of sand plain, and small dune tracts. Low breakaways with short saline footslopes are also occasionally present.
- Broad, flat to undulating, shallow valley plains are below these undulating plains and are formed on Quaternary alluvium and colluvium. These valley plains show little defined drainage and some seasonal lakes and claypans with isolated granitic and basic rock outcrops. Slightly lower down in the landscape are broad, flat valleys with chains of salt lakes. Also present on these valley floors are saline flats, claypans, kopi dunes, sand dunes, and sometimes tors and bosses of outcropping granites.
- Gently sloping to undulating plateau areas on granites and gneisses are situated higher in the landscape. These have long gentle slopes and, in places, abrupt erosional scarps. Some granitic bosses and tors are present.
- Rocky ranges, hills and ridges on the greenstone, along with some undulating to low hilly country. Associated with this hilly terrain are gently undulating stony plains and low rises on limonite.
- Level to gently undulating sandplains and gravelly sandplains are mostly found over lateritic residuals and granitic basement. There are also some extensive loamy plains with sandy surfaces.

Iron ore is proposed to be mined at Carina Extended. A draft Mineral Resource Statement was prepared by Golder Associates in March 2012. This identified a mostly Indicated resource of 4.6 million tonnes (Mt) at 55.3 % Fe, reported at a 50 % Fe cut-off. Optimisation of this resource has identified approximately 1.3 Mt at an average grade of 57.0 % Fe is economically mineable. Total rock movement is 10.8 Mt comprising 9.5 Mt waste and 1.3 Mt ore for a strip ratio of 7.5:1.

For mine waste, at an average of 2.4 tonnes/bank cubic metre (bcm) this equates to 4.0 million bcm. With a swell factor of 1.3 loose cubic metres (lcm) to 1 bcm, this equates to 5.1 million lcm waste in the waste landform.

3.3 Waste Characterisation

As a geological extension of the Carina orebody, waste characteristics are similar to those reported for that project (Mining Proposal ID 28616).

Characterisation of mine waste is an important component of mine planning. Mine waste can contain a range of properties that cause impacts if released to the surrounding environment, or problems for successful rehabilitation of the waste landform. Such properties include:

- **Acid Rock Drainage (ARD)**. Also known as acid mine drainage (AMD). Sulphide components in mine waste when oxidised, can form sulphuric acid in water.
- **Metaliferous drainage.** Usually (but not always) associated with ARD, as acidic conditions increase solubility of many metal species.
- **Salinity and sodicity**. Many mines in the midwest and goldfields regions of WA occur in locations where local groundwater is saline or hypersaline.
- **Poor soil structure**. Properties of mine waste often include material with high clay content and dispersive characteristics.

3.3.1 Acid Rock Drainage (ARD)

Two types of analysis are used to characterise acid generating potential of waste material:

- static testing
- kinetic testing.

Static tests identify the total (maximum) chemical or physical characteristics of a sample. Static tests include measurements of parameters required for Acid Base Accounting (ABA). While these tests provide an indication of the total possible reactivity of material, they do not provide any indication of the rate of reaction under field conditions.

Kinetic tests measure the rate of reaction over time. Laboratory tests are designed to simulate natural weathering over a compressed timeline, to provide an indication of the rate of acid generation over time.

Static tests

ABA evaluates the balance between acid generating processes and acid neutralising processes (DITR 2007). This involves determining the maximum potential acidity (MPA) and the inherent Acid-Neutralising Capacity (ANC) of a material, expressed in units of kg H_2SO_4/ tonne. The Net Acid Producing Potential (NAPP) is the difference between these two factors; the capacity of a material to generate acid against its capacity to neutralise acid and is calculated as:

$$NAPP = MPA-ANC$$

Total sulfur content, expressed as a percentage (% S) is commonly used as an estimate to calculate MPA, on the assumption that, when oxidised, sulphur is converted to sulphuric acid. (MPA = %S x 30.6 [to convert units to kg H_2SO_4/ t]). The literature indicates material with a total sulphur content of <0.3 % generally contains too little sulphur to produce acid of any significant quantity. Such material is normally classed as Non Acid Forming (NAF).

However, not all minerals containing sulphur are acid generating, so total sulphur content often over estimates MPA. Some minerals contain sulphur in forms that are already oxidised to a sulphate

(SO_4-S) which are very stable and rarely react further to produce sulphuric acid. For example, barite, gypsum, anhydrite, alunite and native sulfur, are non-acid generating sulfur forms. Also, sulfur may occur as other metal sulfides (such as covellite, chalcocite, sphalerite and galena) which yield less acidity than pyrite or, in some cases, are non-acid-generating.

If NAPP is positive, the material is likely to be net acid-generating, with highly positive numbers (>40) regarded as strongly acid generating. Conversely, if NAPP is negative, the material's acid neutralising capacity is greater than its ability to generate acid (ANC>MPA). If it is highly negative (<-40) the material is regarded as acid consuming (AC).

The Net Acid Generation (NAG) test involves reaction with hydrogen peroxide to totally oxidise any sulphide minerals. Both acid generation and acid neutralisation reactions occur simultaneously in a strongly oxidising environment. The results represent a direct measure of the net amount of acid generated. The amount of acid produced is determined by titration and expressed in units of (kg H_2SO_4/t). A pH after reaction (NAG pH) of < 4.5 indicates the material is acid-generating. A NAG pH of ≥ 4.5 indicates the sample is not acid-generating.

The Net Acid Generation (NAG) test is used in association with the acid–base calculations to provide greater certainty on the characterisation of a material. Individually, acid–base calculations and NAG tests have limitations, but in combination the reliability of acid generation prediction is greatly enhanced. The risk of misclassifying Non Acid Forming (NAF) material as Potentially Acid Forming (PAF), and vice versa, is substantially reduced by conducting both acid–base and NAG tests.

Stewart *et al* (2006) described a matrix comparison between NAPP and NAG test results. A sample is classified PAF when it has a positive NAPP and NAGpH < 4.5, and NAF when it has a negative NAPP and NAGpH ≥ 4.5. Samples are classified UNCERTAIN when there is an apparent conflict between NAPP and NAG results, which place the sample in neither of the above classes (**Figure 8)**.

Samples that plot in the upper left hand NAF domain and lower right hand PAF domain have consistent NAPP and NAG classifications. These samples can be classified as NAF and PAF with a greater degree of confidence than if only one method was used.

Samples that plot in the UNCERTAIN domain have conflicting NAPP and NAG results. There are various reasons that explain this conflict. Thus shows why reliance on only one method to predict acid potential can lead to misclassification. Identifying conflicts between NAPP and NAG results helps identify when further investigation is warranted. Techniques such as sequential NAG, modified organic carbon NAG, modified ANC methods to account for siderite and ABCC testing can be used to help resolve these conflicts in a relatively short time frame.

Considering the above analysis methods, Polaris has adopted the following classification of mine waste (**Table 5**).

Table 5: Waste Classification

Material	TOS [1] (%)	NAPP (kg H_2SO_4/t)	NAG (pH)
Potential Acid Forming - High Capacity (PAF-HC)	>1.0	>40	<4.5
Potential Acid Forming (PAF)	0.5-1.0	10-40	<4.5
Potential Acid Forming - Low Capacity (PAF-LC)	0.3-0.5	5-10	<4.5
Non Acid Forming (NAF)	<0.3	-5 to +5	≥4.5
Acid Neutralising Capacity – Low capacity (ANC-LC)	<0.3	-5 to -10	≥4.5
Acid Neutralising Capacity (ANC)	<0.3	-10 to -40	≥4.5
Acid Consuming (AC)	<0.3	< -40	≥4.5

1. Total oxidisable sulphur

3.3.2 Mine waste

The general composition of mine waste at Carina Extended is:

	Lithology	Code	Kt	%
1.	Basalt	(BLT)	8,371	50
2.	Ultramafic	(UM)	3,223	19
3.	Chert	(CHT)	1,126	7
4.	Regolith		841	5
5.	Low grade Goethite	(IG)	2,997	18
6.	Pyrite	(PY)	155	1
	Total		16,712	100

Drilling logs show the main source of pyrite material is below the base of the pit floor and will not be disturbed. Depths of high pyrite samples shown in **Table 6** are from 120 m to 130 m below ground level. This material will remain in situ. Only 3,000 tonnes (0.04 %) of pyrite waste is proposed to be excavated, with almost all of this being in the unweathered zone in the bottom 20-30 m of the open pit.

A dedicated encapsulation cell within the waste landform will be established to dispose of pyrite waste during the life of mine.

Samples of major waste types and profiles were analysed by SGS for potential to generate acid (**Table 6**). The complete laboratory analysis is provided in **Appendix 9**. The results, sorted by drill line number, show sample collection was distributed throughout the mine waste profile horizontally, from line 5 to line 20 and vertically from 10 m to 140 m. Samples comprised all major waste types. This sample distribution obtained a representative profile of mine waste types that will report to the waste landform.

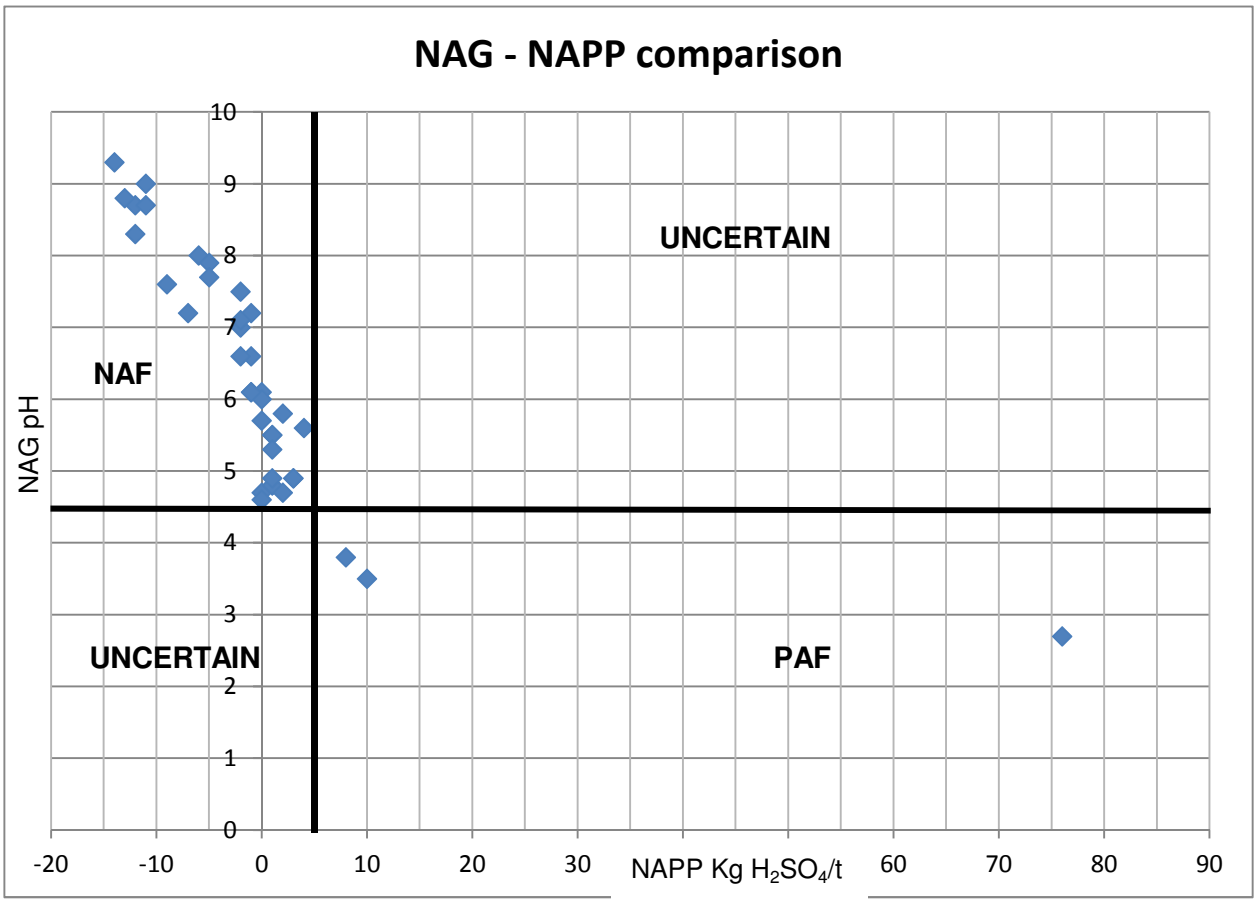
Table 6: Waste Characterisation (sorted by line number)

Line #	Hole ID CXRC…	From	To	Lithology	TOS %	ANC (kg H2SO4/t)	NAPP (kg H2SO4/t)	NAG pH	NAG pH4.5 (kg H2SO4/t)	Result	KNAG test No.
5	0010	20	30	CHT	0.014	<1	0	5.7	<0.5	NAF	1
5	0010	80	90	CHT	0.21	<1	1	5.3	<0.5	NAF	
7	0034	20	30	BLT	0.009	6.5	-6	8	<0.5	ANC-LC	
7	0036	30	40	BLT	0.051	<1	2	5.8	<0.5	NAF	
7	0036	60	70	BLT	0.029	1.7	-1	6.6	<0.5	NAF	
7	0036	70	80	CHT	0.024	<1	0	6	<0.5	NAF	
8	0033	10	20	BLT	<0.005	<1	0	4.6	<0.5	NAF	
9	0003	40	50	UM	0.029	13	-13	8.8	<0.5	ANC	
9	0007	30	40	BLT	0.034	<1	2	4.7	<0.5	NAF	9
9	0007	80	90	MKB	0.012	5	-5	7.7	<0.5	NAF	10
9	0007	100	110	MKB+PY	0.032	3.5	-2	6.6	<0.5	NAF	
9	0007	120	130	MKB+PY	30	<1	930	1.8	430	PAF - HC	12
11	0030	30	40	UM	0.025	10	-9	7.6	<0.5	ANC-LC	
11	0030	50	60	UM	0.014	14	-14	9.3	<0.5	ANC	
11	0038	40	50	BLT	0.27	<1	8	3.8	2.2	PAF-LC	14
11	0038	50	60	BLT+IG	0.029	1.5	-1	6.1	<0.5	NAF	
12	0046	50	60	MKB	0.008	11	-11	8.7	<0.5	ANC	
12	0048	20	30	BLT	0.018	<1	0	4.7	<0.5	NAF	
12	0048	70	80	BLT+PY	0.52	5.4	10	3.5	4.8	PAF	19
12	0049	130	140	BLT+PY	2.7	5.2	76	2.7	26	PAF - HC	18
13	0014	10	20	BLT	0.034	3.2	-2	7.1	<0.5	NAF	
13	0014	30	40	UM	0.011	2.2	-2	7.5	<0.5	NAF	
13	0016	20	30	BLT	0.026	<1	1	4.8	<0.5	NAF	
14	0029	10	20	BLT	0.033	<1	1	4.9	<0.5	NAF	26
14	0029	40	50	CHT	0.018	<1	1	5.5	<0.5	NAF	
14	0029	60	70	CHT	0.018	<1	1	5.5	<0.5	NAF	
14	0039	50	60	BLT	0.023	2.2	-1	7.2	<0.5	NAF	
16	0056	10	20	CHT	0.021	<1	0	6.1	<0.5	NAF	
16	0056	40	50	UM	0.008	12	-12	8.3	<0.5	ANC	
16	0057	30	40	CHT	0.12	<1	4	5.6	<0.5	NAF	
16	0058	50	60	BLT	0.009	2.4	-2	7	<0.5	NAF	31
17	0002	40	50	BLT	0.009	7.5	-7	7.2	<0.5	NAF	
17	0018	20	30	UM	0.006	13	-12	8.7	<0.5	ANC	
17	0067	20	30	BLT	0.026	<1	1	4.8	<0.5	NAF	
18	0069	10	20	BLT	0.14	<1	3	4.9	<0.5	NAF	
20	0063	30	40	BLT	0.013	1.3	-1	6.1	<0.5	NAF	
20	0063	70	80	UM	0.01	11	-11	9	<0.5	ANC	
20	0064	60	70	BLT	0.012	5.6	-5	7.9	<0.5	NAF	
20	0066	30	40	BLT	0.077	<1	3	4.9	<0.5	NAF	

Figure 8 shows the NAPP and NAG comparison of these results. Sample CXRC0007 (at 930 kg H_2SO_4/t) is omitted as including it compressed the graph axis which caused clarity on other results to be lost.

Importantly, the comparison matrix shows no samples in either of the UNCERTAIN domains. This confirms all samples gave consistent results with both static test methods.

Figure 8: Static Test Comparison



Modified from Stewart *et al* (2006)

Table 7 sorts' data shown in **Table 6** by lithology and % sulphur. A number of conclusions can be made from the data in **Table 6** and **Table 7**:

1. Samples were collected throughout the proposed open pit, horizontally (from line 5 to line 20) and vertically (from 10-20 m to 130-140 m). All major waste types were sampled. Due to the pit optimisation identifying the deeper parts of the deposit as sub-economic, many of the acid generating samples are located outside of the proposed pit. However, the samples tested are representative of the lithologies present within the proposed open pit.
2. There is a strong correlation of acid classification with waste lithology. Waste logged as basalt (BLT) and chert (CHT) is NAF; ultramafic (UM) waste generally shows good ANC characteristics. PAF waste is associated with zones containing pyrite, logged as a combination of lithology types.
3. The literature threshold of 0.3 % sulphur for significant acid generating capacity holds true for the samples taken. All samples with TOS % of 0.27 or greater are PAF and all samples less than this are NAF or have ANC.

4. Over 80 % of samples tested have total oxidisable sulphur value <0.1 %. Most are an order of magnitude (0.03 %) less than the literature threshold of 0.3 %. This supports the view that the majority of mine waste has too little sulphur to generate a significant level of acid and should be regarded as NAF.
5. ANC samples have final NAGpH values between 8-9, indicating this waste is suitable for co-mingling with PAF waste, as well as construction of encapsulation cell floor and roof layers.
6. Waste with high pyrite levels (>0.3 % TOS) will need to be encapsulated in the waste landform. With only 3,000 tonnes of pyrite waste anticipated to be excavated PAF mine waste is not expected to pose a significant environmental risk.

Additional samples of ultramafic (UM), basalt (BLT) and chert (CHT) waste were collected, to determine if the ARD properties shown in **Table 7** remained consistent with the above results and also if their properties were consistent with depth (ie: if the NAF or ANC properties were restricted to highly weathered material in the top levels of the pit profile, or were consistent with depth). The results shown in **Table 8** support the earlier findings which are:

- UM material generally has good ANC properties, all samples have negative NAPP with one sample (NAPP of -40 Kg H_2SO_4/t and NAGpH of 9.8) regarded as acid consuming (AC).
- BLT and CHT material is generally regarded as NAF.
- Material at depth (>50 m) has the same properties as shallow profiles.

Acid leachate tests were also undertaken for a range of metals. This test simulates potential metalliferous drainage under acidic conditions caused by ARD. The UM waste produced elevated copper, chromium, nickel and zinc levels, significantly higher than the other two main waste types.

Table 7: Waste Characterisation (sorted by parameter)

Sorted by Lithology		
Hole ID	**Lithology**	**Result**
CXRC0034	BLT	ANC-LC
CXRC0064	BLT	NAF
CXRC0002	BLT	NAF
CXRC0039	BLT	NAF
CXRC0014	BLT	NAF
CXRC0058	BLT	NAF
CXRC0036	BLT	NAF
CXRC0063	BLT	NAF
CXRC0036	BLT	NAF
CXRC0029	BLT	NAF
CXRC0066	BLT	NAF
CXRC0069	BLT	NAF
CXRC0016	BLT	NAF
CXRC0067	BLT	NAF
CXRC0048	BLT	NAF
CXRC0007	BLT	NAF
CXRC0033	BLT	NAF
CXRC0038	BLT	PAF-LC
CXRC0038	BLT+IG	NAF
CXRC0048	BLT+PY	PAF
CXRC0049	BLT+PY	PAF - HC
CXRC0056	CHT	NAF
CXRC0036	CHT	NAF
CXRC0010	CHT	NAF
CXRC0057	CHT	NAF
CXRC0029	CHT	NAF
CXRC0029	CHT	NAF
CXRC0010	CHT	NAF
CXRC0046	MKB	ANC
CXRC0007	MKB	NAF
CXRC0007	MKB+PY	NAF
CXRC0007	MKB+PY	PAF - HC
CXRC0030	UM	ANC
CXRC0063	UM	ANC
CXRC0003	UM	ANC
CXRC0018	UM	ANC
CXRC0056	UM	ANC
CXRC0030	UM	ANC-LC
CXRC0014	UM	NAF

Sorted by %S		
Hole ID	**TOS %**	**Result**
CXRC0033	<0.005	NAF
CXRC0018	0.006	ANC
CXRC0046	0.008	ANC
CXRC0056	0.008	ANC
CXRC0034	0.009	ANC-LC
CXRC0002	0.009	NAF
CXRC0058	0.009	NAF
CXRC0063	0.01	ANC
CXRC0014	0.011	NAF
CXRC0064	0.012	NAF
CXRC0007	0.012	NAF
CXRC0063	0.013	NAF
CXRC0010	0.014	NAF
CXRC0030	0.014	ANC
CXRC0048	0.018	NAF
CXRC0029	0.018	NAF
CXRC0029	0.018	NAF
CXRC0056	0.021	NAF
CXRC0039	0.023	NAF
CXRC0036	0.024	NAF
CXRC0030	0.025	ANC-LC
CXRC0016	0.026	NAF
CXRC0067	0.026	NAF
CXRC0036	0.029	NAF
CXRC0038	0.029	NAF
CXRC0003	0.029	ANC
CXRC0007	0.032	NAF
CXRC0029	0.033	NAF
CXRC0014	0.034	NAF
CXRC0007	0.034	NAF
CXRC0036	0.051	NAF
CXRC0066	0.077	NAF
CXRC0057	0.12	NAF
CXRC0069	0.14	NAF
CXRC0010	0.21	NAF
CXRC0038	0.27	PAF-LC
CXRC0048	0.52	PAF
CXRC0049	2.7	PAF - HC
CXRC0007	30	PAF - HC

Table 8: Waste Characterisation and Leachate

Line	Hole ID CXRC00..	from-to m	Lithology	ANC (Kg H_2SO_4/t)	NAPP (Kg H_2SO_4/t)	TOS	NAG ph4.5 (Kg H_2SO_4/t)	NAG ph	As (mg/L)	Cd (mg/L)	Cu (mg/L)	Cr (mg/L)	Pb (mg/L)	Ni (mg/L)	Se (mg/L)	Zn (mg/L)
0	85	40-50	UM	8.6	-8	0.008	<0.5	6.3	1	0.5	42	720	2	620	<1	85
		150-160	UM	4.7	-4	0.026	<0.5	3.9	4	0.7	70	650	3	380	<1	26
	83	40-50	UM	40	-40	0.008	<0.5	9.8	<1	0.4	40	860	<1	410	<1	25
		110-120	UM	7.2	-7	0.013	<0.5	7.7	2	0.8	100	1100	2	330	2	41
13	84	110-120	UM	11	-10	0.021	<0.5	9.1	47	1.4	50	510	4	220	3	24
17	75	90-100	UM	5.7	-5	0.012	<0.5	7	7	0.7	130	1500	1	710	<1	76
18	76	10-20	UM	12	-12	0.014	<0.5	7	<1	0.5	61	1200	1	820	<1	78
	77	40-50	MKB	6.4	-6	0.021	<0.5	6.4	3	0.4	52	1100	1	570	<1	81
10	71	50-60	BLT	<1	1	0.012	<0.5	6.2	6	0.2	8	6.4	3	26	<1	3
11	80	20-30	BLT	<1	0	<0.005	<0.5	4.7	4	0.4	39	24	4	6.8	<1	9
		80-90	BLT	19	-18	0.033	<0.5	9.4	1	0.3	28	290	<1	320	<1	9
16	74	40-50	CHT	<1	1	0.038	<0.5	7	<1	<0.1	1	4.5	1	1.9	<1	<2
		80-90	CHT+IG	<1	1	0.022	<0.5	6.2	7	<0.1	3	23	2	13	<1	22
		70-80	CHT+IG	<1	32	1	<0.5	6.2	13	0.1	3.9	20	1	11	<1	8
12	82	20-30	CHT+IG +CLY	<1	0	0.012	<0.5	6	2	0.2	21	210	2	39	<1	7
0	87	10-20	MKB	<1	0	<0.005	<0.5	5.1	4	0.2	22	20	1	11	<1	14

Kinetic tests

DITR (2006) describe kinetic leach tests as typically involving subjecting a crushed sample to wetting, drying and flushing cycles. Column leach tests and humidity cell tests are commonly used. The leaching regime is normally selected to optimise oxidation but can also be adjusted to simulate field conditions. Kinetic leach test results may be used to evaluate:

i. oxidation rates
ii. element solubility and leaching behaviour
iii. lag time to onset of AMD and evolution of AMD characteristics
iv. blends and treatment of waste types.

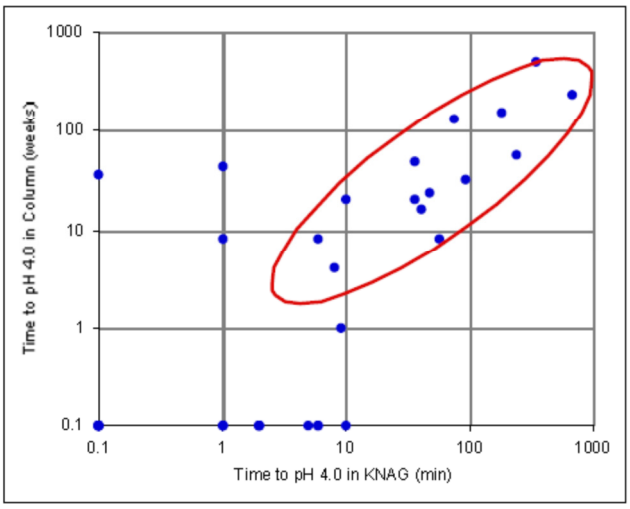
Column leach tests need to operate for at least six months and typically 12 to 24 months before sufficient data is available for effective interpretation of AMD characteristics of a material.

