Newmont Boddington Gold
Life of Mine Extension Project

Public Environmental Review

Prepared for

Newmont Boddington Gold Pty Ltd

by Strategen

August 2013

STRATEGEN
environmental consultants

Newmont Boddington Gold
Life of Mine Extension Project

Public Environmental Review

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August 2013

Limitations

Scope of services

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Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: Newmont Boddington Gold Pty Ltd

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	Rev A	Client review	K Usher, M Brook/ H Ventriss	Electronic	12/10/2012
Preliminary Draft Report	Rev B Main	Client Review	M Brook, L Taylor/ H Ventriss	Electronic	14/12/2012
Draft Report	Rev C	Client Review surface & groundwater	M Brook, L Taylor, R Chesney, M Dunlop, N McAlinden/ H Ventriss	Electronic	17/01/2013
Final Draft Report	Rev D	Client Review	M Brook, L Taylor, R Chesney, M Dunlop, N McAlinden/ H Ventriss	Electronic	30/01/2013
Final Draft Report	**Rev 0**	**Submission to EPA**	**M Brook, L Taylor, R Chesney, M Dunlop, N McAlinden/ H Ventriss**	**hard copy + electronic**	**31/01/2013**
Final Draft Report	Rev E3	Client Review	M Brook, T Stehbens, J Mitchell	Electronic	31/05/2013
Revised Final Draft Report	Rev F	Client Review	M Brook, T Stehbens, N McAlinden/ H Ventriss	Electronic	26/06/2013
Final Report	**Rev 1**	**Submission to EPA**	**M Brook, T Stehbens, N McAlinden/ H Ventriss**	**Hard copy + Electronic**	**27/06/2013**
Revised Final Report	Rev H	Client Review	M Brook, K Browne	Electronic	05/08/2013
Final Report	**Rev 2**	**EPA Review**	**M Brook**	**Hard Copy + Electronic**	**07/08/2013**

INVITATION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

The Proponent, Newmont Boddington Gold Pty Ltd (NBGPL) proposes to extend the life of the existing Newmont Boddington Goldmine (NBG), located near Boddington. In accordance with the *Environmental Protection Act 1986*, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a public review period of 4 weeks from Monday 19 August 2013, closing on Monday 16 September 2013.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Where to get copies of this document

Printed and CD copies of this document may be obtained from Stephanie Myles at Newmont, Level 1, 388 Hay Street, Subiaco WA 6008, 08 9423 6100 at a cost of $10 (including postage and packaging) or a CD version is available free of charge.

The document/s may also be accessed through the proponent's website at http://www.newmont.com/asia-pacific.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992*, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind.

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name,
- address,
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: Monday 16 September 2013.

The EPA prefers submissions to be made by email to *submissions@epa.wa.gov.au*.

Alternatively submissions can be

- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, East Perth Western Australia 6892, Attention: (Vanessa Angus); or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: (Vanessa Angus).

If you have any questions on how to make a submission, please ring the EPA assessment officer, Vanessa Angus on 6145 0800.

Executive summary

Introduction

The Proponent, Newmont Boddington Gold Pty Ltd (NBGPL) proposes to extend the life of the existing Newmont Boddington Goldmine (NBG), located near Boddington, Western Australia (Figure ES1).

The Life of Mine Extension Project (the Proposal) has the potential to extend the mine life until 2041. The Proposal focuses on targeting low-grade hard rock ores lying beneath pits mined during previous operations.

Location

NBG is located in the Shire of Boddington, about 12 km northwest of the town of Boddington and 120 km southeast of Perth, Western Australia. The mine is situated in the Darling Range, within the catchment of Thirty Four Mile Brook. Surrounding land uses include State Forest, timber production, agriculture and mining.

Consistent with the approach outlined in *Environmental Assessment Guideline No. 1* (EPA 2012a), the Proposal is defined within a Development Envelope. The Development Envelope, tenure boundaries and surrounding land uses are shown on Figure ES2.

Assessment process

The Proposal was referred to the Environmental Protection Authority (EPA) under s 38 of the *Environmental Protection Act 1986* (EP Act) on 30 April 2012. On 11 June 2012, the EPA determined the level of assessment for the Proposal as Public Environmental Review (PER) with a four-week public review period.

The EPA issued the Environmental Scoping Document (ESD) for the Proposal on 19 October 2012.

This PER has been prepared in accordance with the EP Act *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012* and the ESD. The purpose of the PER is to present an impact assessment of the key environmental factors with potential to be affected by implementation of the Proposal. The environmental impact assessment is based on conformance with the ESD, and various relevant EPA policy position statements and guidances.

The Proposal was referred to the Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) on 30 April 2012 for consideration under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 2 July 2012, DSEWPaC advised that the action was considered a 'controlled action' under the EPBC Act (EPBC Reference: 2012/6370).

The Proposal will be assessed under the intergovernmental bilateral agreement between the Commonwealth of Australia and the State of Western Australia. The agreement provides for accreditation of the Western Australian EIA process to ensure an integrated and coordinated approach for actions requiring approval under both the EPBC Act and the EP Act.

Description of the Proposal

The latest Life of Mine (LOM) plan involves expansion of existing operations at NBG and will result in the following changes to the current mine:

- expansion (widening and deepening) of the Wandoo North and Wandoo South open pits
- increased ore production and increased waste quantities requiring the expansion of existing and construction of an additional waste rock dump adjacent to the pit with a final combined capacity of up to 1500 Mt
- an increase to size of stockpiles and ancillary infrastructure
- an increase in overall metal production requiring the construction of a second Residue Disposal Area (RDA) and associated infrastructure to provide additional tailings storage of up to 600 Mt
- construction of additional water storage dams and associated infrastructure to replace the water storage dam (D4) which will be covered by the new waste rock dump
- extending mine operations and processing operations to approximately 2041.

The key characteristics of the Proposal are summarised in Table ES1. This table has been developed in accordance with the *Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal Environmental Protection Act 1986* (EPA 2012a).

Table ES1 Key characteristics table

Proposal title	Newmont Boddington Gold Mine Life of Mine Expansion	
Proponent name	Newmont Boddington Gold Pty Ltd	
Short description	The Proposal is for an expansion of the existing operations at the Newmont Boddington Gold Mine and includes • pit expansion • increased ore production resulting in increased waste quantities • increased existing stockpiles and development of ancillary infrastructure • expanded waste rock dumps (WRD) • construction of a new residue disposal area (RDA) • construction of new water storage areas.	
Relevant characteristics	**Current approval**	**This Proposal**
Physical elements		
Mine activities	Open cut basement mining to approximately -125 m AHD	Open cut basement mining to approximately -252 mRL for the north pit and -432 mRL south pit
Waste rock dump (WRD)	820 Mt of waste rock	Approximately 1500 Mt waste rock dump as shown in Table ES2
Residue disposal area (RDA)	Residue disposal capacity of 600 Mt	Construction of a second RDA to provide a combined residue disposal capacity of approximately 1200 Mt as shown in Table ES2
Disturbance footprint	Total cleared footprint of 3679 ha	Total cleared footprint of up to 6520 ha within Development Envelope in Table ES2, including up to 1755 ha of additional clearing of native vegetation.
Water dams	D1 and D4 Dam with capacity of 1300 ML each	D4 Dam to be decommissioned Construction of D5 Dam and potentially D6 Dam as shown in Table ES2

Operational elements		
Mine life	15–20 years	Continued operation up to ≈ 2041
Water use	47 ML/day	Up to 47 ML/day
Processing	Up to 35 Mtpa with potential for further increase of up to 15% through efficiency gains	Not an environmental factor, to be removed

Current operations

NBG is a substantial gold and copper project targeting low-grade hard rock ores lying beneath existing pits mined during past operations. The existing operation includes mining of the Wandoo North and Wandoo South open pits, with an active WRD, accommodation, sewage treatment plants, overland conveyor, processing, storage facilities. Water infrastructure includes water supply reservoirs, pipelines and a pump station.

Stakeholder consultation

NBGPL has proactively consulted with the local community on a regular basis since establishment of its mining operation. Consultation with the communities of Boddington and Dwellingup is carried out through a range of engagement mechanisms and techniques. In addition to these consultation activities, a social impact assessment is carried out by independent consultants every three years to assess the relationship between NBGPL and local communities and to determine the social impacts of its operations.

A Community Partnership Agreement was signed on 16 August 2006 between the Gnaala Karla Booja People (GKB), NBGPL, and the South West Aboriginal Land and Sea Council (SWALSC). A Preservation of Aboriginal Heritage Agreement was prepared by the SWALSC in 2007 between the Gnaala Karla Booja Native Title Group, the SWALSC and NBGPL. The agreement sets out processes for:

- communication and consultation
- the preservation of Aboriginal Heritage
- the preservation of Aboriginal sites and objects.

In September 2011, NBGPL commenced consultation for the proposed expansion. The team consulted with Australian and State Government departments, local government and local communities potentially affected by the proposed expansion. A number of mechanisms were used to enable communication with a broad spectrum of stakeholders, each with different engagement requirements.

The key issues raised by stakeholders related to:

- impacts on black cockatoos and other threatened species habitat
- water use and management
- clearing of native vegetation
- dust emissions
- noise emissions
- closure
- re-routing of the Bibbulmun Track
- community impacts – trucking and local employment
- changes in land use.

NBGPL is committed to continuing engagement with key stakeholders throughout and beyond the environmental approvals process.

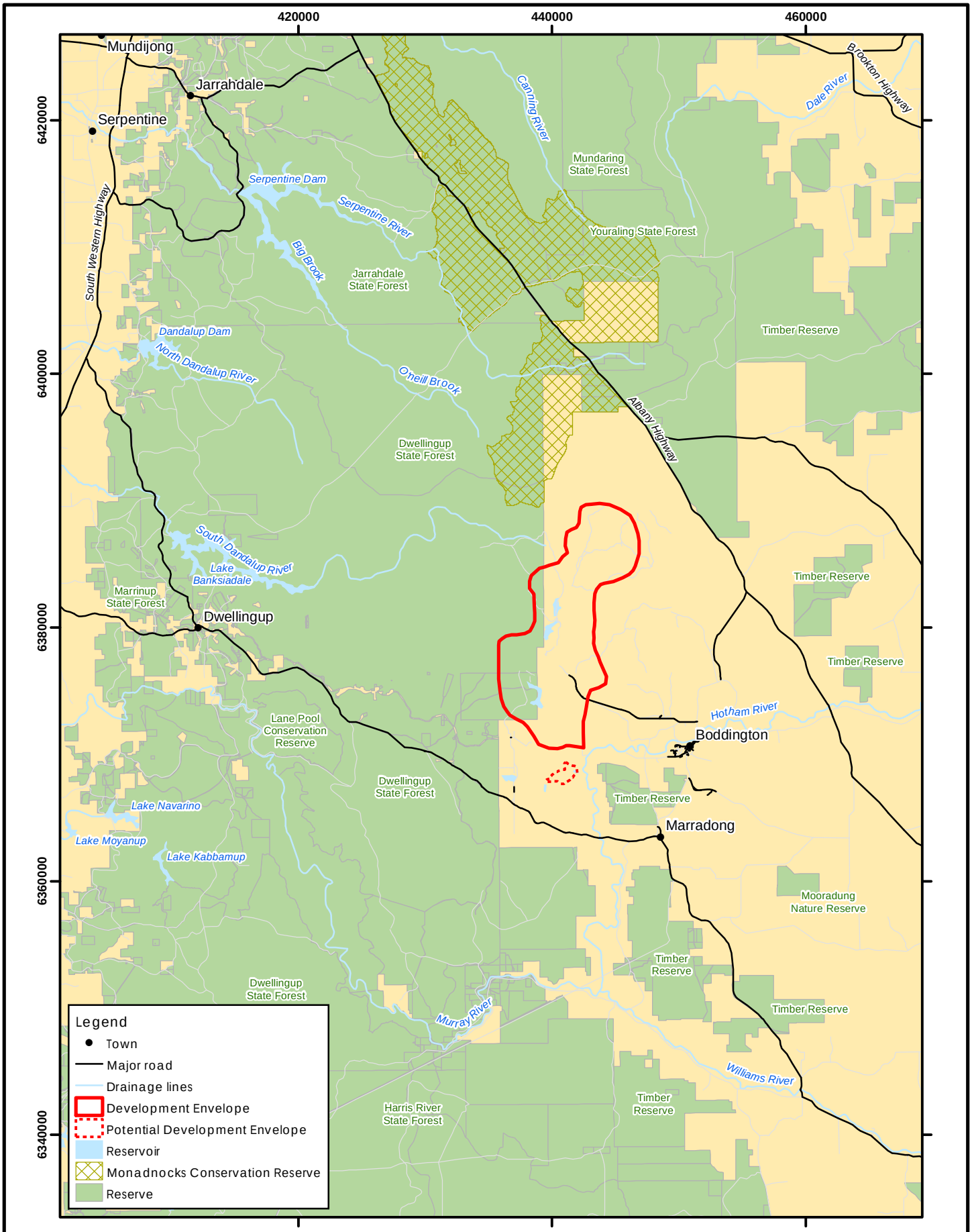

Figure ES 1 Proposal location

Regional Map

Source: ESRI 2006

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Scale
0 2 4 6 8 10
Kilometres

N

1:400,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Reserves: Geoscience Australia 2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_ES_RevH_F001.mxd

435000 440000 445000 450000

6390000 6385000 6380000 6375000 6370000

Proposed RDA
F3 RDA
F1 RDA
R4 RDA
WRD#12
WRD#9
North Pit
South Pit
WRD#8
WRD#7
WRD#11
WRD#10
D5
Accommodation
D6

Figure ES 2 The Proposal

Scale 1:75,000 at A3

0 0.5 1 1.5 2 2.5 Km

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 7/08/2013
Author: CAD Resources
Source: Topography: Geoscience Australia 2011.

Legend

- Diversion Channel
- D5 Pipeline
- Rehabilitated Area
- Waste Rock Dumps (WRD)
- Pit
- Residue Disposal Area (RDA)
- Approved Footprint
- Development Envelope
- Potential Development Envelope
- Proposed Dam

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Environmental impact assessment

The following relevant key environmental factors are addressed:

- groundwater
- surface water
- flora and vegetation
- fauna
- Matters of National Environmental Significance (MNES)
- residual risk management (described in Offset Section, Section 14).

Other environmental factors addressed include public amenity, Indigenous heritage, noise, air emissions, closure and rehabilitation. These factors require less detailed assessment as they can be readily managed through standard operating procedures and adherence to regulations. Table ES2 summarises the potential environmental impacts, impact assessment, proposed management and predicted environmental outcome for each of the key environmental factors assessed in the PER.

Environmental management framework

In addition to implementing the requirements of specific environmental conditions set by the EPA if the Proposal is approved, the Proponent will minimise environmental impacts through:

- maintaining certification to the International Standard for Environmental Management Systems (EMS) through implementation of the Integrated Management System (IMS), which covers Environment, Social Responsibility and Health and Safety implementing an Environmental Management Plan (EMP) for the Proposal
- developing environmental improvement plans for high and extreme risks tracked quarterly through the site risk register
- improving mechanisms to measure water and energy use, and greenhouse gas emissions
- improving the efficiency of water resource use
- updating plans and research and development studies for disturbance and closure, progressively rehabilitating and measuring success
- ensuring all personnel complete relevant environmental awareness and training programs
- ensuring that community views are sought, respected and considered
- reporting regularly to stakeholders on performance.

The environmental aspects of the Proposal will be primarily managed through the Environmental Management Program (EMP). This has been prepared and will be implemented to manage specific environmental issues arising from the Proposal. The following management plans have been developed as part of the EMP:

- Groundwater Quality Management Plan
- Adaptive Groundwater Management Plan
- Surface Water Management Plan
- Vegetation and Flora Management Plan
- Terrestrial Fauna Management Plan
- Black-cockatoo Management Plan
- Indigenous Heritage Management Plan
- Noise management plan
- Air Quality Management Plan.

Offsets

The residual environmental impacts of the Proposal, after consideration of other mitigation measures to be applied, are expected to be:

1. Clearing of up to 1755 ha of good condition native vegetation and fauna habitat within state forest and private land.
2. Clearing of up to 1755 ha of foraging and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoo and foraging habitat for Baudin's Black-Cockatoo.
3. Some fragmentation of local habitat for Woylies and Chuditch.

The three residual impacts identified above have the potential to affect five species listed under the EPBC Act as MNES relevant to the Proposal including:

- Woylie/Brush-tailed Bettong
- Chuditch
- Forest Red-tailed Black-Cockatoo
- Baudin's Black-Cockatoo
- Carnaby's Black-Cockatoo.

An offset strategy is being developed in consultation with the EPA, Department of Parks and Wildlife (DPaW) and DSEWPaC, based on the principles set out in *WA Environmental Offsets Policy September 2011* (Government of Western Australia 2011) and Australian Government Environmental Offsets Policy (DSEWPaC 2012a), to provide offsets for the above expected residual impacts of the Proposal.

The strategy is staged, meaning that aspects of the strategy will be triggered throughout the mine life as development and therefore disturbance is planned.

The offset package components are separated between the WRD and other infrastructure (initial clearing), and RDA development (deferred clearing). The offset package comprises the following components:

1. Direct offsets: WRD and Other Infrastructure (offsetting initial clearing of 965 ha of native vegetation):
   (a) Offset component 1: Protection of 2000 ha of adjacent vegetation with a conservation covenant over private land that NBGPL has acquired and provision of ongoing management of this area (subject to agreement by third parties). If it is not possible to implement this due to by third parties, NBGPL will establish land management agreements with landholders to encourage conservation practices on degraded pastoral lands.
   (b) Offset component 2: Restoration of up to 300 ha of cleared farming land in adjacent areas on private land that NBGPL has acquired and provision of ongoing management of this area.
2. Direct offsets: RDA (offsetting deferred clearing of 790 ha of native vegetation):
   (a) Offset component 3: Restoration of approximately 1050 ha of land previously used for timber plantation to promote fauna linkage between the Monadnocks Conservation Reserve and native vegetation to the east.
3. Indirect offsets (1755 ha):
   (a) Offset component 4: Funding for black cockatoo and Woylie research and/or conservation project/s
   (b) Offset component 5: Land ownership exchange to ensure no net loss of state forest.

Table ES2: Summary of environmental impact assessment of key environmental factors

EPA objective (from Environmental Scoping Document)	Existing environment	Aspect and potential impact (from Environmental Scoping Document)	Impact assessment	Environmental management	Predicted outcome on relative conservation values	Compliance with objective
Groundwater						
To maintain the quality and quantity of groundwater so that existing and potential environmental values, including ecosystem maintenance are protected.	Groundwater in the vicinity of NBG is contained within two main systems; a seasonal shallow groundwater system (upper aquifer) and a deeper weathered and fractured bedrock groundwater system (lower aquifer) The upper aquifer is located within the lateritic horizon, perched above the underlying clays. This aquifer is highly responsive to rainfall infiltration and groundwater elevations tend to change rapidly with no consistent regional trends or responses to mining operations. The main discharge is to alluvial sediments along creek channels, with groundwater flow generally following surface topography and contributing to winter base flow of creeks and streams. Some vertical discharge is likely to occur through higher permeability zones in the form of relict dykes. These zones act as vertical conduits allowing some water to leak down to the lower bedrock aquifers. The main regional aquifer is present in the lower bedrock aquifer, which can be further divided into the weathered and fractured upper bedrock (saprolite) and the deeper, less fractured lower bedrock. Permeability of these lavers is associated with geological structures in the rock, such as shearing, veining and faulting. Although the aquifer appears to have significant storage capacity, its fractured rock nature means that horizontal movement of water through the aquifer is generally slow. Groundwater flow is predominantly to the south, following the overall strike of the regional geological structure (Aquaterra 1999).	**Changes to groundwater levels (drawdown)** in the shallow and bedrock aquifers due to pit dewatering activities, resulting in a reduction in groundwater availability. Impacts to groundwater dependent ecosystems including the Hotham River, as a result of **groundwater drawdown and groundwater abstraction.**	Groundwater drawdown was modelled for 2017, 2022, 2032 and 2041. The drawdown has been calculated as the change of groundwater level from the start of the predictive model in 2012 (Schlumberger 2013). Drawdown initially extends in predominantly northeast and southwest directions in the lower bedrock, with a broader expansion in the upper bedrock. This is a result of the northeasterly–southwesterly alignment of the high vertical conductivity zones under the mine (Schlumberger 2013). The 1 m drawdown contours in the lower and upper bedrock are anticipated to approach the Hotham River in about 2022. The drawdown to the south does not change significantly after this time, and does not cross the river. At the time of completion of mining in 2041, the modelled 5 m drawdown contour in the upper bedrock will extend approximately 8 km east and west of the mine, 10 km north and 6 km south. The 5 m contour in the lower bedrock is of a similar magnitude, Drawdown of greater than 50 m is not expected to extend substantially beyond the pits during the life of mine.	The current monitoring program will be expanded to further include monitoring of potentially groundwater-dependent vegetation in the potential zone of impact along the Hotham River, groundwater and surface water in order to: • improve understanding of regional groundwater and validate predictions of modelling • determine through routine monitoring if changes are occurring regionally • assess whether any changes are due to the propagation of drawdown or external factors such as third party activities or climate change. In addition to the ongoing monitoring program, NBG will undertake a groundwater investigation to assess the degree of interaction between the Hotham River and upper bedrock aquifer in the potential drawdown area at the start of the monitoring program. NBGPL will develop an Adaptive Groundwater Management Plan (AGMP) to mitigate the uncertainty regarding the potential impacts of the groundwater related aspects of the project through: • monitoring to identify potential impacts and better understand the system and its interactions with a particular focus on the relationship between the Hotham River and bedrock aquifer • regular revision of modelling to better understand when and where impacts may occur • contingencies to be implemented if further monitoring and studies indicate high potential for an impact to occur. The AGMP will be a dynamic plan that includes: • extension of the existing groundwater, surface water and potential groundwater-dependent vegetation monitoring programs • decision making process based on the monitoring to determine if an impact has occurred and if that impact is related to the NBG operations • contingency actions to be undertaken if an impact is confirmed as having occurred as a result of mining-related activities.	1. No changes in groundwater levels or flows at South Dandalup River, Pillow, Round or Boomerang Swamps. Impacts on groundwater-dependent ecosystems are therefore, not expected at these locations. 2. Lowering of groundwater levels is anticipated to occur in the upper bedrock aquifer, with the 5 m drawdown contour in the upper bedrock predicted to extend to approximately 8 km east and west of the mine, and 10 km north and 6 km south of the mine at the cessation of mining in 2041. This area includes the upper bedrock aquifer below the Hotham River. This drawdown may affect the shallow aquifer in this area if the clay oxide layer between the lower and upper bedrock aquifers does not prevent interaction between the bedrock and shallow aquifers. 3. Reduction in summer baseflows in the Hotham River may potentially occur if the river is hydrologically connected to the upper bedrock aquifer at this location. This may in turn affect riparian vegetation. With the investigations and contingency mitigation measures proposed within the AGMP, impacts on the riparian vegetation, aquatic fauna and flows in the Hotham River are expected to be satisfactorily mitigated.	After the application of mitigation measures, the Proposal is expected to meet the EPA objective for groundwater.

EPA objective (from Environmental Scoping Document)	Existing environment	Aspect and potential impact (from Environmental Scoping Document)	Impact assessment	Environmental management	Predicted outcome on relative conservation values	Compliance with objective
	Pre-mining records show groundwater salinities in the shallow aquifer across the Thirty Four Mile Brook catchment to have ranged from 1000 mg/L to 3000 mg/L total dissolved solids (TDS) (Schlumberger 2010).	Adverse effects to groundwater as a result of **seepage or runoff from WRDs and RDAs**, including potential impacts to drinking water supplies.	RDAs pose a potential risk to groundwater quality should seepage from the RDA enter groundwater. RDA seepage may contain elevated levels of cyanide and metals. Based on geochemical characterisation studies completed to date, the physical residue to be stored in the facility is indicated to be relatively inert, and is not anticipated to generate acid, nor low concentrations of metals (Schlumberger 2012a). The new RDA will be designed and constructed to prevent adverse groundwater effects. As per the Newmont Standard for Tailings Management, the RDA liner will be required to meet low permeability requirements with an impermeable layer being placed under the supernatant pond area. A water recovery system shall be incorporated into the design and construction of the facility. Any collected water will be returned to the process plant for reuse. Groundwater monitoring bores will be installed, initially to establish baseline groundwater conditions, and later downstream to monitor for seepage from the facility. Only minor periphery modifications are proposed for the existing F1/F3 RDA. As such, the potential for adverse effects to groundwater quality from this facility will not change from the approved operations. A small percentage of the WRDs may potentially generate low pH seepage with elevated concentrations of metals that may adversely affect water quality if allowed to infiltrate into groundwater. Data compiled for waste grade material analysed to date indicates that acid forming properties are only likely to occur in only a small percentage of the waste rock from the expanded mine. Acid forming rock will be encapsulated to reduce the potential for acidic leachate to form. The existing WRD has a perimeter drainage to ensure any potentially mine impacted water (seepage and runoff) is captured and reused through the processing plant. This system will be expanded to cover the new WRD areas, with a drainage blanket to be installed below parts of the WRDs where potentially acid forming rock may be placed (Galt Geotechnics 2012). Based on modelling of water quantity and quality detailed design has been undertaken for the post-closure management of groundwater. This includes covering of the WRD and RDAs to reduce infiltration and seepage. This system manages potential post-closure impacts on groundwater quality from the WRDs and RDAs produced by collecting and treating of seepage to ensure a quality suitable for discharge to the environment.	Management measures for groundwater quality are built into the design and operation of NBG. The design of WRDs and RDAs is undertaken in a manner to prevent leachate entering the groundwater. Annual geotechnical audits of the WRDs and RDAs will continue to be undertaken to confirm these structures are sound and not allowing excessive seepage to enter the environment (NBGPL 2011). In addition, NBGPL is proposing to continue undertaking the management measures for groundwater quality outlined in the Groundwater Quality Management Plan including: • maintaining certification with the International Cyanide Management Code • ensuring WRD expansion areas are equipped with perimeter drainage and ensure that any seepage would report to the Impacted Water Drainage Blanket for collection and use through the processing plant • designing, constructing and operating the new RDA with seepage mitigation measures and solution recovery systems • installing a drainage blanket on lower parts of the WRDs where potentially acid forming rock may be dumped and where drainage would no longer report to the existing impacted Water Sump • constructing the drainage blanket of hard non-acid forming rock with a high void ratio and designed to direct seepage towards perimeter drains. • designing and constructing the new RDA to include a liner below the supernatant pond and solution recovery systems.	No increase in risk of adverse groundwater quality effects as a result of expanded or new infrastructure proposed for the Proposal.	After the application of mitigation measures, the Proposal is expected to meet the EPA objective for groundwater.