A kinetic NAG (KNAG) test has been developed to provide a qualitative indication of the lag to onset of AMD from a sample. This test can be completed within 24 hours (Sapsford *et al*). The KNAG test is identical to the standard NAG test but pH, temperature and conductivity are measured continuously during the reaction. According to Miller *et al* (1997) the kinetics of the NAG test can provide an indication of lag times and oxidation rates in a similar way to leach columns. These authors tentatively suggest a direct relationship between the time for a pH unit decrease in a kinetic NAG test and the time to pH 4 in a leach column.

Stewart *et al* (2006) discusses an indicative relationship between KNAG test results and column lag times for pyritic samples, based on research work using a geochemical data set provided by EGi. **Figure 9** shows the reaction time to reach pH 4 in the kinetic NAG test in minutes compared to the time to attain pH 4 in leach columns of the same samples for the EGi data set, comprised of 37 samples with pyrite the dominant sulfide. The plot shows a broad trend for NAG reaction time greater than 10 minutes when plotted on a log scale, demonstrating that the relationship is sufficient to distinguish between column lag times of days, weeks, months and years. The correlation can be expressed as follows:

Weeks to pH 4 in column = 0.54 × [minutes to pH 4 in KNAG]

Figure 9: KNAG Comparison



Source: Stewart *et al* (2006) - **Figure 10**

The authors conclude (pg 2117) "the kinetic NAG column relationships described in this paper between the time to pH 4 in the kinetic NAG tests and the time to pH 4 in the column test provides an indication (order of magnitude basis) of lag times without the need to carry out leach columns on all samples (**Table 9**). This has the great advantage of allowing kinetic prediction on a broad sample set in a short time frame (approximately 24 hours), which is not possible with column tests. Note that the kinetic NAG test does not replace column leach or humidity cell tests, but is complementary to them."

Table 9: KNAG Comparison

Range of time to pH 4 in KNAG (min)	Indicated column lag to pH 4
<5	<1 month
5-15	1-2 months
15-30	2-4 months
30-50	4-6 months
50-100	6-12 months
100-200	1-2 years
>200	>2 years

Source: Stewart *et al*(2006)- **Table 6**

The suite of static and rapid kinetic test described above allow screening of a range of waste types and samples, to establish with a reasonable degree of certainty those waste types which are clearly benign (NAF or ANC), those that are clearly PAF or those that are uncertain. There is little value in undertaking multiple long term kinetic leach column tests on material that is clearly benign. Waste categorisation using static and rapid KNAG tests allows target profiles and material to be identified for further test work as required.

However, rapid kinetic tests also provide a reasonable degree of certainty on PAF waste types that are clearly PAF with rapid reaction time (<1-2 months) against slower reactive material (>6 months or years). This order of magnitude is often all that is required to define management methods appropriate for respective waste types. Again, there may be little value in undertaking long term leach column tests that just confirm PAF information which is already known.

On the results obtained from the static tests, a selection of samples were tested using the quick KNAG method. The samples tested are identified in **Table 6**. These comprise:

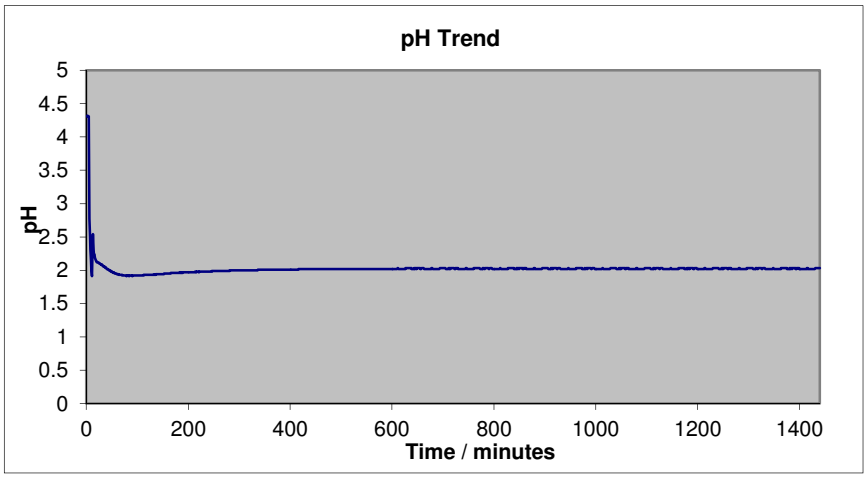
- All samples classed as PAF by static testing
- A selection of basalt and chert samples classed as NAF by static testing

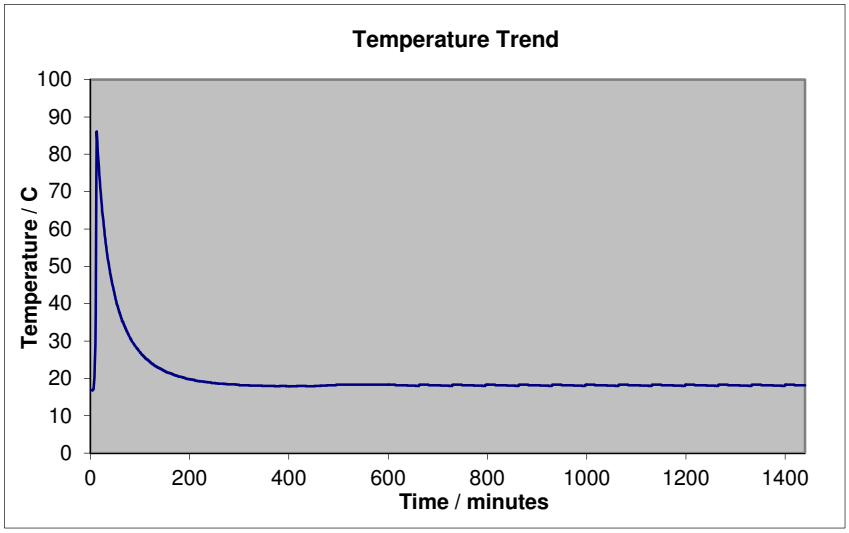
Results of all tests are provided in **Appendix 9**. **Figure 10**, **Figure 11** and **Figure 12** show results of samples classed as PAF-HC, PAF and NAF respectively. These graphs are presented to show characteristics between rapid acid generating material, slow acid generating material and benign material respectively.

Figure 10: No. 12 - PAF-HC. Table 6 shows this sample was the highest pyritic sample tested, with sulphur content of 30 % and a NAPP of 930 Kg H_2SO_4/t.

Very rapid reaction to pH4, with reaction continuing to a final pH of 2 in a time period of minutes. Using **Table 9**, this equates to leach column results within a few months. In practice, the reactivity of this material would be regarded as immediate / rapid oxidising and high acid forming. The rapid reaction is also highly exothermic. Conductivity rapidly increases with increasing acidity, either from sulphate ions in solution, increased mobilisation of metals (see **Table 8**) or other elements in the sample.

Figure 10: No. 12 - PAF-HC





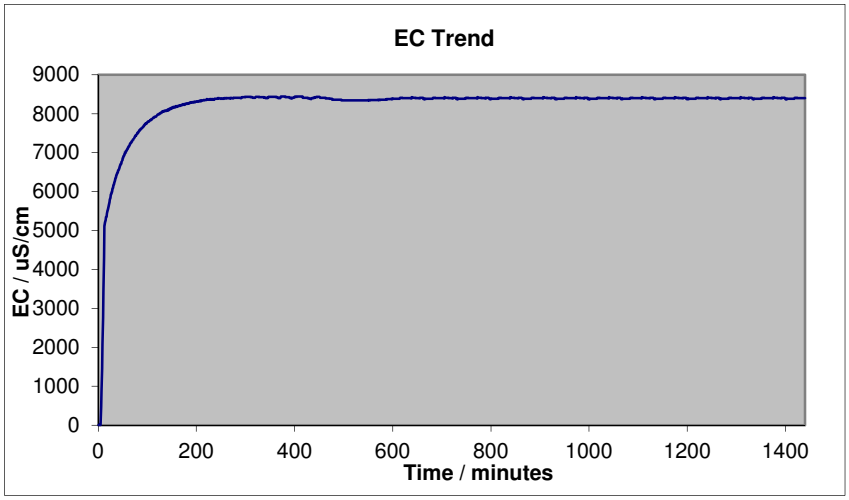
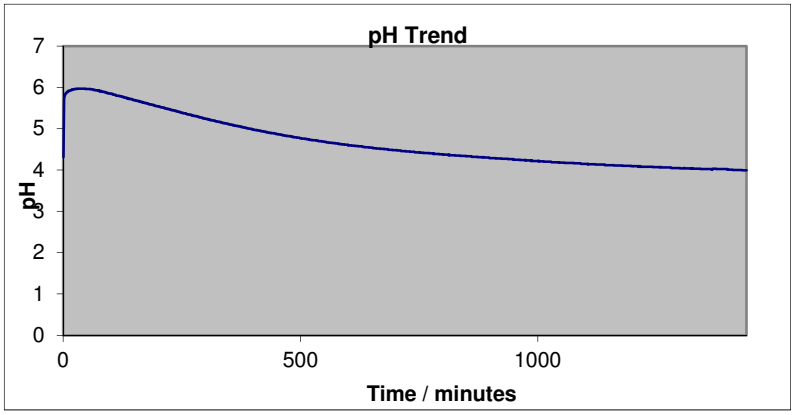
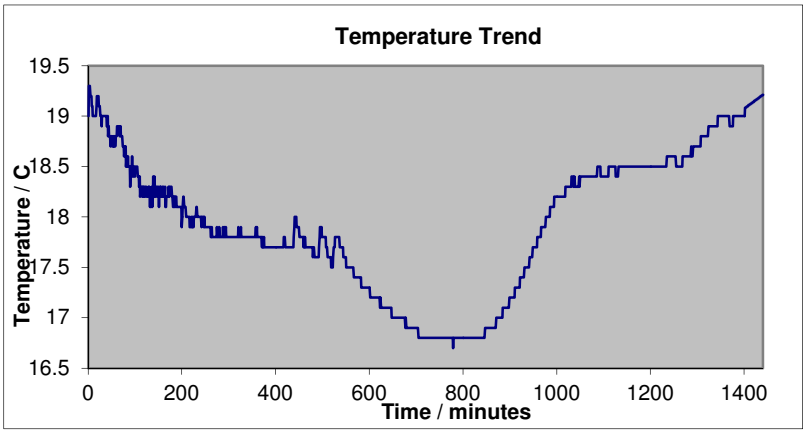


Figure 11: No19 - PAF. Table 6 shows this sample had a sulphur content of 0.52 % and a NAPP of 10 Kg H_2SO_4/t.

The reaction time to pH4 for this sample is approximately 1,400 minutes. Using **Table 9**, this equates to a leach column test greater than a decade (perhaps 14 years). The very slow reactivity of the material is too slow to produce a recordable elevation in temperature. Conductivity results show a slow, minor linear increase but still within the fresh water range. This indicates no significant elevated leaching. This material should be regarded as PAF – LC.

Figure 11: No19 - PAF





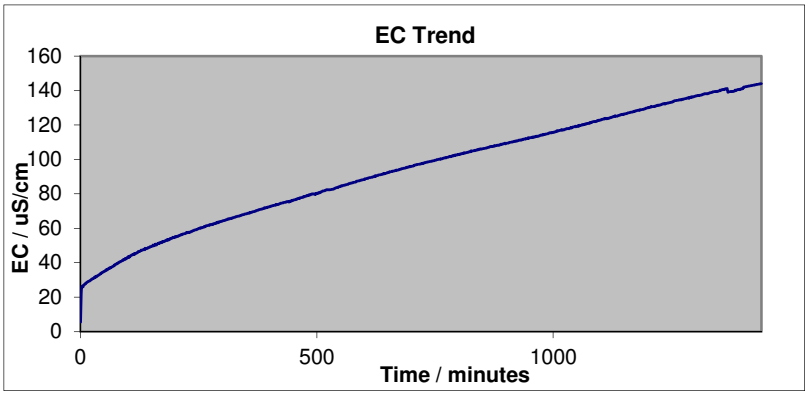
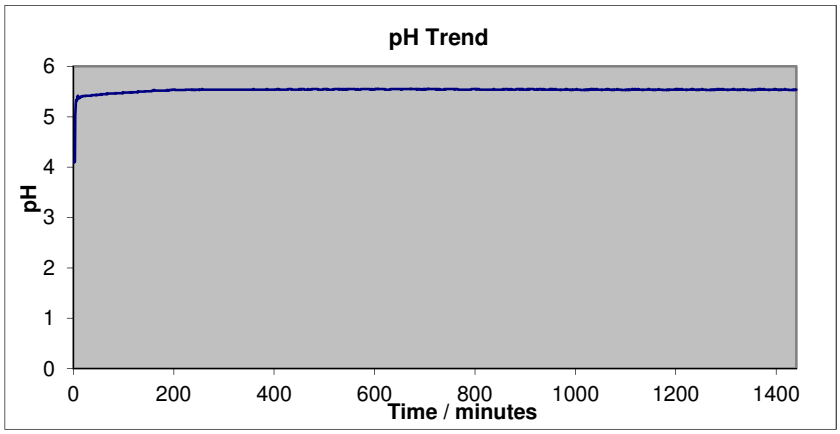
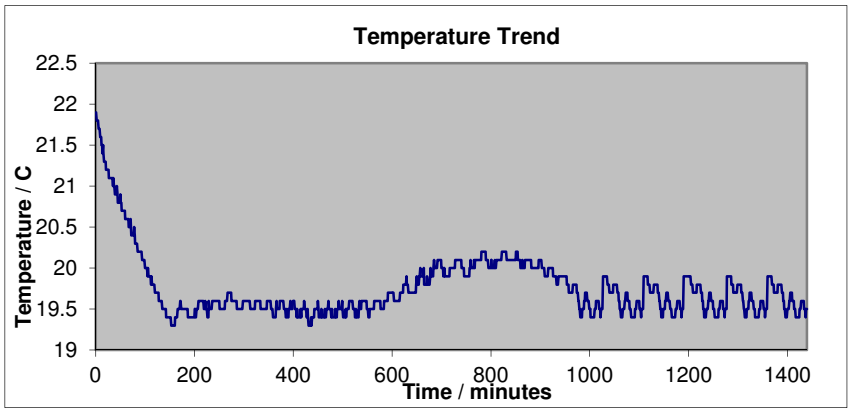


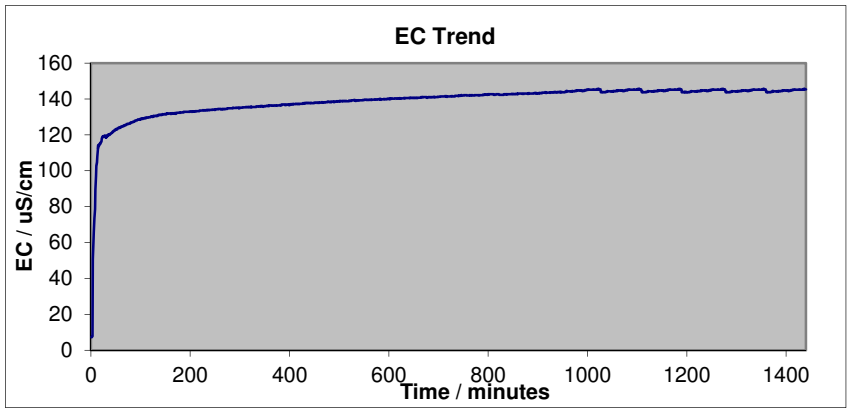
Figure 12: **No 1 - NAF. Table 6** shows this sample had a sulphur content of 0.014 %, NAPP of 0 Kg H_2SO_4/t and a final NAG pH of 5.7.

The graph shows an immediate slight acid neutralising capacity reaction to a pH of approximately 5.5 and then no further reactivity. Reaction temperatures reflect ambient temperatures. EC remains within fresh water quality range with no long term elevated leaching.

Figure 12: No 1 - NAF







The KNAG test results indicate that all waste other than very high sulphur content waste (pyrite waste) is either benign (NAF) or acid forming over a very long time period. Encapsulating high pyrite waste inside the waste landform is considered to provide an acceptable long term management outcome.

3.4 Soils

Carina Extended is located in a mature, healthy native vegetation area comprising acacia shrubland and eucalypt woodland. This suggests in-situ topsoil and subsoil within the root zone of existing vegetation does not possess characteristics which inhibit healthy plant growth.

Topsoil samples distributed over the waste landform and mine footprint were analysed for a range of physical and chemical properties (**Table 10**). Parameters tested were pH, conductivity, stability (Emerson test), texture (particle size distribution) and chemistry (Cation Exchange Capacity (CEC)). Test results indicate the following:

- Topsoil has generally neutral to alkaline pH. More alkaline topsoils have higher Calcium (Ca) content.
- Topsoil has low to moderate salinity levels.
- All samples tested are Emerson class 3. This class is generally stable, with low or moderate dispersive characteristics.
- Soil structure has approximately equal proportions of gravel, sand and fines (silt and clay). The relatively even distribution of major size fractions indicates a well-structured soil.
- Four of the samples tested have moderate levels of the four major cation elements and a moderate total CEC. Two samples have a very low CEC, with scores of 3.8 and 4.9.

Table 10: Topsoil Analysis

No.	pH	Cond.	Salinity	Emerson	>2mm	<2mm–75um	<75um	Na	K	Ca	Mg	CEC
		uS/cm	mg/kg		Gravel	Sand	Silt & Clay	Meq %				
1	8.4	140	450	3	34	38	29	0.25	1.5	22	4.1	28
2	8.4	89	300	3	41	32	27	0.14	1.1	9.5	4.1	15
3	7.3	60	200	3	40	29	30	0.26	1.2	8	3	12
4	8.4	130	420	3	51	30	18	0.1	0.95	22	2.5	26
5	5.7	36	120	3	17	51	33	0.07	0.46	2.5	0.67	3.8
6	6.1	25	81	3	24	46	31	0.07	0.51	3	1.2	4.9

3.5 Hydrology

The current water table elevation is estimated to be approximately 400 mRL, some 70 m below the current ground level surface. This is based on the results of exploration drilling encountering water in a number of holes. The water quality at Carina Extended is saline with total dissolved solids (TDS) ranging between 15,000 and 20,000 mg/L.

Based on the preliminary hydrogeological investigation and the pit dewatering estimate for Carina Extended as completed by Golder Associates Pty Ltd in June 2012, the dewatering extraction rate for Carina Extended is estimated to be of the order of 14 litres per second and will be required for all mining below the 400 mRL (**Table 11**).

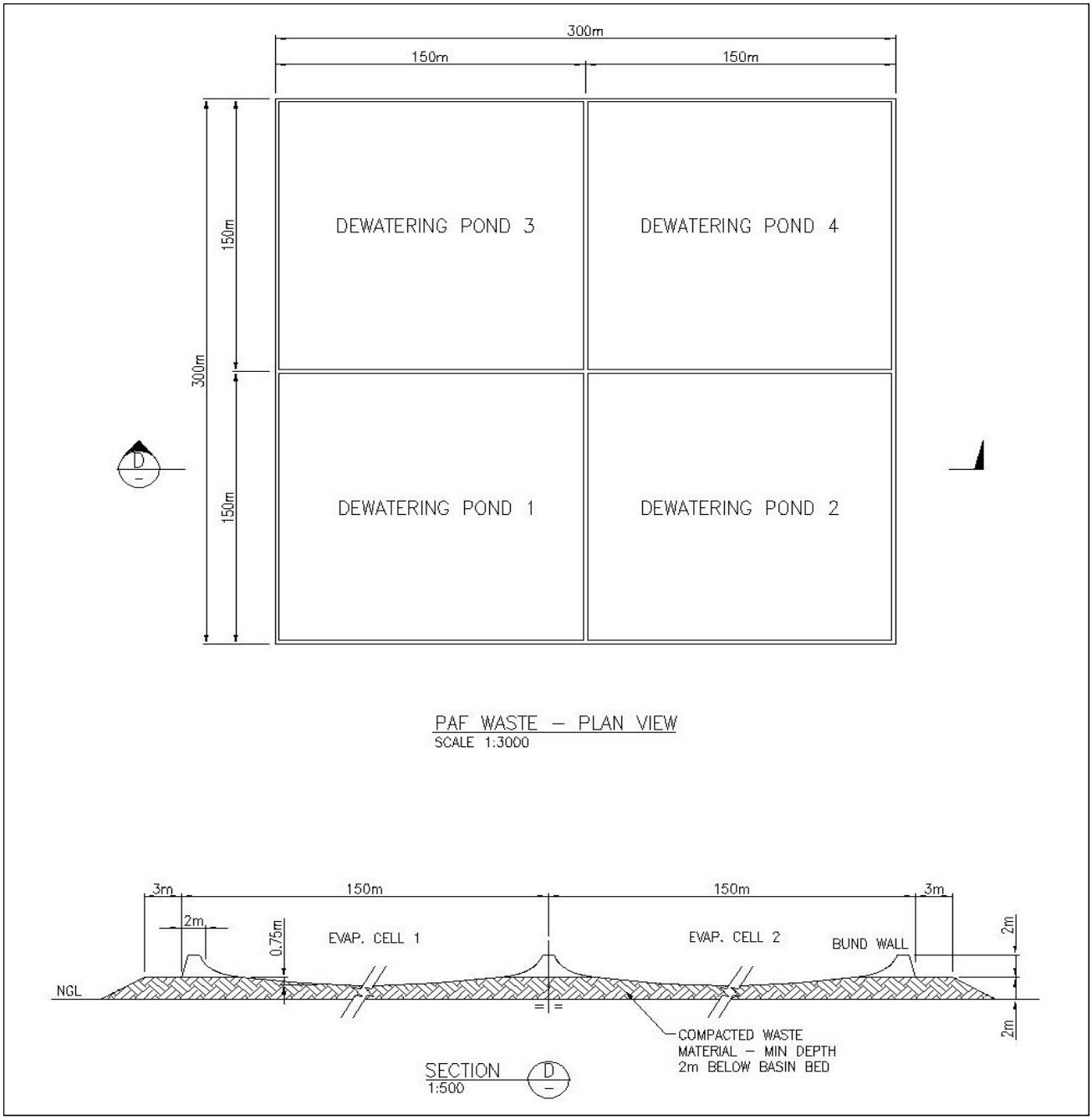
Dewatering will be undertaken using a combination of in-pit sumps and or a dewatering bore located within the pit perimeter for the collection of both groundwater and rainfall catchment and run-off as required and appropriate for the effective dewatering of the pit. Water resulting from dewatering activities including the rainfall catchment and run-off within the pit will be removed from the pit by in-pit sump pumps and or bore pumps and pumped to the surface for disposal either via the turkeys nest as shown in **Figure 5** for general mine operation dust suppression purposes or via evaporation cells for any excess unable to be disposed of otherwise, such as may be experienced during rainfall events. The evaporation cells proposed for the disposal of any excess have the same specifications as those approved for Carina (**Figure 13**).

Table 11: Mine Water Balance

		ML/year	KL/day	Comments
Source	Pit Dewatering	442	1,210	Based on 14 l/s average
	Rainfall Catchment	64	175	Based on average rainfall of 0.32m/year in 20 ha maximum pit
	Total	506	1,385	
Sink	Dust Suppression	506	1,385	Assumes 18 x 50t water cart loads per day
	Total	506	1,385	

Specific details of the groundwater management strategy will be developed following completion of the detailed second phase Carina Extended hydrogeological investigation currently underway and evaluation and assessment of the results.

Figure 13: Evaporation Basis Detail



3.6 Surface Water

A Site Surface Water Management review was completed by Golder Associates Pty in April 2012 using LiDAR topographical survey data with a resolution of ± 0.15 m. This review indicated that surface water flows will not be interrupted by the Carina Extended operation. Carina Extended is located on a low broad rise with a major drainage line approximately 600 m north of the proposed pit as shown in **Figure 14** that will not be impacted by the development of the Carina Extended mine.

Much of the southern portion of the Carina Extended Resource (CER) is located along, or very close to, a local high point forming the catchment boundary of small, south-westerly draining systems. The local topography indicates that there are no direct inflows to this area and that all rainfall falling onto this area would naturally flow away from the site, predominantly draining to the south-west as shown in **Figure 14**.

The north-western section of the site, shown in more detail in **Figure 15** extends within the boundary of a more significant catchment draining from the higher elevation areas to the north and north-east of the site. The northern limit of the resource is located within 250 m approximately from the defined main drainage stream and with the buffered extent within approximately 100 m. Examination of the topographic data and available satellite imagery indicates that surface water flows along this drainage line may not be fully contained within a clearly defined, stable channel, and that surface water flows may potentially migrate laterally, or flood across the adjacent floodplain, during larger storm flow events. The channel system may extend almost up to northern limit of the 150 m boundary of the CER as shown in **Figure 15**.

This analysis based on the CER indicated that:

- The site, when developed, may be at risk from flooding and surface water inflows from the adjacent ephemeral creek to the north of the site; and
- Surface water flows in the creek system close to the CER site may spread laterally across a much wider area during flood events and potentially inundate the proposed pit extent.

Replacing the CER limits with the actual pit shell limits results in the distance from the drainage lines to the pit crest being increased laterally by an additional 200 m and by over 3 m vertically. This increased distance and vertical height from the drainage line to the pit crest results in a significant reduction in the risk of inundation from surface water than that indicated using the CER. This risk will be further mitigated by the additional 1 to 2 m of additional height protection that will be provided by the safety bund to be constructed around the pit crest.

Figure 14: Map of Dominant Surface Water Flow Directions in the Area Surrounding the Carina Extended Resource Site

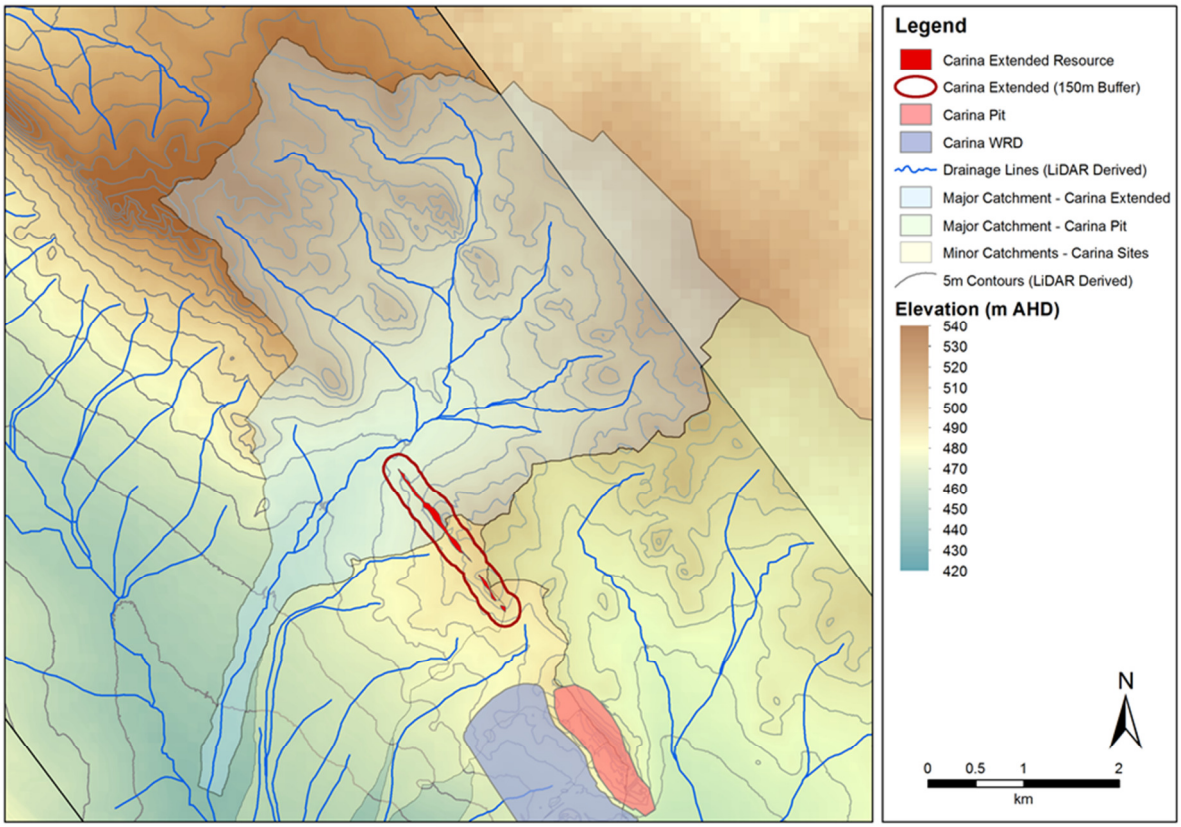
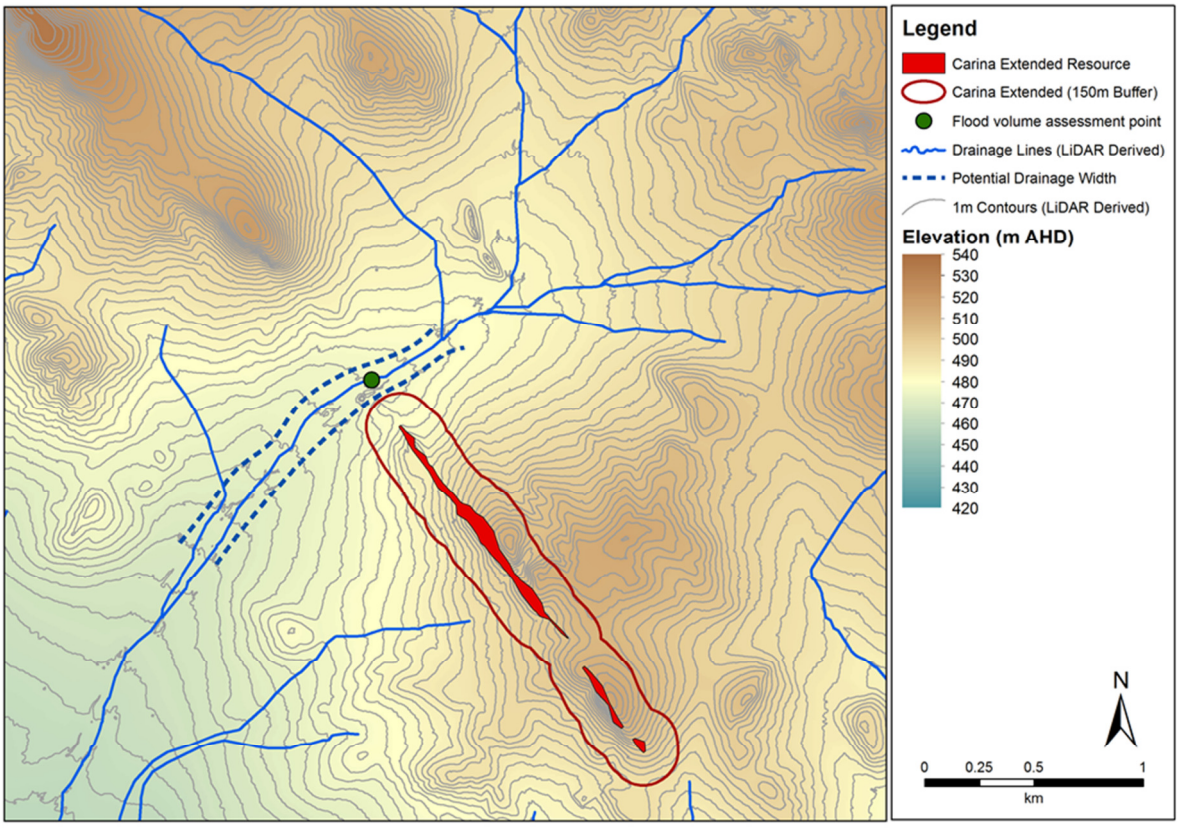


Figure 15: Map of the CER Relative to the Adjacent Surface Water Drainage Channel



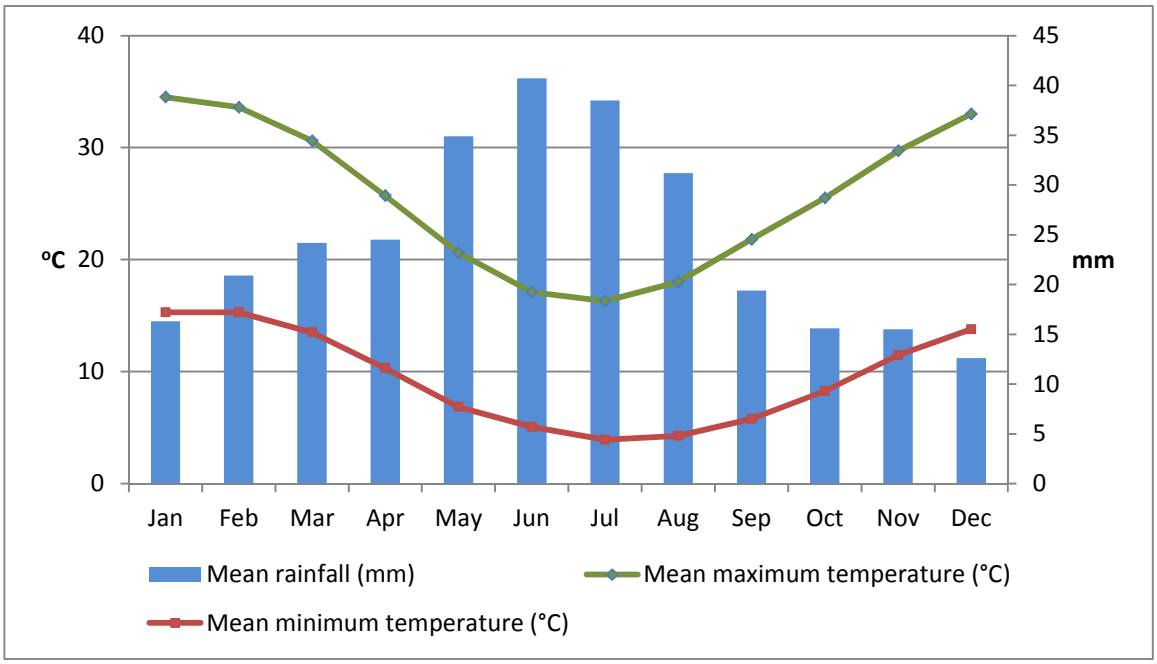
3.7 Climate

The climate of the Coolgardie region is described as arid non-seasonal to semi arid Mediterranean. This is characterised as an arid climate with cool winters and hot, dry summers. Annual precipitation ranges from 200 mm to 300 mm, falling predominantly in the winter months, with sporadic summer cyclonic rainfall. **Figure 16** shows climate data from Southern Cross, which is located 100 km to the southwest of the project area (BOM 2011).

Figure 16 shows rainfall occurs in all months, with the wettest period from May to August. The average annual rainfall of 294 mm is exceeded by the average annual evaporation rate of approximately 2,400 mm (**Figure 17**) by a factor of approximately 8 to 1.

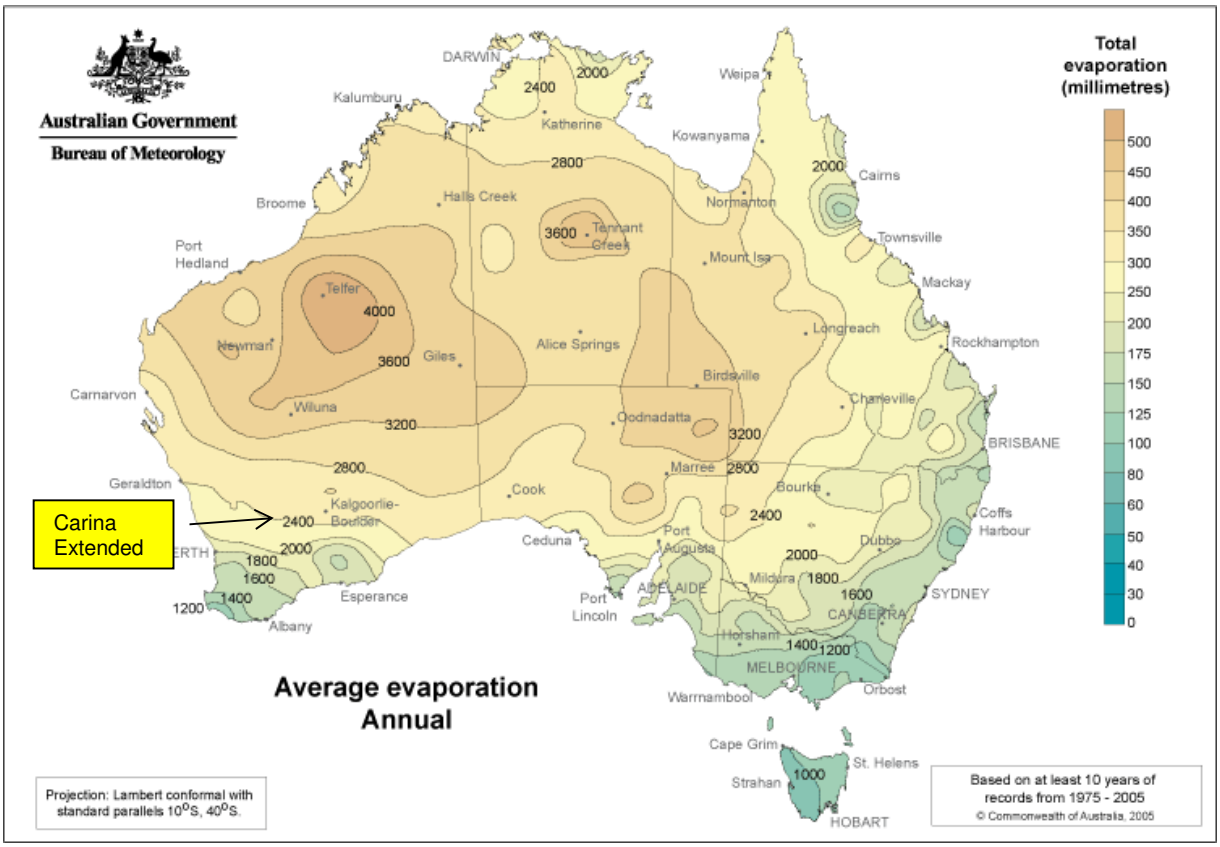
Evaporation exceeds rainfall in all months of the year, with June being the minimum at approximately 70 mm and January, the maximum, at approximately 360 mm.

Figure 16: Southern Cross Climate Data



Source: BOM, 2011.

Figure 17: Annual Evaporation



Source: http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/evaporation.cgi

3.8 Flora and Vegetation

3.8.1 Regional vegetation

Carina Extended is located in the Coolgardie Botanical District, which is characterized by Eucalypt woodlands and covers 5 % of the State of Western Australia (Beard 1990). The dominant plant families within the Coolgardie Botanical District include Myrtaceae (myrtles such as eucalypts and melaleucas), Asteraceae (daisies), Chenopodiaceae (salt bushes) and Poaceae (grasses) (Beard 1972; 1990). The region is east of the wheat belt and although it has a long history of pastoral, historic woodcutting and mining land uses, remains largely uncleared (**Table 12**). Carina Extended is located within Beard vegetation unit 538 – *Acacia brachystachya* scrub, of which approximately 90 % remains (**Table 12** and **Figure 18**). In this sense, environmental issues commonly associated with fragmented landscapes and habitats in extensively cleared regions do not apply.

Table 12: Extent of Vegetation

IBRA Region		Area of vegetation		
	Total area	ha	%	
Coolgardie	12,917,718	12,719,084	98.5	

Source: Shepherd *et al* 2001

Carina Extended is located approximately 20 km from both the existing Mt Manning Nature Reserve and the Helena and Aurora Conservation Park (**Figure 2**). These reserves are located to the north and west. Regional surface drainage generally flows in a southwest direction, so there is a negligible risk of any surface drainage effect to the reserves from the project.

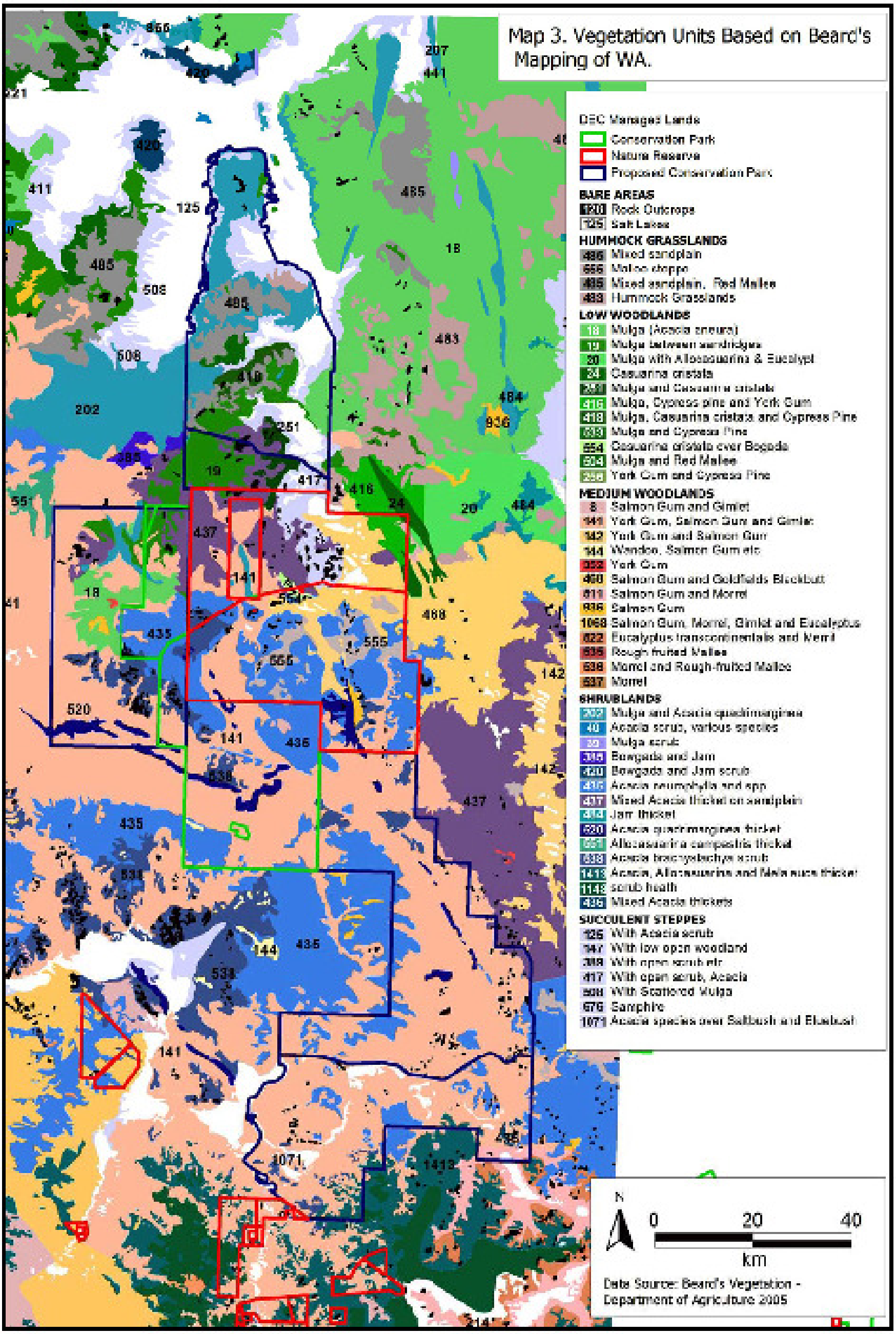
The Continental Divide is located approximately 15 km eastwards. This major geographical feature separates surface drainage flowing towards the coast from drainage flowing to inland salt lake systems.

Regional vegetation types reflect the two major underlying soil and geological types. These are:

- red-brown sandy clay soils of sedimentary origin: producing mixed Eucalypt woodlands
- yellow sandplains of granitic origin: producing Acacia shrublands.

These are shown in **Figure 18** as brown/red and blue/purple colours respectively.

Figure 18: Regional Vegetation Types



3.8.2 Carina Extended vegetation and flora

The following flora and vegetation surveys have been undertaken over the Carina Extended project.

- Mattiske Consulting Pty Ltd (January 2011). Flora and Vegetation Survey (Infill) Carina and Chamaeleon Prospects; Tenements E77/1275, E77/946 & E77/3946-I
- Mattiske Consulting Pty Ltd (March 2012). Threatened and Priority Flora Survey. Tenement M77/1261A: Carina Extended.

Reports on both surveys are provided in **Appendix 4**. These studies represent a continuation of botanical surveys in the locality which began in 2007 for the Carina and Chamaeleon deposits. **Figure 20** shows the resultant combined vegetation mapping in a corridor of approximately 25 km long and 12 km wide. A larger scale plan of this area is provided in **Appendix 2**. The surveys have identified no DRF and added to distributions of Priority species in the locality. The Priority species are broadly distributed through the region, with none being restricted to a particular vegetation type.

TECs and PECs

Communities of plants are described as Threatened Ecological Communities (TECs) if they have been defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee and gazetted under the *Wildlife Conservation Act 1950* (WC Act, 1950). Some Western Australian TECs have also been listed as TECs under the Commonwealth *EPBC Act 1999*.

There are no TEC's listed for the Coolgardie Botanical District.

Some communities which are under consideration for listing as TEC's but do not meet the defined criteria, or are not yet adequately surveyed for a decision to be made, are added to DEC's list of Priority Ecological Communities (PEC's). PEC categories are ranked in order of survey priority. Priorities 1 to 3 require evaluation of conservation status, Priority 4 are rare but not threatened and Priority 5 are conservation dependent.

Carina Extended is located in an area covered by the Finnerty Range PEC (P1) (**Figure 19**). Information obtained from DEC on the extent of the Finnerty Range PEC is shown in **Figure 21**. The PEC extends from Mt Finnerty to Mt Dimer and covers over 7,000 ha. **Figure 21** shows the extent of DEC survey quadrat locations (green diamonds), used to define the Finnerty Range PEC. No DEC survey quadrats are located in the Carina or Carina Extended project areas.

Vegetation mapping over a number of exploration tenements has been undertaken by Mattiske Consulting (2007, 2008 and 2011). These tenements cover an area of approximately 32,639 ha and include a 15 km prospective exploration corridor between the project areas of Carina and Chamaeleon. This is detailed mapping at 1:10,000 scale and is shown in the Mining Proposal. For greater clarity **Figure 20** is also reproduced in **Appendix 2**. This detailed mapping shows that the Finnerty Range PEC is actually a mosaic of different vegetation communities. Most of these communities are widespread and extend well beyond boundaries of the delineated PEC.

Figure 19: Finnerty Range PEC (in relation to Carina Extended)