EPA objective (from Environmental Scoping Document)	Existing environment	Aspect and potential impact (from Environmental Scoping Document)	Impact assessment	Environmental management	Predicted outcome on relative conservation values	Compliance with objective
Surface water						
To maintain the quality and quantity of surface water so that existing and potential environmental values, including ecosystem maintenance are protected.	The existing NBG operations are located in the Thirty Four Mile Brook catchment, which flows into the Hotham River north of Boddington. The Hotham River enters the Murray River, which flows into the Peel-Harvey Estuary to the west of Pinjarra. Four seasonally inundated areas are located near the mine; being Eight Swamp, Round Swamp, Pillow Swamp and Boomerang Swamp (Coffey 2010). The three latter swamps have been identified by the Minister for the Environment as locally significant and are monitored by NBGPL (Coffey 2010). Flow in the Hotham River is highly seasonal, with high flows at Marradong Road Bridge Gauging Station averaging greater than 10 gigalitres per month (GL/month) between June and September, and little flow (mean flow less than 2 GL/month) over the summer and autumn months of December to April (DoW 2012).	Impacts to surface water flows as a result of **placement and design of new infrastructure**, including alterations of existing drainage patterns of Gringer Creek and tributaries of the Hotham River.	The D5 Dam will be located on Hotham farm on the Thirty Four Mile Brook downstream from the current D4 dam site. The D6 dam, if required, will also be located on Hotham Farm, on Junglen Gully, downstream of the Hedges River Water Dam and the Hotham Farm Dam. The construction of the D5 dam is not expected to significantly alter surface water flows in the downstream sections of Thirty Four Mile Brook from those approved for the existing mine. The impacts of the D6 dam on downstream flows in Junglen Gully are not anticipated to be significantly different from the current situation. The new RDA will cover an ephemeral drainage line that drains into the Gringer Creek and will require a diversion of Gringer Creek for approximately 2 km. A diversion channel will be required to ensure minimal ponding of natural stream flows upstream of the facility and minimise any changes in the hydrological flow regime downstream of the RDA (Schlumberger 2012a). The diversion will be designed and installed in a manner that minimises both erosion and changes to flow rates within the catchment. Modelling suggests that the new RDA could reduce the highly ephemeral catchment of Gringer Creek by approximately 12% due to the capture of precipitation and runoff on the facility footprint. The area of the existing RDA is anticipated to increase by 12 ha as a result of some minor modifications required around the facility perimeter (Knight Peisold 2012). No significant impact is anticipated as a result of these works. As a result of the expansion of the WRDs and stockpiles, changes will be made to the surface water management system at NBG. As per the current management processes in place, any mine impacted water (e.g. seepage or surface water runoff from the expanded WRDs) will be captured by drains and water holding structures and will not contribute to downstream flows in Thirty Four Mile Brook.	Management of potential impacts on surface water from this Proposal are addressed in the Surface Water Management Plan in the EMP and includes the following: • managing process water quality through Caro's Acid Cyanide Destruction circuit • conducting inspections of sediment control structures to prevent silt laden water entering the environment as per site monitoring plan • removing sediment from sediment pumps • collecting all runoff from WRDs, RDAs, soil/gravel stockpiles and bauxite stockpiles in storage ponds and reuse as process water • segregating clean and potentially contaminated runoff (runoff from WRDs) • treating runoff and seepage from WRDs if required • continuing to manage the staged construction of the F1/F3 RDA to prevent migration of diffuse seepage into the South Dandalup catchment • managing storage capacities in water holding facilities in accordance with the following: • each facility to be designed with a capacity for a 1-in-25-year Average Recurrence Interval storm event of 24 hours duration in addition to a freeboard allowance • where the facility is the last storage before discharge to the lower sections of Thirty Four Mile Brook or Gringer Creek, the facility shall be designed with capacity for a 1-in-100-year Average Recurrence Interval storm event of 24 hours duration. • discharging of water from the mine site to Thirty Four Mile Brook to only occur in rainfall events greater than 1-in-100 year average return interval, 24 hour event • undertaking abstraction of water from the Hotham River in accordance with Department of Water(DoW) licence conditions and as described in Section 5.4.2 • submitting detailed design of Gringer Creek diversion to DoW and Department of Environment Regulation (DER).	1. No impact on surface water volumes in the South Dandalup Public Drinking Water Source Area (PDWSA). 2. Minor reductions in flow volumes in Gringer Creek (approximately 12%) during the life of the Proposal. No significant alteration to flow volumes in Thirty Four Mile Brook is anticipated. 3. Volumes of water abstracted from Hotham River are expected to remain within the current licensed allocation. Potential impacts on water levels in Hotham River due to mine related drawdown will be mitigated through stream augmentation over the summer months, should these occur. 4. Construction of two pit lakes that will overflow into Thirty Four Mile Brook approximately 81 years after the closure of the mine, with an average overflow rate of approximately 36 ML/day during autumn and winter. 5. Increases in flow volumes following pit lakes overtopping is considered unlikely to impact on downstream flow rates. 6. No impacts to riparian vegetation health and aquatic fauna are anticipated during the operation of the Proposal.	After the application of mitigation measures, the Proposal is expected to meet the EPA objective for surface water.
	NBGPL undertakes quarterly water quality analysis on the Hotham River upstream to the confluence with Thirty Four Mile Brook. Results for 2011 indicate water quality to be brackish primarily resulting from land clearing and agricultural practices in the broader Hotham River catchment (Schlumberger 2010). Sediment sampling in the Hotham River downstream of the mine in 2005 indicated that levels of cyanide or heavy metals downstream of the mine were below detection limits (Streamtec 2005). Thirty Four Mile Brook is ephemeral and highly seasonal with considerable variation in flow and quality from year to year. Water quality in Wattle Hollow Brook (a tributary of Thirty Four Mile Brook) met the irrigation trigger values but exceeded the trigger values for protection of freshwater species for aluminium, chromium, copper, nickel and zinc (Schlumberger 2012b). Water quality in Gringer Creek was similar to that in the mined Thirty Four Mile Brook catchment, except that the Gringer Creek water was more saline and acidic.	Adverse effects to surface water as a result of **seepage or runoff from WRDs and RDAs**, including potential impacts to drinking water supplies.	The NBG water management system has been designed to minimise adverse effects to off-site surface water quality. The mine will continue to operate as a closed system from a surface water perspective, with runoff from the mine, WRD and RDAs being captured and used through the processing plant. Based on modelling by Galt Geotechnics (2012), overflow from NBG into Thirty Four Mile Brook below the D5 dam is anticipated to occur with an average frequency of once every 100 years. Supernatant water and rainfall from the new RDA will be reused on site. The new RDA will be designed such that runoff will not enter Gringer Creek in events less than a 1-in-100-year Average Return Interval, 24-hour storm event. As such, the expansion of NBG will not affect surface water quality in the surrounding creeks and rivers during operation. Post-closure, the primary water bodies in the area will be the mine pit lakes. When the mine pit lakes overflow, this water will enter Thirty Four Mile Brook and the Hotham River. Modelling anticipates this to commence 127 years after closure. Treatment of seepage from the RDAs and WRD areas will occur post-closure until water quality is suitable for release into the environment.	The management of surface water at NBG is based on the principle of retaining potentially impacted runoff on site and reusing it for ore processing. This practice has been successful in maintaining water quality in Thirty Four Mile Brook. Management of potential impacts on surface water quality from this Proposal are also addressed in the Surface Water Management Plan in the EMP and includes the following: • WRD and RDA structures will be designed and operated so that potentially mine affected water does not enter the environment. • Clean forest runoff and potentially mine impacted runoff will be kept separate during operations. • Water quality monitoring will continue to be undertaken in adjacent watercourses including Junglen Gully, Gringer Creek, Thirty Four Mile Brook, Hotham River and South Dandalup River. • Post-closure runoff and seepage from RDAs and WRDs will initially be treated to remove cyanide and acid where required. These treatments will be discontinued when acceptable standards of water quality are met.	1. No impact on surface water quality in the South Dandalup PDWSA. 2. No significant impact to quality of surface water flows is anticipated during operations. Surface water quality in Thirty Four Mile Brook post-closure will be generally similar to current water quality, with some increase in concentrations of chromium, nickel and zinc.	After the application of mitigation measures, the Proposal is expected to meet the EPA objective for surface water.

EPA objective (from Environmental Scoping Document)	Existing environment	Aspect and potential impact (from Environmental Scoping Document)	Impact assessment	Environmental management	Predicted outcome on relative conservation values	Compliance with objective
Flora and vegetation						
To maintain the conservation status, diversity and productivity of flora and vegetation at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	NBG is located within the Darling Botanical District of the Southwest Botanical Province and is largely characterised by open forests of Eucalyptus marginata (Jarrah). Other dominant species include *Corymbia calophylla* (Marri) and *Eucalyptus wandoo* (Wandoo). Riparian vegetation in the Boddington area is dominated by tall shrublands of *Melaleuca* spp. and open woodlands of *Eucalyptus wandoo* and *E rudis*. No threatened communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been identified on site. No Priority Ecological Communities or Threatened Ecological Communities have been identified within the Survey Area. However, species comprising plant communities associated with shallow granitic soil are restricted in the Boddington area and are considered to be of local and regional significance (Mattiske 2005). Vegetation condition throughout the Boddington lease areas is variable. Large areas of intact native forest surround the existing pits and RDA, with vegetation condition generally ranging from very good to excellent. No threatened flora pursuant to Schedule 1 of the *Wildlife Conservation Act 1950* or listed under the EPBC Act have been recorded within the NBG vegetation survey areas, although *Verticordia fimbrilepis* subsp. *fimbrilepis* (Shy Featherflower) is listed as potentially occurring within the area. Nine Priority flora species have been recorded in the NBG vegetation survey areas. Two flora species of conservation significance have been recorded within the Development Envelope.	**Clearing of up to 1755 ha of native vegetation** over the next 15-20 years. **Mining activities such as vehicle movement and site disturbance** associated with the Proposal may result in the spread of weeds and pathogens including dieback within and outside the project area.	The Proposal has been located to minimise the requirement to clear native vegetation by locating expanded and new infrastructure on previously disturbed land such as Hotham Farm to the south of the existing operation and the pine and eucalypt plantations to the north east of the operation. The Proposal will require clearing of up to 1755 ha of native vegetation within the total additional footprint of up to 2895 ha. The Proposal is not expected to significantly reduce the extent of any vegetation complex on a local or regional scale. Priority 1 species, *Gastrolobium* sp. Boddington Prostrate, will not be affected by the Proposal. The majority of cleared native vegetation will be within jarrah-marri forest and wandoo woodland. None of the vegetation types within the Development Envelope are restricted to the Boddington area and all are located within vegetation complexes that are well represented within the mapped extent, further west in the State Forest and in the conservation estate within the northern and eastern jarrah forest. Clearing within all vegetation units will be restricted to below 30% of that recorded in the Survey Area, with the exception of five vegetation units; A3 (40.6%), AD (24.5%) AX (28.2%), O (100%) and Z (20.2%). Of these units only A3 is considered to be of local conservation significance. The total extent of vegetation units AD and O is limited to only 9.4 ha for unit AD and 8.1 ha for unit O. The limited distribution of these units is considered likely to be a result of these units being transitional ecotone vegetation units and not because they are particularly unique Access tracks and ephemeral drainage lines around the mining operation are infected with forest. The expanded waste dumps will intersect at least two areas where *Phytophthora cinnamomi* has been identified. Forest hygiene management is currently undertaken and will continue. As such spread of dieback in the area is not expected to be significantly affected by the Proposal. Two Declared Weed species were identified within the Development Envelope including Cape Tulip and Cotton Bush. As per current site practices, strict weed hygiene measures will be implemented to reduce the risk of weed introduction into adjacent uncleared areas and areas that are largely weed-free.	The potential impacts associated with the Proposal will be managed and mitigated through the implementation of the Vegetation and Flora Management Plan. Key measures in the Vegetation and Flora Management Plan include: • providing information to all employees and contractors (through the site induction process) on vegetation management requirements (e.g. forest disease, weed management and clearing requirements) • using the internal NBG Environmental Disturbance Application process for all areas requiring clearing to ensure activity is in line with internal and external standards and regulations • demarcating clearing boundaries with flagging tape to ensure minimal area is impacted and trees of significance are avoided • conducting post-clearing inspections to determine compliance with NBG Environmental Disturbance Application and preparation for rehabilitation (if applicable) • completing pre-clearing forest disease surveys to determine if forest disease is present and if additional management protocols are required to limit spread of disease • where forest disease is identified in an area to be cleared, management boundaries are to be determined and control protocols communicated • implementing control protocols such as management of drains, topsoil and gravel stockpiling and vehicle washdown • identifying single entry and exit points should crossing of a disease infested area be unavoidable • implementing vehicle washdown protocols at entry into forest areas at all times • restricting access to forest areas when rainfall exceeds 5 mm in 24 hours • inspecting all vehicles prior to entering site for soil and vegetative material • mapping known Declared Weeds locations • undertake weed management such as spraying and manual removal as required • rehabilitating areas no longer required for mining purposes.	1. Clearing of up to 1755 ha of native vegetation within a total additional footprint of 2895 ha. Clearing represents less than 1% of the total mapped area of all regional vegetation complexes. 2. Proposed clearing will not significantly affect the local or regional distribution of any vegetation community of conservation significance. Clearing of conservation significant vegetation units within the DE will affect less than 20% of their extent within the Survey Area (with the exception of transitional ecotone vegetation unit A3, of which 41.6 ha will be affected with the development of the RDA from 2022). 3. There will be a loss in the local abundance of some priority flora but no change in the conservation status of these species will occur as a result of the Proposal 4. Significant residual impacts resulting from implementation of the Proposal will be offset in accordance with EPA and DSEWPaC requirements, within a strategy as discussed in Section 14. 5. Indirect impacts on flora and vegetation (from groundwater drawdown) will be managed through the AGMP and are not considered significant.	After the application of mitigation measures, the Proposal is expected to meet the EPA objective for flora and vegetation.

EPA objective (from Environmental Scoping Document)	Existing environment	Aspect and potential impact (from Environmental Scoping Document)	Impact assessment	Environmental management	Predicted outcome on relative conservation values	Compliance with objective
Terrestrial fauna						
To maintain the conservation status, diversity and productivity of fauna and its habitat at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Eleven dominant fauna habitat types have been identified, based on vegetation and flora surveys conducted to date. The 2011/2012 surveys (Ninox 2012a, 2012b) recorded 11 species of native mammals, 11 frog species, 28 species of reptile and 59 species of native birds. Three introduced species were recorded in the 2011/2012 survey including the Laughing Kookaburra (*Dacelo noveaguineae*), House Mouse (*Mus musculus*) and Pig (*Sus scrofa*). In total, 21 conservation significant terrestrial vertebrate fauna species are currently listed as potentially occurring in the area. These species consist of ten mammals, nine birds (including five migratory species) and two reptiles. All three species of black cockatoo that occur in southwestern Australia (Baudin's Black-Cockatoo, Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoo) have been recorded foraging within the Development Envelope. Carnaby's Black-Cockatoos and Forest Red-tailed Black-Cockatoos are also known to breed within the area (Lee et al. 2012a). Aquatic fauna sampling of watercourses in the vicinity of the Proposal have recorded 111 macroinvertebrate taxa, five native freshwater fish species, two species of native crayfish, two introduced species of fish and one introduced freshwater crayfish (WRM 2011, 2012a, 2012c). A total of 69 identifiable species of invertebrate fauna were recorded during the 2011 survey, of which 24 were considered to be potential Short Range Endemic (SRE) species (Outback Ecology 2012a).	**Clearing of vegetation** would result in loss or fragmentation of fauna habitat and consequential displacement of fauna. **Death or injury of fauna** may occur during clearing and construction.	The Proposal will require clearing of up to 1755 ha of native vegetation within the total additional footprint of up to 2895 ha. All habitat types are well represented outside the Development Envelope with no more than 20% of the Survey Area of any one habitat type proposed to be cleared. Therefore, all fauna habitats will continue to be well represented in the local area and no local extinctions would be expected as a result of the Proposal. The Proposal has potential to increase isolation of the habitat to the east of the Development Envelope and thus affecting the long-term viability of fauna populations in this area. However, the area to the east is substantial in size (Figure ES2) and of good quality and the impact can be mitigated by providing adequate corridors to habitat to the north and west of the operation. Linkages to be maintained include the forested areas between the existing mine pit and RDA. Some roads and pipelines transverse the area, but sufficient habitat exists to act as an effective corridor for small and medium fauna. The second linkage is between the existing RDA and the proposed RDA (construction to commence around 2022) where a 170 m wide band of native vegetation will be maintained between the two RDAs, although this linkage will also be crossed by a road and pipeline. No significant residual impact on the majority of species of conservation significance is expected, with exception of the Carnaby's Black-Cockatoo, Baudin's Black-Cockatoo and the Forest Red-tailed Black-Cockatoo. NBGPL have determined that offsets are required to address significant residual impacts on the Black-Cockatoo species. The offsets package has also taken into account the potential for fragmentation of Chuditch and Woylie habitat.	The potential impacts associated with the Proposal will be managed and mitigated through the implementation of the Black-Cockatoo Management Plan and Terrestrial Fauna Management Plan. Key measures in the Terrestrial Fauna Management Plan include: • providing information to all employees and contractors (through the site induction process) on fauna management requirements (e.g. speed limits, how to manage injured fauna etc) • installing relevant signage on roads and entry points to the mine noting presence of fauna and the reporting of any impact through a formal process • conduct fauna trapping and relocation prior to areas being cleared • implementing a phased clearing approach for area required to be cleared • ensure all access roads are clearly signposted with speed limits • conduct regular spot checks of vehicle speed in and around the Development Envelope • displaying maps and photographs of fauna in the workplace to raise awareness and facilitate identification and on-the-ground management • report all observations of conservation significant fauna to the Site Environmental Department who will maintain records • giving native animals encountered on-site the opportunity to move on if there is no threat to personnel safety in doing so • if sick or injured animals are encountered, contacting local carers to assess possible rescue and rehabilitation of the animal • ensuring food waste is not accessible to attract native fauna or feral animals • prohibiting pets and firearms on the NBG leases • ensuring some connectivity between the eastern and western vegetated areas of the mine site through implementing fauna access and egress ability across roads and pipelines, and/or undertaking periodic trapping and relocation of fauna • reporting all observations of feral animals to the Site Environmental Department who will maintain records • restricting access to NBGPL–owned property for apiarists • controlling feral pigs, cats and foxes in and around the mine site.	1. Vegetation clearing will affect up to 1755 ha of native vegetation, which will reduce the extent of available fauna habitat in the local area but will not have a significant effect on regional fauna habitat availability as the habitat types within the Development Envelope are widespread and well represented in the large areas of Jarrah forest to the west of the Development Envelope. 2. Further fragmentation of habitat to the east of the Development Envelope and increased monitoring and management of the remaining east–west linkages to maintain connections that will allow genetic mixing and recolonisation potential in the event of a fire or disease. 3. Clearing of up to 1755 ha of black cockatoo habitat which is utilised as foraging habitat for all three species of black cockatoo and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoos; rehabilitation will be targeted at providing appropriate foraging species for black cockatoos and eventually providing additional habitat trees. 4. No significant increase in vehicle strike of individual fauna as a result of the Proposal.	After the application of mitigation measures, the Proposal is expected to meet the EPA objective for fauna.

EPA objective (from Environmental Scoping Document)	Existing environment	Aspect and potential impact (from Environmental Scoping Document)	Impact assessment	Environmental management	Predicted outcome on relative conservation values	Compliance with objective
5. Matters of National Environmental Significance						
The EPBC Act objectives are to: • provide for the protection of the environment, especially Matters of National Environmental Significance (MNES) • promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.	Previous surveys, the DSEWPaC Species Profile and Threats (SPRAT) database (DSEWPaC 2013) and literature searches have identified seven Threatened fauna species, one Threatened flora species and five Migratory bird species listed under the EPBC Act that may occur in the Development Envelope. Of the 13 EPBC Act listed species identified as potentially occurring in the area, six have been recorded on or near the mine site. These species include: Birds: • Forest Red-tailed Black-Cockatoo: Vulnerable • Baudin's Black-Cockatoo: Vulnerable • Carnaby's Black-Cockatoo: Endangered • Rainbow Bee-eater – Migratory • Mammals: • Brush-tailed Bettong (Woylie) – Endangered • Chuditch – Vulnerable. The other seven species of MNES are considered unlikely to be present in the Boddington area.	**Clearing of vegetation** resulting in the loss or fragmentation of fauna habitat and consequent displacement of fauna **Vehicle and heavy machinery movements** during clearing and construction may result in fauna strike causing injury or death to individuals.	1. Clearing of up to 1755 ha of black cockatoo habitat which is utilised as foraging habitat for all three species of black cockatoo and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoos. 2. Rehabilitation will target appropriate foraging species for black cockatoos and eventually providing additional habitat trees. 3. Loss of suitable Chuditch habitat causing displacement of some individuals to surrounding Jarrah forest. 4. Some loss of potential Woylie habitat through clearing of suitable habitat types within the Development Envelope. 5. Further fragmentation of habitat to the east of the Development Envelope and increased monitoring and management of the remaining east–west linkages to maintain connections that will allow genetic mixing and re-colonisation potential in the event of a fire or disease. 6. Potential loss of, or injury to, individual fauna due to vehicle strike during clearing and construction; no significant increase in vehicle strike of l fauna during the operational phase of the project. 7. No significant impact to Rainbow Bee-eaters given the wide distribution of the species and its ability to utilise a wide variety of habitats.	The potential impacts associated with the Proposal will be managed and mitigated through the implementation of the Black-Cockatoo Management Plan and Terrestrial Fauna Management Plan. Key measures in the Black-Cockatoo Management Plan include: • providing information to all employees and contractors (through the site induction process) on Black cockatoos and any other factors that may have a direct or indirect impact on populations • avoiding clearing during breeding seasons • installing and maintaining drinking points near known breeding and feeding areas • maintaining water bodies (i.e. D1 WSR) of higher water quality on the site (these are naturally more attractive to the birds than the RDAs) • complying with the ICMC and commitment to remove cyanide to ensure no impact to black cockatoos should they drink from F1 RDA and new RDA • utilising Wildlife Observers to monitor wildlife accessing F1 RDA and new RDA • minimising high noise levels near habitat trees during breeding seasons • ensuring food plant and hollow-producing tree species are used in rehabilitation seed mixes • clearly demarcating areas to be retained for conservation (i.e. protected from mining activities) to ensure the habitat remains of high quality for black cockatoos • investigating the benefit of using artificial nest hollows in remnant forest areas.	1. Clearing of up to 1755 ha of black cockatoo habitat which is utilised as foraging habitat for all three species of black cockatoo and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoos; rehabilitation will be targeted at providing appropriate foraging species for black cockatoos and eventually providing additional habitat trees. 2. Minor increased fragmentation of the 5000 ha of vegetation to the east of the Development Envelope and increased monitoring and management of the remaining east–west linkages to maintain connections that will allow genetic mixing and recolonisation potential in the event of a fire or disease in this eastern area that could affect local populations. 3. Clearing of up to 1755 ha of native vegetation, which will reduce the extent of habitat available to fauna including Chuditch and Woylies in the local area but will not have a significant effect on regional fauna habitat availability. Habitat types within the Development Envelope are widespread and well represented in the large areas of Jarrah forest to the west of the operation.	After the application of mitigation measures, the Proposal is expected to meet the EPBC objectives for MNES.

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1. Introduction

1.1 Proposal overview

The Proponent, Newmont Boddington Gold Pty Ltd (NBGPL) proposes to extend the life of the existing Newmont Boddington Goldmine (NBG), located near Boddington, Western Australia (Figure 1).

The Life of Mine Extension Project (the Proposal) has the potential to extend the mine life until 2041. The Proposal focuses on targeting low-grade hard rock ores located beneath previously mined pits.

1.1.1 Location

NBG is located in the Shire of Boddington, about 12 km northwest of the town of Boddington and 120 km southeast of Perth, Western Australia. The mine is situated in the Darling Range, within the catchment of Thirty Four Mile Brook. Surrounding land uses include State Forest, timber production, agriculture and mining.

Consistent with the approach outlined in *Environmental Assessment Guideline No. 1* (EPA 2012a), the Proposal is defined within a Development Envelope. The Development Envelope, tenure boundaries and surrounding land uses are shown on Figure 2. Current operations are primarily located on land owned by NBGPL. The Development Envelope is located primarily on land owned by NBGPL and includes an additional portion of State Forest in the western portion. In 2011, NBGPL purchased Hotham Farm and Saddleback (formerly Sotico) pine and eucalypt plantations to the south and northeast of the mine, respectively.

A land exchange agreement with the Western Australian Government is currently being progressed to cover the portion of current operations within State Forest that were subject to historical assessment and approval.

1.1.2 Description

The Proposal is to extend the life of the existing mine due to lower grade material becoming economically feasible to mine. NBG first commenced operations in 1987, with mining of the shallow oxide ores (up to 70 m in depth), and entered care and maintenance in 2001. Following the commencement of the basement or-mining phase, commercial production was again realised in 2009, with an anticipated 15–20 year mine life. With the identification of additional resources, this Proposal has the potential to extend the mine life until 2041. The Proposal focuses on continuing to target low-grade hard rock ores located beneath previously mined pits. The Proposal includes additional Waste Rock Dumps (WRD), a new Residue Disposal Area (RDA) and minor modification to the existing RDA, widening and deepening of existing pits, additional stockpiles (for bauxite, topsoil and gravel), new water storage dams and ancillary infrastructure (including roads, power lines and pipelines).

To enable development of these elements, the Proposal will involve diversion of a 2 km section of Gringer Creek and diversion of a small section of the Bibbulmun Track. In total, the Proposal is expected to require clearing of up to 1755 ha of native vegetation over the next 15–20 years.