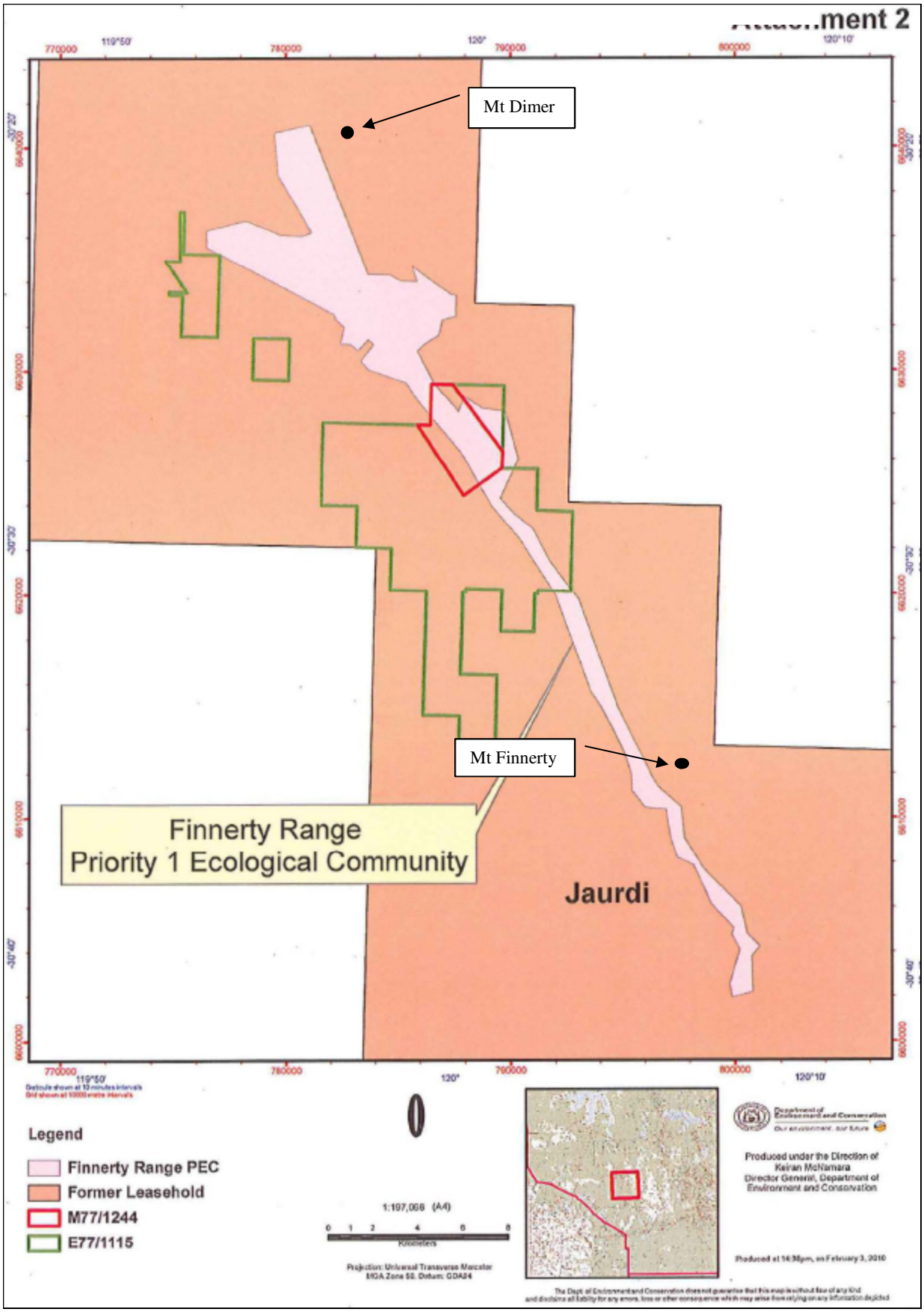
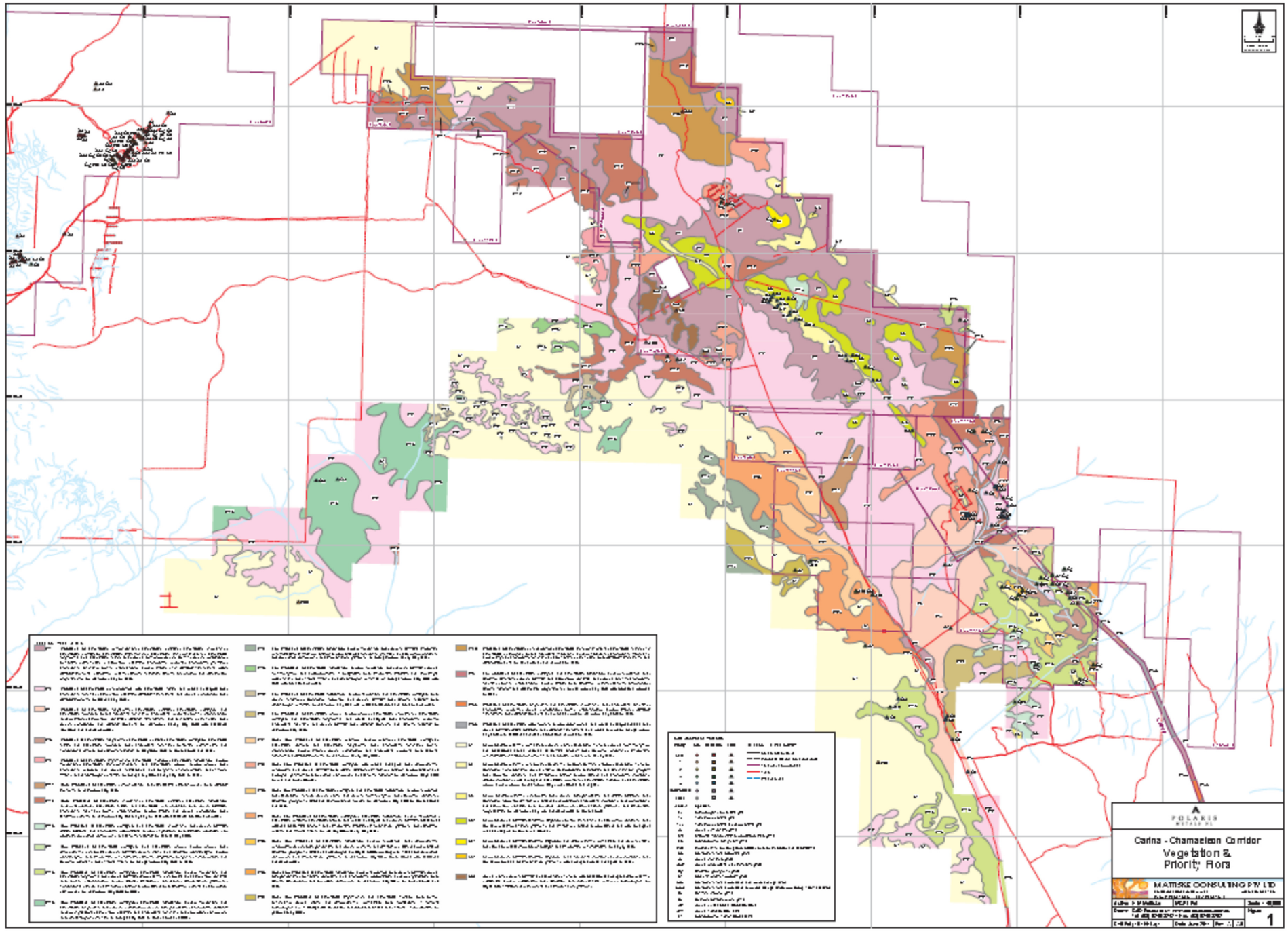
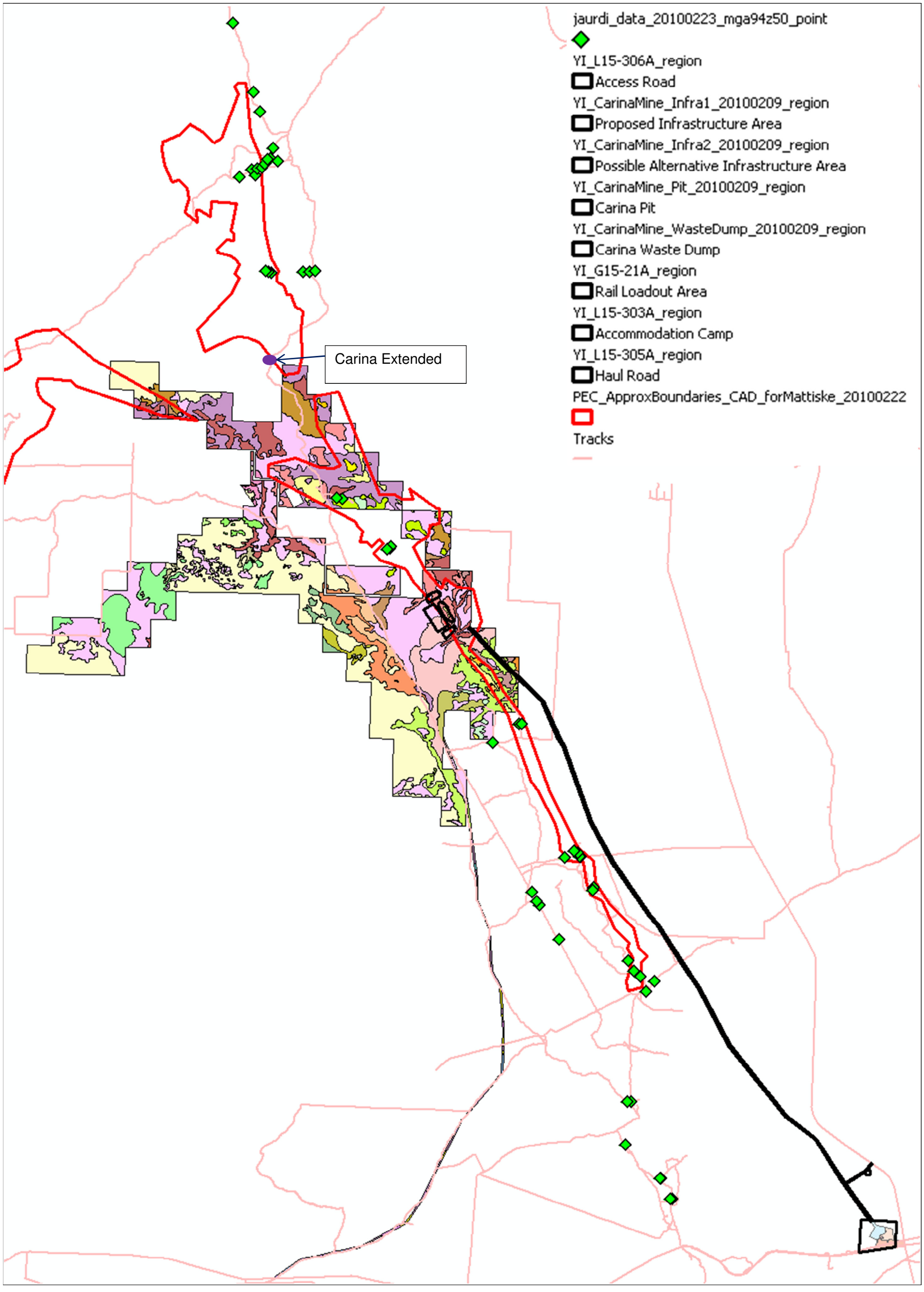


Figure 20: Local Vegetation Mapping



Note: Larger reproduction of this **Figure** is provided in **Appendix 2**

Figure 21: DEC Quadrat Locations used to map the Finnerty Range PEC



Vegetation

Vegetation mapping determined three vegetation communities were present in the Carina Extended mine area: S6, W22 and W2. A further community, W12, is present in the haul road on tenement M77/1244, which connects Carina Extended to the existing haul road.

For the Carina project, statistical comparison was undertaken between survey data for the S2 community as defined by Mattiske Consulting against data from Gibson *et al*. (2001). The S2 community most closely related to the banded ironstone formation description of the PEC. The analysis showed the S2 community had a low similarity with Gibson's data; with the conclusion the S2 community is not the PEC. The S2 vegetation type does not intersect with any of the Carina Extended project area.

For Carina Extended, statistical analysis of the S6 vegetation unit also indicated a low level of similarity with Gibson's data, resulting in the conclusion that S6 also does not form part of the PEC. Gibson's survey plots are shown as green diamonds in **Figure 21**. There are no Gibson survey plots in the Carina Extended mining tenement.

Figure 4 shows the projects impact on the four vegetation types (W22, S6, W12 and W2). **Table 13** shows the extent of disturbance ranges from 0.16 % - 2.85 % of the locally surveyed extent of these communities.

The waste landform has been located to the west of the open pit to avoid any disturbance to the W22 community (present on the east side of the open pit). The pit, topsoil stockpile areas, haul road alignment and borrow pits have all been designed to reduce impacts on W22 vegetation.

Table 13: Vegetation Impacted by the Carina Extended Mining Footprint (divided into vegetation type and tenement)

	S6			W22			W2			W12			Total Disturbed by Project (ha)
Units (ha)	**Project**	**Local [1]**	**%**	**Project**	**Local [1]**	**%**	**Project**	**Local [1]**	**%**	**Project**	**Local [1]**	**%**	
M77/1261	21.77	811	2.68	1.15	954	0.12	111.39	8,021	1.38	0	1,774	0	**134.31**
M77/1244	1.4		0.17	5.37		0.56	34.91		0.43	2.87		0.16	**44.55**
Total	**23.17**	**811**	**2.85**	**6.52**	**954**	**0.68**	**146.3**	**8,021**	**1.81**	**2.87**	**1,774**	**0.16**	**178.86**

1. Local extent: See **Figure 4** and **Table 15**.

W22 Vegetation Type

Detailed discussion on one specific community type is required in this Mining Proposal. This is vegetation community type W22. **Figure 4** shows Carina Extended project components of the open pit and haul road will impact the W22 vegetation type.

W22 is characterised by open low Woodland of *Eucalyptus corrugata* with mixed Eucalypts over *Allocasuarina campestris* and *Acacia burkittii* over *Alyxia buxifolia*, *Philotheca brucei* subsp. *brucei* and *Grevillea paradoxa* over *Scaevola spinescens* and *Olearia muelleri* on red-brown clays soils on mid to lower slopes.

During 2010, EPA assessment of the Carina project determined vegetation type W22 had a locally restricted distribution. A clearing limit of 66 ha of the W22 vegetation type was imposed on the Carina project.

Since then, further surveys have identified more W22.

Vegetation mapping in **Appendix 2** shows the W22 community ending at the;

- tenement boundary of the Taipan mine (tenement not held by Polaris)
- tenement boundaries northeast and east of Carina (M77/1244)
- tenement boundary northeast of Chamaeleon (E77/1418).

It is evident this vegetation type extends past these boundaries. It is reasonable to deduce it is also likely to be present in other tenements in the locality. Polaris considers this additional information is cause to review the statements made and conclusions drawn on this vegetation type during the Carina assessment. **Table 14** provides particular statements made in EPA Report 1368 and MS 852 and Polaris corresponding comments. Salient parts have been highlighted.

Table 14: Points on W22 Community

EPA Comment	Polaris Comment
EPA Report 1368 (pg 15) When considering the trend of vegetation associated with BIF, it can be reasonably deduced that the current mapped extent of S2 and W22 vegetation communities represents the limit of their distribution. The EPA notes however that the S2 vegetation community is also present on the crest of the remainder of the Yendilberin Hills where development is not proposed. It should also be noted that since flora surveying of the minesite was undertaken, the proponent has relocated the waste dump to reduce impact on the W22 vegetation community which also contained a large population of the P3 flora species *Grevillea georgeana*. The EPA notes that the residual impact on the S2 vegetation community is approximately 7.6 %, and for the W22 it is approximately 12 %.	Vegetation mapping present by Polaris in the PER, and reproduced (in part) in Report 1368 Figure 4, shows multiple populations of W22 that end at tenement boundaries. It is reasonable to deduce these populations extend beyond those boundaries, so the total extent of this community would be greater than initially reported.
EPA Report 1368 (pg 16) Furthermore, it is the view of the DEC that the S2 and W22 vegetation communities occur over a limited area and would not be expected to be regionally common.	Vegetation mapping of the Chamaeleon tenements, north of Carina was presented in the PER (Figure 13 and Table 17). These showed more W22 community was present in these tenements and the proportional impact of the project on the surveyed extent of this community was 7.5 %, not 12 % as reported in EPA Report 1368.
MS 852 – Condition 5 5 Protection of vegetation 5-1 The proponent shall implement the proposal so that it does not adversely affect vegetation, in particular S2 and W22 vegetation communities, outside the proposal boundary as shown in Figure 2 and delineated by MGA co-ordinates listed in Schedule 2. 5-2 The proponent shall ensure that the implementation of the proposal does not result in (through either direct or indirect impacts) a loss of more than 8.6 ha of the S2	The defined scope and boundary of Carina Extended is outside the Carina project boundary. Comments made in EPA Report 1368 are subjective. Evidence presented in the PER showed both vegetation types are also present north of the Carina project area. W22 community is not a TEC (there are no TEC's listed for the Coolgardie bioregion). W22 is not the Finnerty Range PEC. Therefore, the level of local significance of the W22 community is

vegetation community and 66 ha of the W22 vegetation community.	open to interpretation. Polaris submits the extent of W22 community is far greater than indicated by comments in EPA Report 1368. Based on the current known local extent of W22 in tenements just held by Polaris, the combined impact on this community from the Carina and Carina Extended projects is 67 ha and 6.52 ha respectively, (7.7 % of the 954 ha). It is reasonable to deduce that this community is not solely confined to tenements held by Polaris in the local area, so more W22 is likely to occur elsewhere in the vicinity. Analysis of the flora composition of W22 community against the other 25 communities mapped in tenement E77/1115 is presented in **Appendix 3.** All species in W22 are common, with 66 of 70 species (94 %) also present in other communities in tenement E77/1115. A further 2 are recorded on tenement E77/1418 (68 of 70 [97%] local). The last 2 are common species with wide distributions. Polaris submits the species composition of this community is not significant. Polaris submits the W22 community is well represented locally and has a greater local extent than previously considered. All species comprising this community are common. Polaris's operations in the proposed conservation and mining reserve impact only approximately 7.7 % of the W22 recorded to date. Polaris considers this does not represent a significant impact on the vegetation community or its species composition.

Table 15 lists the total area of W22 shown in **Figure 4** and **Appendix 2** is 954 ha. This adds to the 543.9 ha stated in EPA Report 1368 (Pg11) by 410 ha, almost doubling the local extent of this vegetation type. In total up to 178.86 ha of vegetation will be disturbed by the Carina Extended Project, 6.52 ha of this is W22 vegetation.

Table 15 shows W22 is the 9th most common community in the mapped area. There are 25 other communities with lesser local extents than W22. This information indicates that within the surveyed area, which is over 32,000 ha, area alone cannot be used as the basis of determining whether a particular community is locally restricted or at the extent of its known range. No survey information from the wider region was presented during the Carina assessment supporting the stated view that the W22 community is restricted to this local area.

The S6 vegetation type is disturbed by the pit, topsoil stockpile areas, and where the ROM intersects with the haul road. This disturbance has been reduced where possible during the design phase and will more than likely equate to less than the proposed 23.17 ha.

Table 15: Mapped Vegetation Communities

Sorted by area	
Veg Code	**Area (Ha)**
S5	15
W35	15
W14	16
W25	20
S8	21
W26	25
W33	36
S7	37
W34	39
W23	49
W36	52
W19	93
W18	106
W7	142
S30	173
W13	174
W27	189
W11	211
W5	269
W17	292
W20	310
S2	468
W21	508
S6	811
W28	852
W22	954
W24	984
W16	1,347
W4	1,471
W15	1,492
W12	1,774
W1	4,316
S1	7,359
W2	8,021
Total	**32,639**

*Grey indicates vegetation types impacted by the Carina Extended Proposal.

Flora

Species of flora are defined as Rare or of Priority conservation status where their populations are restricted geographically or threatened by local processes. Rare flora species are gazetted under Subsection 2 of Section 23F of the *WC Act 1950* and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the *WC Act, 1950* defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means."

Unlike Rare flora, Priority flora has no statutory protection. Priority flora is under consideration for declaration as Rare flora. Priority One to Three is in urgent need of further survey and Priority Four requires monitoring every five to ten years.

DEC (2011b) define Priority Three (P3) as "taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey."

DEC define Priority Four – Rare Threatened and other species in need of monitoring as:

> "a. Rare - Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.
> b. Near Threatened - Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
> c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy."

A search of the DEC Nature Map database was undertaken in June 2012. The reports are provided in **Appendix 1**. The Nature Map database has not been updated with tenement M77/1261, either as a pending or now granted tenement. A coordinate search with radius 2 km was selected, to cover an area that includes tenement M77/1261. No results were returned from this database search. The search area was increased to 5 km radius, to encompass the project boundary, both tenements M77/1261 and M77/1244. One conservation species, *Grevillea georgeana* (P3) was identified as being listed in this area.

Locally, flora surveys have recorded *G. georgeana* over a wide area of approximately 50 km to the west and south of the project area (**Figure 22**).

Mattiske (March 2012) undertook a Threatened and Priority flora survey between 8-12 August 2011 over Carina Extended by traversing the entire tenement M77/1261 at 50 m intervals in open eucalypt woodlands and at 25 m intervals in denser scrub on hill slopes.

Two listed Priority species were recorded; *Spartothamnella* sp. Helena & Aurora Range (P.G. Armstrong 155-109) (P3) and *Banksia arborea* (P4). A total of 23 *Spartothamnella* sp. Helena & Aurora Range were recorded at 11 separate locations. A total of 51 *B. arborea* were recorded at 3 locations. A forth location consisting of 5 individuals was recorded outside the north western boundary of the tenement M77/1261. Locations of individual plants that fall within the mining area are shown in **Figure 4** and impacts based on local abundance is shown in **Table 16**.

B. arborea was not listed as a Priority species in 2008 when many of the other surveys by Mattiske Consulting were undertaken in the region, including those for the Carina iron ore project. So while this species may have been recorded in other surveys, specific population counts were not taken.

Mattiske (January 2011) describes *B. arborea* as a tree or shrub (large), 2–8 m high, producing yellow flowers between March and May, and September to October. It grows on stony loam, ironstone hills. There are 38 records of this taxon in the database of the Western Australian Herbarium (DEC 2011g). An additional 51 individuals of *B. arborea* were recorded in the survey.

Mattiske (March 2012), pg 14 states; "Two of the four populations of *Banksia arborea* (P4) recorded in this survey represent new, previously unknown populations. This species is present throughout the S6 community, which is well represented within the area. Given that only a restricted section of the S6 vegetation community has been searched for *B. arborea* (P4), it is reasonable to postulate that further populations of this taxon would be recorded if the entire S6 vegetation community was searched.

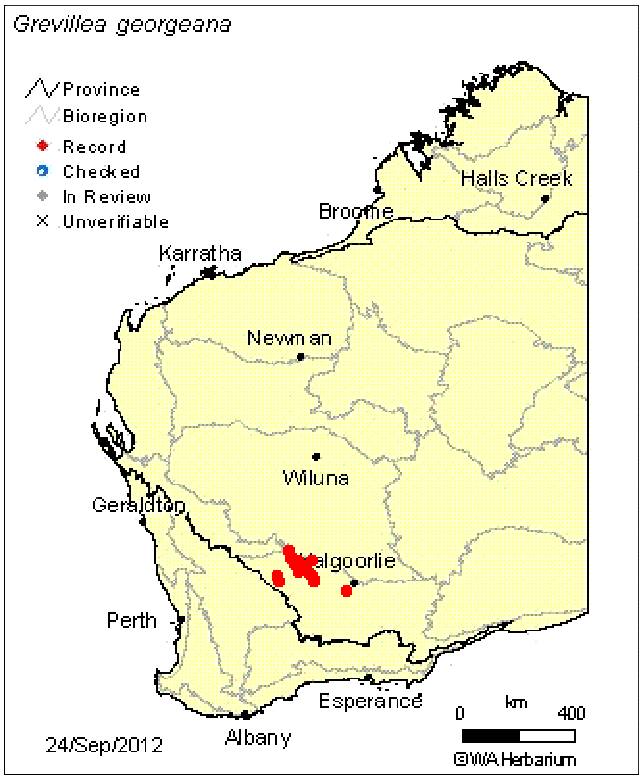
Any clearing activity within the Carina Extended mine tenement (M77/1261A) is likely to impact the population of *B. arborea* recorded within the S6 vegetation community (Figure 1). Whilst *B. arborea* (P4) is restricted to rocky hill slopes, it has been recorded on numerous other hills in the region (Gibson *et al* 2007), as well as on hill slopes immediately outside the perimeter of the Carina Extended mine tenement. The potential clearing of the small population within the tenement should have a minimal impact on the overall population of this species."

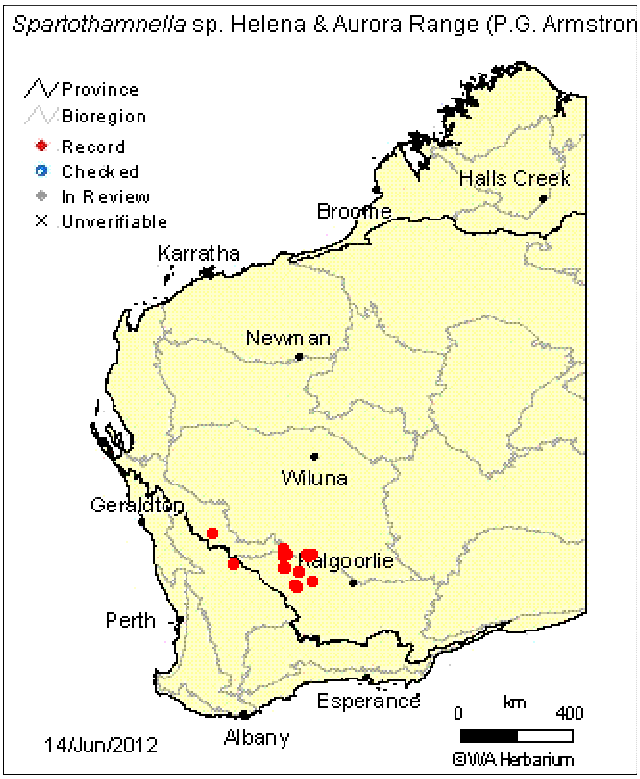
Table 16: Conservation Significant Flora Impacts (individual plants)

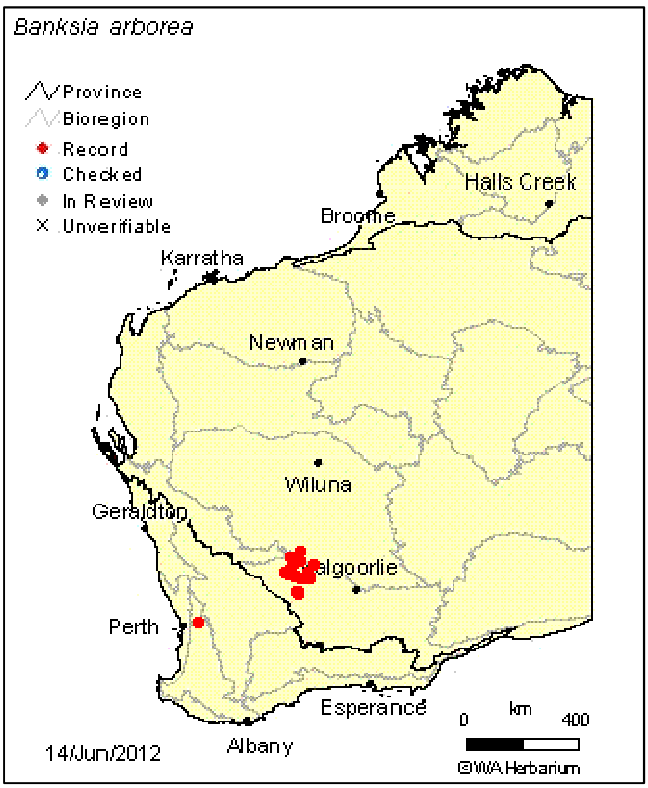
	B. arborea (P4)			*Spartothamnella sp.* Helena & Aurora Range (P.G. Armstrong 155-109) (P3)		
	Project	Local [1, 2]	%	Project	Local [1]	%
Open Pit	9	102	9.18	0	23	0
Waste Dump	0	102	0	0	23	0
Haul Road and Other	0	102	0	0	23	0
Total	**9**	**102**	**9.18**	**0**	**23**	**0**

1. Mattiske Consulting Pty Ltd (March 2012). Threatened and Priority Flora Survey. Tenement M77/1261A: Carina Extended.
2. Mattiske Consulting Pty Ltd (January 2011). Flora and Vegetation Survey (Infill) Carina and Chamaeleon Prospects; Tenements E77/1275, E77/946 & E77/3946-I.

Figure 22: ***Grevillea georgeana, Spartothamnella sp.*** **Helena & Aurora Range (P.G. Armstrong 155-109) and** ***Banksia arborea*** **distribution**







Grevillea georgeana **Distribution** - occurring on stony loam/clay, ironstone hilltops & slopes. Is has been recorded in the Eremaean; COO and MUR bioregions.

Spartothamnella sp. **Helena & Aurora Range** (P.G. Armstrong 155-109) - Distribution: Beard's Provinces: Eremaean Province, South-West Province. IBRA Regions: Avon Wheatbelt, Coolgardie, Murchison, Yalgoo. IBRA Subregions: Avon Wheatbelt P1, Eastern Murchison, Southern Cross, Tallering. Local Government Areas (LGAs): Coolgardie, Menzies, Mount Marshall, Perenjori, Yilgarn.

Banksia arborea - Tree or shrub (large), 2-8 m high. Fl. yellow, Mar to May or Sep to Oct. Stony loam. Ironstone hills. Distribution: Eremaean and South-west. COO and MUR. JF.

Source: Florabase, 2012

Although the proposed footprint for Carina Extended will result in the loss of some individuals of *B. arborea*, it will be kept to a minimum where possible.

Clearing of individuals of *Spartothamnella sp.* Helena & Aurora Range (P.G. Armstrong 155-109) (P3), and *B. arborea,* as identified in flora surveys, and the project would not likely have a significant impact on the respective populations. *G. georgeana* (P3) was not identified within the project area.

To manage impacts to Priority flora within the Carina Extended project area targeted surveys will be conducted prior to ground disturbance to further identify the above listed species. Any new locations of listed or Priority flora will be provided to the DEC as required.

There will be separate stockpiling of W22 vegetation and associated topsoil.

All areas will be progressively rehabilitated throughout the life of mine as clearing occurs to minimise cleared areas at any given time and to promote swift reestablishment of native flora and vegetation values to the area. Cleared vegetation will be stockpiled with topsoil to help maintain the seed bank and promote growth during rehabilitation.

Commitment 1: targeted flora surveys for conservation significant species prior to disturbance

Commitment 2: effective site selection of infrastructure to minimise disturbance to the W22 and S6 vegetation types

3.9 Fauna

3.9.1 Regional fauna and fauna habitat

Carina Extended lies close to the boundary between the Eremaean and the South-West Botanical Province: described as the 'mulga - eucalypt line' (Burbidge *et al*. 1995), where Acacia shrublands of the arid interior transition into the Eucalyptus woodlands and forests of the South-west. Due to this, the fauna is believed to include a range of species that are at the south-western and north-eastern limits of their distribution, resulting in a very diverse range of species (Ninox 2009).

Fauna surveys and discussion in this section includes:

- Vertebrate fauna
- Invertebrate fauna including Short-Range Endemics (SREs)
- Subterranean fauna which divides into:
    - Stygofauna
    - Troglofauna

3.9.2 Carina Extended vertebrate fauna

Bamford and Basnett (2012) undertook vertebrate surveys at Carina Extended and analogue locations at Chamaeleon and Carina North in October 2011 and March 2012. The complete report is attached as **Appendix 5**. Key features of the fauna assemblage expected during these surveys for the Carina Extended area were (Bamford and Basnett 2012):

- **Uniqueness:** The assemblage has an unusual composition reflecting the biogeography of the project area. The project area lies within the Great Western Woodlands, one of the most intact and biodiverse regions in the world. It is also in a biogeographic interzone between the temperate south-west and the arid interior, resulting in a number of different habitat types converging in the one area. Therefore the fauna assemblage has elements of both zones. In

addition, the project area lies in a land system of rocky hills and clay to loam soils that support eucalypt woodlands and mixed shublands, whereas 10 km to the east lie the heaths and scrub-heaths of the Boorabin sandplains. There is thus potential for some fauna species more typical of the sandplain environment to be present in the project area, and this was found with at least one mammal species typical of sandplain area recorded.

- **Completeness:** The assemblage almost entirely lacks a major component, medium sized ("critical weight range") mammals. These have declined across much of southern Australia due to factors such as predation by feral species (particularly the Red Fox) and altered fire regimes (Burbidge and McKenzie 1989). Despite this, the assemblage is otherwise substantially complete because the project area lies within largely undisturbed environments.
- **Richness:** The assemblage can be described as only moderately rich in a regional sense. This is partly because of the loss of some mammal species, but in addition the nearby sandplain heaths are likely to be richer in reptiles and possibly small mammals, although possibly less so for birds. The overlap of fauna assemblages between the eucalypt woodlands on heavy soil and the heaths and scrub-heaths on sand may add to the species richness slightly.

The desktop study identified 247 vertebrate fauna species as potentially occurring in the project area (**Table 17**): 4 frogs, 82 reptiles, 125 birds and 36 mammals. The assemblage includes 24 species of conservation significance, which are discussed in the full report. The presence of just under half these species was confirmed during field investigations.

Table 17: Vertebrate Fauna

Taxon	Number of Species Expected	Number Recorded	Significant Fauna Expected			Significant Fauna Recorded		
			CS1	CS2	CS3	CS1	CS2	CS3
Frogs	4	2	-	-	-	-	-	-
Reptiles	82	28	3	-	-	1	-	-
Birds	125	69	4	6	8	2	3	6
Mammals	36 (6*)	16 (5*)	1	1	1	-	-	-
Total	**247**	**115**	**8**	**7**	**9**	**3**	**3**	**6**

* Introduced species included in total.
Source: Bamford and Basnett (2012), **Table 4.**

As a fauna value, the most important features of the assemblage were that it contained elements that have declined or disappeared from the adjacent Wheatbelt, and that the assemblage lay close to a major transition between the eucalypt woodlands on heavy soil and the heaths and scrub-heaths on sand.

The assemblage is very similar to that documented for Carina by Ninox (2009) and for the Koolyanobbing/Mt Jackson/Windarling region (Bancroft and Bamford 2008), as would be expected given similar landforms and vegetation types. Sampling techniques and effort were broadly similar between the Carina sites of Ninox (2009), sites sampled in spring 2009 in the east of the Koolyanobbing Range (Huang 2009) and the current project areas, including Carina Extended. In all cases the sampling recorded about half the expected assemblage. **Table 19** shows the conservation significant fauna recorded in vertebrate surveys of the project area by Bamford and Basnett 2012.

Most species were recorded in only small numbers, but some differences in the assemblage between the project areas were apparent (**Table 18**):

- The terrestrial gecko *D. pulcher* was not recorded at Chamaeleon but was common at Carina North (11 captures) and Carina Extended (4 captures). It may favour the broader areas of gravelly soils at the latter two sites.
- The greater abundance of the small skink *Larista timida* at Chamaeleon may also reflect a habitat preference, as this is a burrowing species that probably favours loose soil under leaf-litter in Eucalypt woodland on the plain.
- The presence of a single Ashy-grey Mouse or Noodji, *Pseudomys albocinereus*, at Chamaeleon was unexpected as this is a sandplain species; this was presumably an animal dispersing from the sandplains over 5 km to the east.

The greatest differences in abundance across the three project areas occur with two rodents, the introduced House Mouse *M. musculus* (12, 7 and 0 captures at Carina North, Carina Extended and Chamaeleon respectively) and the Sandy Inland Mouse (7, 3 and 1 captures at Carina North, Carina Extended and Chamaeleon respectively). Both may favour the variable and often slightly rocky environments at Carina North and Carina Extended, but both (and especially the House Mouse) may be responding to levels of disturbance from exploration.

Table 18: Recorded Fauna

CONSERVATION STATUS		CS1				CS2	CS3	Status in Project area	Recorded
COMMON NAME	**SPECIES NAME**	**EPBC**	**WA Act**	**JAMBA**	**CAMBA**				
REPTILES									
Woma	*Aspidites ramsayi*		S4					May occur on nearby sandplains but possibly locally extinct	
South-Western Carpet Python	*Morelia spilota imbricata*		S4			P4		Resident	+ CH, CN
Gilled Slender Blue-tongue	*Cyclodomorphus branchialis*		S1 (Vul)					Resident	
BIRDS									
Peregrine Falcon	*Falco peregrinus*		S4					Resident	
Square-tailed Kite	*Lophoictinia isura*						+	Visitor	
Malleefowl	*Leipoa ocellata*	VUL	S1 (Vul)					Resident	+ **CE**, CH, CN
Major Mitchell's Cockatoo	*Cacatua leadbeateri*		S4					Resident	
Scarlet-chested Parrot	*Neophema splendid*						+	Vagrant	
Australian Bustard	*Ardeotis australis*					P4		Visitor	
Bush Stone-curlew	*Burhinus grallarius*					P4		Resident	
Fork-tailed Swift	*Apus pacificus*	MIG	MIG	+	+			Regular migrant	
Rainbow Bee-eater	*Merops ornatus*	MIG	MIG					Regular migrant	+ **CE**, CH, CN
Rufous Treecreeper	*Climacteris rufa*						+	Resident in eucalypt	+ **CE**, CH Camp
Blue-breasted Fairy-wren	*Malurus pulcherrimus*						+	Resident in heaths and scrub-heaths on sandplains to east; probably only a vagrant in the project area.	
Shy Heathwren (western ssp)	*Hylacola cauta whitlocki*					P4		Resident	+ CN

CONSERVATION STATUS		CS1				CS2	CS3	Status in Project area	Recorded
COMMON NAME	SPECIES NAME	EPBC	WA Act	JAMBA	CAMBA				
Rufous Fieldwren (Wheatbelt)	*Calamanthus campestri montanellus*					P4		Resident in heaths and scrub-heaths on sandplains to east; probably only a visitor to the project area.	
Redthroat	*Pyrrholaemus brunneus*						+	Resident	+ **CE**, CH, CN
Crested Bellbird (southern)	*Oreoica gutturalis gutturalis*					P4		Resident	+ **CE**, CH, CN
White-browed Babbler (wheatbelt)	*Pomatostomus superciliosus ashbyi*					P4		Resident	+ **CE**, CH, CN
Western Yellow Robin	*Eopsaltria griseogularis*						+	Resident	+ **CE**, CN
Southern Scrub-robin	*Drymodes brunneopygia*						+	Resident	+ **CE**
Gilbert's Whistler	*Pachycephala inornata*						+	Resident	+ **CE**, CH, CN
Chestnut Quail-thrush	*Cinclosoma castanotum*						+	Resident	+ **CE**, CN
MAMMALS									
Chuditch	*Dasyurus geoffroii*	Vul	S1 (Vul)					Visitor (low numbers)	
Woolley's Pseudantechinus	*Pseudantechinus woolleyae*						+	Resident	
Inland Greater Long-eared Bat	*Nyctophilus timoriensis*					P4		Resident	

Source: Bamford and Basnett (2012) **Table 5**
CE – Carina Extended
CH – Chameleon
CN – Carina North

Table 19: Vertebrate Fauna Trapping Results

Species	Carina Extended	Carina North	Chamaeleon
Frogs			
Neobatrachus kunapalari	2	1	2
Reptiles			
Diplodactylus granariensis		1	
Diplodactylus pulcher	4	11	-
Underwoodisaurus milii	-	-	1
Ctenophorus reticulatus	1	-	-
Moloch horridus	-	-	1
Pogona minor	-	2	-
Ctenotus uber	4	4	1
Lerista timida	2	0	5
Menetia greyii	1	1	4
Ramphotyphlops australis	-	3	1
Mammals			
Sminthopsis dolichura	-	2	-
Cercartetus concinnus	-	-	1
Mus musculus	7	12	0
Notomys mitchellii	-	2	-
Pseudomys albocinereus	-	-	1
Pseudomys hermannsburgensis	3	7	1
Number of Species	8	11	10
Number of Captures	21	46	18

Source: Bamford and Basnett (2012) **Table 6**

Malleefowl (*Leipoa ocellata*)

Malleefowl is listed under both the *EPBC Act* (1999) as *Vulnerable* and the *WC Act* (1950) as Schedule 1 '*fauna that is rare or is likely to become extinct'*.

Table 20 shows 6 Malleefowl nests were recorded in the Carina Extended survey area. The most recently active nests were recorded at Carina North. The ages of nests at Carina Extended ranged from >10 to much greater (>>) than 100 years.

Only one mound will be disturbed by the project (**Figure 4** and **Figure 5**), the others are outside of the footprint and are unlikely to be disturbed. Given the estimated age of the remaining mounds, Polaris does not believe any special management measure needs to be applied to this location.

Based on the findings of Bamford and Basnett (2012), the known distribution of Malleefowl across the southern parts of Australia and the small number of unused mounds (mostly overgrown) identified during the survey, there will be no significant impact to this species, the population or its distribution regionally, through the implementation of this project.

Table 20: Malleefowl Mound Recordings

No.	Site	Age	Diameter	Comments
1	C. Extended	>50	10m	Many other slight depressions on surface, vegetation growing on mound, some larger acacias have lived and died.
2	C. Extended	>100	10m	Mature trees growing in the middle and mostly gravel
3	C. Extended	>100	10m	Mature trees growing in the middle and animal burrows
4	C. Extended	>10	2.5m	Played with recently. Gravel
5	C. Extended	>100	12m	Mature shrubs. Mostly gravel
6	C. Extended	>>100	4m	*Varanus sp.* diggings. Dead mature trees
1	Chamaeleon	>100	2.5m	
1	Carina North	>100	7m	Slight crater. Calcrete brought to surface. Reptiles inhabiting now.
2	Carina North	>50	3m	plants growing in crater
3	Carina North	>100	3m	
4	Carina North	1 to 3	6m	Little vegetative matter, eggshell fragments in crater.
5	Carina North	>100	6m	Tree growing in crater
6	Carina North	>10	4m	
7	Carina North	NA	1m	Recent excavation by Malleefowl but hit rock so stopped
8	Carina North	>100		Adjacent to 7a
9	Carina North	>100	15m	Mature acacia in crater
10	Carina North	1 to 3	3.5m	Lots of vegetative matter still in crater, in good condition and moist. No shell visible. 2 fox scats on mound, in thick shrubland.
11	Carina North	Ancient	2,5m	
12	Carina North	Very Ancient	15m	Mature trees. Gravel
13	Carina North	Very Ancient	15m	Mature trees. Gravel, cobbles and loam
14	Carina North	10-20	10m	Gravel, cobbles very loose in centre. Two other craters in mound not part of main crater.
15	Carina North	Ancient	6m	Mature trees and shrubs in centre
16	Carina North	Ancient		Gravel, loam and rocks. Live and dead trees in centre
17	Carina North	>100	6m	Mature trees (Allocasuarina) in the middle
18	Carina North			
19	Carina North			
20	Carina North	>100	4	Growth around the edge of the mound. Gravel, loam.

Source: Bamford and Basnett (2012) **Appendix 9**

Chuditch/Western Quoll (*Dasyurus geoffroii*)

The Chiditch is listed as *Vulnerable* under the EPBC Act (1999) and as Schedule 1 '*fauna that is rare or is likely to become extinct*' under the WC Act (1950). Although suitable habitat for this species occurs within the project area, particularly the low rocky ridges, it was not recorded and its distinctive scats are not difficult to find. Therefore, it is probably only a vagrant in the area and is

deemed a 'visitor- in low numbers' to the project area (**Table 18**). Due to its lack of presence in the area, the project will not have a significant impact on this species.

Birds

Chamaeleon had the lowest number of bird species but a very high number of individual records. This was due largely to the abundance of the Yellow-plumed Honeyeater and Weebill, both eucalypt foliage specialists. This result therefore reflects the greater representation of Eucalypt Woodland at Chamaeleon than at the other two sites, which were dominated by rocky hills. Carina Extended also had large numbers of Weebill that were foraging in Mallee mixed with scrub-heath along the ridge; there was little of this mallee at Carina North and subsequently few records of the Weebill.

Species of scrub and scrub-heath were more abundant at Carina North and Carina Extended because of the greater representation of these vegetation types at these two project areas, and these species include several of conservation interest. Of the nine conservation significant bird species recorded during the survey (**Table 21**), three were observed at Chamaeleon, whereas four and six species respectively were recorded at Carina North and Carina Extended. The species recorded at Carina North and Carina Extended were largely restricted to dense vegetation along the ridges.

Fork-tailed Swift (*Apus pacificus*) and Rainbow Bee-eater (*Merops ornatus*)

The Fork-tailed Swift (*A. pacificus*) and Rainbow Bee-eater (*M. ornatus*) are 'regular migrants' to the project area but the project is not expected to have a significant impact on these highly mobile species.

Gilled Slender Blue-tongue (*Cyclodomorphus branchialis*)

This species is listed as Schedule 1 '*fauna that is rare or is likely to become extinct'* under the *WC Act* (1950). However, the nearest record is approximately 50 km from Carina North, some distance from Carina Extended. Details of this record are not available. BCE records of this species are all from rocky hills (e.g. on Karara station over 300 km to the north-west). On this basis the rocky hills of the three project areas provide suitable habitat, but the species was not recorded and nor has it been recorded in the Koolyanobbing/Mt Jackson/Windarling region where extensive fauna investigations have been undertaken for over 10 years (Bancroft and Bamford 2008).

It is not likely the project will have a significant impact on this species.

Table 21: Bird Records

Species	Carina Extended	Carina North	Chamaeleon
Collared Sparrowhawk	-	-	1
Brown Falcon	1	-	-
Galah	-	2	-
Australian Ringneck	1	6	-
Budgerigar	5	-	-
Red-backed Kingfisher	-	-	1
Rainbow Bee-eater	-	-	2
Rufous Tree-creeper	-	-	10
Striated Pardalote	2	3	2
Redthroat	3	1	-
Weebill	68	10	28
Inland Thornbill	8	1	3
Chestnut-rumped Thornbill	8	2	-
Red Wattlebird	1	-	9
Spiny-cheeked Honeyeater	5	6	-
Singing Honeyeater	4	9	3
White-eared Honeyeater	3	1	1
Yellow-plumed Honeyeater	8	1	70
Brown Honeyeater	1	5	3
White-fronted Honeyeater	1	1	-
White-browed Babbler	3	4	-
Chestnut Quail-thrush	-	2	2
Black-faced Cuckoo-shrike	-	-	1
Crested Bellbird	1	1	-
Gilbert's Whistler	1	-	-
Golden Whistler	-	2	-
Rufous Whistler	3	1	-
Grey Shrike-thrush	4	1	3
Masked Woodswallow	-	-	10
Grey Butcherbird	3	-	-
Grey Fantail	-	1	-
Australian Raven	-	1	-
Torresian Crow	1	-	2
Red-capped Robin	4	-	-
Western Yellow Robin	1	-	-
Southern Scrub-robin	2	-	-
Number of Species	25	22	16
Number of Records	142	65	149

Source: Bamford and Basnett (2012)
*Grey – indicates species of conservation significance.

Summary

Systematic sampling revealed some trends of interest and importance in impact assessment (Bamford and Basnett 2012):

1. Bird species of conservation significance tend to be associated with the rocky hills vegetation/substrate association at Carina Extended (except for the Rufous Treecreeper which is a Eucalypt Woodland specialist).

2. Higher numbers of bird species at Carina Extended and Carina North than at Chamaeleon, reflecting environmental differences. Importantly, the scrubs and scrub-heaths of the rocky hills vegetation and substrate association are richer in bird species than the Eucalypt woodland vegetation and substrate association, even though levels of abundance may be higher in the woodland due to a few abundant eucalypt specialists.
3. High abundance levels of reptiles and mammals at Carina North. This probably reflects environmental complexity in the rocky hills vegetation and substrate association in this project area, although disturbance may be a factor with some rodents.

Fauna values in the study area can be summarised as follows (Bamford and Basnett 2012):

- **Vegetation and Substrate Associations (VSAs) -** The project areas are dominated by two major VSAs: scrub and scrub-heath on rocky hills and Eucalypt woodland on loam to clayey loam plains. The rocky hills VSA is complex and restricted regionally, whereas the woodland on plains is very extensive. Carina Extended and Carina North support mainly rocky hills VSA, whereas Chamaeleon consists mainly of woodland on plains VSA with a small area of rocky hills.
- **Fauna assemblage -** Moderately rich and substantially intact except for the loss of a suite of medium-size mammal species. Distinctive in that it contains elements from both Eremeaen (arid) and Bassian (Mediterranean) regions, including species that have declined or disappeared from the adjacent Wheatbelt. The assemblage may contain some elements of the sandplain fauna assemblage. The assemblage appears typical of fauna associated with rocky ridges in the region and is probably less rich, at least for reptiles and small mammals, than the assemblage of the nearby sandplains.
- **Patterns of biodiversity -** The intensive sampling found that the rocky hills VSA had higher levels of abundance of reptiles and higher bird species richness than the woodland on plains VSA. Most of the suite of bird species of conservation significance were restricted to the rocky hills VSA.
- **Key ecological processes -** Main processes currently affecting the fauna assemblage in the surrounding project area include local hydrology, fire and fauna interactions (feral predators, over-abundant native species).

3.9.3 Invertebrate fauna and SREs

Harvey (2002) defines short-range endemics (SREs) as those fauna that have a naturally small range of less than 10,000 km^2. He describes them as possessing similar ecological traits including poor powers of dispersal, confinement to specialised often discontinuous habitats, slow growth and low fecundity. While SREs consist mainly of invertebrates, the term can also refer to some fish, frogs and reptiles (Harvey 2002). For the purposes of this current document, the term SRE is confined to invertebrates.

Dalcon Environmental (2012) undertook invertebrate surveys at Carina Extended and analogue locations, in July and November-December 2011 (**Appendix 6**). They also surveyed the Chamaeleon prospect area and an analogue location to that site at the same time. At the time of the survey, exact locations of the Carina Extended open pit and waste landform were not available. Each survey area comprised a 2 km x 2 km square. This provides a sufficient area to contain project infrastructure. A summary of key outcomes of the report is provided below:

1. No confirmed SRE species collected from Carina Extended, were endemic to the project area.

2. **Table 22** details potential and confirmed SRE taxa collected from the surveys (Dalcon 2012). This shows all except one potential SRE taxa (Teyl 'MYG021) were also collected in at least one of the other locations surveyed in 2011. Ninox Consulting (2009) (**Appendix 7**) collected two specimens of Teyl 'MYG021' at Chamaeleon during the fauna surveys for the Carina iron ore project. This report was appended to the Carina PER. Combined, this information confirms no potential SRE taxa were collected that are unique to the Carina Extended project area.
3. The major drainage line immediately north of the proposed mine disturbance area contained the highest localised concentration of Mygalomorphae in the study area. This landscape profile is not uncommon in the region. Notwithstanding, the proposed Carina Extended mine will not impact this drainage line.
4. Habitat assessment indicated a local mosaic of SRE potential habitat (scored as low, moderate and high) within the 2 km x 2 km survey areas. The landform types characterised in this habitat assessment also occur outside the survey areas, indicating potential SRE habitat continues beyond the actual surveyed areas. At a regional scale, the project area is part of a range of low broken hills trending SE to NW that is approximately 70 km long.
5. The surveys conducted by Dalcon (2011) and Ninox (2008) cover two sites approximately 10-12 km apart within this range. Both surveys have recorded common potential SRE species over this distribution. Polaris considers it reasonable that these taxa extend at least further along the range beyond the two sites surveyed.
6. The only confirmed SRE taxa, *Antichiropus sp.* 'Mt Jackson 1', is now known from both Carina Extended and Chamaeleon plus other sites approximately 70 km to the NW.

Table 22: Confirmed and Potential SRE Taxa

Taxon	Species	Significance	Carina Extended	Carina Extended Reference Site	Chamaeleon	Chamaeleon Reference Site	Total	Comment
Araneae								
Mygalomorphae								
Barychelidae	*Synothele sp. indet.*	Potential SRE				A-CHA-REF-TD05	1	
Dipluridae	*Cethegus sp. indet.*	Potential SRE	B-CAR-EXT-T086, B-CAR-EXT-TD08	B-CAR-EXT-REF-T096, B-CAR-EXT-REF-T110 B-CAR-EXT-REF-T090			5	Five specimens collected at both Carina Extended and Carina Extended Reference sites. Confirms presence of this taxa in locations outside the proposed development area.
Idiopidae	*Aganippe* 'MYG239	Potential SRE	A-CAR-EXT-T021, A-CAR-EXT-T027,	A-CAR-EXT-TD30			3	Collected in both Carina Extended and Carina Extended Reference sites.
	Aganippe 'MYG240	Potential SRE		A-CAR-EXT-REF-T065			1	Collected outside the proposed development area.
	Aganippe sp. indet.	Potential SRE	A-CAR-EXT-TD02		A-CHA-TD12		2	Collected at both Carina Extended and Chamaeleon, which are 10 km apart.
Nemesiidae	*Aname sp. indet.*	Potential SRE	B-CAR-EXT-T063		B-CHA-TD06		2	Collected at both Carina Extended and Chamaeleon, which are 10 km apart.
	Teyl 'MYG021	Potential SRE	B-CAR-EXT-T078				1	See Ninox (2009). 2 specimens also collected from Chamaeleon area. Confirms presence of this taxa in locations outside the proposed development area.
Pseudoscorpionida								
Olpiidae	*Austrohorus sp.*	*Potential SRE	A-CAR-EXT, B-CAR-EXT-T065	A-CAR-EXT-REF	A-CHA		7	Seven specimens collected at Carina Extended, Carina Extended Reference site and Chamaeleon. Confirms presence of this taxa in multiple locations inside and outside the proposed development area.
	Beierolpium 'sp. 8/3 large'	*Potential SRE		B-CAR-EXT-REF-T093			1	Collected outside the proposed development area.
	Euryolpium sp	*Potential SRE		A-CAR-EXT-REF			1	Collected outside the proposed development area.
	'PSEAAA' sp	*Potential SRE			A-CHA		1	
Isopoda								
Ligiamorpha								
Philosciidae	Genus unknown sp. nov.	Potential SRE			A-CHA		2	
Diploda								
Polydesmida								
Paradoxosomatidae	*Antichiropus* 'Mt Jackson 1'	Confirmed SRE			A-CHA-T043		1	

Note: * – indicates SRE taxa considered Potential SREs due to application of the Precautionary Principle (DEC 1986).
Source: Dalcon 2012.

3.9.4 Subterranean fauna

Bennelongia (2011) undertook a subterranean fauna survey during 2010 at Carina Extended as well as other locations as part of a regional baseline survey (**Appendix 8**). A summary of findings are provided below (**Table 23**):

> The 2010 survey data supported findings of earlier surveys undertaken for the Carina environmental impact assessment and further documented the occurrence of an unremarkable troglofauna community of low abundance in the YIOP (Yilgarn Iron Ore Project).
>
> The 2010 survey collected 6 species, of which only 2 had been previously recorded, *Trichorhinae sp.* B1 was found during the Carina Iron Ore Mine EIA (Bennelongia 2009a) and *Chilenophilidae sp.* B1 was found at Mount Jackson Range (Bennelongia 2008a) (Table 5.1).
>
> Ten of the 15 species collected were singletons and singleton records provide no information about the extent of a species' range (Appendix 2). Furthermore, *Philosciidae sp.* B9 is also only known from one drill hole, where 10 specimens were collected (Appendix 2). The 4 species that were represented by specimens collected from more than one bore (*Philosciidae sp.* B8, *Trichorhinae sp.* B1, *Chilenophilidae sp.* B1 and *Campodeidae sp.* B2) were found to be relatively widespread, with linear ranges of between 12.5 and 34.5 km (Table 5.1, Figure 5.2). All 4 species were found at multiple iron ore deposits of the YIOP and *Chilenophilidae sp.* B1 has previously been recorded at Mount Jackson Range (Table 5.1).