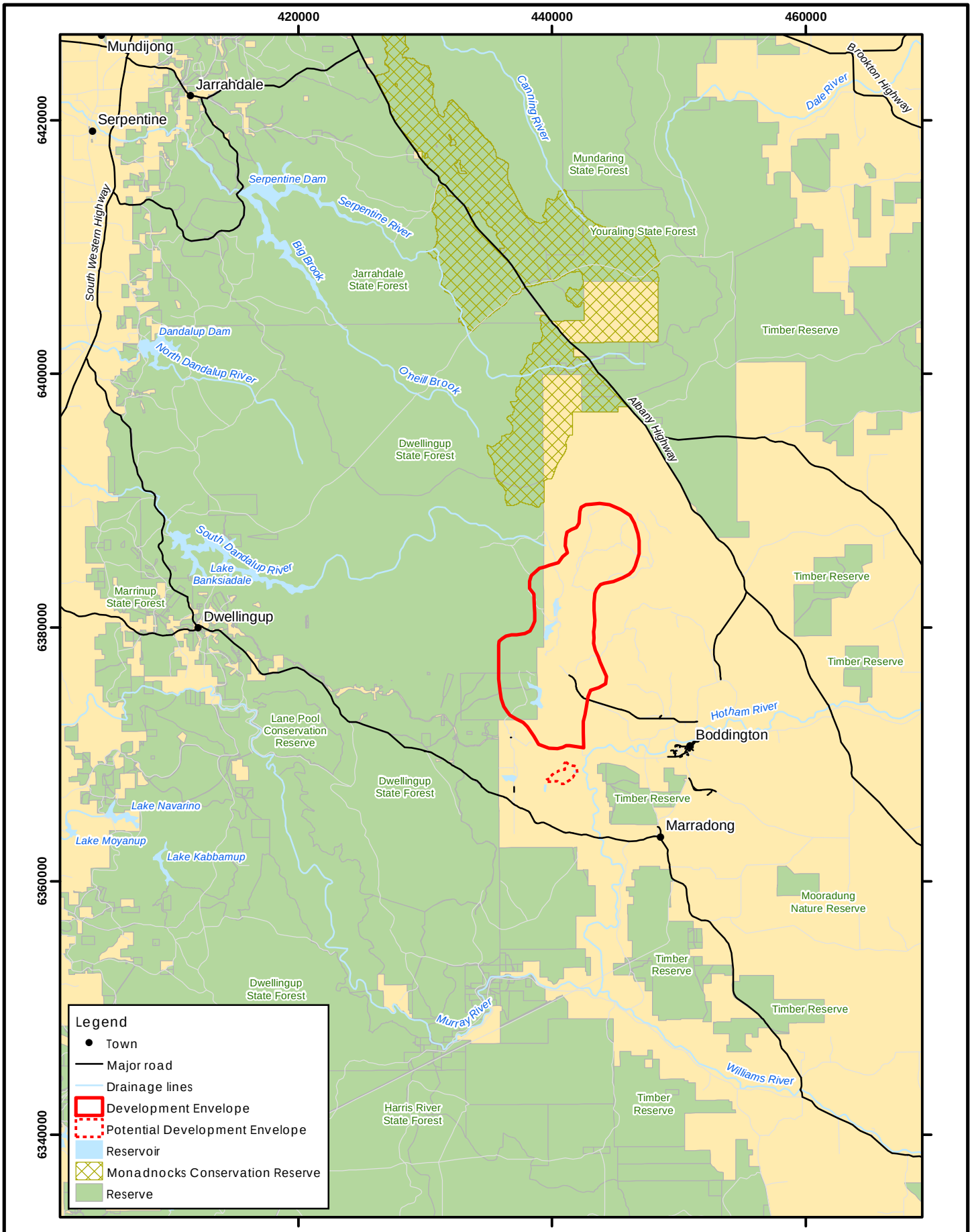

Figure 1 Proposal location

Regional Map

Source: ESRI 2006

STRATEGEN
info@strategen.com.au
www.strategen.com.au

Scale
0 2 4 6 8 10
Kilometres

N

1:400,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Reserves: Geoscience Australia 2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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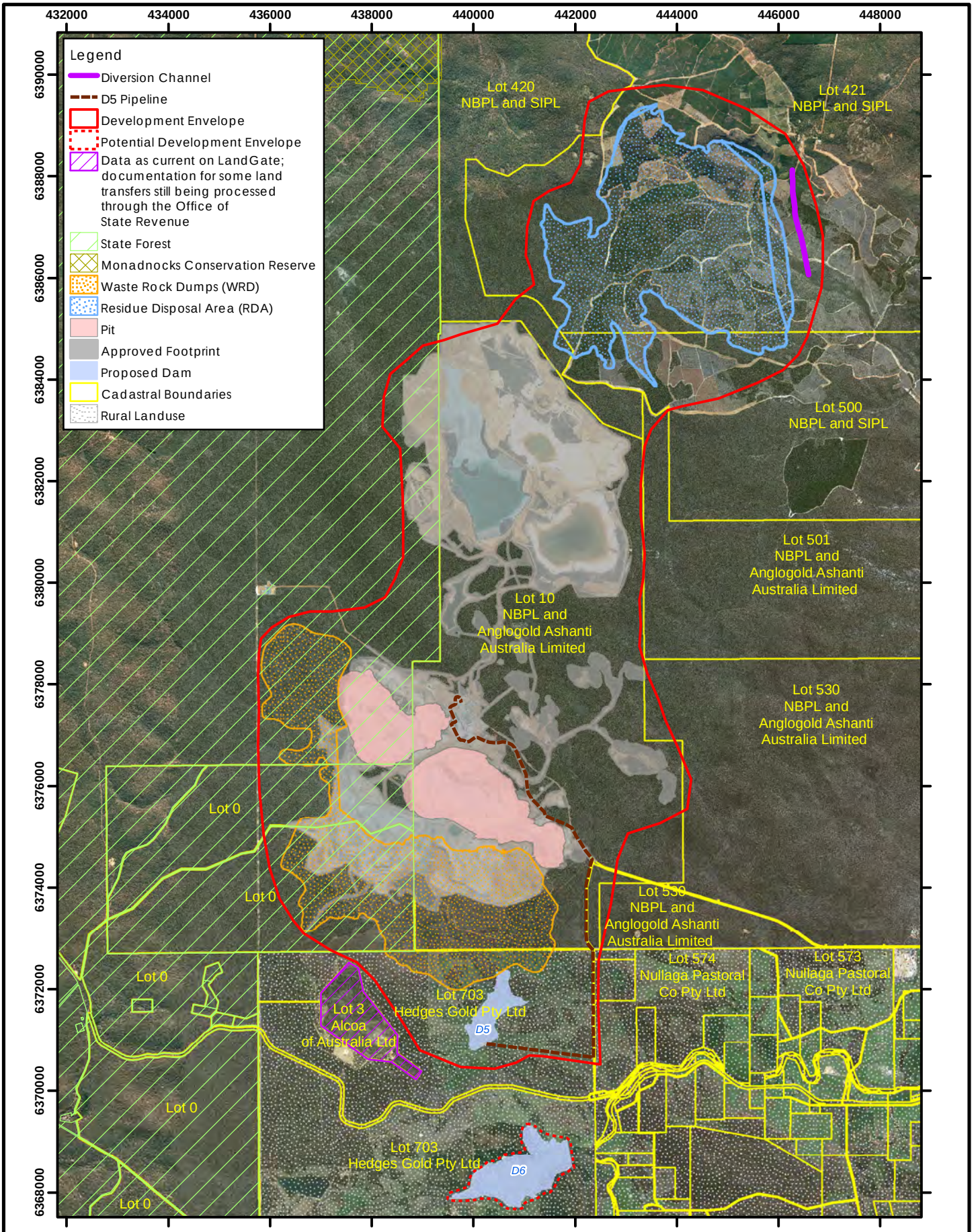

Figure 2 Tenure and surrounding land use

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: State Forest: DEC 2012. Mine layout & Cadastre: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F002.mxd

1.2 The Proponent

NBG is managed on behalf of the Newmont Boddington Gold Joint Venture (NBGJV) by the Proponent; NBGPL (ACN: 101 199 731). NBGJV ownership comprises:

- Newmont Boddington Gold Pty Ltd (ACN: 062 936 547), a wholly owned subsidiary of Newmont Mining Corporation: $66^{2}/_{3}$% share
- Saddleback Investments Pty Ltd (ACN: 134 978 224), a wholly owned subsidiary of Newmont Mining Corporation: $33^{1}/_{3}$% share.

The Proponent contact for the Proposal is:

Stephanie Myles
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Telephone: (08) 9423 6100
Email: *stephanie.myles@newmont.com*.

1.3 WA environmental impact assessment process

The Proposal was referred to the Environmental Protection Authority (EPA) under s 38 of the *Environmental Protection Act 1986* (EP Act) on 30 April 2012. On 11 June 2012, the EPA determined the level of assessment for the Proposal as Public Environmental Review (PER) with a four-week public review period.

The EPA issued the Environmental Scoping Document (ESD) for the Proposal on 19 October 2012.

This PER has been prepared in accordance with the EP Act *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*. The purpose of the PER is to present an impact assessment of the key environmental factors with the potential to be affected by implementation of the Proposal. The Environmental Impact Assessment (EIA) is based on conformance with the ESD, and various relevant EPA policy position statements and guidance documents.

Following a four-week public review, the EPA will provide the Proponent with a summary of, and copies of any submissions received. The Proponent will be required to respond to the summary of key issues and matters raised in the submissions, to the satisfaction of the EPA.

The EPA will assess the PER document, submissions, proponent response to submissions, and obtain advice from any other persons it considers appropriate and submit its assessment report to the Minister for the Environment.

The Minister for the Environment will subsequently publish the EPA report. As provided for under s 100(1)(d) of the EP Act, any person may lodge an appeal to the Minister against the findings or recommendations of the EPA assessment report within 14 days of publication of the report. Following determination of any appeals and consultation with decision-making authorities[1], the Minister will determine whether the Proposal should be implemented and if so, under what conditions.

The PER assessment procedure is outlined in Figure 3.

[1] Decision-making authority means a public authority empowered to make a decision in respect of any proposal, including any Minister prescribed as being the Minister responsible for that proposal;

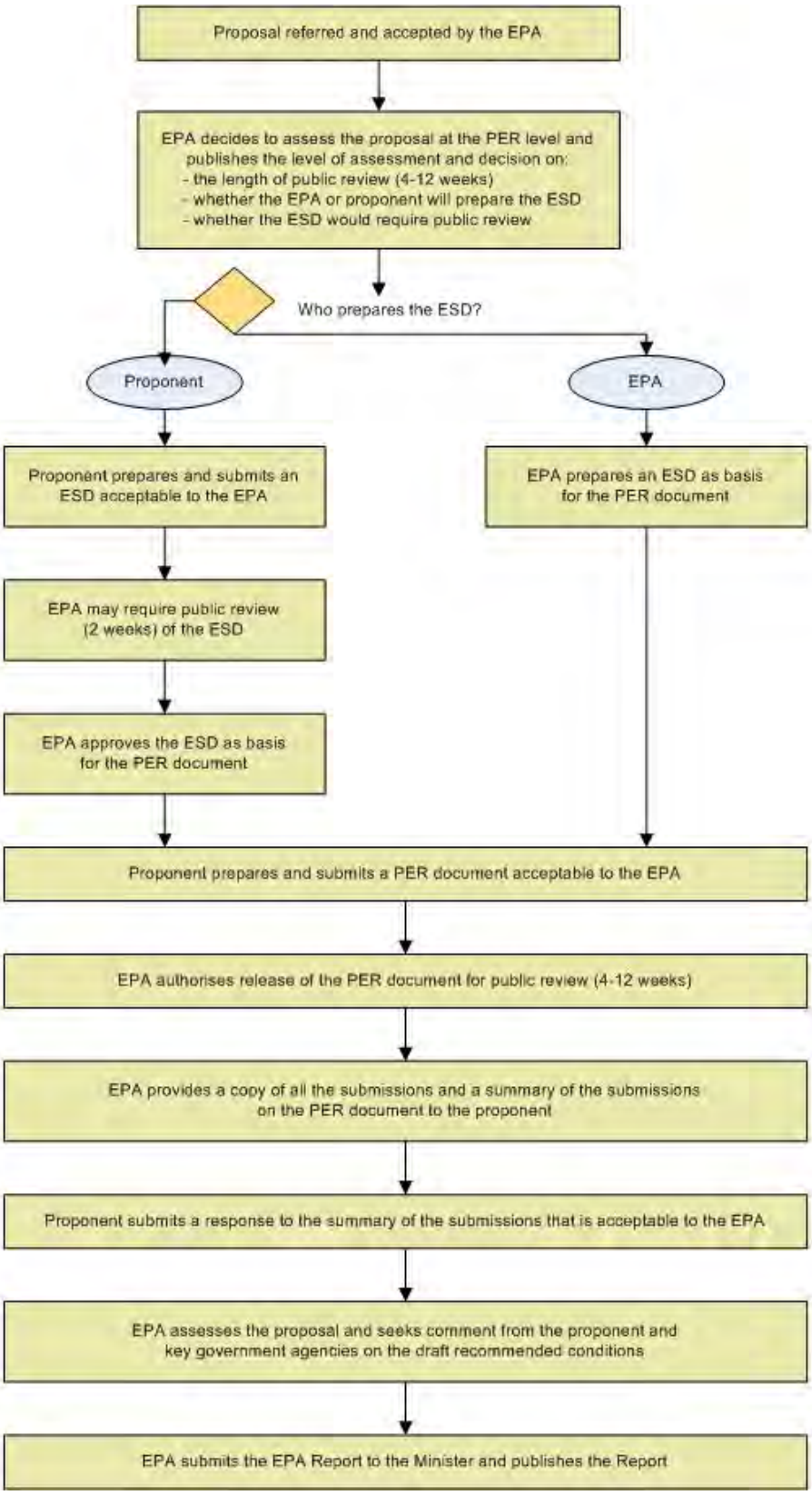

Figure 3 PER assessment procedure

1.4 Existing approval

The mine first commenced operations in 1987 and operated continuously until 2001 when it was placed under 'care and maintenance' pending a decision to initiate large-scale basement ore mining. The mine has undergone a number of changes since 1987 that have been assessed under the EP Act. These are listed in Table 1. The existing project as amended is referred to as the Original Proposal.

Table 1 Approvals under EP Act

Statement	Approval	Status of approval
Statement 19 (1988)	Worsley Alumina Pty Ltd 1988 for the Boddington Gold Mine Enhancement of Facilities	Superseded
Statement 20 (1988)	Alcoa of Australia Ltd in 1988 for the Hedges Gold Project	Superseded
Statement 49 (1988)	Worsley Alumina Pty Ltd in 1988 for Boddington Gold Mine Projects Expansion of Facilities Stage 2	Superseded by Statement 85 (1989).
Statement 85 (1989)	Worsley Alumina Pty Ltd in 1989 for Boddington Gold Mine, Mining and Processing of Supergene / Basement ores and consolidation and updates of Environmental Commitments	In conjunction with Statement 19 (1988).
Statement 100 (1990)	Section 46 amendment to conditions	Amendment to conditions in Statement 85 (1989).
Statement 299 (1993)	Worsley Alumina Pty Ltd in 1993 for Boddington Gold Mine, Development of Eastern Anomalies (700)	Amendment to conditions in Statement 100 (1990).
Statement 379 (1995)	Worsley Alumina Pty Ltd for a section 46 Amendment to conditions applying to proposals of conditions set between 1988 to 1993	Amendment replacing conditions in Statements 19 (1988), 49 (1988), 85 (1989), and 299 (1993).
Statement 450 (1997)	Hedges Gold Pty Ltd 1996, *Proposal for an increase in approved annual throughput from 2 Mtpa to 4 Mtpa — Section 46 Review*	Amendment replacing conditions in Statement 20 (1988).
Statement 453 (1997)	Worsley Alumina Pty Ltd Boddington Gold Mine, Extended Basement Operation	Amendment replacing conditions in Statement 379 (1995).
Statement 489 (1998)	Welker Environmental Consultancy 1996, *Boddington Gold Mine Proposed Extended Basement Operation (EBO) Consultative Environmental Review and Section 46 Review*	Amendment replacing conditions in Statements 19 (1988), 49 (1988), 85 (1989), 100 (1990), 299 (1993), and 379 (1995).
Statement 590, 591 and 596 (2002)	Welker Environmental Consultancy 2001, *Boddington and Hedges Gold Mines Boddington Expansion Shire of Boddington Section 46 Review and Gas-Fired Power Station and Natural Gas Pipeline 12 km Northwest of Boddington Environmental Protection Statement*	Statement 590: Amendment replacing conditions applicable to activities *other than mining* in Statements 20 (1988) and 450 (1997). Statement 591: Amendment replacing conditions applicable to mining in Statements 19 (1988), 49 (1988), 85 (1989), 100 (1990), 299 (1993), 379 (1995), 453 (1997), 489 (1998), 20 (1988), and 450 (1997).
Attachment 4 to Statement 591 (2006)	Strategen 2005, *Boddington Gold Mine Expansion. Section 45C Assessment of modifications to project: increase in nominal rated throughput and associated variations*	Current
Statement 591 (2012)	Newmont Boddington Gold 2012b, *Section 45C Assessment of modifications to project: Modification to pit boundaries and associated changes*	Current

There have been two key phases to the Original Proposal:

- original 'oxide' phase of the mine (previously referred to as Boddington Gold Mine [BGM]) and Hedges Gold Mine (HGM), which were developed as two separate mining operations
- current 'basement rock' phase of mining, which was originally assessed in two separate proposals in 1996, resulting in Statements 450 and 453 being published in 1997.

With acquisition of the Hedges mining area in 1998, a s 46 review was prepared and incorporated with an Environmental Protection Statement (EPS) in December 2001 (Welker Environmental Consultancy 2001) to review the elements of the operation. The EPS included modifications to the approved projects, development of a new gas-fired power station (including gas pipeline from Pinjarra to the mine) and rationalisation of existing statements. The EPS and s 46 applications were approved in May 2002, resulting in issue of Statement 591 for the mining operation and Statement 596 for the gas-fired power station and gas pipeline. The gas-fired power station project was not progressed and the approvals associated with this project have now expired.

The mine was placed into care and maintenance in December 2001. A further feasibility study and reassessment of the project was conducted between 2003 and 2005. This process identified a number of modifications to the mine that were addressed in an s 45C submission, which was subsequently approved on 21 March 2006. This revised proposal (the Original Proposal, as amended) was for a 15–20 year, 600 Million tonne (Mt) expansion with a processing rate of 35 Mt per annum (Mtpa) (with potential for an additional 15% through efficiency gains).

Ongoing resource development drilling around the Wandoo North and South pits and favourable adjustments to gold and copper prices increased the volume of identified ore beyond the approved pit outlines. As a result, an s 45C application was lodged in November 2011 for an 'interim permit' for minor expansions of the Wandoo North and Wandoo South pit footprints and to increase storage capacity of the southern boundary of WRD 7 and WRD 8 (Figure 4). This was approved by the EPA in February 2012 and a revised key characteristics table was issued (Attachment 4 to Statement 591). Statements issued prior to 2002 have been superseded by Statement 591 and subsequent statements. The Proposal layout is presented in Figure 4.

1.4.1 Relationship to mining neighbours

As shown in Figure 2, the Development Envelope is subject to *Mining Act 1978* (Mining Act) tenure by other mining companies. NBGPL owns the majority of land within the Development Envelope as freehold and has Mining Act tenure for resources excluding bauxite (Figure 5). A bauxite resource lies above the gold and copper resources. The bauxite resource typically occurs at shallow depths in the profile relative to the gold resources.

There are tenements relating to two prospective bauxite mining projects within or in close proximity to the Development Envelope:

- M258SA: BHP Billiton/Worsley Alumina Project
- ML1SA: Alcoa.

In addition to Mining Act tenure, the majority of the Development Envelope is within the BHP Billiton/Worsley Alumina (Worsley) mining envelopes as described in Figure 2 of Statement 719. Statement 719 expands a previous approval (Primary Bauxite Areas) with mining envelopes for the New Mining Areas covering approximately 75 000 ha, of which approximately 21% (or approximately 16 000 ha) was estimated to be a bauxite reserve. Figure 6 illustrates that the RDA is entirely within the Hotham North (from the Primary Bauxite Area) and Hotham North Extension (New Mining Area) of the Worsley project.

Under Statement 719, disturbance within mining envelopes has been approved provided Worsley undertake biodiversity investigations to describe the key biodiversity values to be protected. Specific environmental values identified in Statement 719 that have to be protected are:

- vegetation complexes which have less than 30% of their pre-European extent remaining
- Threatened Ecological Communities (TECs)

- heathland
- granite outcrops as identified in the biodiversity-related investigations
- naturally rare or restricted floristic communities, vegetation or ecological communities and key ecological linkages
- Threatened Flora, unless approved under the *Wildlife Conservation Act 1950* (WC Act)
- significant populations of Priority Flora
- significant areas of habitat for Threatened, Priority listed and other significant fauna, significant Short Range Endemic (SRE) fauna, and other significant invertebrate taxa
- stream zones considered to be sensitive water bodies, except for the construction and operation of stream crossings for haul roads, service roads, transport corridors, mine water supply and other infrastructure
- other important conservation values and habitats.

The Worsley Project was assessed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Department of Environment and Water Resources (now the Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC]) included additional conditions in EPBC Act Approval 2004/1566. These conditions related to the inclusion of species listed under the EPBC Act into the biodiversity investigations.

Statement 719 included offset provisions related to catchment and landscape enhancement for previously cleared land in the region. The offsets are to be funded up to $100 000 pa for the duration of mining of private land, for a maximum of up to 10 years.

Under private commercial arrangements, where NBGPL encounters bauxite within the Mining Act tenure, NBG preserves the bauxite, which entails delineation and stockpiling. Therefore, disturbance within areas covered by Part IV approvals under the EP Act for Worsley (i.e. the RDA) has already been assessed and offsets for the clearing specified. Further details on how the Worsley Part IV approval relates to the requirements for offsets are provided in Section 14.

1.4.2 Other WA environmental approvals

Other relevant environmental legislation includes:

- *Rights in Water and Irrigation Act 1914* (RIWI Act)
- *Conservation and Land Management Act 1984* (WA) (CALM Act)
- *Wildlife Conservation Act 1950* (WA) (WC Act)
- *Mining Act 1978* (WA) (Mining Act)
- *Aboriginal Heritage Act 1972* (WA) (AH Act).

1.5 Australian Government environmental impact assessment process

The Proposal has the potential to affect Matters of National Environmental Significance (MNES) protected under the EPBC Act. The EPBC Act provides that actions that have or are likely to have a significant impact on MNES require approval from the Australian Government Minister for Sustainability, Environment, Water, Population and Communities. The Proposal was referred to DSEWPaC on 30 April 2012 for consideration under the EPBC Act. On 02 July 2012, DSEWPaC advised that the action was considered a 'controlled action' under the EPBC Act (EPBC Reference: 2012/6370).

The Proposal will be assessed under the intergovernmental bilateral agreement between the Commonwealth of Australia and the State of Western Australia. The agreement provides for accreditation of the Western Australian EIA process to ensure an integrated and coordinated approach for actions requiring approval under both the EPBC Act and the EP Act.

435000 440000 445000 450000

6390000 6385000 6380000 6375000 6370000

Proposed RDA
F3 RDA
F1 RDA
R4 RDA
WRD#12
WRD#9
North Pit
South Pit
WRD#8
WRD#7
WRD#11
WRD#10
D5
Accommodation
D6

Figure 4 The Proposal

Scale 1:75,000 at A3

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N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 7/08/2013
Author: CAD Resources
Source: Topography: Geoscience Australia 2011.

Legend

- Diversion Channel
- D5 Pipeline
- Rehabilitated Area
- Waste Rock Dumps (WRD)
- Pit
- Residue Disposal Area (RDA)
- Approved Footprint
- Development Envelope
- Potential Development Envelope
- Proposed Dam

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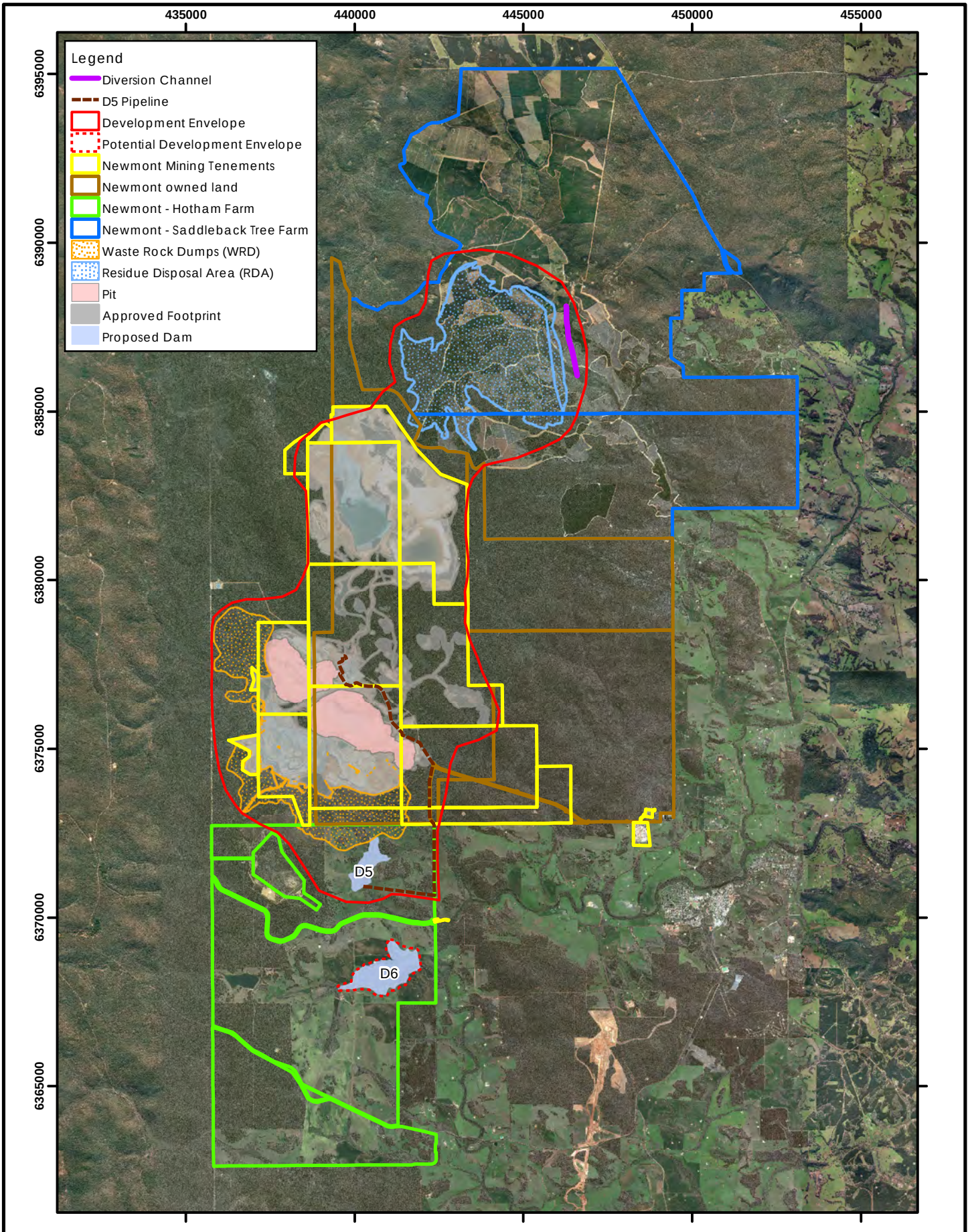

Figure 5 Property owned by NBG or under NBG mining tenement

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Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2013.
Note that positional errors may occur in some areas