The OEPA released a discussion paper in February 2012 on a review of subterranean fauna assessment in Western Australia. It provides valuable context on the relative significance of troglofauna communities in ironstone geology in the Yilgarn. Significant hot spots for subterranean fauna populations include limestone geology in the Cape Range and Nullabor regions, calcrete in the arid zone and banded iron formations in the Pilbara. Fractured rock zones and vuggy geology in the Yilgarn do provide subterranean fauna habitat but appear to contain less species than other habitat types.

Table 23: Subterranean Fauna Collected in the YIOP surveys.

Order	Species	Carina	Carina Extended	Carina North	Capella	Chaemeleon	Mount Finnerty	Survey	Known Linear Range (km)	Comments
Isopoda										
	Philosciidae sp. B8	3				1		Carina EIA	12.5	
	Philosciidae sp. B9					10		Carina EIA	-	
	Trichorhinae sp. B1	1	1	4		2		Carina EIA, 2010 Survey	13.7	
	Troglarmadillo sp. B10					1		Carina EIA	-	
Geophilomorpha										
	Chilenophilidae sp. B1		1		2			2010 Survey, Bennelongia 2008a	34.5	Also known from the Mount Jackson Range
Scolopendromorpha										
	Cryptops sp. B18		1					2010 Survey	-	
Pauropodina										
	Pauropodina sp. B18		1					2010 Survey	-	
Symphyla										
	Symphyla Gen. 1 sp. B1	1*						Carina EIA	-	
Diplura										
	Campodeidae sp. B2	1				1		Carina EIA	13	
	Japygidae sp.						1	Carina EIA	-	
	Japygidae sp. B12					1		Carina EIA	-	
	Parajapygidae sp. B6	1						Carina EIA	-	
Hemiptera										
	Meenoplidae sp.		1					2010 Survey	-	Immature specimen, very likely to be the same species that occurs at Koolyanobbing and Windarling (Bennelongia 2008b, 2010)
Coleoptera										
	Carabidae sp. B4		1					2010 Survey	-	
	Curculionidae Gen. 2 sp. B6	1*						Carina EIA	-	

*Collected during stygofauna sampling.
Source: Bennelongia 2001.

3.10 Social Environment

3.10.1 Aboriginal heritage

The heritage clearance survey for mining on M77/1244 was undertaken as part of the Carina iron ore project (O'Reilly 2010). A Section 18 clearance for the one site identified in the Carina open pit was obtained from the Minister for Energy; Training and Workforce Development; Indigenous Affairs on 17 May 2011. The haul road extension to Carina Extended through M77/1244 will not impact any Aboriginal heritage site.

Two Traditional Owner groups have surveyed the Carina Extended mining area (Cecchi 2011; *unpublished* Mathieu 2012). No sites of significance were recorded.

3.10.2 Native title

There are no registered claims over the Carina Extended project area.

3.10.3 Community

Carina Extended is located in a remote part of the shire of Yilgarn. The shire of Yilgarn is 30,720 km^2 in area and has a population of approximately 3,000. Southern Cross (370 km east of Perth) is the major town in the shire. Other town sites include Bodallin, Bullfinch, Koolyanobbing and Marvel Loch (Shire of Yilgarn 2011). Carina Extended is located approximately 100 km northeast of Southern Cross and 60 km northeast of Koolyanobbing.

Workforce will be sourced from the existing workforce at the Carina mine. No additional workforce or support infrastructure is required.

3.10.4 Land use

Carina Extended is located in the proposed Conservation and Mining Reserve in the Mount Manning Area group of existing and proposed reserves. This proposed reservation confirms mining and conservation as multiple land use categories for this area.

Figure 2 shows Carina Extended is located approximately 20 km from both the existing Mt Manning Nature Reserve and the Helena and Aurora Conservation Park. These reserves are located to the north and west. Regional surface drainage generally flows in a southwest direction, so there is a negligible risk of any surface drainage effect to existing reserves from the project.

Carina Extended is outside the buffer radii of the Mt Walton Intractable Waste Storage Facility. Polaris has consulted with the agency managing the facility and its access road, the Department of Treasury and Finance, Building Management and Works. An agreement has been reached for Polaris to use the southern portion of the access road for general traffic. It is anticipated the project will have a negligible effect on the waste facility or intermittent transport of waste on the access road.

The dominant land use in the north eastern part of the region is grazing which has led to some degradation. The western part of the Southern Cross subregion is cleared for dry land agriculture and salinity problems are emerging. Mining activities are present and weed and feral animals can be found throughout, although weeds in particular are worse near agricultural areas. The Coolgardie

region is generally in good condition however the Southern Cross subregion is considered to be stressed (McKenzie *et al*., 2003, as cited in Bamford and Basnett, 2012).

A draft Mining Proposal was submitted to DMP, DEC (EMB), DEC (Kalgoorlie) and the Shire of Yilgarn for comment. Input and comments received have been reconciled and included in this document.

4. PROJECT DESCRIPTION

4.1 Area of Disturbance

Table 24: Area of Disturbance Table

Tenement Number:	M77/1261	M77/1244
Description of Mining Disturbances	**Area (ha)**	**Area (ha)**
Open Pit	22.44	0
Waste Dump	53.50	0
Haul road between Pit and Waste Dump (50 m wide)	3.18	0
Topsoil and Vegetation Stockpiles	26.18	0
ROM (including areas for stockpiling)	21.62	1.69
Core Storage Area	0.91	0
Haul Road (from Carina) (50 m wide)	0	21.97
Borrow Pits	0	18
Borrow Pit Access Tracks (connecting to haul road)	0	0.76
Light Vehicle Access Tracks*	6.23	2.11
Turkey Nest (and access track)	0.21	0
Total Proposed Disturbance	134.27	44.53
Undisturbed Area (After Proposed Disturbance)	357.09	954.97
Total (should equal tenement area)	**491.36**	**999.5**

* 15 m wide and includes a) widening of existing track from Carina to Carina Extended, b) new tracks around ROM (travelling north past Waste Dump) c) widening and extension of existing track north towards Mt Dimer Rd (ending at M77/1261 boundary).

These disturbance areas do not include any previous clearing under the Carina Mining Proposal (M77/1244) or any existing clearing at Carina Extended from Exploration (M77/1261), approved under POWs.

4.2 Mining Operations

Carina Extended will consist of the following components;

- open cut mining from one pit: ore haulage 2 km to tie into the existing Carina logistics system consisting of:
  - ore haulage approximately 52 km to a siding on the existing trans Australian railway
  - dry crushing and screening, and
  - train loading at the siding.

The maximum mining rate will not exceed 1Mtpa from an Reserve of approximately 1.3Mt. The actual mining rate is likely to be somewhat lower than the maximum depending on the blending requirements. Ore from Carina Extended will be blended with ore from the existing

Carina operation to achieve the customer product specification. The maximum mine life is estimated at 5 years, dependant on the blending requirements.

4.2.1 Open pit

The maximum footprint of the proposed Carina Extended pit is shown in **Figure 4** and includes a 20 m expansion from the pit crest. This expansion is to provide a clear area for pit crest inspections, the pit crest safety bund and access roads outside the bund. This footprint is 22.4 ha in area. The pit depth in this proposal is a maximum of 160 m from the highest to the lowest elevation. The outer most boundary of the pit as shown on **Figure 4** and **Figure 5** will also require an abandonment bund placed 45 m from the edge of the pit. However, it is unlikely that the pit will be mined to the outermost boundary of the design shown, which will then allow for this 45 m spacing within the approved area for the abandonment bund.

The combined surface area provided for the stockpiling of topsoil and vegetation from the proposed clearing of the ROM, waste rock landform, pit footprint, mine roads and turkeys nest is 26.2 ha. The proposed ratio of: the area required for stockpiling to the area cleared is 0.24 and was estimated from the actual clearing and stockpiling areas of the nearby Carina operation with an overall average topsoil height of 1.2 m. These areas exclude the road-train haul-road and the borrow pits as: the topsoil and vegetation from the clearing of the road-train haul-road is provided for within the proposed respective footprint; and the topsoil and vegetation from the borrow pits will be used for progressive rehabilitation on completion of each borrow pit on a cell by cell basis.

The mining method will use conventional drill and blast techniques followed by hydraulic excavation, load and haul. Likely configuration of mine equipment is a 120 tonne excavator matched to 90 tonne off highway dump trucks. Mine waste will be deposited on the waste landform, west of the open pit. Ore will be deposited on the ROM stockpile and then transported in off highway road trains to the crushing plant located at the rail siding.

Approximately 1.3 million tonnes of ore is proposed to be mined over a maximum of 5 years. This will be blended with ore from Carina.

Design parameters for the open pit are:

Ramp Width	15 m
Ramp Gradient	10 %
Pit Wall Face Angles*	35° to 65°
Berm widths*	5 m to 7 m
Inter-berm heights*	15 m to 20 m
Inter-berm heights*	15 m to 20 m
Maximum overall pit wall angle	40°

*Differences in these design parameters are based on geotechnical domains incorporating weathering profiles and local conditions

Different pit wall angles will be used on different faces of the open pit and will result in a potential zone of pit wall instability from the pit crest as shown in **Figure 23** and **Figure 24**.

Figure 23: Indicative Section (red) through Carina Extended Pit with Potential Zone of Instability (green)

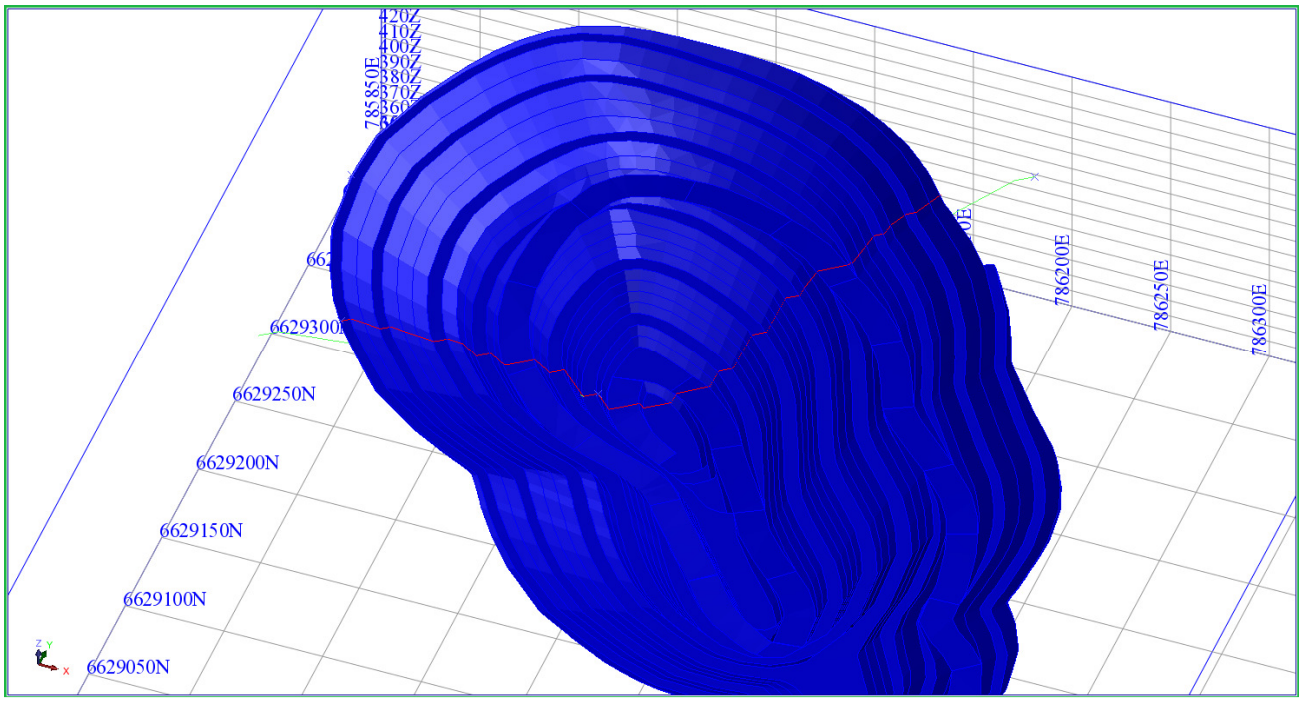
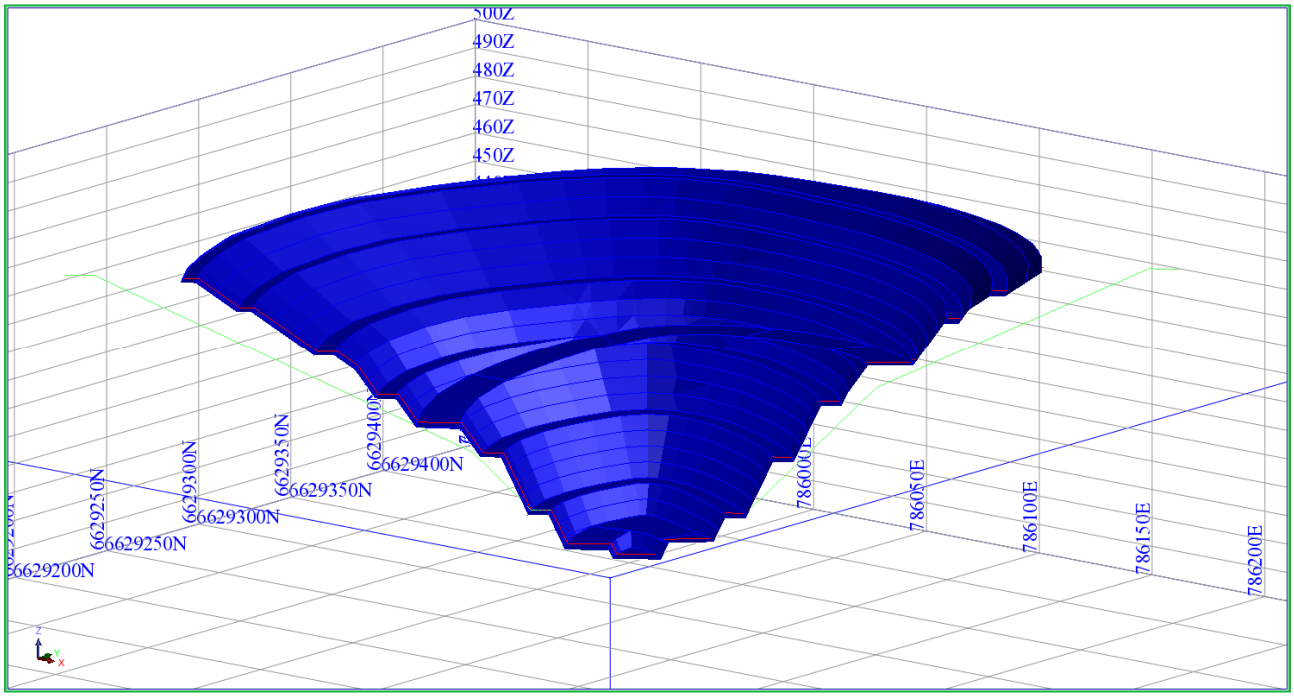


Figure 24: Indicative Cutaway Section through Carina Extended Pit showing potential Zone of Instability (green)



4.2.2 Waste landform

The Carina Extended WRL has capacity for approximately 9.1 LCM with the design parameters as shown below.

Parameter	
Final maximum face angle	20°
Final overall maximum face angle	18°
Maximum first lift height	15 m
Second lift height	10 m
Maximum elevation	487 mRL
Berm width	10 m

This design makes provision for additional material movement within the proposed pit footprint.

The area allocated adjacent to the waste dump has been designed to cater for access roads, topsoil and vegetation stockpiles and other ancillary infrastructure. Waste dump clearing will be staged as required and rehabilitated progressively. A haul road has been included from the pit to the waste dump (**Figure 25**).

4.3 Dewatering

Prior to the implementation of any water bores for dewatering, all required Department of Water (DoW) licences and approvals will be obtained. See **Section 3.5.**

4.4 Ore Processing

Ore processing consists of dry crushing and screening into two products; 'lump' (nominally between 6 mm – 32 mm) and 'fine' (<6 mm).

Ore processing will be undertaken at the existing crushing plant at the Carina ore processing plant and rail siding (DEC Licence L8596). No additional ore processing infrastructure is required for this proposal.

4.5 Tailings Storage

No process tailings will be produced in this proposal.

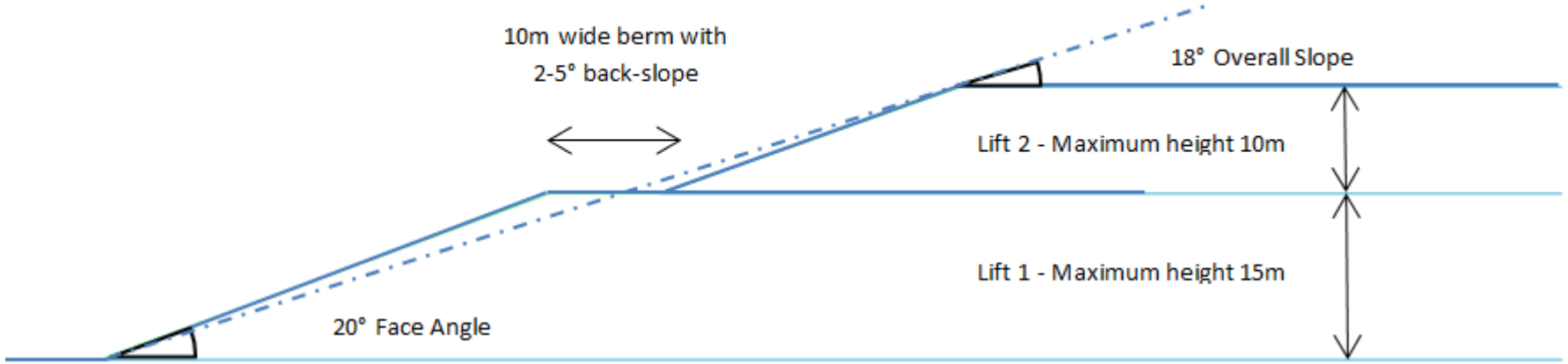
4.6 Support Facilities

All support facilities including offices, workshops, fuel storage, staff accommodation and explosives magazine will be provided from existing facilities at Carina.

4.7 Workforce

The workforce for the project will be provided from the nearby Carina mine. No additional workforce is required for this project.

Figure 25: Waste Landform Cross Section



4.8 Transportation Corridors

Transport of ore will be by internal haul road from granted mining leases M77/1261 into M77/1244. This internal haul road will be a dedicated road to Carina Extended. It bypasses the existing Carina mine operation. The internal haul road will join onto the existing haul road to the rail siding, on tenement L15/305. No change to the existing Carina haul road is required.

The proposed haul road runs south from the ROM to link up with the Carina Haul road. The alignment is designed to minimise disturbance to W22 vegetation and also Priority flora species.

Ore from Carina Extended will be railed to KBT2 at Kwinana and shipped from that port along with ore from the existing Carina operation. No change to this process is required.

An existing track running north from the Carina pit to the explosives magazine will be widened for safe passage of traffic and will extend to the core storage area at Carina Extended, around the ROM. An access track abutting the western side of the waste dump with an appropriate safety buffer, allowing access to the waste dump and through to the north of the mining lease (M77/1261), allowing a link to Mt Dimer Rd will also be required.

There are also two haul roads from the pit to the waste dump (**Figure 5**).

4.9 Borrow Pits

Indicative borrow pit areas have been mapped in **Figure 4** along the proposed haul road from Carina Extended, south, to where it intersects with the existing Carina haul road. The 6 proposed pits are no greater than 3 km^2 each and include an access track from the haul road into the pits and are linked to each other via an access track.

The use of these pits, located within the W2 vegetation type along the proposed haul road is subject to assessment for appropriateness of borrow material.

4.10 Resource Requirements and Regional Infrastructure

Resources and infrastructure required for this project were constructed as part of the Carina proposal. No additional regional resources or infrastructure is required.

4.11 Compliance with Legislation and Other Approvals

In addition to this Mining Proposal **Table 25** lists other approvals, licences and permits required to operate Carina Extended. Polaris will implement the following commitment -

Commitment 3: to obtain all other required permits and licences to operate Carina Extended.

Table 25: Other Approvals

Agency	Type	Approved
DMP	Tenements:	
	M77/1261 – Carina Extended mine tenement	15 May 2012
	M77/1244 – Carina mine tenement	7 Dec 2009
	Purpose clearing permit – included with this Mining Proposal.	TBC
DIA	Heritage surveys of tenements.	Complete
DEC – Works Approval and Licence	Category 6 – Mine dewatering (50,000 tonnes or more per year).	TBC
DOW	Pit dewatering - Licence to abstract water (5C) and construct bored (26D).	TBC

5. ENVIRONMENTAL IMPACTS AND MANAGEMENT

Environmental management of impacts associated with this proposal is based on the risk management framework. The main objectives of environmental management in this Mining Proposal are to:

1. Identify activities that could result in environmental impacts to key factors.
2. Quantify the relative level of inherent risk from the activity (without control measures applied).
3. Develop management processes to reduce the inherent risk to an acceptable level (residual risk).
4. Document these processes so they become part of the Company's management actions once the project is in operation.
5. Monitor the effectiveness of 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 in order to reduce them. As different activities differ in scale and nature of impact, control measures are tailored to ensure they are relevant and effective in mitigating risk. Detailed management plans may be required for high or moderate risk aspects while routine procedures are considered sufficient to adequately manage low risk aspects.

Polaris 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.

A summary of project impacts and management is provided in **Table 26**. Polaris has developed plans, procedures, checklists and forms to manage impacts on key environmental factors to reduce residual impacts (**Table 27**).

Table 26: Environmental Impacts and Management

No.	Environmental Factor	Environmental Impacts	Environmental Management	Implementation timeline	Predicted Outcome	Performance to date (complete in AER)
1	Vegetation	The proposal will result in a total up to 1, 351.64 ha of vegetation being cleared (M77/1244 and M77/1261 combined).	Clearing of native vegetation will be kept to a practical minimum, particularly in regards to W22 and S6 vegetation within the project area. Local reduction in abundance of vegetation communities due to clearing. All communities are well represented in the region. Rehabilitation of mined areas to return native vegetation and habitat for native fauna. Clearing will be progressive to limit clearing only to what is necessary for mining operations. Weed Control Procedures will be implemented on site.	During construction and early operation until project footprint is fully cleared.	No significant impact to vegetation.	
2	Flora	The clearing of up to 1, 351.64 ha will result in loss of individuals of flora species. All species are well represented in the region.	Clearing Procedure implemented to minimise disturbance area to that required for the work. Collect seed before clearing where available. Strip topsoil and stockpile for use in rehabilitation. W22 will be stockpiled separately and marked with signage. Cleared vegetation will be respread on rehabilitated areas.	During construction and early operation until project footprint is fully cleared.	No significant impact to flora.	

No.	Environmental Factor	Environmental Impacts	Environmental Management	Implementation timeline	Predicted Outcome	Performance to date (complete in AER)
3	Significant flora	No DRF in the project area. Removal of 9 *Banksia arborea* (P4) from the pit area. Many more of these species have been recorded in the wider area.	Individuals of priority species will be avoided where possible. Seed collection from priority species. Mine closure rehabilitation completion criteria will be established in conjunction with DMP as stated in Guidelines.	Ongoing: During construction and operation.	No significant impact to conservation significant flora.	
4	Weeds	Machinery and equipment may introduce and spread weeds in the project area.	Implement procedures to clean down equipment and site inspection to identify weed infestations, similar to existing procedures already in place at the Carina mine.	Ongoing: During construction and operation.	No introduction or spread of significant weeds.	
5	Fauna	The clearing of up to 1, 351.64 ha of vegetation and open pit mining will result in a minor reduction of fauna habitat in the region. Survey of analogue sites identified similar species and habitat in the local area.	The wider locality is totally covered in native vegetation. Clearing Procedure implemented to minimise disturbance area to that required for the project. Re-establish fauna habitat during rehabilitation. Feral animals will be addressed in a Feral Animal Management Program.	Ongoing: During construction and operation.	No significant impact to fauna.	
6	Significant fauna	The clearing of up to 1, 351.64 ha of vegetation and open pit mining will result in a minor reduction of fauna habitat in the region.	The wider locality is totally covered in native vegetation. Rehabilitation will return vegetation and habitat at the conclusion of the project.	During construction and early operation until project footprint is fully cleared.	No significant impact to Threatened fauna. Habitat at the project area is not critical for significant fauna or fauna unique to the region.	