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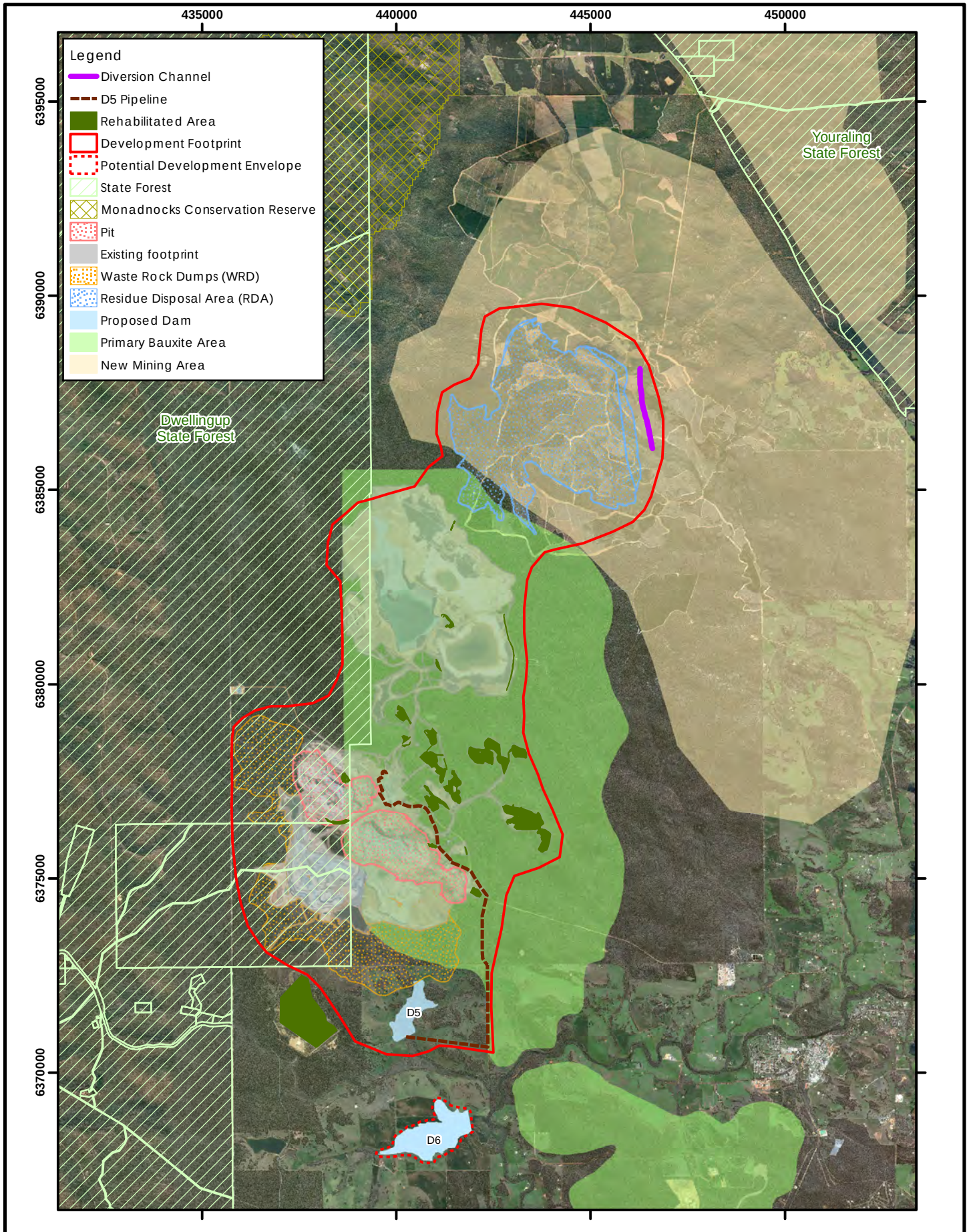

Figure 6 Extent of Worsley Part IV approval under Statement 719

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Scale

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Kilometers

1:130,000 at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: State forest: DEC 2012. New mining area & bauxite areas: Client 2003. All other data: Client 2012.
Note that positional errors may occur in some areas

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1.5.1 Previous approvals

The 2006 expansion, which included clearing of 250 ha, of remnant vegetation was referred to the (then) Department of the Environment and Heritage on 9 February 2006 (EPBC 2006/2591) with the decision (3 April 2006) that the project was not a controlled action, provided that the proposed action was undertaken in a particular manner. The referral described the following measures to minimise potential impacts on the listed threatened Carnaby's Black-Cockatoo and Baudin's Black-Cockatoo:

1. Areas disturbed by mining-related activities will be revegetated with endemic species with the aim of providing foraging and longer-term potential nesting habitat for black cockatoos.
2. Pre-clearing surveys will be undertaken to identify high value trees and hollows. To the extent practicable, high value trees and hollows will be relocated to areas not disturbed by mining operations.
3. Fauna drinking points will be established away from mining operations.
4. In collaboration with the WA Museum and the Department of Conservation and Land Management (now Department of Environment Regulation [DER]), Boddington Gold Mine Management Company Pty Ltd (now NBGPL) will:
    - extend current work on establishing artificial nesting boxes in the Boddington area
    - develop and implement programs to manage competition to black cockatoos for nesting and breeding sites
    - monitor habitat usage by black cockatoos within the mining lease area to assist the development and implementation of species recovery programs.
5. In consultation with the Department of Parks and Wildlife (DPaW), high value privately-owned bushland will be purchased and vested to the State for incorporation into the Western Australian conservation estate.

In 2011, the requirement for an Interim Permit was referred to DSEWPaC. The Interim Permit was for minor extensions and modifications to the existing mining operation to enable mining to continue while this Proposal was in preparation. These minor modifications included:

- adjustment of pit boundaries requiring the clearing of 13.5 ha of native vegetation
- additional waste rock storage on WRD from previous operations
- modifications to drainage around WRD requiring clearing of 5.5 ha of native vegetation.

The Interim Permit was considered to be a Controlled Action (2011/6192) and was assessed through Preliminary Documentation.

1.6 Current operations

NBG is a substantial gold and copper project targeting low-grade hard rock ores lying beneath existing pits mined during past operations. Current operations of the Original Proposal, as amended, include:

- mining of the Wandoo North and Wandoo South open pits
- active WRD
- accommodation village and sewage treatment plant
- operation of the overland conveyor bisecting the Wandoo North and Wandoo South pits as it transports crushed ore from the primary crusher to the processing plant
- processing of up to 35 Mtpa plus 15% efficiency gains
- explosives manufacturing and storage facilities
- water supply reservoirs
- pipelines and a pump station to pump water from the Hotham River
- RDAs F1/F3 and R4 (the latter only used to store water during the current phase of operations) with associated infrastructure
- ancillary facilities including workshops and refuelling facilities.

The footprint and layout of the Original Proposal as amended are shown on Figure 4. Power supply for the mine and processing plant is taken from the Western Power grid.

Regarding voluntary codes of conduct, NBGPL is a signatory to a number of sustainability initiatives including the Minerals Council of Australia's framework for Sustainable Development, Enduring Value, and the International Cyanide Management Code. All sites within the Australia New Zealand Region (including Boddington) are certified against the international standard for Environmental Management Systems, ISO14001. NBGPL also holds its operations to internal global Environmental, Social Responsibility and Health, Safety and Loss Prevention Standards.

1.7 Rationale for Proposal

The current Life of Mine (LOM) plan for NBG is significantly larger in terms of ore and waste quantities and overall metal production than was envisaged during the Feasibility Study Update project conducted from 2002–2005 that anticipated a mine life of 15–20 years. The operation will consequently require additional footprint to that approved in 2006. The proposed expansion requirements will allow the operation to continue to operate until 2041.

The Proposal will provide long-term employment opportunities within the southwest of WA. Construction and operation of the Proposal will generate significant economic revenue for the Boddington shire with flow-on effects for local industries.

1.8 Purpose and scope of this document

This document is a PER and has been prepared in accordance with the EP Act *Environmental Impact Assessment (Part IV Divisions 1 and 2) Administrative Procedures 2012*.

The purpose of this document is to present a description of the key components, environmental aspects, EIA, and mitigation measures associated with the Proposal, for consideration by the EPA at the level of PER. This PER includes:

- a description of the existing environment
- a detailed description of the Proposal
- a description of the stakeholder engagement and consultation process undertaken for the Proposal
- a factor-by-factor assessment of the environmental impact of the Proposal
- a description of key environmental management measures and controls and expected environmental outcomes
- a strategy for the provision of offsets for any significant residual environmental effects.

Identification and assessment of factors has been guided by the ESD, as prepared by the EPA.

1.9 Project study team

Preparation of this PER has utilised a range of specialist consultants as listed in Table 2.

Table 2 Project consultants

Consultant	Role
Strategen Environmental Consultants Pty Ltd	Environmental impact assessment
Ninox	Terrestrial fauna survey
Murdoch University (Dr. Finn)	Black-Cockatoo studies
Wetland Research and Management (WRM)	Aquatic biology surveys
Outback Ecology	Short range endemic and invertebrate fauna surveys, subterranean fauna, residue decommissioning and landform slope design, closure
Mattiske Consulting Pty Ltd (Mattiske)	Flora and vegetation
Glevan	Dieback survey
Schlumberger Water Services	Residue Disposal Area (RDA) catchment study, water balance, acid rock drainage (ARD) assessment, groundwater and surface water modelling
Golder Associates	Site water balance
Graeme Campbell and Associates	ARD geochemical assessment
Metago Environmental Engineers (Metago)	Landform surface water drainage
DumpSolver	waste rock dump design and configuration
Ecoscape	Visual amenity
ECS	Air quality modelling
Lloyd George Acoustics	Noise modelling
Yates Heritage Consultants	Aboriginal heritage

2. Overview of receiving environment

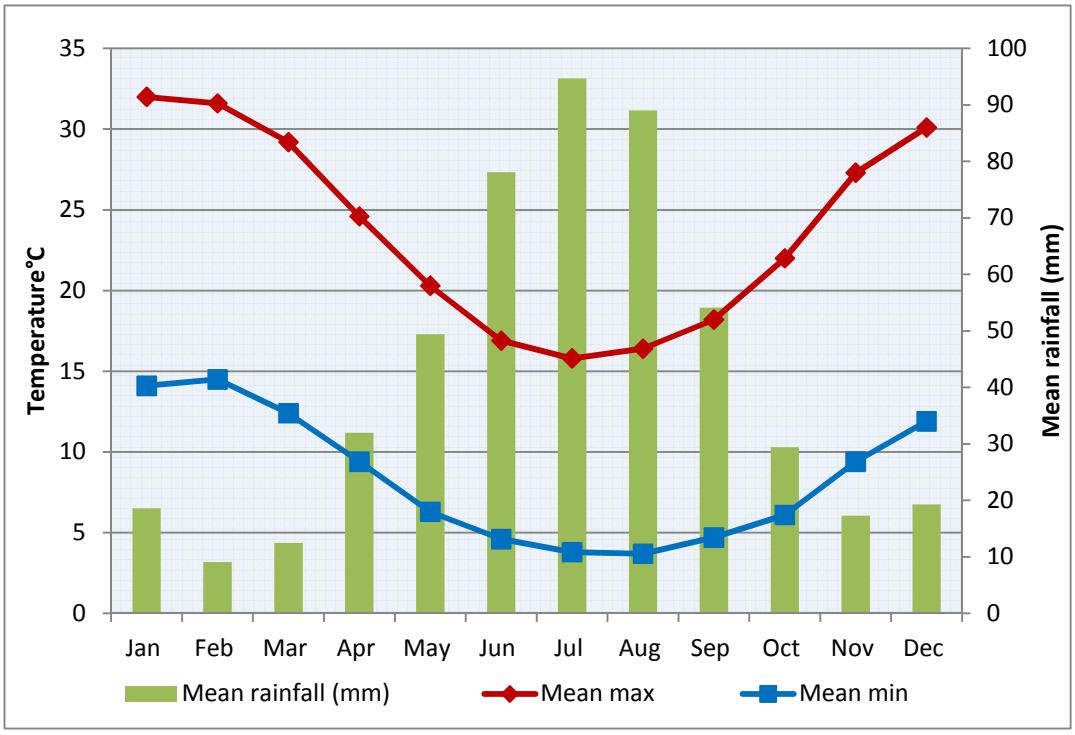
2.1 Bio-physical setting

2.1.1 Climate

NBG is located in the Peel region in the southwest of Western Australia, within the temperate climate zone of Australia. The region experiences four distinct seasons and is characterised by warm to hot, dry summers, and cool, wet winters. Maximum summer temperatures typically exceed 30°C, while overnight winter temperatures are typically less than 10°C, as shown on Figure 7 for the Wandering Monitoring Station, approximately 23 km east of the mine (BoM 2012).

Climate data has been collected from the site meteorological station on Communications Hill since 1984. Data shows that the average (1984–2010) annual rainfall for the site is 752 mm, of which 75% (564 mm) occurs in winter. The wettest year recorded was 1996 with 990 mm, while the driest occurred in 2010, with 406 mm of rainfall. The highest daily precipitation recorded in the period 1984–2010 was 62 mm on 25 June 2005.

The majority of rainfall occurs over winter, with half the total rainfall received between June and August, on average (BoM 2012).



Source: BoM 2012

Figure 7 Climate averages for Wandering

2.1.2 Geology

NBG is situated on the Darling Plateau, within the Yilgarn Craton (Figure 8). The NBG gold-copper deposit is located in the Saddleback Greenstone Belt (SGB); a fault-bounded sliver of greenstones about 50 km long and 8 km wide, bounded by granite and gneiss terrain (Coffey 2010).

The SGB mine area is subdivided into three formations, from oldest to youngest:

- metabasaltic lavas and related gabbroic intrusions of the Marradong Formation (northern SGB)
- felsic to intermediate volcanics and related intrusions of the Wells Formation, main host to the NBG gold-copper mineralisation (northern SGB)
- metasedimentary rocks of the Hotham Formation (southern SGB).

The NBG mineralised system is predominantly confined to the intermediate volcanic zone of the Wells Formation.

Extensive weathering of the basement geological units has resulted in a profile with the following strata:

- a lateritic surface layer of approximately 5–10 m thick
- a clay zone underlying the laterite of approximately 60–80 m thick (reduced or absent on eroded hill slopes)
- chemically weathered saprolite underlying the clay zone, approximately 15 m thick
- bedrock with the top 10–15 m locally broken and weathered (Schlumberger 2013).

Surface soils of the Darling Plateau are sandy and/or gravelly lateritic gravels. The majority of the mine is covered by lateritic gravels. Topsoil and subsoil gravels from the mine are typically acidic, with approximately 5% organic carbon, and low salinity and nutrient levels (Coffey 2010).

2.1.3 Surface water

The central part of the Darling Plateau is dissected by several major watercourses and their tributaries, which originate to the east in agricultural land. Drainage is intermittent and the quality of water varies from fresh to saline. All current NBG operations are located within the catchment of Thirty Four Mile Brook, a tributary of the Hotham River (Figure 9). The Hotham River flows in a southwesterly direction into the Murray River. Thirty Four Mile Brook contributes approximately 0.4% of the water to the Hotham River (Aquaterra 1999).

The Hotham River has a catchment of 3963 km^2 (Golder 2005). The Hotham River catchment includes the sub-catchment of Thirty Four Mile Brook (Figure 9). Flows at the Hotham River gauging station at Marradong Road Bridge indicate an average annual flow of 101 800 megalitres per annum (ML/a) between 1966 and 2011. Flows are variable between years and highly seasonal, with flows occurring predominantly between June and September.

Additional surface water information can be found in Section 8.

2.1.4 Groundwater

Groundwater in the vicinity of NBG is contained within two main systems; a seasonal shallow groundwater system (upper aquifer) and a deeper weathered and fractured bedrock groundwater system (lower aquifer) (Schlumberger 2010) (Figure 10).

The upper aquifer is located within the lateritic horizon, perched above the underlying clays. This aquifer is highly responsive to rainfall infiltration and groundwater elevations tend to change rapidly with no consistent regional trends or responses to mining operations. The main discharge is to alluvial sediments along creek channels, with groundwater flow generally following surface topography and contributing to winter base flow of creeks and streams. Some vertical discharge is likely to occur through higher permeability zones in the form of relict dykes. These zones act as vertical conduits allowing some water to leak down to the lower bedrock aquifers (Aquaterra 1999).

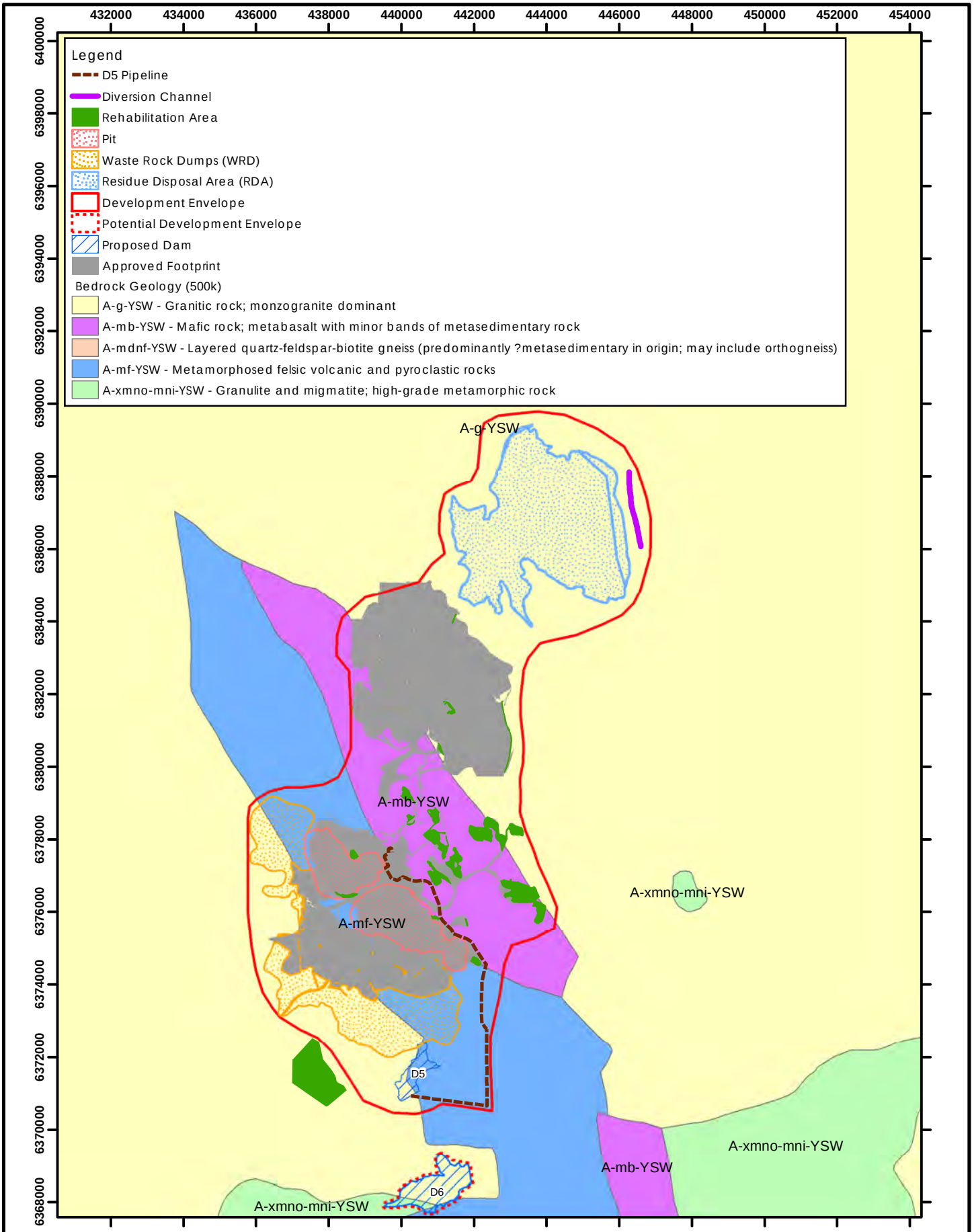


Figure 8 Regional geology

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Scale
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Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Mine layout & aerial image: Client 2011-2012. Geology: DMP 2008.
Note that positional errors may occur in some areas

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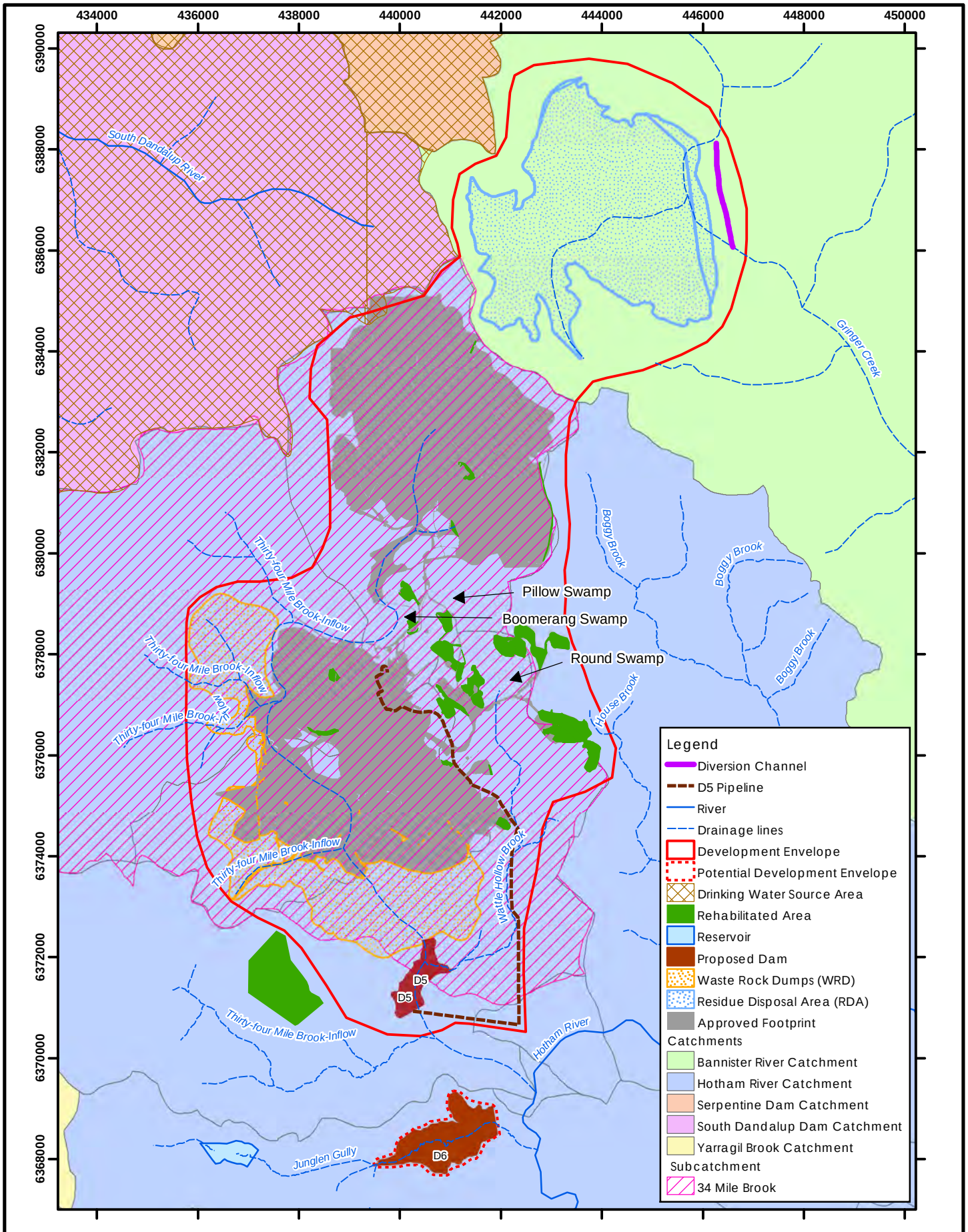

Figure 9 Rivers and catchments

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Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Catchments & PDWSA: Department of Water 2012.
Mine layout, reservoirs, rivers: Client 2011-2012.
Note that positional errors may occur in some areas

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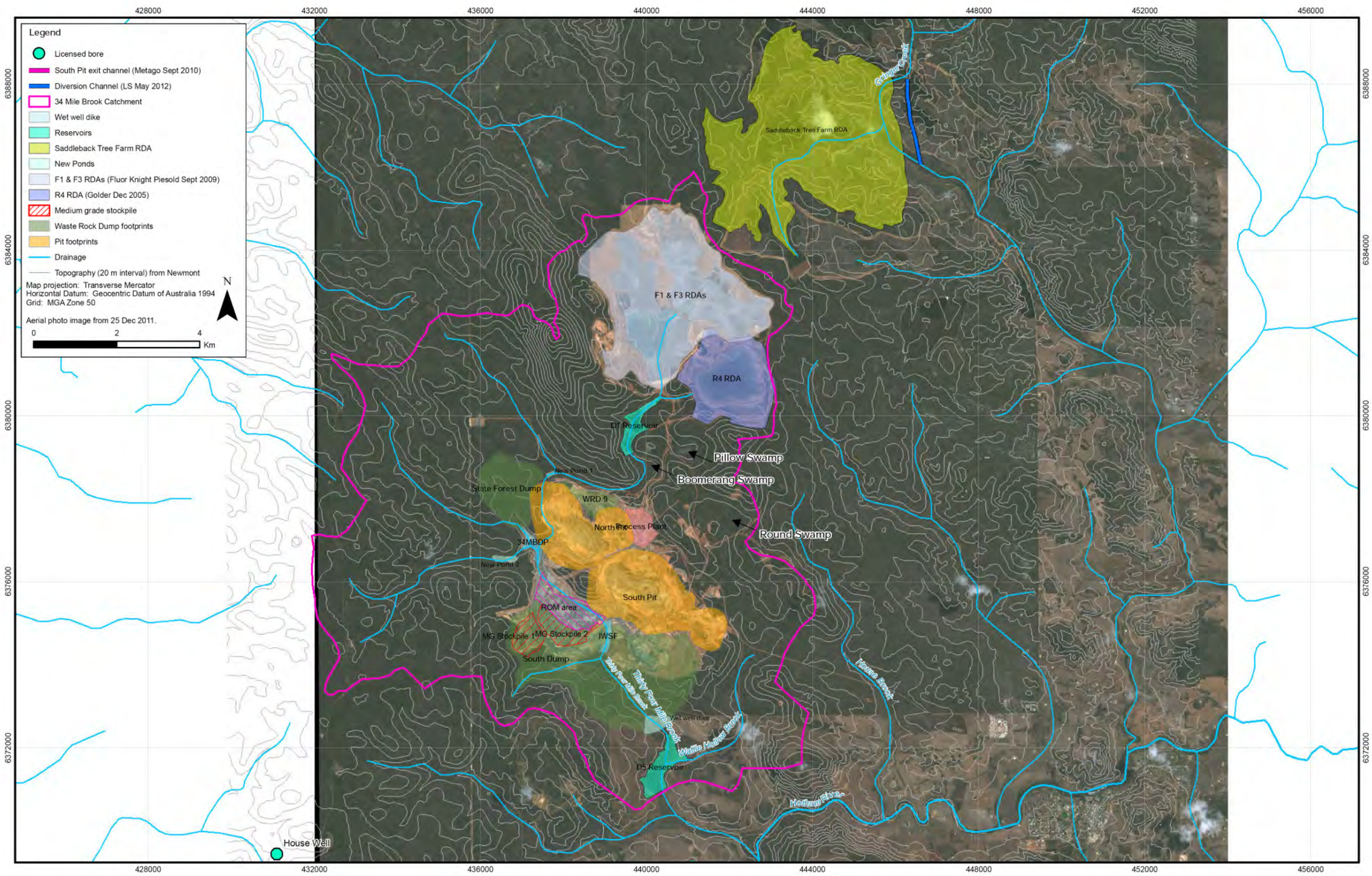

Note: Reproduced from Schlumberger 2013

STRATEGEN	Newmont Boddington Gold Life of Mine Expansion Project Regional hydrogeology	Figure 10

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The main regional aquifer is present in the lower weathered clay and rock (saprolite), and bedrock horizons. Permeability of the aquifer is associated with geological structures in the rock; such as shearing, veining and faulting. Although the aquifer appears to have significant storage capacity, its fractured rock nature means that horizontal movement of water through the aquifer is generally slow. Groundwater flow is predominantly to the south, following the overall strike of the regional geological structure (Aquaterra 1999).

Pre-mining records show groundwater salinities in the shallow aquifer across the Thirty Four Mile Brook catchment to have ranged from 1000 mg/L to 3000 mg/L total dissolved solids (TDS) (Schlumberger 2010).

Additional groundwater information can be found in Section 7.

2.2 Biological setting

NBG is located in the Jarrah Forest Biogeographic Region and Northern Jarrah Forrest Subregion as per the Interim Biogeographic Regionalisation for Australia (IBRA) (Environment Australia 2000). The biological setting has been characterised through a range of biological surveys conducted in and around NBG. These surveys have focused on recording species present as well as identifying species and communities of conservation significance. The key surveys in the area are detailed in Table 3.

Table 3 Biological surveys conducted in the vicinity of the Proposal

Survey	Reference
Vegetation and flora	
Review of Flora and Vegetation Located in the Boddington Gold Mine and Hedges Lease Areas	Mattiske 2005
Assessment of the Wetlands on the Boomerang, Pillow and Round Swamps	Mattiske 2010
Desktop Flora and Vegetation Survey of Sotico Survey Area June 2011	Mattiske 2011
Threatened and Priority Flora Assessment of the Hotham Pipeline and Hedges Dam	Mattiske 2012a
Flora and Vegetation of the Sotico Survey Area	Mattiske 2012b
Riparian ecology	
Hotham River — Ecological Water Requirements and Ecological Sustainable Yield Downstream of Tullis Bridge	WRM 2011
Thirty Four Mile Brook Ecological Monitoring Aquatic Fauna September 2010 / August 2011	WRM 2012a
Gringer Creek Baseline Aquatic Fauna Sampling October 2011	WRM 2012b
Terrestrial fauna	
Sotico Pty Ltd Boddington Plantation Expansion – Fauna Assessment	Biota 2003
Assessment of Habitat Values for Black Cockatoos within the Eastern Acquired Lands at Newmont Boddington Gold Mine	Finn 2011
Assessment of Habitat Values for Black-Cockatoos within selected sites at Newmont Boddington Gold Mine	Finn 2012
Waste Rock Dump & Residue Disposal Area Expansion: Phase 1 Terrestrial Short-range Endemic Invertebrate Fauna Desktop Assessment	Outback Ecology 2011
Terrestrial Short-ranged Endemic Invertebrate Fauna Baseline Survey	Outback Ecology 2012a
Waste Rock Dump & Residue Disposal Area Expansion: Subterranean Fauna Desktop Assessment	Outback Ecology 2012b
The Vertebrate Fauna of the Boddington Gold Mine	Ninox 2003
Vertebrate Fauna Survey within Newmont Boddington Gold Mine, An assessment of potential waste rock disposal areas	Ninox 2012a
Vertebrate Fauna Survey within Newmont Boddington Gold Mine, An Assessment of potential residue disposal areas	Ninox 2012b

2.2.1 Flora and vegetation

NBG is located within the Darling Botanical District of the Southwestern Botanical Province and is largely characterised by open forests of *Eucalyptus marginata* (Jarrah). Other dominant species include *Corymbia calophylla* (Marri) and *Eucalyptus wandoo* (Wandoo). The diversity of the area is greater than western jarrah forest areas as the flora reflects the interface between eastern sections of the northern jarrah forest and the Wheatbelt region (Mattiske 2005).

Wide-ranging landform and soil types also play an important role in plant distribution and increased species diversity. Site conditions range from clay-loam valley systems to upland lateritic hills to shallow granitic soil associated with the SGB (Mattiske 2005).

Local flora and vegetation types recorded in the NBG area are generally well represented at a regional scale. However, a few species are restricted to the Boddington area and are considered to be of local and regional significance. These species generally occur in plant communities associated with shallow granitic soils (Mattiske 2005).

Further flora and vegetation information can be found in Section 9.

2.2.2 Fauna

Fauna surveys and monitoring have been conducted in the Boddington mine area since the early 1980s, including a baseline study in 2001/02 (Ninox 2003). A Level 1 desktop fauna assessment has also been undertaken in the vicinity of the current RDA area (Biota 2003). The area has been assessed for Black-Cockatoo habitat (Finn 2011), and a detailed habitat assessment of the land subject to the interim project has also been undertaken (Lee 2012a). Desktop assessments have been completed for short-range endemic (SRE) invertebrates (Outback Ecology 2011, 2012a) and subterranean fauna (Outback Ecology 2012b). Additional fauna surveys have been completed over 2011 and 2012 for terrestrial fauna (Ninox 2012a, 2012b), aquatic fauna (WRM 2012a, 2012b) and SRE invertebrates (Outback Ecology 2012a).

Fauna surveys have identified a total of 14 native mammal species, 22 reptile species, 14 frog species, and 91 species of native birds. Most of the species in relevant surveys were common to the 1980s and 2001/02 surveys; some species (most notably birds) were unique to either survey. Six introduced species were identified, with the feral pig being the most common.

Riparian vegetation was surveyed by Mattiske Consulting (2005) to define vegetation complexes, their zonation and elevation relative to water level, with comment on their differing water requirements. In general, the health and vigour of riparian vegetation is maintained by the flow regime. Factors that are affected by flow regimes and are known to influence riparian vegetation include: bank soil moisture content; the proximity of groundwater to the root zone; and, the period and season of flooding that inundates the floodplain and riparian vegetation (WRM 2011).

Further information about fauna including additional baseline surveys that have been completed for the Proposal can be found in Section 10.

2.3 Socio-economic setting

NBG is situated in the Shire of Boddington, approximately 120 km southeast of Perth. The nearest residence to the mine is approximately 7 km away, located on Hotham Farm. The town of Boddington is approximately 12 km southeast of the mine. The mine is located primarily on freehold land owned by NBGPL with a portion located in state forest (to the west of the mine). State forest is managed for plantation and natural forestry, conservation, water supply and recreation. Much of the land to the south of the mine has been cleared for agriculture and is used for grazing and cropping (freehold farmers). A mixture of pine and eucalypt plantation and private forest occurs to the north and east.

At the end of 2012, NBG was the largest gold producing operation in Australia. At year-end 2012, NBG had a permanent workforce of 1005 with an additional 768 contractors (this number includes long-term maintenance contractors) of which approximately 5% identified as Indigenous and 9.3% were female. NBG has an aim for 100 indigenous employees on site and numbers increased from 68 in 2011 to 84 in 2012. Approximately 27% of our permanent employees live within 50 km of the Boddington town centre. The remainder is based at the accommodation village on the mine lease on a drive-in drive-out basis. NBGPL has incentives in place to encourage its employees to live in communities within a 50 km radius of Boddington.

In 2012, NBG contributed a total local and national spend on goods and services of $1 380 975 000. If additional aspects such as community investment, taxes, government royalties, royalties paid to third parties, land use payments and payroll are included the total value added to the Australian economy in 2012 was $1 619 998 000.

2.3.1 Native title agreements

A Community Partnership Agreement (CPA) was reached on 16 August 2006 between the Gnaala Karla Booja People (GKB), NBGPL, and the South West Aboriginal Land and Sea Council (SWALSC). It has a current expiry date of 31 December 2025, which can be amended as agreed between the parties. It covers all operations on current mining leases, future exploration tenements, infrastructure titles, mining leases and general purpose leases. The CPA takes future expansions into account with an agreement to negotiate with a genuine regard to each other's interests and expectations.

A Preservation of Aboriginal Heritage Agreement between the Gnaala Karla Booja Native Title Group, SWALSC and NBGPL was prepared by SWALSC in 2007. The agreement sets out processes for:

- communication and consultation
- preservation of Aboriginal heritage
- preservation of Aboriginal sites and objects.

Aboriginal heritage sites identified in surveys have been registered with the Department of Indigenous Affairs.

2.3.2 Land use

Land required for the Proposal is predominantly vegetated jarrah forest and pine plantation. Within the vicinity of the Proposal, land is primarily held as either freehold land or is within the Dwellingup State Forest. Pine and blue gum plantations are located on freehold land within the Development Envelope. The other dominant land use on freehold land in the area is farming (grazing and cropping).

NBGPL and Saddleback Investments Pty Ltd recently purchased Hotham Farm and the Saddleback Tree Farm plantations (previously Sotico plantations) to the south and northeast of the mine respectively. With purchase of the plantations, the Proponent has also taken over the contracts associated with the plantations.

The Bibbulmun Track is a nationally significant recreational walking trail within the State Forest component of the land within the Development Envelope. The Proposal will potentially intersect the present location of the Bibbulmun Track, which will require diversion of this section of the track.

3. Description of Proposal

3.1 Development overview and key characteristics of Proposal

The latest LOM plan involves expansion of existing operations at NBG and will result in the following changes to the current mine:

- expansion (widening and deepening) of the Wandoo North and South open pits
- increased ore production and increased waste quantities requiring both the expansion of existing and construction of an additional WRD adjacent to the pit with a final combined capacity of up to 1500 Mt
- an increase in size of existing stockpiles (gravel, topsoil and bauxite) and development of additional ancillary infrastructure
- an increase in overall metal production requiring the construction of a second RDA and associated infrastructure to provide additional tailings storage of 600 Mt
- construction of additional water storage dams and associated infrastructure to replace the water storage dam (D4) which will be covered by the new waste rock dump
- potentially extending mine operations and processing operations to approximately 2041.

The key characteristics of the Proposal are summarised in Table 4. This table has been developed in accordance with the *Environmental Assessment Guideline for Defining the Key Characteristics of a Proposal Environmental Protection Act 1986* (EPA 2012a). The format and content of the table includes rationalisation of items that are now covered under other legislation or regulations. As the project definition has been refined, the table has been revised from the one prepared for referral of the Proposal.

Table 4 Key characteristics table

Proposal title	Newmont Boddington Gold Mine Life of Mine Extension	
Proponent name	Newmont Boddington Gold Pty Ltd	
Short description	The Proposal is for an expansion of the existing operations at the Newmont Boddington Gold Mine and includes: • pit expansion • increased ore production resulting in increased waste quantities • increased existing stockpiles and development of additional ancillary infrastructure • expanded waste rock dumps (WRD) • construction of a new residue disposal area (RDA) • construction of new water storage areas.	
Relevant characteristics	Current approval	This Proposal
Physical elements		
Mine activities	Open cut basement mining to approximately -125 m AHD	Open cut basement mining to approximately -252 mRL for the north pit and -432 mRL south pit
Waste rock dump (WRD)	820 Mt of waste rock	Approximately 1500 Mt waste rock dump as shown in Figure 4
Residue disposal area (RDA)	Residue disposal capacity of 600 Mt	Construction of a second RDA to provide a combined residue disposal capacity of approximately 1200 Mt as shown in Figure 4
Disturbance footprint	Total cleared footprint of 3679 ha	Total cleared footprint of up to approximately 6520 ha within Development Envelope in Figure 4, including up to approximately 1755 ha of additional clearing of native vegetation.

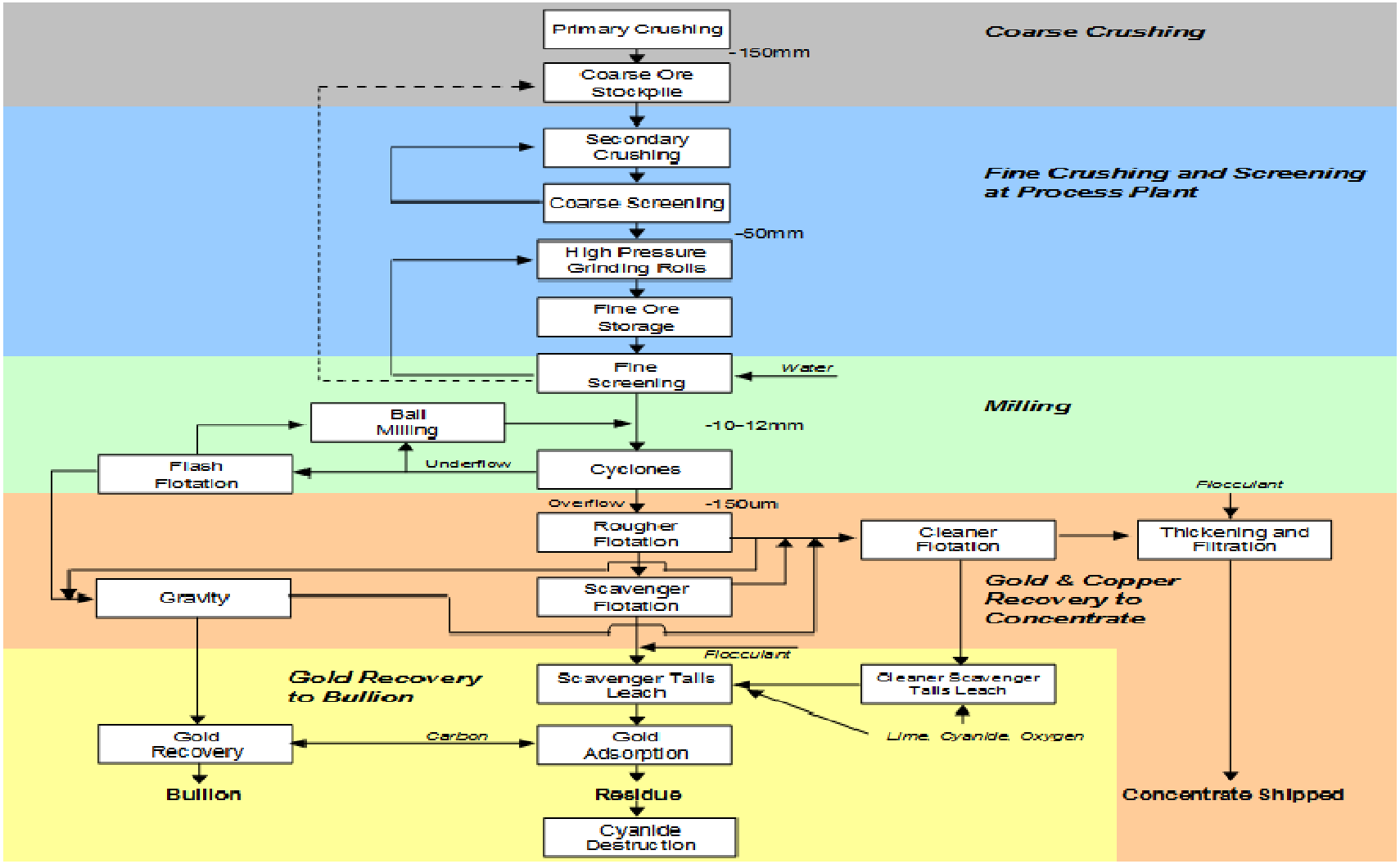
Proposal title	Newmont Boddington Gold Mine Life of Mine Extension	
Water dams	D1 and D4 Dam with capacity of 1300 ML each	D4 Dam to be decommissioned Construction of D5 Dam and potentially D6 Dam as shown in Figure 4
Operational elements		
Mine life	15–20 years	Continued operation to ~ 2041
Water use	47 ML/day	Up to 47 ML/day
Processing	Up to 35 Mtpa with potential for further increase of up to 15% through efficiency gains	Not an environmental factor, to be removed

3.2 Exclusions from the Proposal

The Proposal covers the proposed mining and operation of the NBG. It does not cover operation of the pastoral land or plantations held by NBGPL. The Proposal is an extension proposal; and as such, this assessment does not cover areas or activities subject to previous approvals.

3.3 Mining process

The mining and processing of ore will be in accordance with existing procedures as shown in Figure 11.



STRATEGEN

Newmont Boddington Gold Life of Mine Expansion Project

Mining process flow diagram

Figure 11

3.4 Components of Proposal

3.4.1 Vegetation disturbance

The current approved operation includes a disturbance footprint of 3679 ha. The expansion operations will require an additional footprint of up to 2895 ha over the next 15–20 years. This includes clearance of up to 1755 ha of native vegetation and will bring the overall footprint of NBG up to 6520 ha. As detailed in Table 5, the majority of the clearing will be for the new RDA and expansion of WRDs.

Table 5 Indicative disturbance area

Project Component	Native vegetation				Hotham Farm: cleared or degraded (ha)	Plantation (ha)	Total (ha)
	State Forest (ha)	Private forest (ha)	Hotham Farm (ha)	Total (ha)			
Initial Clearing							
Pit expansion	20	2	0	22	0	0	22
WRD expansion	349	205	7	561	23	0	583
Stockpiles	76	23	0	99	7	0	106
Existing RDA	0	12	0	12	0	0	12
Drainage and other earthworks	173	98	0	271	29	0	300
Water supply storage dams	0	0	0	0	220	0	220
Totals:	**618**	**340**	**7**	**965**	**280**	**0**	**1244**
Deferred Clearing							
New RDA	0	790	0	790	0	860	1650
Totals:	**618**	**1130**	**7**	**1755**	**280**	**860**	**2895**

3.4.2 Mining

The Proposal is to enable continuation of the existing mining process. This Proposal will deepen and widen existing mine pits, increasing the depth of the pits from -125 mRL to approximately -252 mRL for the north pit and -432 mRL for the south pit. To support the increased depth, the pits will be widened to ensure pit wall stability and safety. With widening of the existing pit, some existing access roads, power line corridors, setbacks, WRDs, stockpiles and drainage structures will have to be relocated outside the expanded pits.

To ensure ore can be accessed safely, the pit will continue to be progressively dewatered. All water from the dewatering process is captured and used for processing. There will not be any discharge of water captured from dewatering.

The mining method will continue in accordance with existing operations.

3.4.3 Ore production and processing

The Proposal will continue to use existing ore processing facilities and procedures. The Proposal is expected to result in an increase in the processing rate from 35 Mtpa +/- 15% efficiency gains to approximately 40 Mtpa +/- 15% efficiency gains. Ore processing methods will continue in accordance with existing operations.

The existing processing method involves primary crushing at the mining operation, then transportation of the ore by conveyor to the processing plant for secondary and tertiary crushing. Crushed ore is then slurried with water, ground into finer particles by ball milling to liberate the valuable minerals and introduced to the flotation circuit to generate a copper-gold concentrate for export. The concentrate is thickened and filtered, prior to transport to the Bunbury port by trucks.

The flotation tailings stream is thickened and leached in elevated cyanide leach circuits, where it undergoes a conventional leach/adsorption process using activated carbon to recover the gold from solution. Residual cyanide is removed from the tailings of the carbon in leach circuit prior to disposal. Gold is recovered by electrowinning, cathode sludge filtration and drying followed by smelting to produce bullion.

All NBGPL operations that utilise cyanide in the processing of gold ore in the Asia-Pacific (APAC) region are certified under the International Cyanide Management Code (ICMC). The ICMC was developed under guidance of the International Council on Metals and the Environment and the United Nations Environment Program. The application of the ICMC is described in Table 6. NBG underwent its first certification audit in 2011 and was deemed certified to the ICMC in February 2012.

Table 6 Application of the International Cyanide Management Code

Element	Requirement
Aims	It is a voluntary industry program for the gold mining industry to promote: • responsible management of cyanide used in gold mining • enhance the protection of human health • reduce the potential for environmental impacts.
Objective of the Cyanide Code	To improve the management of cyanide used in gold mining and assist in the protection of human health and the reduction of environmental impacts.
Auditing requirements	Companies that become signatories to the ICMC must have their operations audited by an independent third party to demonstrate their compliance with the ICMC. Audit results are made public on *http://www.cyanidecode.org/* to inform stakeholders of the status of cyanide management practices at certified operations. NBG (which commenced operations in late 2009) underwent its first certification audit in late 2011 and was certified under the ICMC in February 2012 following review of the audit report. The audit results are made public to inform stakeholders of the status of cyanide management practices at the certified operation.
Compliance requirements	Sites need to demonstrate consistent compliance with the ICMC in all of the elements including: • procurement • engineering • operations • maintenance • environment • decommissioning • safety • training • emergency response • community.
Ongoing requirements	Following certification, sites are audited every three years to ensure that they are maintaining operational standards to satisfy the ICMC. As part of re-certification, sites must also demonstrate that continuous improvement has occurred in the management of cyanide in the three years since the last audit. Sites will need to ensure that evidence of continued compliance and continuous improvement can be demonstrated through the maintenance of site documents and records including: • operational procedures and protocols • change management • inspection and maintenance records • audits and system review.

3.4.4 Waste rock dumps

The Proposal includes new WRDs south of the mine (WRD 10 and 11, which will be adjacent to existing WRDs 7 and 8) and a new WRD northwest of the mine pits (WRD12) (Figure 4). The WRDs will have a combined capacity of 1500 Mt.

These dumps have been designed on the basis of waste rock stability characterisation, soil characterisation, as well as investigations into vegetation, erosion modelling, drainage design and visual amenity as described in Section 4.2. The WRDs will be designed and closed to ensure slope geometry, benches and crest bunds are optimised with respect to minimising erosion and gully development in the future. Current waste dump heights are fixed at 355 mRL and the Proposal will increase heights to 360 mRL. A typical cross-section of a waste dump is shown in Figure 12.

3.4.5 Residual disposal area

The Proposal includes construction of a new RDA with a capacity of 600 Mt (the current RDA also has a capacity of 600 Mt). The new RDA will have a footprint of approximately 1650 ha and will be located northeast of the existing RDA. The majority of the area is covered by monoculture timber plantations (Figure 4).

The RDA will be located within a valley to reduce the amount of clearing required and also to reduce costs. The new RDA will be a cross-valley type storage facility with an embankment wall extending from one valley wall to another. The embankment wall will be approximately 2.5 km long with a maximum height of 75 m. Water-control structures will be incorporated into the design to control any surface water run-off that results from direct precipitation onto the dam surface (Knight Piesold 2012).

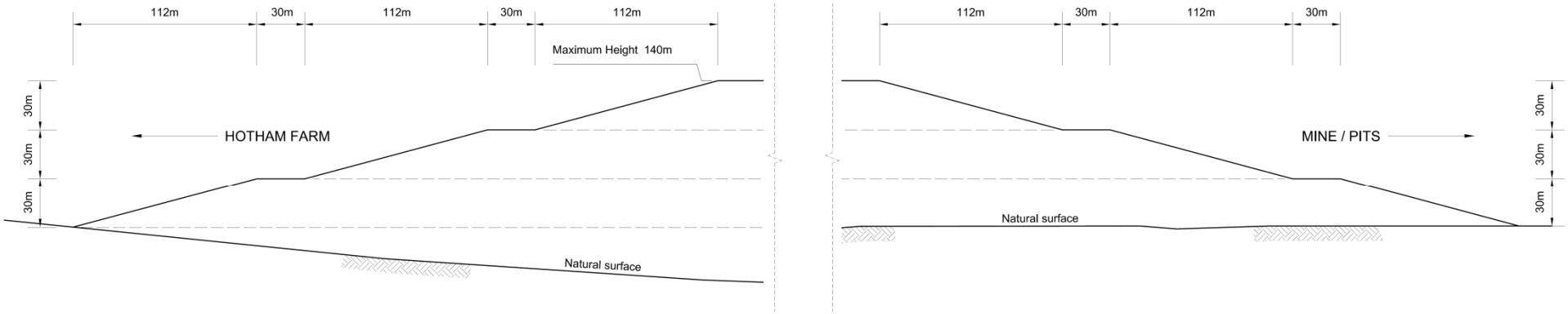
The RDA will interrupt the flow of an ephemeral creek that drains into Gringer Creek and will disturb approximately 790 ha of native vegetation that exists as a buffer along the edge of this drainage line and to the west of the plantation. The Proposal includes establishing an approximate 2 km diversion of Gringer Creek to the east of the new RDA.

The facility has been designed in accordance with the current reserve estimate of 1200 Mt of ore and processing throughput of 38.6 Mtpa with a residue density of 1.5 t/m^3 (Knight Piesold 2012). Construction of the new RDA is not anticipated to commence until approximately 2022.

The process to determine the form and location of the new RDA involved significant environmental and economic evaluation, as described in Section 4.1.

3.4.6 Transport

Transport of copper concentrate for the current operation is prescribed as being by road train, four per day, six days per week. To build flexibility into operations, the Proposal does not set the number of vehicle movements per day. This approach is consistent with *Environmental Assessment Guideline No. 1 for Defining the Key Characteristics of a Proposal* (EPA 2012a). The number of vehicle movements is not expected to significantly increase in accordance with the increase in throughput of 35 Mtpa + 15% efficiency gains to 40 Mtpa + 15% efficiency gains.



TYPICAL CROSS SECTION (1:2500)

STRATEGEN	Newmont Boddington Gold Life of Mine Expansion Project Typical cross-section of waste rock dump	Figure 12

3.4.7 Water supply and dams

Water supply requirements are met through use of water from mine dewatering, intercepted rainfall and the abstraction of water from the Hotham River during periods of flow above levels specified in licence conditions (as gauged at Marradong Bridge—GS614224) (to a maximum of 10 GL/annum in accordance with existing licences under the RIWI Act). NBG recognises the need for efficient water usage and in addition to recycling of process water through the processing plant, residue is thickened to 60% solids to recover water at the plant and treated effluent is used in the processing steam. At any one time, approximately 40% of the water used in the processing plant is recycled water. The existing D4 Dam is an essential component of the water management system for NBG. The primary purpose of the D4 Dam is to manage runoff and drainage downstream of the mine site as well as being the primary storage reservoir for water extracted from the Hotham River. Water from the D4 Dam is used for dust suppression and ore processing.

With the expansion of the mine pits and WRD, the D4 Dam will be covered in around 2017. This Proposal includes construction of the D5 dam and potentially the D6 Dam to replace the functions of the D4 Dam and to increase site water storage capacity. The D5 Dam will be located on a section of the Thirty Four Mile Brook below the mine operation on Hotham Farm; the D6 Dam will be located on Junglen Gully, a small tributary of the Hotham River also located on Hotham Farm (Figure 4). The increase in potential storage capacity is designed to improve the water management across to the site to enable flexibility of processing operations.

There will be no change to the D1 water storage reservoir and water management around the existing RDA will continue as per current operations.

The overall site water balance is not expected to change significantly as a result of this Proposal. This Proposal does not include any increase in the 10 GL/annum of water taken from the Hotham River. The total water balance for the site is described in Section 7.4.1.