No.	Environmental Factor	Environmental Impacts	Environmental Management	Implementation timeline	Predicted Outcome	Performance to date (complete in AER)
7	Subterranean fauna	Open pit excavation and pit dewatering have the potential to affect troglofauna species.	Local impact to troglofauna population in the open pit footprint. Troglofauna habitat occurs in the wider region. Troglofauna species also recorded outside the project area.	Ongoing: During construction and operation.	No significant impact to subterranean fauna.	
8	Surface water quantity	The project will not redirect major surface drainage patterns.	Install culverts on the haul road to maintain current surface flow paths.	Ongoing: During construction and operation.	No significant impact to surface water.	
9	Surface Water quality	Potential exists for contamination of surface water with sediment and pollutants.	Runoff will be directed to sediment basins prior to discharge to natural waterways. Hydrocarbons and other chemicals will be stored in bunded facilities off site at Carina.	Ongoing: During construction and operation.	No significant impact to surface water.	
10	Groundwater quantity	Pit dewatering only in the latter stages of mining and only for a short duration.	Monitoring bores will record changes in groundwater levels.	During operation.	No significant impact to ground water.	
11	Groundwater quality	There is a low risk of significant contamination to groundwater as it occurs at depth and is naturally saline, so unsuitable for most alternative uses.	Bulk hydrocarbons will not be stored in the project area. Spill Procedure will reduce impact of localised spills. Monitoring bores will record changes in groundwater quality parameters. Groundwater potentially impacted by oxidation of minerals in pit walls will be contained in a groundwater sink pit void lake.	Ongoing: During construction and operation.	No significant impact to ground water.	

No.	Environmental Factor	Environmental Impacts	Environmental Management	Implementation timeline	Predicted Outcome	Performance to date (complete in AER)
12	Landform	Alteration of the current landform due to mining. Open pit and a waste landform will remain at the conclusion of mining	Mining will be conducted in accordance with approved mine plans. Mine closure rehabilitation completion criteria will be established in conjunction with DMP as stated in Guidelines.	During operation and closure.	No significant impact to regional landforms.	
13	Mine waste	Contamination of soil, groundwater and surface water from acid rock drainage	Encapsulation of PAF rock in the waste landform.	During operation and closure.	No significant impact from mine waste.	
14	Waste disposal	Incorrect disposal of wastes may cause pollution of surface and ground waters or land contamination.	No waste disposal facility on site.	NA	No significant impact from waste disposal.	
15	Noise	There is a low risk of noise impact as the project area is remote from any nearby sensitive premises.	No specific management measures proposed.	NA	No significant impact from noise.	
16	Air quality	Dust from mining and ore transport may adversely affect vegetation and flora in close proximity to operations. Greenhouse gas emissions from fuel combustion (earthmoving machinery, power generation).	Water from dewatering of the pit will be used to suppress dust in operational areas. Progressive rehabilitation will be implemented as soon as practical. Management to reduce greenhouse emissions. Quantity of project emissions from fuel combustion not considered as a significant emitter.	Ongoing: During construction and operation.	No significant impact from air emissions.	
17	Aboriginal and Cultural Heritage	Disturbance to sites of Aboriginal significance	Two surveys have identified no sites of significance.	NA	No impact on significant Aboriginal heritage sites.	
18	Visual amenity	There is a low risk of impact on visual amenity as the project area is remote from any nearby sensitive premises or public transport routes.	Rehabilitation and mine closure measures implemented to ensure that the post mining landscape blends with the surrounding landscape.	During operation and closure.	No significant impact on visual amenity.	

Table 27: Environmental Controls

Document (What)	Control Function (How)	Application (When)	MP Section (Where)
Vegetation and Flora			**5.1**
EOP06 Clearing Procedure	Manage clearing process. Issue of permit, topsoil stockpiling.	When undertaking clearing	**Appendix 11**
EOP10 Internal Clearing Permit	Manage clearing process. Issue of permit, topsoil stockpiling.	When undertaking clearing	
Clearing Register	Documents progressive clearing against permits/approvals.	Ongoing through life of mine	
EOP12 Weed Procedure	Equipment hygiene, Restrict vehicle movement to designated areas.	When undertaking clearing	
ENVF04 Vehicle Hygiene Checklist	Records inspection of vehicles for soil, weeds and safety items.	As required	
Terrestrial Fauna			**5.2**
Malleefowl Sighting Form	Records sightings of Malleefowl and other significant fauna species.	As required	**Appendix 11**
EOP07 Malleefowl Conservation Procedure	Conservation of fauna, specific to the Malleefowl.	As required	
EOP02 Fauna Management Procedure	Conservation of fauna.	As required	
Fauna Interaction Register	Records fauna interactions on roads etc.	As required	
Acid Rock Drainage			**5.6**
EOP04 Waste Management Procedure	Documents the process for PAF mine waste management.	Ongoing through life of mine	Will be developed closer to implementation of this proposal.
Water			**5.4**
Water Monitoring	Documents the process for water monitoring.	Ongoing through life of mine	**Table 31**
Chemicals			**5.8**
EOP03 Hydrocarbon and Chemical Management Procedure	Documents the process to clean up localised spills.	Ongoing through life of mine	**Appendix 11**
EOP04 Waste Management Procedure	Regulates management of all wastes on site.	Ongoing through life of mine	

Document	Control Function	Application	MP Section
(What)	**(How)**	**(When)**	**(Where)**
Hazardous Materials Register	Records hazardous materials.	Ongoing through life of mine	**Appendix 11**
Incident/Spill Register	Records incidents or spills.	Ongoing through life of mine	
Dust			**5.9**
Dust Procedure	Documents the process for dust control.	Ongoing through life of mine	Will be created closer to implementation of this proposal.
Rehabilitation			**7.2**
EOP09 Rehabilitation Procedure	Documents the process for rehabilitation.	Ongoing through life of mine	**Appendix 11**
EOP11 Topsoil Management Procedure	Documents the process for topsoil management.	Ongoing through life of mine	
EOP08 Vegetation Management Procedure	Documents the process for vegetation management.	Ongoing through life of mine	

5.1 Vegetation Clearing

A Purpose clearing permit application required under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* is submitted with this Mining Proposal as a separate document. For completeness, a copy is included in **Appendix 3**.

Clearing will be kept to the minimum required to undertake site operations. Polaris has an internal Clearing Procedure to cover all clearing activities during the mining phase of the project which is included in **Appendix 10**. The procedure involves:

- Internal application to clear with management signoff.
- Induction/training of personnel on the importance of minimising clearing.
- Marking out the extent of clearing and exclusion areas.
- Supervision of clearing activity.

The extent of clearing will be reported in the Annual Environmental Reporting (AER) process.

Clearing of vegetation in WA is assessed against 10 Clearing Principles outlined in Schedule 5 of the *Environmental Protection Act 1986*. The principles address four main environmental areas of biodiversity significance, land degradation, conservation estate and water quality (both surface and groundwater). **Table 28** details how Polaris has addressed the 10 Clearing Principle's and established measures to ensure potential impacts from clearing can be managed to avoid serious degradation to vegetation systems or habitats.

Commitment 4: Clearing of vegetation will be progressive and on an as-needed basis.

Table 28: Clearing Principles

No.	Principle Native vegetation should not be cleared if-	Existing Environment	Potential Impact	Management Action	Outcome
Biodiversity Significance					
1.	it comprises a high level of biological diversity.	Vegetation communities and flora species are well represented in the wider region.	The project will result in only minor local biodiversity loss (by reduction in the gene pool of individuals cleared).	Seed collection in advance of clearing to return local provenance genetic material in mine rehabilitation.	Project is not at variance with this principle.
2.	it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to WA.	Fauna surveys have not identified significant fauna habitat unique to the project area.	The project will result in only minor local habitat loss in a region otherwise covered in native vegetation.	Rehabilitation will return habitat to the majority of the project area.	Project is not at variance with this principle.
3.	it includes, or is necessary for the continued existence of, rare flora.	No Declared Rare Flora (DRF) has been located in the project area.	No impact to DRF.	No specific management measures necessary for this principle.	Project is not at variance with this principle.
4.	it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	No Threatened Ecological Community (TEC) is located in the project area.	No impact to TEC.	No specific management measures necessary for this principle.	Project is not at variance with this principle.
5.	it is significant as a remnant of native vegetation in an area that has been extensively cleared.	The region is predominantly covered by native vegetation.	No remnant vegetation communities in the project area.	No specific management measures necessary for this principle.	Project is not at variance with this principle.
6.	it is growing in, or in association with, an environment associated with a watercourse or wetland.	There are no permanent watercourses or wetlands in the region.	The project has been designed to avoid local drainage lines and watercourses.	No specific management measures necessary for this principle.	Project is not at variance with this principle.
Land Degradation					
7.	the clearing of vegetation is likely to cause appreciable land degradation.	The region is predominantly covered by native vegetation.	Localised clearing associated with the project, in a region extensively covered by native vegetation, is unlikely to cause appreciable land degradation.	Clearing procedures are to be implemented as routine controls.	Project is not at variance with this principle.
Conservation Estate					
8.	the clearing of vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The nearest gazetted conservation area (Mt Manning Nature Reserve) is approximately 20 km to the northwest and will not be impacted by the project.	The project is located in a proposed conservation and mining reserve – not yet gazetted.	Clearing procedures are to be implemented as routine controls.	Project is not at variance with this principle.
Ground and Surface Water Quality					
9.	the clearing of vegetation is likely to cause deterioration in the quality of surface or underground water.	There are no permanent surface water bodies in the vicinity. Short duration surface water flows follow intermittent heavy rainfall. Groundwater is naturally saline, with salt levels approximately that of seawater. Groundwater is approximately 70 m below ground level.	Turbid water from intense rainfall events may enter local watercourses. Saline groundwater will not be discharged to local watercourses.	Detention basins containing sediment off disturbed areas prior to discharge to local waterways.	Project is not at variance with this principle.
10.	clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	The project is located in an arid climate, on a local topographic high.	The project is unlikely to cause or exacerbate the incidence of flooding.	Stormwater control measures to be put in place if found to require management.	Project is not at variance with this principle.

5.2 Flora, Fauna and Ecosystem

Vegetation management is important for the following reasons:

1. **Reduce vegetation clearing** to as small as necessary to undertake site activities. This minimises disturbance to surrounding vegetation and also reduces the area subsequently requiring rehabilitation.
2. **Manage topsoil** removal, stockpiling and return operations. Topsoil is a critical factor in achieving successful rehabilitation of disturbed areas, as it contains the majority of seeds, soil micro-organisms, organic matter and nutrients.
3. **Control weed infestations** that have the potential to take over and smother native plant regeneration or rehabilitation.

Actions to be undertaken to manage vegetation and flora are outlined in **Table 29**.

Table 29: Vegetation Management

Action	Who	When
Clearing activities		
Submit an internal clearing permit prior to conducting clearing.	All personnel	Prior to clearing
Comply with the clearing procedure and any permit conditions.	All personnel	During clearing
Clearing permits are to conform to approved clearing areas	Environment Department	Ongoing

The site Environment Department will monitor the site for the following:

- Reconcile that areas approved for clearing conform to surveyed boundaries of cleared areas.
- Visually inspect that topsoil and vegetation stockpiles conform to approved locations and design.
- Inspect for weed infestations and success of any control actions (**Appendix 10**).

Table 30 documents actions to be implemented for identified non compliances.

Table 30: Corrective Actions

Subject	Issue	Actions
Vegetation clearing and Priority Flora	Clearing native vegetation outside designated area. Damage to significant flora outside designated area.	Fill out the environmental incident report form, conduct investigation and implement corrective actions. Reinstate fencing, barriers or flagging to delineate clearing boundaries. Place removed vegetation over cleared area to provide erosion control and seed stock. Include area in annual rehabilitation program. Report to DMP / DEC immediately (as soon as practically possible).
Vegetation management	Fire	Follow fire management procedures. Fill out the environmental incident report form. Report the fire to DMP / DEC immediately (as soon as practically possible).
Weeds	Weed species previously not recorded in the area.	Record location of the weed species and implement control measures.
Altered drainage patterns	High sediment runoff, erosion and decline in the health of vegetation in and around the project area.	Implement corrective drainage measures. Include area of disturbance into annual rehabilitation program.

Native Fauna

Some localised fauna impact from vegetation clearing and mine activities will occur but is not anticipated to have significant impacts to fauna populations on a regional scale. The fauna present in the project area is mostly wide-ranging with no species recorded that is unique to the project area (refer to Fauna Procedure, **Appendix 10**).

In order to minimise terrestrial fauna impacts the following measures will be implemented.

- Avoid unnecessary clearing beyond that required for the project.
- Retain cleared vegetation and topsoil for use in rehabilitation.
- Progressive clearing to ensure fauna can migrate to new areas.
- Progressively rehabilitate areas when they are completed.
- Induct all personnel on important fauna constraints and factors at the site.
- Reduce vehicle speed on roads and tracks.
- Exclude firearms and pets from the project area.
- Manage rubbish disposal to discourage scavenging by native and feral animals.
- Routine site inspections so problems can be identified and remedied at an early stage.
- Create fauna egress points in water storage dams by constructing shallow sloped sides or install mats.

The site Environment Department will conduct 6 monthly audits of the site to assess compliance with this plan. This will involve providing a brief report to the Mine and Environmental Manager summarising data on:

- Recorded sightings of significant and feral fauna.
- Log of fauna trapped in trenches.

- Records of injured or killed fauna in the Fauna Interactions Register.

Feral fauna will be addressed in a Feral Animal Management Program.

The AER will include a summary of all environmental incidents recorded for the period and documented remedial actions. This includes incidents associated with fauna.

5.3 Topsoil and Soil Profiles

Topsoil is a valuable resource in achieving successful rehabilitation of disturbed areas, as it contains the majority of seeds, soil micro-organisms, organic matter and nutrients.

There is no universal definition of topsoil depth. Seed store is usually concentrated in the top few centimetres. Organic matter and mycorrhizal fungi vary in depth depending on soil profile and type. It is generally accepted that the majority of topsoil value is contained within the top 100 mm. Removing a layer significantly greater than this increases dilution of topsoil with underlying subsoil. In practice, earthmoving equipment used to strip topsoil largely defines topsoil depth. Large earthmoving equipment routinely used in mining operations is poorly suited to stripping layers of less than 100-150 mm.

Use of fresh topsoil is regarded as the optimum method of topsoil management. However, in green field projects when initial clearing and development is occurring, no finished areas are available for progressive rehabilitation. In these cases, topsoil is stored in stockpiles. Topsoil is retrieved from these stockpiles and respread when rehabilitation is commenced.

The time topsoil is stored also affects its value. It is generally accepted that topsoil value declines with increasing storage time, with storage times significantly over 12 months having measureable effects on topsoil.

Topsoil depth for Carina Extended will be determined based on available topsoil during clearing.

As a green field site, clearing and topsoil stripping to develop project components will generally occur before areas are completed and progressive rehabilitation can commence. For some components, such as the haul road and ROM, these areas will remain open for the life of the project. Topsoil stripped from these areas during construction and stockpiled is expected to have reduced value resulting from long term storage. Supplementary seeding and fertiliser application can be an important component in the rehabilitation plan, intended to offset reduction in topsoil viability from extended storage.

Topsoil samples distributed over the waste landform and mine footprints were analysed for a range of physical and chemical properties (**Table 10**). Parameters tested were pH, conductivity, stability (Emerson test), texture (particle size distribution) and chemistry (cation exchange capacity, CEC). Results are discussed in **Section 3.4**. These tests have not identified any significant constraints in the topsoil that may affect rehabilitation performance.

5.4 Water

Water monitoring is to be undertaken in accordance with licence conditions. Water monitoring actions are outlined in **Table 31**.

Table 31: Water Monitoring

Action	Who	When
Meter Readings		
Reading water meters is required to determine water abstraction and usage. Meter readings are to be entered into the water production spreadsheet.	Environment Department	monthly
Water Levels		
Check that the water level probe is operational.	Environment Department	quarterly
Lower the probe into the bore until contact with the water is confirmed by both the audible beep and/or visual red light.	Environment Department	
Read the depth level to the top of casing (TOC) to within the nearest centimetre. Use of previous monitoring data will help to estimate the point of contact.	Environment Department	
Ensure the 'stick-up' distance – the height of the TOC above ground level, is recorded for the bore. This allows measured results to be calibrated to 'ground levels'.	Environment Department	
Note should be made if the bore is dry.	Environment Department	
Groundwater (bore) Samples		
Purge bores according to AS 5667.1.1998.	Environment Department	quarterly
Take sample with bailer. Rinse bailer with RO water between samples	Environment Department	
Place sample in plastic container and record Electrical Conductivity and pH.	Environment Department	
Ensure that the bore cap is replaced.	Environment Department	
Send samples to external laboratory for analysis.	Environment Department	
On receipt of data from laboratory, enter data into the water production spreadsheet.	Environment Department	

Table 32 provides targets and performance criteria to be used to track progress in achieving water monitoring objectives.

Table 32: Water Monitoring Targets

Objectives	Target	Performance
Comply with all licence conditions.	Comply with all licence / permit water monitoring requirements.	All licence requirements met.
Assess environmental effects of activities by regular monitoring and review of performance.	Record all monitoring results and assess against standards / limits set.	All results within licence limits.
	Review monitoring results and provide regular internal reports to site managers.	Regular internal water monitoring reports circulated.

The site Environment Department will conduct 6 monthly reviews. This will involve providing a brief report to the Mine Manager and Environmental Manager summarising data on:

- Water abstraction against licence limit.
- Water quality parameters against licence limits.
- Commentary on important findings and notes.

The AER will include a summary of water management results.

5.5 Waste Products

Carina Extended is to be operated as a satellite pit to the Carina project. No separate waste product management is required for Carina Extended. All domestic and solid waste will be disposed of at existing facilities at Carina.

Waste oil from onsite servicing of mine equipment will be taken to bulk tanks at Carina for recycling. Regular routine site inspections at Carina Extended will satisfy compliance against all approvals, permit and licenses will also include waste inspection.

5.6 Waste Rock and Tailings

The majority of mine waste is benign. A very small proportion of mine waste will be potentially acid forming. A final decision is yet to be made on whether this material will be encapsulated in the waste landform.

Rehabilitation of the waste landform is addressed in **Section 4.2.2.**

Waste characterisation and potential acid formation (PAF) from waste types has been described in detail in **Section 3.3**. With only a very small quantity of PAF waste to be excavated, encapsulation in the waste landform is considered a sufficient management measure for this factor.

Potential impacts from acid rock drainage are:

- Acidic runoff or drainage from waste landforms impacting surrounding soil and vegetation.
- Acidic drainage from pit walls impacting water quality in pit void lakes and groundwater.
- Increased mobilisation of metals in acidic water.
- Rehabilitation failure due to acidic soil or water.

Actions to be undertaken to manage acid rock are outlined in **Table 33**.

Table 34 provides targets and performance criteria to be used to track progress in achieving acid rock management objectives.

Table 33: ARD

Action	Who	When
Induction and Training		
All personnel will be inducted on the significance of acid rock in the project area and management actions established to reduce impacts.	All personnel	Commencement on site
Mine plan to map high sulphur waste zones within the open pit to enable appropriate management of this waste when it is intersected.	Mine Engineer	Commencement on site
Make a final decision of the PAF waste encapsulation location early in the mine development, to enable PAF waste to be deposited in this location when it is excavated.	Mine Engineer	Commencement of waste landform construction
Construct groundwater monitoring bores around open pit and waste landform to monitor groundwater quality.	Environment Department	Early in open pit development

Table 34: Performance Criteria

Objectives	Target	Performance
To avoid or contain potential impacts of ARD from mine waste and the pit void.	Establish encapsulation location early in the mine development process to allow appropriate management of problematic material when encountered.	No dumping of PAF material on external faces of waste landform.
	Groundwater containing increased acidic or metalliferous concentrations contained within the pit void / mine perimeter and not impact on surrounding soil, vegetation and groundwater.	Water quality monitoring within set limits and having no detrimental effect to off-site. No impact to surrounding vegetation and soil from acid drainage.
To recognise and appropriately manage any potentially acid forming materials during mining operations.	Map PAF material in the orebody prior to mining to identify zones of problematic material.	No dumping of PAF material on external faces of waste landform.

The site Environment Department will conduct surface and ground water monitoring as specified in the site's operating license. It is anticipated this will be on a quarterly basis.

The site Environment Department will conduct 6 monthly audits on operation of the encapsulation cell and the waste landform to ensure no inappropriate dumping of PAF waste has occurred.

In the event that non-compliance with elements of this procedure is identified, corrective actions will be developed based on the extent and severity of the exceedence. The process used on site to record, track and resolve non compliances is the Incident or Spill Register, for significant issues that require formal investigation and corrective actions.

The AER will include a summary of all environmental incidents recorded for the period and documented remedial actions. This includes incidents associated with PAF material.

5.7 Hydrocarbons

Carina Extended is to be operated as a satellite pit to the Carina project. No separate hydrocarbon storage facility is required for Carina Extended. Daily servicing and refuelling of mine equipment will be via a service truck from Carina.

No separate fuel storage facilities will be constructed at Carina Extended. Spills from refuelling activities will be managed according to the spill procedure shown in (**Appendix 10).**

5.8 Dangerous Goods and Hazardous Substances

Carina Extended is to be operated as a satellite pit to the Carina project. No separate dangerous goods storage is required for Carina Extended. The explosives magazine at Carina will be used to supply explosives for Carina Extended. The bulk fuel diesel storage tanks at Carina will be used to supply the mining fleet at Carina Extended.

5.9 Atmospheric Pollution and Noise

Dust

The project's remote location relative to sensitive residential receptors indicates dust is considered not likely to cause human health or amenity issues to neighbouring communities or residents.

Common dust suppression measures and management practises used in the mining industry in WA are expected to be sufficient to control environmental impacts to acceptable levels. These measures include:

- Disturbed areas progressively rehabilitated, to reduce exposed area for dust generation.
- Water trucks water unsealed, regularly trafficked areas such as internal roads and work areas.
- Limit vehicle speeds and restrict access to some areas.

Polaris will develop a Dust Procedure to manage dust at Carina Extended.

Dust monitoring occurs for Particulate Matter 10 micron or less (PM_{10}) and Total Suspended Particulates (TSP) using a continuous air sampling unit, the 'E-Sampler' monitoring unit at Carina. This is considered sufficient to monitor dust generation from mining activities. It will be determined through regulator discussions whether dust monitoring is relevant to Carina Extended.

Greenhouse Gas Emissions (GGE)

Greenhouse gas emissions will be produced from burning diesel fuel for mine equipment and ore haulage. Estimates of fuel usage from similar mining operations are 5,000 kL/pa for mining equipment and 2,000 kL/pa for ore haulage.

Management practices commonly used in the mining industry include regular maintenance and servicing of all diesel engines. This reduces excessive emissions from machinery not operating at optimum levels. No other specific management measures are proposed for this factor.

Noise

Southern Cross, the nearest town site, is located approximately 100 km to the south west of the project area. Due to the significant distance of noise generating activities to any noise sensitive premises, it is not considered likely mine activities will have a significant noise impact. Given the low risk of impact to this factor, it is not considered quantitative assessment or modelling of noise impacts is required. No specific noise management measures are considered to be required.

5.10 Routine Inspection

Regular routine site inspections will be carried out by the site Environment Department to ensure compliance with all environmental approvals. An Inspection Checklist/Procedure will be developed once all approvals have been gained, tailored to Carina Extended.

6. SOCIAL IMPACTS

WA's economy is heavily dependent on mineral resource projects, their ability to provide direct employment over a sustained period and flow on benefits in infrastructure construction and supply of goods and services.

The Carina Extended project adds to the regional resource base of the existing Carina operation. This extends the predicted mine life of the combined project which will have the following benefits:

- Investment of capital into the WA economy.
- Anticipated revenue from the project is estimated at over $400 million.
- Continued direct local employment with an operational workforce between 150 - 200.
- Indirect benefits from demand for goods and services from local communities.
- Additional Commonwealth and State Government revenues through additional royalties, taxes and other charges.
- Increased export value of WA iron ore to international customers.

6.1 Heritage

Two Traditional Owner groups have surveyed the Carina Extended tenement M77/1261 (Cecchi 2011; *unpublished* Mathieu 2012). No sites of significance were recorded.

6.2 Land Use and Community

The community groups identified for the project area for consultation are listed below.

Indigenous groups

- The Central West Goldfields People
- The Gubrun People
- The Kelamaia Kabu(d)n People
- Goldfields Land and Sea Council

Special Interest Groups

- Conservation Council
- Wilderness Society
- Wildflower Society

All relevant groups will be consulted where appropriate.

6.3 Workforce Induction and Training

The Carina Extended project is located in a region recognised for its environmental values. Priority species of flora and significant fauna occur in and around the project area.

A site specific induction will be developed for Carina Extended. As a satellite operation to Carina, the induction will incorporate some safety aspects used for Carina, as well as any necessary site specific aspects.

7. MINE CLOSURE

Guidelines for preparing Mine Closure Plans (June 2011) ("the guidelines") have been jointly prepared by DMP and EPA. In 2010, amendments to the *Mining Act 1978* require a Mine Closure Plan (MCP) to be submitted to DMP for approval as part of Mining Proposal applications received after 30 June 2011. The plan must be prepared in accordance with these guidelines.

For new proposals, such as Carina Extended, or major changes to an existing operation, the Preliminary MCP is to be provided as a separate document to the Mining Proposal.

A separate Preliminary MCP document is submitted with this Mining Proposal. However, for completeness of this document, salient parts of the Preliminary MCP are repeated in sections below.

7.1 Post Mining Land Use

Carina Extended is located on the former Jaurdi pastoral station, purchased by CALM in 1989. Government policy proposes to reserve the portion of the former pastoral station that contains Carina Extended as a conservation and mining reserve. No framework has yet been produced by Government on long term management of this reserve category.

During the life of mine, Polaris will consult with DEC and DMP on mine closure options. At present, the following principles are proposed for mine closure:

1. All mine infrastructure will be removed.
2. Haul road and access roads will be rehabilitated.
3. The waste landform will be rehabilitated.
4. The final landform will be rehabilitated to closely resemble its original and surrounding environment and natural landform.
5. The open pit will remain as a pit void and will be the only mine component that will be left 'un-rehabilitated'. An abandonment bund, to DMP specifications will be constructed around the pit to prevent vehicle access. It is anticipated a pit void lake will develop after mine closure.