3.4.8 Bibbulmun Track diversion

Creation of WRD 12 will intersect the Bibbulmun Track for approximately 2 km. A diversion is currently being planned with input from key stakeholders, as shown in Figure 13.

3.4.9 Stockpiles

This Proposal includes an expanded footprint for stockpiles of topsoil, gravel and bauxite. As part of agreements with other mining companies that have tenure for bauxite reserves in the area, NBG will mine and stockpile the bauxite for these companies where these reserves are encountered. Where possible, stockpiles will be located on already disturbed lands (e.g. Hotham Farm). Stockpiling of gravels and topsoil requires expansion of the footprint for rehabilitation of the WRDs in this area.

3.4.10 Other infrastructure

The Proposal includes a disturbance provision of 271 ha of native vegetation for ‘drainage and other earthworks’, which may include roads, power lines, pipelines and other associated infrastructure (including pumping facilities).

3.4.11 Closure

Closure planning is a dynamic process that requires regular review and development throughout the life of the operation, to take into account changes in legal obligations, corporate requirements, community expectations and technical knowledge.

3.4.12 Changes since referral

Since referral of Proposal under the EP Act and EPBC Act there have been a number of changes to the design of the project. The referral of the Proposal under these acts identified a footprint of up to 3400 ha and a project life extending until 2060. Following further design work, the Proposal has been reduced in size to include a maximum footprint of up to 2895 ha with a project life extending to 2041. This change has substantially reduced the extent of native vegetation clearing required up to 1755 ha.

3.4.13 Closure

Key considerations relating to closure include:

- stakeholder expectations
- potential impacts to surface and groundwater and associated biodiversity
- construction of stable landforms
- re-establishment of self-sustaining vegetation
- future land use
- timing of closure activities.

A number of studies pertaining to closure were completed prior to commencement of the current mining operations. While many aspects of these studies are likely to be relevant for the Proposal, closure plans will be updated to include areas new to the operation, particularly, the RDA in the Gringer Creek sub-catchment area.

Mine closure plans (MCPs) for the existing operation will be updated to account for the proposed extension in accordance with the current Department of Mines and Petroleum (DMP) and EPA mine closure guidelines (DMP & EPA 2011). The additional requirements prescribed by the 2011 guidelines include:

- closure specific stakeholder consultation regarding end land use, particularly final void for the new pit extent
- domain based rehabilitation plans
- methodology of determining closure costs (in a separate document if preferred)
- post-closure land use determination
- detailed risk assessment.

NBG has prepared a Preliminary MCP in accordance with these guidelines. NBG will continue to update the closure plan over the life of the mine. Additional closure discussion can be found in Section 12.5.

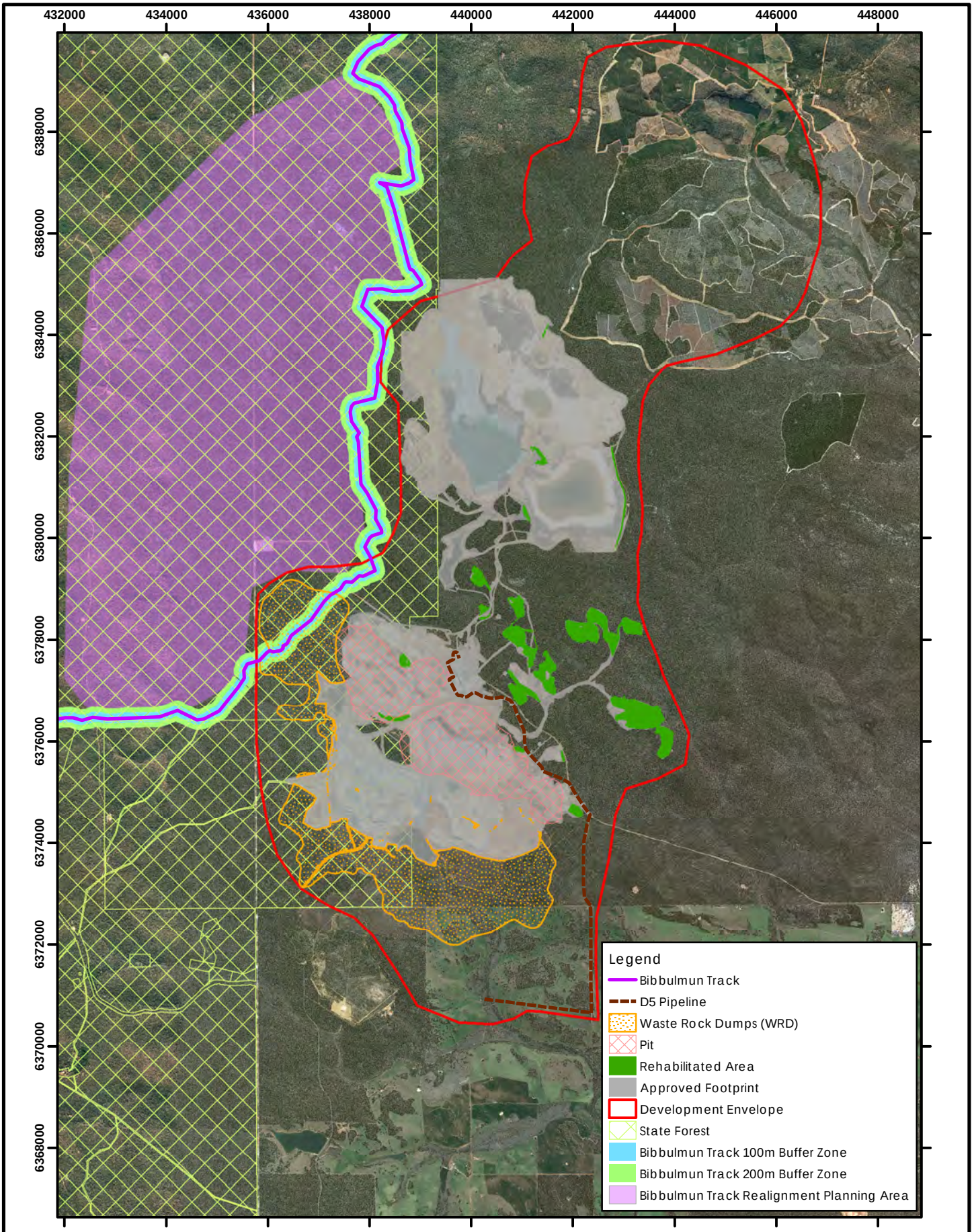


Figure 13 Bibbulmun Track diversion

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info@strategen.com.au
www.strategen.com.au

Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F013.mxd

4. Consideration of alternatives and avoidance of impact through design

Several alternative designs or approaches were considered in developing the Proposal. The analysis of alternatives took financial, logistical, environmental and surrounding land use considerations into account. Various options and alternatives were considered in design of the RDA, WRDs and water supply, as discussed in detail below.

4.1 Residue disposal area

Design planning for the RDA considered five potential locations for a new facility as well as increasing the capacity of the existing facility. The design planning considered:

- minimising total area of native vegetation disturbed
- avoiding areas that included conservation significant species and their habitat
- avoiding the South Dandalup Public Drinking Water Source Area (PDWSA)
- avoiding state forest and power lines
- impacts on Aboriginal heritage
- public amenity – including visual amenity and impacts on Bibbulmun Track
- operational impacts (e.g. requirement to move other infrastructure)
- economic cost
- potential impact on Worsley Alumina infrastructure (i.e. overland conveyor)
- required capacity
- location of existing mining leases.

The review process considered maximising the ability to access future ore resources while:

- minimising need to clear native vegetation
- minimising potential impacts upon watershed
- maintaining visual amenity.

The three main alternatives investigated were to:

1. Increase the height of, and expand the existing RDA.
2. Establish a new RDA east of the mine in close proximity.
3. Establish a new RDA within the plantations to the northeast of the existing RDA.

A review indicated that increasing the height of the existing RDA would require complicated design measures and large quantities of fill to raise the existing RDA embankments (Knight Piesold 2012). This option was determined to be impracticable in order to fulfil the revised LOM requirements of 1200 Mt.

Locating the RDA east of the existing mine would substantially increase efficiencies due to the proximity of the processing operations; however, this option was considered the least preferable in terms of the amount of native vegetation clearing required (i.e. around 3000 ha for a 1000 Mt facility).

The preferred alternative is to construct a new RDA on the timber plantation to the northeast of the operation. This site is located in an existing valley and predominantly covered by exotic timber plantations (pine and eucalypt). This location minimises both the amount of clearing required and the overall impact of the RDA on vegetation and fauna.

4.2 Waste rock dumps

Design planning for the WRD considered approximately 20 alternatives. These alternatives included:

- expanding existing WRD configurations
- maintaining all dumps within existing mining tenure
- increasing height of existing WRD up to 400 mRL (current approved final height is 355 mRL)
- expansion west into state forest
- expansion east into forest privately owned by NBGJV
- expansion south into forest and previously cleared rural land.

The design planning considered:

- location of existing mining leases
- minimising total area of native vegetation disturbed
- avoiding areas that included conservation significant species and their habitat
- avoiding South Dandalup PDWSA
- avoiding state forest and existing power lines
- impacts on Aboriginal heritage
- public amenity – including visual amenity and impacts on Bibbulmun Track
- operational impacts (e.g. requirement to move other infrastructure)
- planning around known and anticipated bauxite reserves
- economic cost.

The selected configuration consists of two dumps; one northwest of the operations (WRD 12) and an extension of the southern dumps extending into Hotham Farm (WRDs 10 and 11). The WRDs require clearing of approximately 560 ha, of which 355 ha is located within state forest.

Expansion east (which would have avoided the need to enter state forest and would have entirely contained the WRDs on land owned by NBGPL) was not considered environmentally favourable due to the recording of fauna species of conservation significance in this area — the Woylie (*Bettongia penicillata ogilbyi*; WC Act – Schedule 1, EPBC Act – Endangered). To protect potential Woylie habitat in this area, the eastern extension of dumps was eliminated from further consideration.

Current waste dump heights are fixed at 355 mRL and the Proposal will increase heights to 360 mRL. Increasing the height to 400 mRL was considered and modelled. This was dismissed as it could potentially further impact on the visual amenity of the area and would result in structures with extensive outslopes considered to have a much higher risk of post-closure failure. Therefore, this option was discarded.

Backfilling of pits was considered as an option, but discounted as full sterilisation drilling has not been undertaken and it is not known whether further resources exist at the base of the pit. This will be investigated throughout the life of the mine.

The selected configuration minimises the impact of the WRD expansion on the Woylie population while managing visual impacts and reducing risk of post-closure failure.

4.3 Water supply and storage

Water availability has been identified as a risk to the NBG operation. NBGPL is investigating more water efficient processing (such as dry stack tailings placement) and alternative water sources to reduce reliance on the Hotham River for processing water requirements. Investigations are continuing into the following:

1. Obtaining water from the Harvey Water Scheme – Wellington Dam Pipeline. This project would re-direct some saline flows from the Wellington Dam to reduce the salinity in the dam. The branch of the Collie River East currently contributes approximately 50% of the total input of salt into Wellington Dam but contributes only approximately 15% of the annual flow into the dam. Despite the salt content, based on an initial assessment of this water it appears suitable for use at NBG. It is understood that the diversion of these flows is already being considered with one option directing this water out to sea via a pipeline.
2. Kwinana Waste Water Treatment – Pinjarra Pipeline. This would involve installation of a pipeline from Pinjarra to NBG to allow treated water from Kwinana waste water treatment plant to be pumped to site for use.
3. Dry Stacked Tailings. This involves filtering the process residue to reclaim water and allow the residue to be mechanically stacked rather than pumped. This will increase the volume of water reclaimed from tailings and reduce the required storage volume requirements for the RDA (and future RDA).

These options are currently being reviewed to determine if they are viable and economically feasible. As these are long-term strategies to water availability they will require considerable work and if considered to be both viable and economically feasible, will require additional environmental approvals.

5. Stakeholder consultation

5.1 Stakeholder engagement process

5.1.1 Previous consultation

NBGPL has proactively consulted with the local community on a regular basis since establishment of its mining operation. Since the mine has been re-commissioned, NBGPL has established a community consultation program that provides regular updates to the community.

Consultation with the communities of Boddington and Dwellingup is carried out through a range of engagement mechanisms and techniques. NBGPL operates a dedicated community information centre on the main street in Boddington. The information centre provides the community with a point of contact and source of information and feedback. Regular briefings are held in Boddington and Dwellingup to update community members on general mining operations, economic benefits, employment statistics and community concerns. The Proposal has been discussed at these community meetings since September 2011. Updates have also been provided in the Boddington Community Newsletter (Bodd News) and the NBG Golden Scoop publication, which is mailed out to Boddington residents. Local community members can also contact NBGPL community engagement officers via email and telephone.

In addition to these consultation activities, a social impact assessment (SIA) is carried out by independent consultants every three years to assess the relationship between NBGPL and local communities and to determine the social impacts of its operations. The SIA is also used to document the perceptions of the local community of the positive and negative impacts of the mine. The information is used to inform community investment activities, operations policies and subsequent engagement activities. The last SIA was completed in May 2012 (Banarra 2012).

5.1.2 Aboriginal heritage

A Community Partnership Agreement (CPA) was signed on 16 August 2006 between the GKB, NBGPL, and the South West Aboriginal Land and Sea Council (SWALSC). The CPA has a current expiry date of 31 December 2025, which can be amended as agreed between the parties. It covers all operations on current mining leases, future exploration tenements, infrastructure titles, mining leases and general purpose leases. The CPA takes future expansions into account with an agreement to negotiate with a genuine regard to each other's interests and expectations.

The Proposal has been communicated to the SWALSC and GKB Working Party. Communications regarding the project commenced in September 2011 and updates have been provided throughout 2012–2013.

A Preservation of Aboriginal Heritage Agreement was prepared by the SWALSC in 2007 between the Gnaala Karla Booja Native Title Group, the SWALSC and NBGPL. The agreement sets out processes for:

- communication and consultation
- the preservation of Aboriginal Heritage
- the preservation of Aboriginal sites and objects.

A desktop heritage study of the proposed RDA site was undertaken by Yates Heritage consultants in 2011. The areas researched included two large areas of land formerly owned by Sotico. Aboriginal heritage sites were found in the 1980s in one of these areas along the margins of the creeks. Field surveys with traditional owners of the area were conducted in 2012 covering the potential RDA area as well as the tributary where the potential D6 Dam would be located. The area of the D5 Dam has been covered under previous surveys. As these tributaries represent a Registered Heritage Site (the Hotham River and its tributaries are a site), a notice under s 18 of the AH Act for consent to use land will be prepared.

All surveys and s 18 Notices will be managed in accordance with the provisions of the AH Act and the Indigenous Heritage Management Plan, which is contained in the Environmental Management Plan (EMP) (Appendix 1).

5.1.3 Public Environmental Review consultation

In September 2011, NBGPL commenced consultation for the proposed expansion. The team consulted with Australian and State Government departments, local government and local communities potentially affected by the proposed expansion. A number of mechanisms were used to enable communication with a broad spectrum of stakeholders, each with different engagement requirements. These mechanisms include:

- the Newmont Boddington Gold Community Information Centre located on Boddington main street
- community meetings (in Boddington and Dwellingup)
- project overviews
- fact sheets
- advertorials and newsletters.

A summary of the key stakeholder consultation undertaken to date is included in Table 7.

Table 7 Summary of key stakeholder consultation undertaken for this Proposal to date

Stakeholder	Consultation date
Community	
Dwellingup community	28/09/2011; 6/12/2011; 21/03/2012; 26/06/2012
Boddington community	29/09/2011; 7/12/2011; 22/03/2012; 27/06/2012
Shire of Boddington	27/09/2011;
Shire of Murray	25/11/2011
Local Business	30/09/2011; 13/10/2011
Boddington Local Emergency Management Committee	28/11/2011
Bibbulmun Track Foundation	16/02/2012; 23/02/2012
Gnaala Kaala Booja Working Party	12/10/2011; 8/03/2012; 6/07/2012; 15/08/2012; 22/11/2012
SWALSC	9/02/2012; 4/04/2012
Boddington Supertowns Implementation Committee	27/09/2011
Peel Regional Development Australia	03/10/2011
Western Australian Government	
Boddington Gold Mine Environment Management Liaison Group	31/10/11; 07/11/11; 01/05/12; 01/11/2012
Department of Mining and Petroleum	19/09/2011; 29/06/2012
Office of the Premier	20/09/2011
Office of the Environmental Protection Agency	22/09/2011; 17/02/2012; 15/08/2012; 11/10/2012; 04/12/2012
Office of the Environmental Protection Agency & the Department of Environment and Conservation	02/11/2011; 26/09/2012
Office of Minister for Environment; Water	11/10/2011
Department of Environment and Conservation	26/09/2011; 22/06/2012; 05/07/2012; 26/09/2012; 23/10/2012
Department of Premier and Cabinet	28/09/2011
Local Member for Murray-Wellington	28/09/2011
State Opposition (Leader of the Opposition, Shadow Minister for State Development and Shadow Minister for Mines and Petroleum)	04/10/2011

Stakeholder	Consultation date
Local Member for Wagin	06/10/2011
Department of State Development	28/11/2011; 08/05/2012; 28/08/2012
Department of Indigenous Affairs	12/12/2012
Australian Government	
Office of the Minister for Sustainability, Environment, Water, Population and Communities	14/09/2011
Office of the Minister for Resources, Energy and Tourism	13/09/2011
Department of Sustainability, Environment, Water, Population and Communities	13/09/2011; 15/09/2011; 21/03/2012; 29/06/2012; 21/11/2012
Department of Resources, Energy and Tourism	15/09/2011; 22/03/2012
Senator Glenn Sterle	13/09/2011
Shadow Minister for Environment	14/09/2011
Member for Canning	07/10/2011
Member for Groom (Shadow Minister for Energy and Resources)	19/07/2012

5.2 Key issues raised and Proponent responses

Table 8 contains a summary of the key issues raised during the engagement process and the responses provided by NBGPL during this time.

Table 8 Summary of key topics raised regarding Proposal during stakeholder consultations

Topics raised	Proponent response
Impacts on black cockatoo habitat	The Forest Red-tailed Black-Cockatoo, Baudin's Black-Cockatoo and Carnaby's Black-Cockatoo are endemic to the southwest of Western Australia. The species populations of all three black cockatoos have declined greatly since European settlement due to the clearing of native vegetation in the region. All three species are listed as threatened under State and Australian legislation and are considered in need of special protection. All three species occur in the areas surrounding NBG, which is located along the eastern margin of the Jarrah forest. All three species feed within native vegetation and mine-site rehabilitation areas, and nest sites for Carnaby's Black-Cockatoos and Forest Red-tailed Black-Cockatoos have been identified within tenements and surrounding lands. In partnership with Murdoch University, the WA Museum and the DER, NBGPL is funding a long-term research and management project identifying the key habitat features required by black cockatoos within the jarrah forest, with the ultimate aim of providing these habitat features in post-closure rehabilitation. Investigations already undertaken by the team include the biodiversity value of habitats at the mine site, conserving black cockatoo habitats within mining landscapes, and how they use food, water and breeding hollows at the mine site. Studies indicate that cockatoos begin feeding in rehabilitation areas within eight years post-rehabilitation. Key food plants are seeds and flowers of Banksia and Hakea species, as well as Marri seeds.
Flora and fauna	NBGPL has completed fauna and flora surveys of the areas planned for disturbance over the life of the mine. As part of the project fauna surveys the Woylie (Brush-tailed Bettong) has been found to the east of the operation as part of the project fauna surveys. This was a key factor in the NBGPL decision not to expand the waste rock area to the east. The Chuditch (or Western Quoll); listed as vulnerable, has also been found in the forest areas around the mine site. This species is known to travel large distances and has a large home range.

Topics raised	Proponent response
Water management	NBGPL invests significant resources to understand and appropriately manage water resources in and around its mine sites. A combination of science, state-of-the-art computer modelling, field data and monitoring is used to develop and implement management programs that identify and mitigate potential impacts on water resources. Site-specific water management planning begins with a thorough understanding of climate, hydrogeology, surface water, groundwater and site water needs. NBGPL uses data and information from monitoring and modelling to develop the site-wide water balance, which evaluates all the inputs (i.e. precipitation and storm water), outputs (i.e. evaporation and discharges) and uses (i.e. processing, dust suppression and storage). The primary objective for water use at NBG is to efficiently use and reuse water and to contain all mine waters within the operations. An important component of the NBG water management plan is active environmental monitoring to ensure that management systems and programs are performing as intended. NBG currently has a licence from the DoW to draw water from the Hotham River for ore processing and dust suppression. This water is pumped to an existing dam to be stored for mine use. To date NBG has extracted below the allowable annual volume permitted under this licence. Water usage requirements fluctuate and may increase under the proposed mine expansion; however, NBGPL is not seeking permission to increase the annual extraction limit from the Hotham River. Instead, NBGPL is looking to increase the water storage capacity of the mine with the construction of up to two new potential water dams to be located on Hotham Farm. As part of the EIA process, NBGPL is undertaking hydrogeological studies and modelling to determine the specific impacts that these changes will have on surface and groundwater systems and associated vegetation. These results, together with future updates of the modelling, will be used to revise of the site groundwater and surface water management plans at regular intervals.
Clearing of native vegetation	Careful consideration has gone into the placement of infrastructure to minimise the clearance of native vegetation. An offset package is being developed in consultation with government, land management experts and black cockatoo specialists which is likely to include preservation of existing forest, rehabilitation of degraded landscapes, support to a range of research projects and building Indigenous enterprise in the region. NBGPL is developing a detailed schedule for land clearance based on the mine plan, but estimate by 2041, about 1755 ha of native vegetation will be cleared for the Proposal. Harvesting of timber is expected to commence 12 months before the land is required, to allow for seasonal restrictions, harvesting of rehabilitation material and construction of appropriate drainage works.
Rehabilitation of cleared land	Topsoils and gravels are collected and stockpiled during clearing and reused as growth material for planting and seeding of native vegetation during rehabilitation. Eventually all land cleared and used as part of the operation will be rehabilitated with the exception of the pits. There are some good examples of rehabilitation success in the area such as the works completed by Alcoa on the Hedges tailings dam on Hotham Farm, which was part of the original Boddington Gold Mine. The majority of the satellite pits from the oxide mining period have been rehabilitated. NBG will also adopt lessons from other rehabilitation works in the region such as the award winning rehabilitation completed by Alcoa and BHP Billiton/Worsley Alumina.
Dust	A modelling study has been commissioned to investigate potential impacts of the expanding operation on air quality with a focus on dust (i.e. particulates). In addition to the use of water to suppress dust on site, NBG also utilises dust suppressants on roads and construction areas. Major permanent access roads are sealed. Topsoil and gravel stockpiles are revegetated where practical or sprayed with hydromulch. NBG uses a hydroscopic dust suppressant in the water cart system, which attracts and retains moisture to stabilise surfaces and suppress dust. This is used on unsealed roads within the mine site such as the overland conveyor road (between the two open pits) and the road from the processing plant to the RDA.
Air quality monitoring	Ambient air quality is measured by a Tapered Element Oscillating Balance (TEOM) unit located at Communications Hill on the mine site. This station provides continuous data for PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO and CO_2. The data is assessed against current National Environmental Protection Measure (NEPM) Guidelines for air quality. Two portable units are used to measure air quality in areas where there is a perceived dust risk and to gauge background air quality.
Noise	Noise emissions associated with the Proposal will be controlled through implementation of the site Noise and Vibration Management Plan and proposed management measures, and is not expected to result in significant impacts. Noise emissions from the operations will be managed in accordance with noise regulations.

Topics raised	Proponent response
Closure plan	The long-term plan is for the pits to form a lake system. Modelling suggests the pits will take around 80 years to fill to the point of periodic overflow in the base case model. The modelling work has also incorporated scenarios including a drying climate, which extends the filling time to 250 years to fill to the point of periodic overflow. As part of both the EIA and revision of the Closure Plan, NBGPL will hold discussions with stakeholders on expectations for future land use of the mine area. This information will be used to further refine the Closure Plan that was re-submitted to the DMP at the end of 2012 and will be resubmitted every three years as per tenement conditions. Following consultation with stakeholders the retention of other infrastructure (such as dams) may remain throughout the life of the mine.
Changes in land use	The forestry land is being investigated for a number of future uses including offsets, future habitat, and additional land / storage areas. Commitments to logging industry contracts for pine and eucalypt remain at this stage. Several issues or concern have been raised by community members including the following: • that Boddington is a pastoral community and that there is already substantial native vegetation in the area (in regards to rehabilitation offsets) • there have been requests for the use of the land that has been purchased be used for community groups such as equestrian and mountain bike trails • whether product trucks would be re-routed through Hotham Farm to avoid Boddington main street (there is no plan to do this at this stage) • changing the land use of the plantation with the placement of the RDA.
Bibbulmun Track and the required diversion	Consultation has been undertaken with DER and the Bibbulmun Track Foundation and will be ongoing.
Increased product transport	There may be a slight increase in truck numbers but the extension of the mine life will mean trucks will need to travel to the port at Bunbury for a longer period.
Employment and local investment	Personnel recruitment is likely to occur during the operational phase of the Proposal. It is recognised that the importance of local staff recruitment is evident amongst the community (both at Boddington and Dwellingup).

5.3 Ongoing consultation

NBGPL is committed to continuing engagement with key stakeholders throughout and beyond the environmental approvals process.

Ongoing communication and consultation with relevant local, State and Australian Government representatives, business and industry leaders, Traditional Owners, local community groups, and surrounding landholders will continue in order to provide critical information to aid the identification of communication issues that will need to be addressed during the process.

NBGPL will also continue its cyclical SIA process to thoroughly assess and document the social impacts of its operations.

6. Framework for environmental impact assessment of the Proposal

6.1 Identification of key factors and their significance

The ESD has identified the following key factors as needing to be addressed in this PER:

- flora and vegetation
- fauna
- surface water and groundwater
- residual risk management (described in Offset Section, Section 14).

This PER has been structured in accordance with the ESD. The surface water and groundwater factors have been separated into separate sections for ease of use. Assessment under the EPBC Act is authorised through a bilateral agreement between the Australian and Western Australian governments, and MNES are consequently dealt with in a specific chapter (Section 11).

Table 9 describes the EPA environmental objectives, potential impacts and work required from Table 2 of the ESD and identifies where this has been included in this document.

Discussion of proposed management, monitoring and mitigation methods to be implemented are included for each factor.

6.2 Other factors

In addition to the key factors, the ESD identified the following other environmental factors required to be considered in the PER:

- public amenity (with particular regard to the Bibbulmun Track)
- water use and supply
- Indigenous heritage
- noise
- air
- closure and rehabilitation.

Management of these other factors is discussed in Section 12.

Table 9 Consistency with Environmental Scoping Document

Environmental Factor	EPA objective	Potential impact	Work required identified in ESD	Section
Groundwater	To maintain the quality and quantity of groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected	Impacts to groundwater-dependent ecosystems including the Hotham River, as a result of **groundwater drawdown and groundwater abstraction**	Assess groundwater drawdown associated with future operations	7.4.2
			Demonstrate that existing design of facilities, procedures and management measures have not resulted in significant impact to any environmental values as a result of changes to groundwater quantity. This should include information regarding the extent of adverse soil and groundwater quality effects associated with the existing facilities	
			Predictive assessments of the hydrodynamics and hydrochemistry of pit water over time showing potential interactions of pit water with local and regional groundwater during mining and following mine closure	
			Analysis and discussion of any additional impacts to surface water or groundwater expected as a result of the proposed changes	
			Discussion using current predictions of potential for climate change or drying climate to increase the direct and indirect impacts to groundwater identified	
		Contamination of groundwater as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies	Provide a detailed description of the design and location of the proposed WRD and RDA facilities and any other elements of the Proposal with the potential to affect groundwater. This should include a final determination of which option will be implemented in relation to tailings storage	7.4.4
Surface water	To maintain the quality and quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected	Impacts to surface water flows as a result of **placement and design of new infrastructure**, including alterations of existing drainage patterns of Gringer Creek and tributaries of the Hotham River	Characterise baseline hydrological regimes and water quality	8.4.1
			Demonstrate that existing design of facilities, procedures and management measures have not resulted in significant impact to any environmental values as a result of changes to surface water flows. This should include information regarding the extent of adverse soil and groundwater quality effects associated with the existing facilities	
			Predictive assessments of the hydrodynamics and hydrochemistry of pit water over time showing potential interactions of pit water with local and regional surface water during mining and following mine closure	
			Analysis and discussion of any additional impacts to surface water expected as a result of the proposed changes	
			Discussion using current predictions of potential for climate change or drying climate to increase the direct and indirect impacts to surface water identified	
		Contamination of surface water as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies	Demonstrate that existing design of facilities, procedures and management measures have not resulted in significant impact to any environmental values as a result of changes to surface water flows. This should include information regarding the extent of adverse soil and groundwater quality effects associated with the existing facilities	8.4.2

Environmental Factor	EPA objective	Potential impact	Work required identified in ESD	Section
Flora and vegetation	To maintain the conservation status, diversity, and productivity of flora and vegetation at the species and ecosystem levels through the avoidance or management of adverse impacts and improvements in knowledge	**Clearing** of up to 1755 ha of native vegetation over 40 years	Detailed description of the proposed new facilities and additional clearing to be carried out, including an options analysis of the proposed waste dump, which includes consideration of environmental constraints	9.4.1
			Desktop study and discussion of flora and vegetation surveys conducted in areas that are likely to be directly or indirectly disturbed as a result of the Proposal. Where previous survey information is not available, or is not of acceptable quality in accordance with Guidance Statement 51, surveys are to be undertaken in accordance with Guidance Statement 51	
			Analysis of the extent of clearing and conservation status of vegetation and/or flora species to be cleared, including percentages of vegetation types and/or conservation significant species to be cleared to assist in the determination of the significance of impacts	
			Discussion of potential for indirect impacts to flora and vegetation, including impacts to groundwater-dependent vegetation as a result of increased dewatering activities	
			Discussion using current predictions of potential for climate change or drying climate to increase the direct and indirect impacts to flora and vegetation identified	
			Discussion of the success of existing or previous rehabilitation works carried out in relation to the existing operations, including lessons to be applied to rehabilitation works related to the proposed expansion	
		Mining activities such as vehicle movement and site disturbance associated with the Proposal may result in the **spread of weeds and pathogens including dieback** within and outside the project area	Baseline mapping of weed and dieback affected areas in any area likely to be directly or indirectly impacted by the Proposal	9.4.2
			Discussion of available baseline and monitoring data in relation to the spread or introduction of weeds and/or dieback related to the existing operations, including lessons to be applied to rehabilitation works related to the proposed expansion	
Fauna and habitat	To maintain the conservation status, diversity and productivity of fauna and its habitat at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge	**Clearing of vegetation** would result in loss or fragmentation of fauna habitat and consequential displacement of fauna	Desktop study of information available to provide a comprehensive listing of fauna known or likely to occur in the habitat present, and identification of conservation significant fauna species likely to occur in the area	10.4.1
			Where previous surveys are not available, or are not of acceptable quality in accordance with Guidance Statement 56, Level 1 survey and mapping of habitats within areas to be cleared should be conducted in accordance with Guidance Statement 56	
			Identification of important, rare or unusual habitat types	
			Analysis of the extent of clearing (including percentages of habitat types to be cleared) to assist in determination of significance of impacts	
			Where the desktop study and habitat analysis indicates that it is appropriate, conduct targeted Level 2 surveys for conservation significant species	
			Discussion of all available information on the Woylie population east of the Proposal area and identification of any potential impacts to this population from habitat fragmentation. Discussion of potential monitoring and management of potential impacts to this population	
			Targeted SRE survey and habitat mapping	
			Brief discussion of potential for impacts to subterranean fauna and reasoning behind the decision not to conduct subterranean (stygofauna and troglofauna) surveys	

Environmental Factor	EPA objective	Potential impact	Work required identified in ESD	Section
			Discussion of potential impacts to fauna as a result of the Proposal, with particular regard to MNES, and provision of quantitative data on impacts of the Proposal to species of conservation significance	
			Discussion using current predictions of potential for climate change or drying climate to increase the direct and indirect impacts to fauna and habitat identified	
		Death or injury of fauna may occur during clearing and construction.	No specific work required	10.4.2
Residual risk management	To ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a positive environmental gain, with an aspirational goal of achieving a 'net environmental benefit' (EPA 2006)	Potential impacts on vegetation, flora, habitat and fauna species of State and National significance	Examination of residual impacts and, if required, development of draft program of environmental offsets	14
			Identification of residual impacts with regard to MNES	
			Inclusion in the PER of the completed Environmental Offsets Reporting Form and any offsets required and proposed	

6.3 Consistency with environmental principles

The environmental protection principles listed in s 4A of the EP Act, are:

- precautionary principle
- principle of intergenerational equity
- principle of the conservation of biological diversity and ecological integrity
- principle relating to improved valuation, pricing and incentive mechanisms
- principle of waste minimisation.

These principles have been incorporated in the design and implementation of the Proposal as presented in Table 10.

Table 10 Consistency with principles of environmental protection

Principle	Consideration given in the Proposal	Section addressed in PER
1. Precautionary Principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment b. an assessment of the risk-weighted consequences of various options.	NBGPL maintains an Integrated Management System (IMS) that addresses all of its activities with a potential to affect the environment and is certified with ISO14001. The key elements of the IMS include assessing environmental risk arising from environmental aspects with the intention of identifying issues early in the process to enable planning to avoid, prevent or manage impacts through design and operation of the site (including placement of RDA and WRDs). Part of this process includes undertaking detailed site investigations of the biological and physical environs. Where these investigations identify significant environmental issues, management measures are incorporated into the project design to avoid, where practicable, and/or minimise any potential impacts.	4; 13.1
2. Intergenerational Equity The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	The NBGPL approach to sustainability is based upon a focus in striving to achieve industry leading environmental performance and by creating shared value with the communities that host NBG operations. NBGPL integrates the principles of sustainable development into all aspects of its operations to contribute to sustainable development in Australia. This includes ensuring that processes and outcomes are socially and environmentally sustainable and have an intergenerational focus.	13.1
3. Conservation of Biological Diversity and Ecological Integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Conservation of biological diversity and ecological integrity is fundamental to environmental management and is a major environmental consideration for the project. Biological investigations have been undertaken early in the project planning process to identify values of environmental conservation significance required to be protected from disturbance. NBGPL is committed to restoring disturbed environments upon decommissioning and creating safe, stable, non-polluting landforms. Revegetation will be conducted with native species, and surface flows designed to avoid flooding. The aim of this is to establish sustainable endemic vegetation units consistent with reconstructed landforms and surrounding vegetation.	9.2; 10.2

Principle	Consideration given in the Proposal	Section addressed in PER
4. Improved Valuation, Pricing and Incentive Mechanisms a. Environmental factors should be included in the valuation of assets and services. b. The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement. c. The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes. d. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentives structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.	NBGPL acknowledges the need for valuation, pricing and incentive mechanisms and endeavours to pursue these principles when and wherever possible. For example: • environmental factors have been considered in the design of the WRDs and RDA • procedures have been put in place that will ensure that pollution-type impacts are minimised as far as practicable • NBGPL is certified to the voluntary *International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold* (ICMC) the protection of human health, and minimise the potential for environmental impacts.	4; 13.1
5. Waste Minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	NBGPL approach to waste management in order of priority is to: • avoid and reduce at source • reuse and recycle • treat and/or dispose. NBGPL will operate an appropriately licensed landfill for the disposal of general domestic solid wastes and will recycle scrap metal, rubber, waste oil and batteries. NBGPL will continue to investigate other waste management opportunities with the aim of minimising waste generation and disposal requirements.	13.1; 14

7. Groundwater

7.1 Relevant environmental objectives, policies, guidelines, standards and procedures

7.1.1 EPA objectives

The EPA environmental objectives for groundwater are:

> *To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.*

7.1.2 Legislation, policy, guidance

National

In 1996, the Australian and New Zealand Environment and Conservation Council (ANZECC) together with the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) developed the *National Principles for the Provision of Water for Ecosystems* (ANZECC & ARMCANZ 1996). These national principles aim to improve the approach to water resource allocation and management and to incorporate the water requirements of the environment in the water allocation process. The overriding goal of the principles is to provide water for the environment to sustain and, where necessary, restore the ecological processes and biodiversity of water-dependent ecosystems.

Water quality guidelines for the protection of marine and freshwater ecosystems have been released under the auspices of the National Water Quality Management Strategy (NWQMS). The guidelines provide a comprehensive list of recommended low-risk trigger values for physical and chemical stressors in water bodies, and are applied to five geographical regions across Australia and New Zealand. The NWQMS is supported by the *Guidelines for Groundwater Protection in Australia* (ARMCANZ & ANZECC 1995), which outline a framework for protecting groundwater in Australia. The Guidelines require the identification of beneficial uses for groundwater in aquifers, and prescribe policy to manage these issues.

A series of Guidelines on national water quality management has also been released by the Natural Resource Management Ministerial Council (NRMMC), in some cases in collaboration with the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers Conference. These Guidelines address a range of issues including policies and processes for water quality management, water quality benchmarks, groundwater management, diffuse and point sources, guidelines for sewerage systems, effluent management and water recycling.

There is no Federal groundwater legislation relevant to this Proposal.

State

The *Rights in Water and Irrigation Act 1914* (RIWI Act) makes provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes. The Proposal is not within a proclaimed groundwater area. As such, licensing is only required for artesian wells (defined as meaning wells including all associated works from which water flows, or has flowed, naturally to the surface). A “well” is defined as meaning an opening in the ground made or used to obtain access to underground water.

The Government of Western Australia developed the *State Water Quality Management Strategy* in 2001 to supplement the *National Water Quality Management Strategy* with the objective “to achieve sustainable use of the Nation’s water resources by protecting and enhancing their quality while maintaining economic and social development”.

The *State Water Quality Management Strategy* (Government of Western Australia 2001) proposes that a Water Conservation Plan be developed before a water allocation licence is issued or renewed. The Water Conservation Plan must outline water efficiency objectives and timeframes. Licence conditions can then require implementation of the Water Conservation Plan to an agreed schedule.

In 2000, the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP) developed a series of Water Quality Protection Notes and Guidelines for mining and mineral processing. These guidelines address a range of issues including the installation of mine site groundwater monitoring wells, mine site water quality monitoring, mine site stormwater management, and acid mine drainage (Table 11).

Table 11 Department of Water policy and guidelines relevant to maintain water quality

Legislation or guideline	Intent
Statewide Policy No. 5 – Environmental water provisions policy for Western Australia, 2000	This policy informs DoW how water will be provided and managed to protect ecological values and sustainable development consistent with the requirements of the *Rights in Water and Irrigation Act 1914* and the *Environmental Protection Act 1986*. The policy incorporates the concepts of Ecological Water Requirements and Ecological Water Provisions for water-dependent environments in terms of both water quantity and quality regimes.
Water Quality Protection Note No. 26: Liners for containing pollutants, using synthetic membranes	This note applies to synthetic lining of structures used for holding low hazard materials that may pollute water resources. These structures include: • ponds used for waste-water treatment, and mineral processing fluids • solid materials holding areas such as mining residues. The note sets out the required properties of the liner, together with construction and other requirements for their use to ensure the efficacy of the liner(s).
Water Quality Protection Note No. 27: Liners for containing pollutants, using engineered soils	This note describes soil liner attributes and construction methods for sealing ponds, mining residue storage areas and other material holding facilities where the stored matter could harm the environment should fluids escape in sufficient quantities. The note sets out the requirements for design, material selection, construction, certification, and monitoring and management to ensure the efficacy of the liner(s).
Water Quality Protection Note No. 28: Mechanical servicing and workshops	This note applies to the design, installation and operation of mechanical servicing and workshop facilities for: • motor vehicles • earthmoving machinery • industrial plant (e.g. pumps and generators) • similar equipment where harmful fluids could escape into the environment and potentially contaminate water resources. The note sets out the requirements for construction, operation, management, monitoring and reporting to minimise the potential for adverse discharges to the environment.
Water Quality Protection Note No. 30: Groundwater monitoring wells	This note sets out the requirements for the siting, construction and sampling of screened or slotted casing groundwater monitoring wells.
Water Quality Protection Note No. 51: Industrial wastewater management and disposal	This note applies to mineral processing, vehicle and plant servicing, water and wastewater treatment works including contaminated stormwater, cooling water, process waters and wash-down waters. The note sets out the requirements for the design and construction, operation and management, monitoring, contingency planning, emergency response and reporting associated with the handling, treatment and removal of the industrial wastewater. The note sets out indicative wastewater discharge quality criteria to waterways.
Water Quality Protection Note No. 52: Stormwater management at industrial sites	This note applies to management of stormwater on light, general and heavy industrial sites throughout Western Australia. The note sets out the requirements for stormwater system design, management, treatment, disposal and contingency planning.
Water Quality Protection Note No. 65: Toxic and hazardous substances — storage and use	This note applies to the storage and use of substances that, if released into the environment in significant quantities, may harm living things that are dependent on clean water resources. The note sets out the requirements for siting, construction, stormwater management, accident management, emergency response and closure.

Legislation or guideline	Intent
Water Quality Protection Note No. 68: Mechanical equipment washdown	This note applies to any facilities and procedures used to clean vehicles, earth moving plant and other mechanical equipment. The note sets out the requirements for siting, construction, management and waste disposal.
Water Quality Protection Guidelines No. 1: Water quality management in mining and mineral processing: An overview	Provides an overview of the application of the various specific Water Quality Protection Guidelines, including those listed below.
Water Quality Protection Guidelines No. 2: Mining and Mineral Processing — Tailings facilities	These guidelines are designed to be used to manage the impact of tailings containment facilities on the quality of the region's water resources. These guidelines apply to mining or mineral processing operations where the disposal of tailings occurs. These guidelines do not apply to overburden dumps and mineral leaching facilities. The guidelines set out the requirements for tailings disposal containment facility design and site assessment, operation, accidents and emergencies, monitoring, reporting and decommissioning. The safety and environmental aspects of tailings disposal are regulated by the DMP through the *Mining Act 1978*, Mining Act Regulations 1981, *Mines Safety and Inspection Act 1994* and Mine Safety and Inspection Regulations 1995.
Water Quality Protection Guidelines No. 3: Mining and Mineral Processing — Liners for waste containment	These guidelines are designed to be used for the construction of liners required to contain chemicals, ores or waste. These guidelines apply to any operation where liners are required to protect the quality of water resources in the vicinity of mining and mineral processing operations. The guideline lists the types of material that can be used, their attributes and applicability, and monitoring requirements.
Water Quality Protection Guidelines No. 4: Mining and Mineral Processing — Installation of minesite groundwater monitoring wells	These guidelines are designed to be used for the construction of wells that monitor groundwater at mineral and mining operations. These guidelines apply to construction of wells for projects that have the potential to impact on groundwater levels and water quality. They also apply where baseline groundwater quality data are being established prior to the development of a project. The guidelines set out the requirements for design, construction, sampling and decommissioning of groundwater monitoring wells.
Water Quality Protection Guidelines No. 5: Mining and Mineral Processing — Minesite water quality monitoring	These guidelines are designed to be used for establishing and operating minesite water monitoring programs in order to protect the quality of the region's water resources. The guidelines apply where a program is used to monitor changes in water quality resulting from a mining operation involving, for example, handling of chemicals and disposal of wastes. The guidelines set out the requirements for design, construction, sampling techniques, monitoring frequency, water quality criteria and reporting.
Water Quality Protection Guidelines No. 6: Mining and Mineral Processing — Minesite stormwater	These guidelines are designed to be used for managing stormwater so the region's water resources are protected. These guidelines are to apply where rainfall on minesite areas is likely to impact on the quality of water resources. This includes runoff generated from land such as stockpiles, process plants, dumps, haul roads and rehabilitated areas. The guidelines provide a high-level outline of the requirements for the management of stormwater on a minesite.
Water Quality Protection Guidelines No. 7: Mining and Mineral Processing — Mechanical servicing and workshop facilities	These guidelines are designed to be used in the operation and disposal of waste from mechanical servicing facilities to ensure the quality of the region's water resources are protected. These guidelines apply to all sites where mechanical servicing of vehicles or equipment occurs. They cover, but their scope is not limited to, mining workshops, treatment plants and machinery servicing facilities. The guidelines set out the requirements for workshop areas, operation, disposal of liquid wastes, storage and disposal of solid wastes, and spill containment.

Legislation or guideline	Intent
Water Quality Protection Guidelines No. 8: Mining and Mineral Processing — Laboratory waste discharge	These guidelines are designed to be used to ensure the quality of the region's water sources are protected where disposal of laboratory wastewater to a sewer system is not possible. These guidelines apply to all laboratories where disposal of wastewater to a sewer system is not available. It is specifically directed to minesite analytical facilities and bulk commercial analytical laboratories that service the mining and exploration industries. The guidelines detail the management requirements for the disposal of laboratory waste by discharge to the environment.
Water Quality Protection Guidelines No. 9: Mining and Mineral Processing — Acid mine drainage	These guidelines are designed to be used where there is the potential to generate acid mine water, or where acid mine water exists and has the potential to impact on the quality of the region's water resources. These guidelines apply to mining and mineral process operations that have the potential to generate acidic mine water, or where acid mine water exists. The guidelines set out the requirements for prevention, disposal and monitoring of acid mine drainage. The discharge of acid mine drainage is regulated by the DMP through the *Mining Act 1978*.
Water Quality Protection Guidelines No. 10: Mining and Mineral Processing — Above-ground fuel and chemical storage	These guidelines are designed to minimise the potential impacts on water resources from poorly managed aboveground fuel and chemical storage facilities. These guidelines apply to all mine sites where the volume of above-ground storage of fuel or toxic/ harmful chemicals exceeds 250 L. Above-ground tanks are regulated by the DMP under the *Dangerous Goods Safety Act 2004* and relevant regulations.
Water Quality Protection Guidelines No. 11: Mining and Mineral Processing — Mine dewatering	These guidelines are designed to be used to manage the impact of minesite dewatering on the quality of the region's water resources. These guidelines apply to the discharge of water pumped as part of mining or mineral processing operations, and propose water quality criteria for receiving waters. The guidelines set out the requirements for assessment of impacts, dewatering treatment and disposal, receiving water quality criteria and monitoring.

7.2 Current Operations

7.2.1 Mine Water Balance

Water at NBG is primarily used for ore processing, with small amounts used for dust suppression and to supply water to the accommodation village. The mine currently uses up to 29 GL/yr of water. Approximately half of the water is used in ore processing becomes entrained in the tailings and enters the RDA (Figure 14). The balance of the water used for processing is returned from the RDA and reused (Figure 14).

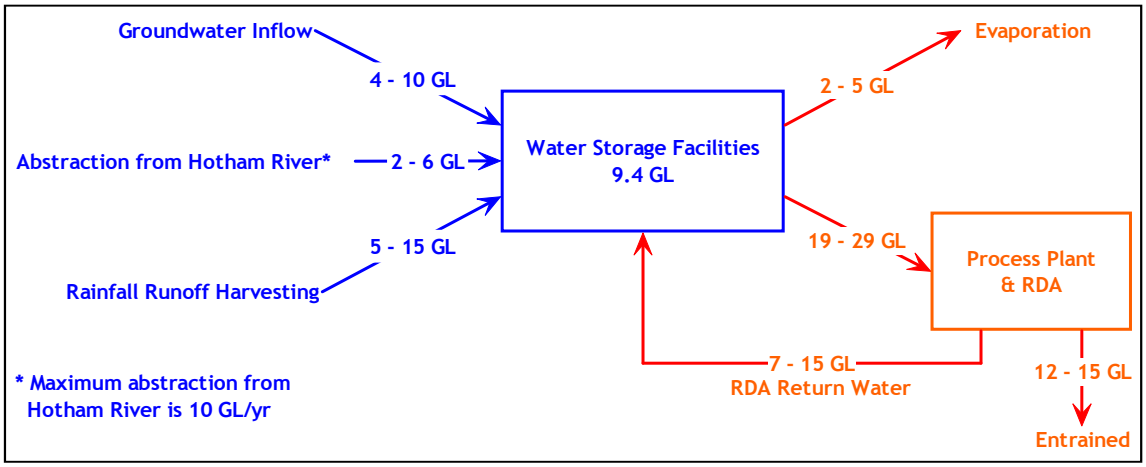
Current mining activities have resulted in the following with respect to groundwater quality:

1. Fluctuating groundwater levels in the three existing RDA areas in response to water storage and transfer, resulting in groundwater mounding in the area. Recovery bores reduce groundwater levels and salinity trends around the R4 eastern embankment, particularly in the north. The southern bores along this embankment show slightly increasing water levels and salinity (NBGPL 2012a).
2. Drawdown around the mining area in response to dewatering activities.

Water is primarily sourced from:

- rainfall runoff harvesting in the Thirty Four Mile Brook Catchment, primarily from the NBG site (5 to 15 GL/yr)
- groundwater inflow into the pits (4 to 10 GL/yr)
- abstraction from the Hotham River (2 to 6 GL/yr but potentially up to 10 GL/yr based on abstraction licence conditions).

The amount drawn from the various sources depends on rainfall conditions and groundwater flows into mine pits. Groundwater flows may be increased when high permeability fracture zones are encountered (Golder 2005). The location and frequency of these zones is unknown, although it is anticipated that at least one of these will be intersected during the course of mining, which will influence dewatering rates for the mine.



Note: all values are in gigalitres (GL) per year, 1 GL equals 1000 ML

Figure 14 Water balance for current operations

Groundwater inflow into the pits is transferred into the North and South Clear Water Ponds. Water from the Hotham River is pumped into a number of water storage facilities including the D4 and D1 Dams, prior to being used in processing. These dams also harvest rainfall runoff from the catchments above the dams.

Water used in processing is recycled back into water tanks for reuse in processing (7 to 15 GL/yr) or entrained into tailings and pumped into the RDA (12 to 15 GL/yr). The volume of water utilised and abstracted by the mine is not anticipated to increase as a result of this proposal.

Abstraction from the Hotham River only occurs when flows are greater than 342 kL/hr at Marradong Bridge Gauging Station with a maximum abstraction rate of 3300 kL/hr. The volume of surface water abstracted is maintained below the licensed limit of 10 GL/yr.

Volume and flow requirements for surface water abstracted from the Hotham River and Thirty Four Mile Brook have been met since operations re-commenced (Golder 2013). To support the application for renewal of the surface water licence, NBGPL has undertaken a review of environmentally sustainable yields and ecological water requirements for the Hotham River (Section 8.2.1). This document has been used in determining the conditions of the revised licence.

Strategies in place to limit mine water use include:

- optimising residue thickening to limit the water lost to evaporation in the RDA
- maintaining water storage volumes on the current RDA at minimal operating levels and preferably storing water in the D1 and D4 Water Storage Reservoirs (WSR) to reduce the surface area to volume ratio of water storages, which limits evaporation.

7.2.2 Groundwater quality management and monitoring

NBG has an extensive groundwater monitoring network that focuses on regular, routine sampling of groundwater levels and quality around the mining and processing operations. Compliance with the current licence conditions resulted in the collection of 1416 items of data from 51 monitoring sites in 2012 (NBGPL 2013). However, the NBG monitoring program extends beyond what is required by compliance and data is recorded and analysed from over 200 monitoring sites annually. Collected samples are analysed at an off-site, independent, NATA accredited laboratory, whilst pH, EC and TDS is recorded in the field.

Monitoring data is annually reviewed by a third party consultant to assess changes in groundwater levels and water quality. This assessment is provided to the OEPA, DER, DSD, DoW and DMP as part of the Annual Environmental Report (AER) and exceptions are discussed at bi-annual regulatory meetings that are attended by all the aforementioned regulators. The groundwater monitoring program at NBG is dynamic and undergoing regular change including decommissioning of bores no longer required and addition of new groundwater monitoring bores, or piezometers or pump back wells. For example, in 2012 an additional 25 bores were installed including eight deep and two shallow piezometers to the north and east of the current open pit workings and a further eight deep and six shallow piezometers located on Hotham Farm. There was also one deep interception piezometer installed below the medium grade stockpile.

The primary mining influences observed on groundwater at NBG to date, are the extent of drawdown around the main mining area from dewatering activities and elevation of groundwater levels surrounding the existing RDA. These changes in groundwater levels represent the effect of water movement around site, and how dewatering or water storage may affect natural groundwater levels and water bodies. Salinity is used as an indicator of environmental change for the following reasons:

1. Salinity concentration occurring through evaporation and re-use of decant water is indicative of changes resulting from mining activity.
2. The dominant chloride (particularly) and sodium ions are regarded as “conservative” parameters, meaning they show little or no interaction within the soil profile. They are therefore suitable as environmental ‘tracers’.
3. Water is imported from the Hotham River, which is more saline than the groundwater and surface water occurring on site, for gold processing.
4. Salinity is easy to analyse for and is monitored at many locations.

Where significant changes in groundwater levels and salinity are evident, closer scrutiny of the monitoring data and assessment of the changes has been conducted. These are discussed further in Section 7.2.5.

Management measures for groundwater quality are built into the design and operation of NBG. The design of WRDs and RDAs is undertaken in a manner to prevent leachate entering the groundwater (Section 8.4.1). In addition, NBGPL is committed to manage the impacts of residue disposal activities through:

- maintaining certification with the ICMC
- ensuring WRD expansion areas are equipped with perimeter drainage and ensure that any seepage would report to the Impacted Water Drainage Blanket for collection and use through the processing plant
- designing, constructing and operating the new RDA with seepage mitigation measures and solution recovery systems
- installing a drainage blanket on lower parts of the WRDs where potentially acid forming rock may be dumped and where drainage would no longer report to the existing impacted Water Sump
- constructing the drainage blanket of hard non-acid forming rock with a high void ratio and designed to direct seepage towards perimeter drains
- designing and constructing the new RDA to include a liner below the supernatant pond and solution recovery systems.

These commitments have been included in the Groundwater Quality Management Plan.