7.2 Rehabilitation

Waste rock material from the Carina Extended pit will likely be placed into the waste rock landform. The proposed waste rock landform has a maximum volumetric capacity of 8.6 Mm3 with a footprint of 53.5 ha and a maximum total height of 22 m.

A summary of key points on waste landform design is provided below.

1. The waste landform will be shaped to form a stable structure, consistent with the surrounding environment, or as close to its pre-mining state as possible.
2. A conceptual design for the final waste landform is provided in **Section 4.2.2**.
3. Construct final batter slopes to less than 20 degrees, separated by a back sloping 10 metre wide berm between the lifts, to maximise retention of water.

4. Construct 1 metre high bunds on the crown and leading edge of the berm to prevent water flowing down the batter slopes.
5. Infrequent cyclonic or very intense rainfall events have the potential to exceed the design capacity of retention structures. This results in overtopping/breakout, which can cause considerable erosion in locations where access to undertake remedial work is often difficult. The stormwater design is to include an 'overflow' option, by directing peak storm flows off the crown and berm using the landform ramps, which channel this water to the open pit. In this way, very intense rainfall is shed off the landform and fully contained in the open pit. Any subsequent remedial/maintenance work on the ramps is easily implemented. The pulse of fresh water provided to the pit lake from these events has the additional benefit of reversing the gradual salinisation due to evaporative concentration.
6. Shape a concave surface on the top of the waste landform to promote water retention and infiltration rather than water shedding.
7. Spread stockpiled vegetation on reshaped surfaces to provide erosion protection and fauna habitat.
8. Spread available topsoil on reshaped surfaces to provide seed source and microbial inoculum.
9. Deep rip surfaces on contour to assist with water infiltration and provide a seed bed (with the exception of the encapsulation cell).
10. Apply seed and fertiliser to the newly ripped surfaces.

A Rehabilitation Plan will describe rehabilitation processes and actions needed to undertake progressive and final mine rehabilitation. The strategies are designed to ensure maintenance free rehabilitation over the long term. The Rehabilitation Plan is an adaptive document. Results of any research trials or surveys will be incorporated into revisions of the document so that the rehabilitation prescription will evolve during the life of mine.

Rehabilitation will be progressive across the Carina Extended project.

Polaris will implement the following commitment –

Commitment 5: to undertake progressive rehabilitation during the life of mine.

7.2.1 Clearing

One of the first activities undertaken on new projects is clearing for project works. Clearing procedures are included in **Appendix 10**. Where possible, seed collection from cleared vegetation is to occur, for use in rehabilitation.

7.2.2 Topsoil

See **Section 5.3** for topsoil information.

7.2.3 Waste landform design

The waste landform and open pit are the two dominant landscape features that remain after mining, essentially in perpetuity.

Preliminary design of the mine waste landform is provided in **Section 4.2.2**. Initial rehabilitation prescription is provided in **Section 7.2.7**. The preliminary design has incorporated standard industry practices and used conservative final batter angles of the waste landform.

7.2.4 Topsoil and vegetation return

Once primary earthworks on the waste landform are completed, available topsoil is respread over the waste landform. Available stockpiles of vegetation are then pushed over batters of the waste landform to provide seed, mulch and fauna habitat. In some locations, collections of timber, vegetation and large rocks may be pushed together in piles, to provide a diversity of habitat types.

7.2.5 Water management

Water management earthworks are a key component of waste landform rehabilitation. Infrequent cyclonic or very intense rainfall events have the potential to exceed design capacity of water retention structures. This results in overtopping/breakout of structures, which can cause considerable erosion on waste landforms, often in locations where access to undertake remedial work is difficult. Stormwater design is to include an 'overflow' option, by directing peak storm flows off the crown and berm to the landform ramps, which then channel this water to the open pit. In this way, very intense rainfall is shed off the landform and fully contained in the open pit. Easy vehicle access to ramps allows maintenance work as required. The pulse of fresh water provided to the pit lake from these events has the additional benefit of reversing gradual salinisation due to evaporative concentration.

7.2.6 Abandonment bund

The abandonment bund is to be constructed using competent (rocky) mine waste. Trucks are to end tip loads of mine waste along the designated circumference from the open pit in a continuous barrier a minimum of 2 m high.

Openings in the abandonment bund are to be left for access during the life of mine, providing haul road and access track entry to the open pit. A stockpile of mine waste is to be left at each opening, so that at mine closure, a front end loader can complete the abandonment bund.

The abandonment bund does not cross natural drainage lines, so creating a permeable section using large (1 m diameter) rocks to allow water to flow through the barrier while still preventing vehicle access is not required.

7.2.7 Revegetation

After primary earthworks have been completed to reshape the waste landform and construct major water management features, the revegetation process can be implemented. This is to be scheduled just prior to or at the onset of seasonal rains. This is generally between May and June. Steps in the revegetation process are:

1. Ripping waste landforms on contour at approximately 3 m spacing
2. Application of local native seed mix at rates between 5–10 kg/ha
3. Application of phosphorous and trace elements fertiliser at a rate of 100kg/ha if deemed necessary
4. Supplementary planting of seedlings (optional).

7.2.8 Ripping

The primary earthworks to reshape waste landforms effectively break any compaction from the placement phase, so ripping is not required to break compacted areas. The primary function of ripping waste landforms is to provide large furrows on slopes, to resist surface water flow, increase infiltration and provide a seed bed.

To this end, wide furrows created by wide (winged) tines are preferable to narrow rip lines. The latter are created by conventional bulldozer tines, which are designed to rip rock or hard compacted surfaces rather than act as an agricultural plough. **Figure 26** shows wings fitted to the shank of a bulldozer tine to expand the width of the furrow (**Figure 27**). This machine is also equipped with a trommel, which applies seed and fertilizer during ripping.

7.2.9 Seed mix

The vegetation survey data provided in Mattiske (2011) has been used to select rehabilitation species for seed collection (**Table 38**, **Appendix 10**). *Acacia, Allocasuarina, Atriplex, Eucalyptus* and *Maireana* genera have been selected as the dominant components, due to their ease of collecting in significant quantities and their track record of successful establishment in mine site rehabilitation.

Research trials will be commenced to determine the practicality of collecting sufficient quantity of seed, its viability if applied as direct seed or whether greater success is achieved by germinating seed in nurseries and planting out as tube stock.

Figure 26: Winged Tines on Cat D8

Figure 27: Winged Tine Furrows

7.2.10 Fertiliser

Waste landforms created from excavated material are generally nutrient poor. Most topsoil used in the rehabilitation process has been stored, often for a number of years. The rehabilitation seed mix uses a number of nitrogen fixing species, so application of nitrogenous fertiliser is generally not required. High nitrogen fertilisers also have a disadvantage in promoting rapid weed growth, if these species are present. Nitrogen applied as nitrate or urea is also subject to loss by uptake from soil microorganisms or volatilisation, before plants are developed enough to access this resource.

If fertiliser application is required a phosphorous, potassium and trace elements fertiliser will be applied to rehabilitated areas. These elements are rapidly fixed to clay minerals and iron in

the soil, so remain on the waste landform to be used by developing vegetation. An application rate of 100 Kg/ha is proposed.

7.2.11 Planting

A number of native species are difficult to establish in rehabilitated areas. This may be due to a number of reasons including:

- Seed is difficult to collect in any quantity, does not set on a regular basis, has low viability or cannot be easily germinated.
- Species naturally propagate from bulbs or rhizomes, rather than seed.
- Other factors (eg; mycorrhizal fungi, parasitic host) are absent in rehabilitated environment.

Successful return of these 'recalcitrant' species may be better achieved by propagating these plants in a nursery and planting seedlings on waste landforms.

7.2.12 Grazing protection

The project area is located in a former pastoral station, purchased by CALM (now DEC) in 1989. Stock have been removed from the station, however a small number of cattle remain. Other introduced grazing animals, such as camels have also been recorded, although also in low numbers.

The low numbers of large grazing animals are not anticipated to have such a significant impact to warrant fencing waste landforms. Fencing to exclude rabbits is problematic. The small mesh size required to exclude all rabbits is not robust and prone to damage by larger animals (kangaroos, cattle etc). Rabbits then enter through damaged sections. Rabbits can also burrow under fences, requiring skirts to be fitted. This substantially increases the cost and maintenance of fencing. The extent of grazing impact will be monitored in rehabilitation areas. If significant, advice will be sought from DEC and DAF on alternative control actions which may include baiting programs.

7.2.13 Weed control

Mattiske (Sept 2008) recorded only two weed species in the exploration tenement, *Erodium cicutarium* and *Erodium botrys.* These species are common on farmlands, pastures and along roadsides, especially in loamy soils. Surveys to date have not identified either of these weeds in the project area. However, draft weed management procedures can be found in **Appendix 10**, for vehicle inspections and periodic site inspections for weed infestations.

7.2.14 Research trials

When undertaken, research trials will focus on the following areas:

a) Species selection from local vegetation communities.

b) Propagation methods.

Results of rehabilitation research trials will be reported in the AER.

7.2.15 Monitoring

Completion criteria are agreed standards to be achieved on particular aspects of the project. Progressive assessment against these criteria demonstrates the relative success of rehabilitation in achieving desired outcomes.

While the overall objective of the closure plan is to establish safe, stable final landforms, with a preference for self-sustaining vegetation, similar to that in the surrounding landscape, specific completion criteria will be developed to address aspects of the site including:

- Public safety
- Geotechnical stability
- Water quality
- Chemical stability
- Revegetation.

Completion criteria will be developed in consultation with stakeholders, to define measurable goals for rehabilitation and closure. Agreed criteria and detailed actions necessary to satisfy the criteria will be described in subsequent versions of this document.

Agreed criteria will include progressive targets, to provide milestones on whether final criteria are likely to be achieved. Assessments over time plots development of rehabilitated areas against reference (analogue) sites and also the defined target score. Targets will be periodically reviewed in liaison with regulatory authorities, usually through the annual reporting mechanisms required in statutory approvals.

Guidelines published by ANZMEC (2000) for completion criteria state they should be:

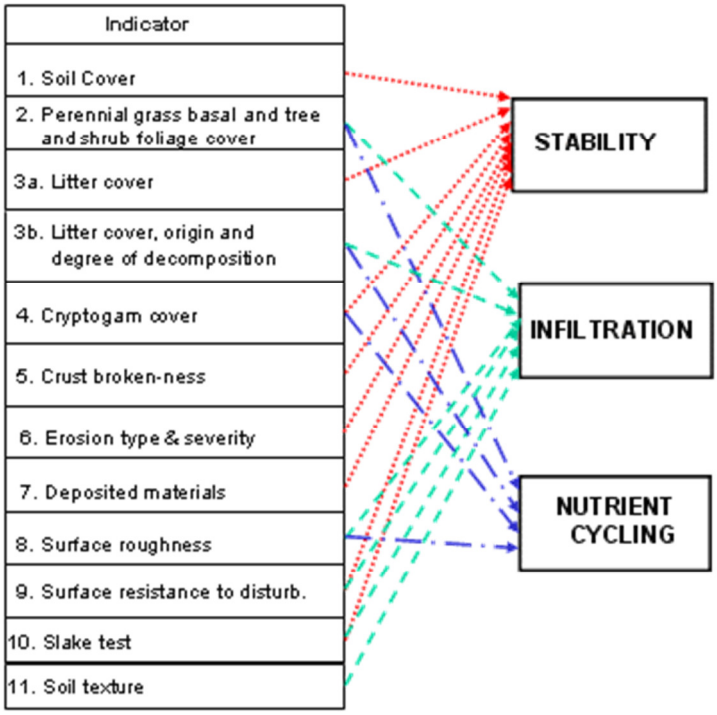
1. Specific enough to reflect the unique set of environmental, social and economic circumstances at the site.
2. Flexible enough to adapt to changing circumstances without compromising overall objectives.
3. Include indicators suitable for demonstrating that rehabilitation trends are heading in the right direction.
4. Undergo periodic review resulting in modification if required due to changed circumstances or improved knowledge.
5. Based on targeted research which results in more informed decisions.

The proposed mechanism for monitoring and assessing rehabilitation success will be based on the Ecosystem Function Analysis (EFA) methodology. EFA will be undertaken on rehabilitated areas periodically through the life of mine.

Outcomes will be incorporated into subsequent reviews of the Rehabilitation Plan. The EFA is a multi-factorial assessment method, conducted on both soil and vegetation criteria. For soil, various indices are derived from a list of assessment criteria. The indices include soil stability,

infiltration/runoff and nutrient cycling status (**Figure 28**). Criteria used to assess habitat complexity are shown in **Figure 29**. Repeated assessments plot development of rehabilitated areas against analogue sites and also defined interim or final completion targets.

Figure 28: Soil Indices



Source: Tongway and Hindley (2004)

Figure 29: Habitat Complexity Data Sheet

Site: _____ Date: _____

Transect: _____ Observer: _____

Structure	Score				Assigned Score:
	0	1	2	3	
Tree Canopy Cover (%)	0	<30	30-70	>70	
Shrub Canopy Cover (%)	0	<30	30-70	>70	
Ground Herbage	Sparse <0.5m	Sparse >0.5m	Dense <0.5m	Dense >0.5m	
Logs, Rocks, Debris, etc (%)	0	<30	30-70	>70	
Soil Moisture	Dry	Moist	Permanent Water Adjacent	Water Logged	
				TOTAL SCORE:	

EFA is a monitoring procedure that establishes how well an ecosystem works as a biophysical system. The conceptual framework was published in Ludwig et. al. (1997). It uses simple, visual, rapidly assessed indicators that focus on soil surface processes. As such it differs from conventional monitoring that typically records the presence and/or abundance of selected biota. It is made up of three modules:

- landscape function analysis (LFA)
- vegetation composition and dynamics
- habitat complexity.

EFA is designed for repeated use so that development, or degradation, of a site can be assessed over time. It includes an analytical process to examine trajectory of the ecosystem being monitored and to use this information to decide if the site is converging on a target level, or needs further work to ensure ultimate success.

7.2.16 Targets and performance

Polaris proposes to use the EFA methodology in assessing rehabilitation success. Initial completion criteria, objectives and interim targets are proposed in **Table 35**. Further consultation with stakeholders will refine these targets through the life of mine. The interim targets will be reviewed against progressive rehabilitation results, to establish final closure targets in the Final Mine Closure Plan.

Table 35: Completion Criteria and Initial Targets

Criteria	Objective	Initial Targets
Safety, stability, and sustainability	The overall health and safety of humans, stability of soils and landforms, long-term sustainability for agreed land uses.	Safety and abandonment structures in place.
Soils	Soil profiles and structures must ensure landform stability.	Rehabilitated waste landforms achieving defined scores/indices. Interim targets to be defined in subsequent reviews of the document.
Off-site impacts	Significant adverse off-site impacts must be avoided.	No off site impacts recorded
Pollution	Pollutants due to chemical spillage, excavation of substrates or changes to hydrology (e.g. acid drainage) avoided or managed within rehabilitated areas as required.	Monitoring showing that pollution levels are within parameters set by Regulatory agencies.
Hydrology	If there are major changes to hydrology as a result of mining operations, establish criteria that measure flows and availability of surface and groundwater to receiving environments.	Photographic record showing flow in all creek systems. Temporary creek diversions rehabilitated and original pathway restored.
Resilient and self-sustaining vegetation	This is a frequently used completion criteria that is linked to other criteria listed below:	
• Species diversity	Specified targets based on site data or analogue plots. Setting appropriate targets requires knowledge of the proportion of plant species that are unlikely to recruit or can be propagated from seed in the short term.	Rehabilitated waste landforms achieving defined scores/indices. First trend target of 30% reference site after 3 years is proposed. Further targets to be defined in subsequent reviews of the document.
• Abundance and cover	Sustainable rehabilitation requires vegetation cover to be sufficient to stabilise landforms and exclude weeds. In most cases, completion criteria are based on relative cover (% of area) occupied by native plants, in permanent plots or transects. Permanent photographic-monitoring points should also be established.	Rehabilitated waste landforms achieving defined scores/indices. First trend target of 30% plot cover after 3 years is proposed. Further targets to be defined in subsequent reviews of the document. Permanent photographic monitoring points installed.
• Weed management	Effective weed management requires demonstration that: (a) the relative cover of minor weeds is low (b) major weeds capable of becoming dominant at the expense of native plants are absent.	Monitoring and photographic records showing weed species on site limited to minor infestations (<5% cover).
Pest species	Control of introduced animal species that can have a major impact on native plants and animals. Animal grazing also requires effective management in rehabilitated areas.	Declared pest species controlled over rehabilitated areas. Installation of fencing around waste landforms if required.

7.2.17 Bond review

Rehabilitation bond will be established with the Department of Mines and Petroleum (DMP) through the Mining Proposal process, in accordance with the department's bond policy (DMP 2009). **Table 36** from the bond policy shows the current minimum bond rates applicable to mine components and **Table 37** shows progressive bond reduction as rehabilitation is undertaken. During the life of mine, as progressive rehabilitation is undertaken and reported in AER documents, progressive partial return of bonds will be requested as detailed in the policy.

Table 36: Minimum Bond Rates

Rate	Description	Rate/ha (Min)
1	Tailings Storage Facilities, including in pit disposal, Heap/Vat leach, Evaporation dams, Turkey Nest Dams, High risk waste dump (sulphides present, highly erodible pr >25m high)	$18,000*
2	Low risk Waste dumps, ROM pads, low grade oxide stockpiles, plant sites, workshops and process water dams.	$15,000*
3	Camp Sites, Strip Mining (backfilled mining voids), hyper saline pipelines (>15,000 TDS), causeways, haul roads, sewage ponds and landfill.	$7,500
4	Roads and access tracks, "Fresh" water pipelines, laydown areas, borrow pits and airstrips.	$4,500

* The Bond rates will be determined on a case-by-case basis.
Rated are effective 1 Jan 2012.

Table 37: Progressive Bond Reduction

Stage	Action	Completion Criteria Met	Reduction Rates
1	Primary Earthworks - Reshaping - Drainage	Structure stable. Erosion controlled. Water run-off managed effectively.	50% total
2	Finishing Earthworks - Topsoil spread - Deep ripping	Appropriate topsoil cover. Adequate, contour ripping. Demonstrated stability and erosion control.	30% total
3	Revegetation - Seeding - Planting	Vegetation established but not demonstrated to be self-sustaining. Weed control program commenced. Grazing control commenced.	20% total
4	Relinquishment	All actions complete All criteria met.	Bond retired

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APPENDICES

Appendix 1: EPBC Protected Matters Search Tool and Nature Map Results

Appendix 2: Vegetation Map-A0

Appendix 3: Purpose Clearing Permit Application

Appendix 4: Botanical Reports

Appendix 5: Vertebrate Survey Reports

Appendix 6: Invertebrate Survey Reports

Appendix 7: Ninox 2009 Report

Appendix 8: Subterranean Fauna Report

Appendix 9: ARD Laboratory Analysis

Appendix 10: Draft Procedures etc.

Table 38: Species List for Rehabilitation

SPECIES	VEGETATION COMMUNITY						
	W1	W2	W13	W22	S2	S6	S30
Acacia burkittii	x	x	x	x	x	x	x
Acacia colletioides	x	x		x			
Acacia erinacea	x	x		x	x	x	
Acacia jennerae	x	x					
Acacia merrallii		x					
Acacia prainii	x	x					
Acacia quadrimarginea				x		x	
Acacia ?*ramulosa* var. *ramulosa*					x		
Acacia sibina	x				x		x
Acacia tetragonophylla	x	x		x	x	x	x
Acacia sp. novel (KR054)		x		x			
Acacia sp.	x						
Allocasuarina acutivalvis subsp. *acutivalvis*	x	x			x	x	x
Allocasuarina campestris				x	x		
Alyxia buxifolia	x	x	x	x	x	x	x
Amphipogon caricinus	x	x		x	x	x	x
Amyema benthamii	x						
Amyema miquelii	x	x				x	
Arabidella chrysodema		x					
Asteraceae sp.	x	x				x	
Atriplex nummularia	x	x		x			
Atriplex vesicaria	x	x		x			
Austrostipa elegantissima	x	x	x	x	x	x	x
Austrostipa platychaeta	x					x	
Austrostipa trichophylla						x	
Baeckea elderiana					x	x	x
Banksia arborea (P4)	x				x	x	x
Beyeria sulcata var. *sulcata*	x	x				x	
Brachychiton gregorii	x			x	x	x	x
Calycopeplus paucifolius					x	x	
Casuarina pauper	x						
**Centaurea melitensis*		x					
Cheilanthes sieberi	x				x		
Cheilanthes sp.	x				x	x	
Comesperma volubile	x				x	x	
Cyanicula amplexans	x						
Daucus glochidiatus		x					
Daviesia purpurascens (P4)						x	
Dianella revoluta	x				x	x	x
Dodonaea lobulata	x					x	
Dodonaea microzyga var. *acrolobata*	x	x			x	x	
Dodonaea pinifolia					x		
Dodonaea stenozyga	x			x	x		
Dodonaea viscosa subsp. ?*angustissima*		x					
Drosera macrantha subsp. *macrantha*					x	x	x

SPECIES	VEGETATION COMMUNITY						
	W1	W2	W13	W22	S2	S6	S30
Drosera sp.	x				x	x	
Enchylaena tomentosa var. *tomentosa*		x					
Eremophila caperata	x	x	x				
Eremophila decipiens subsp. *decipiens*	x	x			x	x	x
Eremophila granitica	x	x		x	x	x	x
Eremophila interstans subsp. *interstans*	x			x			
Eremophila interstans subsp. *virgata*		x		x			
Eremophila ionantha	x	x		x			
Eremophila latrobei subsp. *latrobei*	x	x			x	x	
Eremophila maculata subsp. *brevifolia*		x					
Eremophila oldfieldii subsp. *angustifolia*	x	x	x		x	x	x
Eremophila oppositifolia subsp. *angustifolia*	x			x	x	x	
Eremophila scoparia	x	x		x			
Eucalyptus campaspe		x					
Eucalyptus celastroides subsp. *celastroides*	x	x					
Eucalyptus corrugata	x	x	x	x	x	x	x
Eucalyptus ewartiana				x	x	x	x
Eucalyptus gracilis	x	x					
Eucalyptus horistes	x			x	x	x	x
Eucalyptus longicornis	x	x		x	x		
Eucalyptus longissima	x	x					
Eucalyptus loxophleba subsp. *lissophloia*	x	x	x	x	x	x	x
Eucalyptus ravida	x	x			x		
Eucalyptus salmonophloia	x	x		x			
Eucalyptus salubris	x	x					
Eucalyptus sheathiana	x	x	x	x	x		x
Eucalyptus transcontinentalis	x	x	x	x			
Exocarpos aphyllus	x	x	x	x	x	x	
Grevillea acuaria	x	x	x	x	x		
Grevillea georgeana (P3)					x		
Grevillea juncifolia	x	x		x		x	
Grevillea obliquistigma subsp. *obliquistigma*	x						
Grevillea paradoxa	x			x	x	x	x
Grevillea zygoloba	x	x		x	x	x	x
Hakea francisiana							x
Haloragis gossei				x			
Hibbertia eatoniae	x				x	x	x
Hibbertia exasperata						x	
Hibbertia stowardii					x	x	
Hybanthus floribundus subsp. *curvifolius*						x	
Lepidosperma sp. novel (MVW18)							x
Leptospermum fastigiatum							x
Leucopogon sp. Clyde Hill (M.A. Burgman 1207)	x			x	x	x	x
Lomandra effusa	x						
Lysiana casuarinae	x	x					
Maireana georgei	x	x		x	x		x
Maireana trichoptera	x	x		x			

SPECIES	VEGETATION COMMUNITY						
	W1	W2	W13	W22	S2	S6	S30
Maireana triptera	x	x	x	x			
Marsdenia australis	x	x					
Melaleuca hamata				x	x		x
Melaleuca nematophylla	x				x	x	x
Mirbelia depressa						x	
Olearia exiguifolia	x						
Olearia humilis					x		
Olearia muelleri	x	x	x	x	x	x	x
Olearia pimeleoides	x	x		x	x	x	x
Orchidaceae sp.					x		
Persoonia coriacea						x	
Phebalium canaliculatum					x		x
Phebalium filifolium	x					x	x
Phebalium laevigatum	x					x	x
Phebalium lepidotum						x	x
Philotheca brucei subsp. *brucei*	x	x			x	x	x
Pimelea microcephala subsp. *microcephala*	x	x					
Pittosporum angustifolium	x	x					
Prostanthera campbellii	x			x	x	x	x
Prostanthera grylloana	x			x	x	x	x
Ptilotus exaltatus var. *villosus*	x	x					
Ptilotus obovatus var. *obovatus*	x	x			x	x	x
Rhagodia drummondii	x	x					
Rhagodia spinescens		x					
Rhodanthe rubella	x						
Rinzia carnosa				x	x	x	x
Santalum acuminatum	x	x		x	x		
Santalum spicatum	x	x	x	x	x	x	x
Scaevola spinescens	x	x	x	x	x	x	x
Sclerolaena fusiformis	x	x	x				
Senna artemisioides subsp. *filifolia*	x	x		x		x	x
Senna cardiosperma	x						
Solanum nummularium	x	x		x		x	
Stenanthemum stipulosum					x	x	
Stylidium limbatum							x
Swainsona ?canescens				x			
Templetonia sulcata	x	x					
Thryptomene urceolaris							x
Thysanotus patersonii					x	x	
Triodia scariosa	x						
Waitzia suaveolens	x				x	x	x
Westringia cephalantha	x		x	x	x	x	x
Zygophyllum apiculatum	x				x		
Zygophyllum ?aurantiacum		x					

Source: Mattiske (January 2011)
* indicates introduced (weed) species; P1, P2, P3 and P4 denote - Priority Flora Species

Appendix 11: Tenement Conditions

Appendix 12: Preliminary Mine Closure Plan (PMCP)