7.2.3 Soils and geology

NBG is located within a fault bounded, northwest trending sliver of greenstones 50 km long by 8 km wide bounded by granite and gneiss terrain. Extensive weathering of the basement geological units has resulted in a profile with the following strata:

- a lateritic surface layer of approximately 5–10 m thick
- an oxidised clay zone underlying the laterite of approximately 60–80 m thick (reduced or absent on eroded hill slopes)
- chemically weathered saprolite underlying the clay zone, approximately 15 m thick
- bedrock with the top 10–15 m locally broken and weathered (Schlumberger 2013).

The lateritic surface layer consists of a number of sub-layers that include:

1. A topsoil layer, approximately 0.1 m thick, that contains gravel, sand and elevated quantities of organic matter, including areas of high concentration organic oils that can cause water repellence (Schlumberger 2013).
2. A gravelly soil layer, which is generally 0.5–8 m thick. This layer is predominantly pea-sized gravels and has an accordingly high hydraulic conductivity.
3. A lateritic cap rock layer of 1–5 m thick (Schlumberger 2013).

7.2.4 Hydrogeology

Conceptual hydrogeology

According to Aquaterra (1999) and Schlumberger (2013), groundwater in the vicinity of NBG is contained within two main systems:

1. A seasonal shallow groundwater system (shallow aquifer) located within the gravelly soils.
2. A bedrock groundwater system (bedrock aquifer), conceptually divided into a weathered and fractured saprolite upper bedrock aquifer and a deeper, less fractured lower bedrock aquifer.

Figure 15 presents a diagrammatic representation of the conceptual hydrogeology.

An oxidised clay zone averaging 40 m thickness, and up to 70 m thickness occurs between the shallow and bedrock aquifers (Schlumberger 2013). This zone has a low hydraulic conductivity but significant potential for water retention and storage (Schlumberger 2013). This layer is considered to effectively act as a semi-confining layer between the shallow and bedrock aquifers (Golder 2005), except in locations of elevated topography where the saprolite layer may approach the surface (Schlumberger 2013).

The bedrock contains a series of dolerite intrusions or dykes with an approximately southeasterly–northwesterly alignment, parallel to the Saddleback Greenstone intrusion (Schlumberger 2013). These dykes alter the hydrological properties of the aquifers such that hydraulic conductivity has been reported to be 10–70 times higher in a direction parallel to the intrusion compared to a direction across the intrusion (Schlumberger 2013).

Mining currently occurs in the upper and lower bedrock aquifers (Schlumberger 2013).

Shallow aquifer

The shallow aquifer is located within the gravelly soil layer perched above the underlying clay zone (Schlumberger 2013). This aquifer is highly responsive to rainfall infiltration and groundwater heads tend to change rapidly (Schlumberger 2013). The aquifer provides water for winter creek flows (Figure 15; Aquaterra 1999). Portions of the aquifer are seasonally saturated, with permanent saturation occurring at some topographically lower points. Seasonal water level variation in the shallow aquifer is approximately 2 m (Schlumberger 2013).

The main discharge is to alluvial sediments along creek channels, with groundwater flow generally following surface topography and contributing to winter flows in creeks and streams, such as the Hotham River. Some vertical discharge is likely to occur through higher permeability zones in the form of relict dykes. These zones act as vertical conduits allowing some water to leak down to the bedrock aquifers (Figure 15; Aquaterra 1999).

Upper bedrock aquifer

The weathered and fractured saprolite layer that forms the upper bedrock aquifer is considered the main continuous and connected hydraulic system in the NBG area (Schlumberger 2013). However, the hydraulic properties of the aquifer vary greatly at a local level (Schlumberger 2013). The aquifer is approximately 30 m thick (Schlumberger 2013).

Lower bedrock aquifer

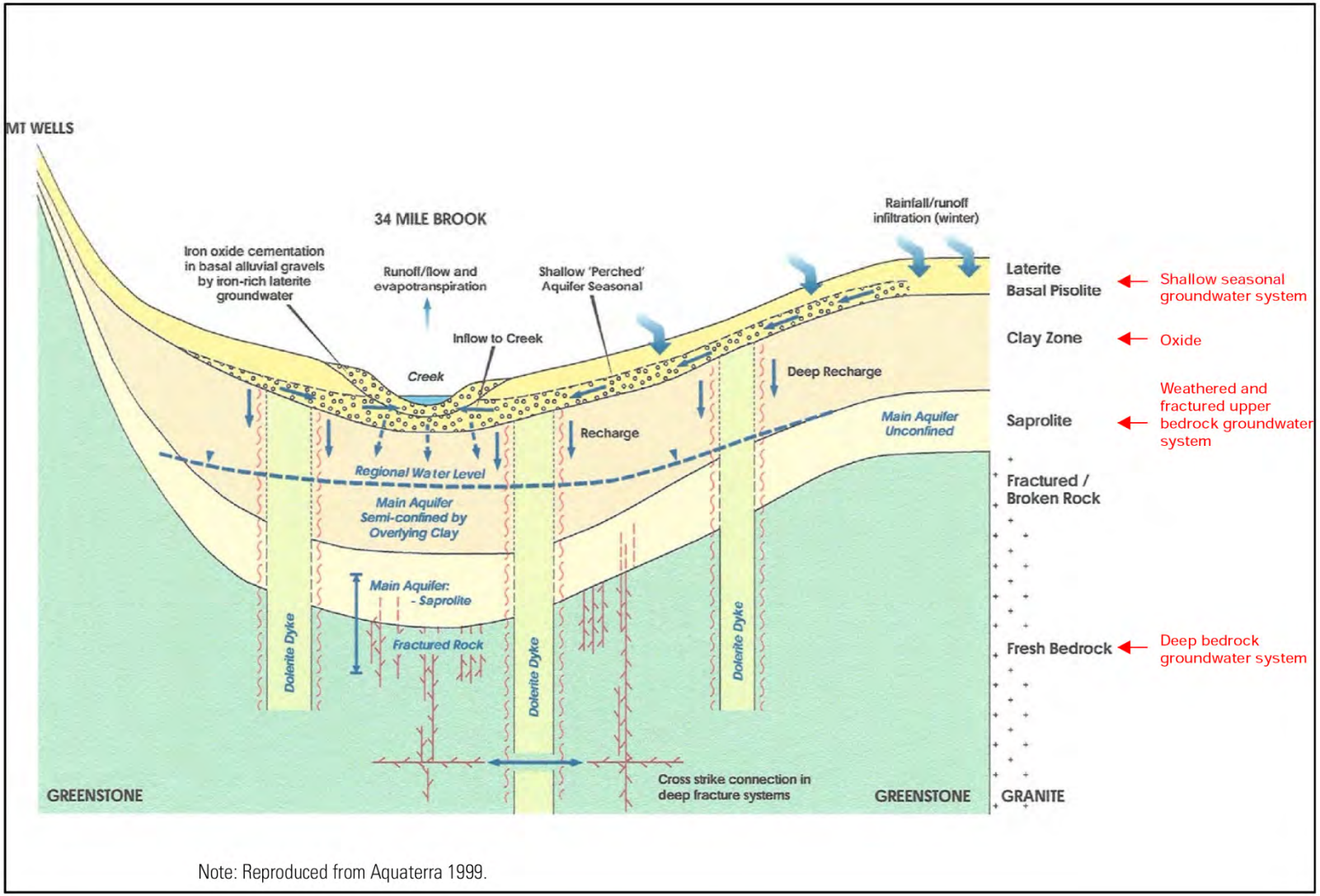
The lower bedrock aquifer consists of fresh rock. This aquifer is less permeable than the upper bedrock aquifer as the majority of fracturing generally occurs within the upper 20 m of the bedrock (around 100 m below ground level [mbgl]), although some highly permeable fracture zones have been reported at depths greater than 250 mbgl (Schlumberger 2010). The most notable of these intersected to date is the Fish Shop Window shear zone (Schlumberger 2010). When intersected during underground mining, this zone produced groundwater inflows in the order of 100 L/s for around three years (Schlumberger 2010).

Modelled hydrogeology

Groundwater modelling has been revised as part of the environmental assessment for the Proposal . The model has been set up as a series of layers, which roughly correspond to the hydrogeology described above, as outlined in Schlumberger (2013) and Table 12. The hydraulic characteristics are presented in Table 13. In the greenstone intrusion, hydraulic conductivity parallel to the intrusion is approximately twice that compared with across the intrusion (Table 13; Schlumberger 2013).

Table 12 Model layer thicknesses

Aquifer layer	Model layer	Thickness (m)	Equivalent layer from conceptual hydrogeology (Figure 15)
Weathered zone	1	12 (average)	Laterite and basal pisolite /shallow seasonal aquifer
Transition zone	2	9 (average)	Clay oxide zone
Upper bedrock	3	150	Saprolite
Intermediate bedrock	4	69	Deep bedrock
	5	71	Deep bedrock
Lower bedrock	6	197	Deep bedrock
	7	200	Deep bedrock
	8	300	Deep bedrock



Note: Reproduced from Aquaterra 1999.

Table 13 Modelled hydraulic conductivity and specific storage of bedrock aquifers

Aquifer	Greenstone intrusion				
	Kx (across intrusion) (m/s)	Ky (parallel to intrusion) (m/s)	Kz (vertical), low Kz zone (m/s)	Kz (vertical), high Kz zone (m/s)	Specific storage (m^{-1})
Weathered zone	1×10^{-7}	1×10^{-7}	2×10^{-6}	n/a	N/A
Transition zone	1×10^{-6}	2×10^{-6}	2×10^{-6}	n/a	4×10^{-6}
Upper bedrock	2×10^{-6}	3.5×10^{-6}	2×10^{-6}	n/a	3×10^{-6}
Intermediate bedrock	1×10^{-7}	2×10^{-7}	5×10^{-8}	1×10^{-7}	3×10^{-6}
Lower bedrock	1×10^{-8}	2×10^{-8}	5×10^{-9}	1×10^{-7}	2×10^{-6}
Aquifer	Gneiss				
	Kx (across intrusion) (m/s)	Ky (parallel to intrusion) (m/s)	Kz (vertical) (m/s)		Specific storage (m^{-1})
Weathered zone	1×10^{-7}	1×10^{-7}	2×10^{-6}		N/A
Transition zone	1×10^{-7}	1×10^{-7}	5×10^{-8}		1×10^{-3}
Upper bedrock	5×10^{-8}	5×10^{-8}	2.5×10^{-8}		1×10^{-6}
Intermediate bedrock	5×10^{-8}	5×10^{-8}	2.5×10^{-8}		1×10^{-6}
Lower bedrock	5×10^{-8}	5×10^{-8}	2.5×10^{-8}		1×10^{-6}

7.2.5 Hydrology

The understanding of the hydrogeology and hydrology of the Boddington area has been developed through monitoring of the NBG site and surrounds. NBGPL undertakes water monitoring for water quality and levels throughout the year in accordance with the existing approvals for the mine, including Ministerial Conditions, surface water abstraction licences and the EP Act Part IV Prescribed Premises Licence. Compliance with the groundwater monitoring requirements involves collection of 2844 items of data from 66 sites annually (NBGPL 2012a).

Groundwater monitoring at NBG is undertaken using a combination of manual soundings and vibrating pressure transducers.

Groundwater levels prior to mining

Prior to mining commencing in the 1980s, groundwater flow was predominantly to the south, towards Thirty Four Mile Brook, following the overall strike of the regional[2] geological structure (Aquaterra 1999). Groundwater levels varied from approximately 310 mAHD at the northern end of the existing RDA to approximately 215 mAHD at the southern end of the D4 dam with groundwater levels in the vicinity of the mine inferred to be between 220 and 260 mAHD (Schlumberger 2013; Figure 16).

[2] For the purposes of this section, 'regional' is defined as being on a scale of kilometres. 'Local' refers to a scale of 100 m or less.

Current groundwater levels

Dewatering operations have resulted in lowering of bedrock aquifer groundwater levels in the areas surrounding the mine compared to 1987 water levels (NBGPL 2012a). In the centre on the main mining area the maximum difference between September 2012 and pre-mining baseline water levels is about 200 m. This represents a total decrease in water level of approximately 180 m since commencement of pre-expansion works in 2006. The extent of drawdown is in the centre of Thirty-four Mile Brook catchment and there is little or no drawdown beyond the catchment boundary.

The lowering of ground water levels in all units remains relatively close to the open pits and is currently over 4 km from the Hotham River (NBGPL 2012a).

Seasonal variation in groundwater levels from summer to winter range from less than 1 m to a maximum of 5 m (Schlumberger 2012). In addition, all bores display a long-term trend of declining groundwater levels that started during the pre-NBGPL mining period and continued during the period of care and maintenance prior to NBGPL takeover of the mine (Schlumberger 2013). This decline is considered a response to long-term declines in precipitation in the Boddington area (Schlumberger 2013). Average long-term decline in groundwater levels has been estimated at 0.4 m/yr (Schlumberger 2013).

Based on groundwater monitoring, a 2 m drawdown contour has been developed for the upper bedrock aquifer (Schlumberger 2013; Figure 17). Two metres has been used as the minimum discernible difference that can be attributed to the mining project because the annual variation and long term regional decline in groundwater levels prevents the identification of impacts smaller in magnitude (Schlumberger 2012).

Consistent with the alignment of the intrusions, drawdown has primarily occurred in a northwesterly and southeasterly direction to a maximum distance of 4 km from the mine, but generally less than 1.5 km (Schlumberger 2013; Figure 17). Currently the 2 m drawdown contour is approximately 4 km from the Hotham River, at its closest point (Figure 17).

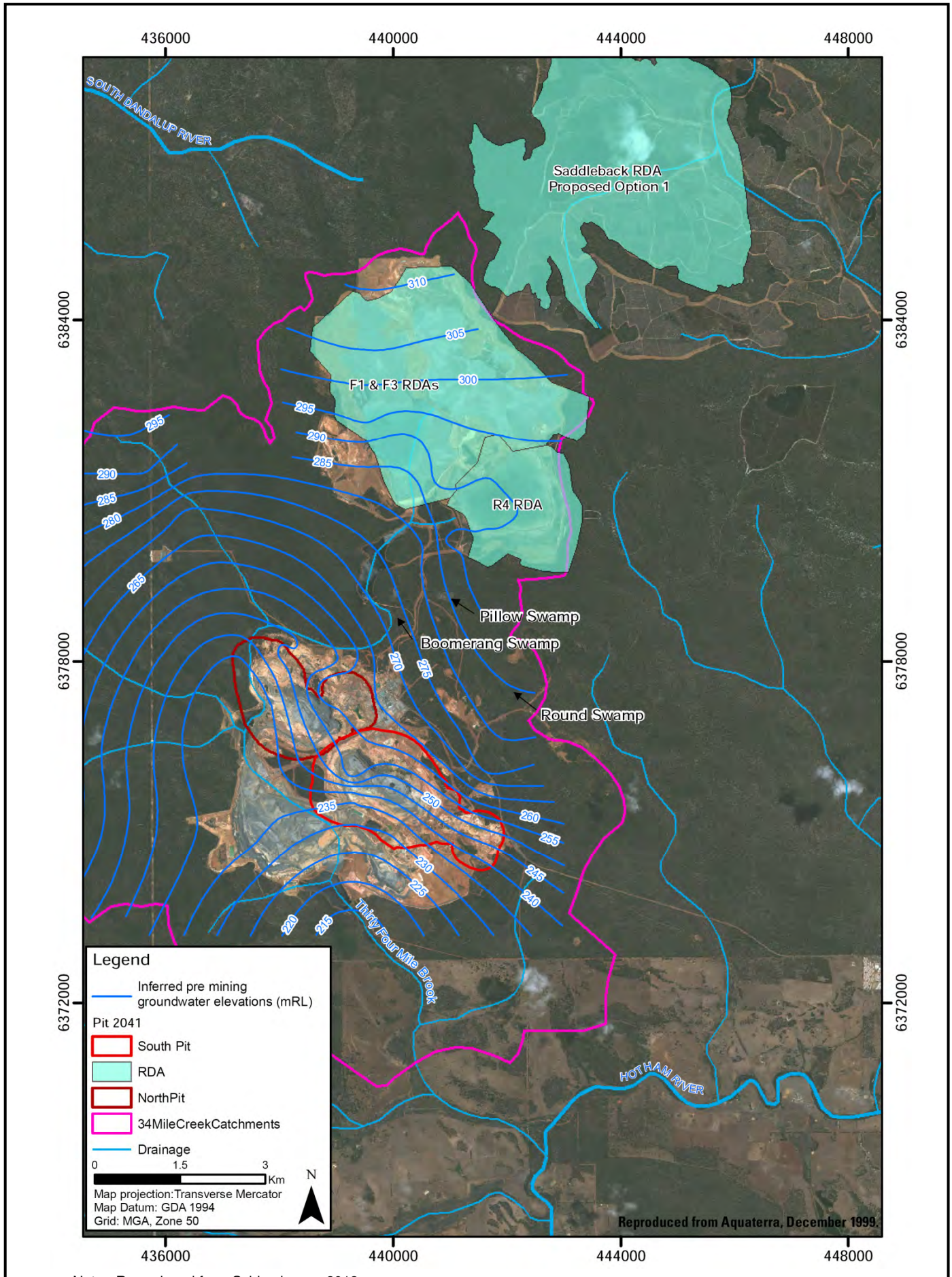
Determining the extent of drawdown to the south and west of the mine has been complicated as the drawdown zone is within the WRD area (Figure 17) where dumping of waste rock limits the installation of monitoring bores. Drawdown has not yet been observed in bores to the west and south of the WRD (Figure 17).

Rises in groundwater levels have occurred around the RDAs (NBGPL 2012a). This mounding is due to the seepage of impounded runoff, imported water from the Hotham River and recirculated mine and process water through the floor and walls of the RDA. The mound is about 20 m above the pre-mining baseline conditions at R4 RDA, 30 m at F3 and 35 m at F1, which is consistent with data from 2011. Groundwater levels around the RDAs have fluctuated in response to various water transfers and residue deposition. Comparison of the current water levels to the pre-expansion baseline data shows the groundwater mounds have increased by 25 m at F1, increased slightly by 10 m at F3 and remained relatively stable at R4. However, the groundwater mounding is not expected to result in any surface expressions or affect vegetation in the area.

Water quality

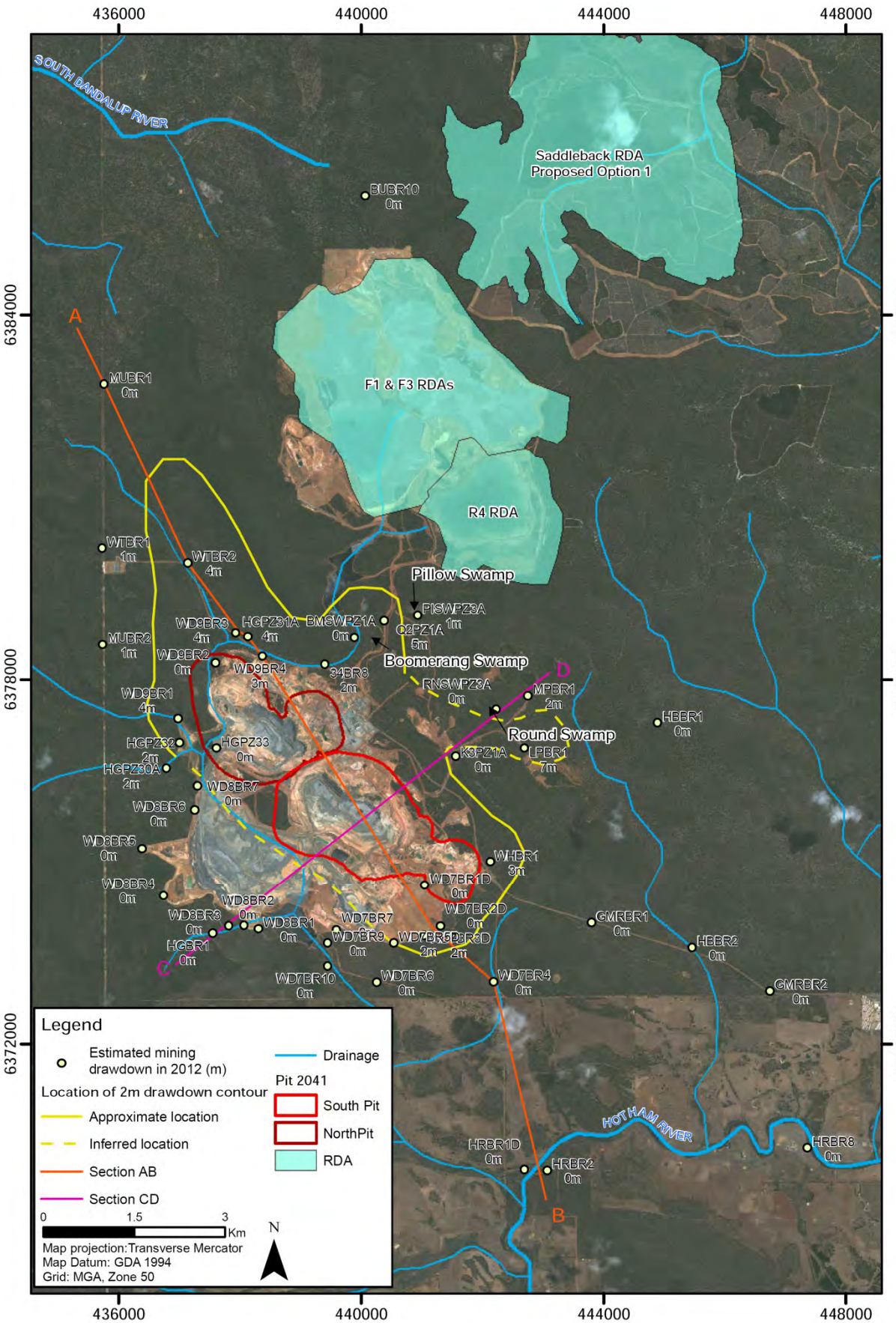
Pre-mining records show groundwater salinities in the shallow aquifer across the Thirty Four Mile Brook catchment ranged from 1000 mg/L to 3000 mg/L total dissolved solids (TDS) (Schlumberger 2010). Water imported from the Hotham River generally has a much higher salinity (up to 10 000 mg/L) and as such, salinity has been used as a monitoring trigger to detect seepage of groundwater from facilities (Schlumberger 2010).

Bores screened in the upper bedrock aquifer generally exhibit salinities between 3300 to 4500 mg/L TDS (Schlumberger 2012). Mining of the open pits has increased salinity around the mine pits by 1000 to 2500 mg/L (NBGPL 2012a).



Note: Reproduced from Schlumberger 2013

STRATEGEN	Newmont Boddington Gold Life of Mine Expansion Project Groundwater levels prior to mining commencing (1987)	Figure 16



Note: Reproduced from Schlumberger 2013

STRATEGEN	Newmont Boddington Gold Life of Mine Expansion Project Mining related drawdown in 2012	Figure 17

During operation of the RDAs, increases in groundwater salinity in the shallow aquifer associated with facility seepage have been identified. Prior to mining, groundwater in this area ranged between 2 000 to 4 000 mg/L TDS (Schlumberger 2010). Prior to the mine entering temporary care and maintenance in 2001, groundwater TDS concentrations surrounding the RDAs had increased by 1 000 to 10 000 mg/L, most likely as a result of seepage (Schlumberger 2010). This seepage had predominantly occurred from the eastern embankment of the R4 oxide tailings dam. This facility is no longer used for tailings deposition.

High salinity levels ranging 2000–7000 mg/L occur north and northeast of the F3 RDA. These levels are consistent with the 2010 and 2011 salinity levels in the area. These higher salinity levels occur outside the Thirty-four Mile Brook catchment boundary. Outside this catchment boundary, the salinity levels are naturally higher than levels surrounding the F3 RDA as shown by many of the bores outside the Thirty-four Mile Brook catchment boundary. Consequently, seepage from the F3 RDA may not be the cause of the high salinity levels occurring outside the catchment boundary as lower salinity levels have been observed at the bores closer to the F3 RDA.

Although comparisons with the pre-mining (1987) baseline conditions indicate that salinity has generally increased in the residue disposal areas, with localised increases of up to 2000 mg/L and 5000 mg/L on the southern corner of the F1 RDA and on the south eastern corner of R4 RDA respectively, salinity appears to have reduced between 2000–6000 mg/L around the F1 and F3 main embankments since the pre-expansion works (2006).

Following an increase of up to 5000 mg/L at the northern corner of the mining area, an additional groundwater bore was added to the program more regionally. Since this time, salinities in the bore have remained stable at a level of 4000 mg/L. There has been no significant increase in salinities in this area from the 1987 baseline data, which showed monitored salinity levels, have reached around 4000 mg/L in this area. Salinity impacts due to mining activities generally do not appear to extend beyond the Thirty-four Mile Brook catchment boundary with the exception of the boundary of the Boggy Brook catchment at the northern and eastern embankment of the R4 RDA.

Groundwater pH generally ranges from 5.5–8, within the range set by the water quality guidelines for the site Prescribed Premises Licence (Schlumberger 2010). Low pH readings were recorded in one compliance bore and one nearby background bore during 2011; however, these results are not considered related to mining or RDA operations but are instead primarily related to bacterial mediated ferrolysis[3] (NBGPL 2012a). NBGPL is currently seeking a licence amendment to address this natural process.

During the mining period there have been occurrences of slightly elevated metal concentrations being identified in deeper monitoring bores (i.e. not in the superficial aquifer); these have mostly been correlated with dewatering periods in which oxidation of exposed sulphides may have occurred (Schlumberger 2010).

7.2.6 Groundwater-dependent ecosystems

Groundwater-dependent ecosystems (GDEs) in the area surrounding NBG are considered to include Pillow, Round and Boomerang Swamps and potentially the Hotham River and associated riparian vegetation. Riparian vegetation associated with minor watercourses may also be dependent on shallow groundwater, where watercourses persist over the summer months. Upland vegetation in the Boddington area is not considered to be of a type dependent on groundwater, although may use groundwater should it be available.

The South Dandalup River is primarily fed by rainfall rather than groundwater and is; therefore, not considered groundwater-dependent (Section 8.2.1).

This section describes the current understanding of the interaction of these GDEs with groundwater. A description of vegetation in these areas can be found in Section 9.2.

[3] The biochemical reduction of free iron(III) oxides to Fe2+ and re-oxidation of Fe2+ during alternating reducing and oxidizing conditions in the soil that results in acidification.

Hotham River

The Hotham River is the main permanent surface water feature in the Boddington area. A discussion of the surface water hydrology and quality of the Hotham River is presented in Section 8.2.1. Riparian vegetation is discussed in Section 9.2.3. Aquatic fauna is described in Section 10.2.3.

In summary, winter flows in the Hotham River are related to catchment-scale rainfall events, while summer flows are considered to result from groundwater baseflow throughout the catchment and leakage from Lions Weir in the Boddington town site (Golder 2005). Prior to construction of the weir, the river did not flow throughout the summer months (DoW 2012). This indicates that the river does not receive significant baseflow from groundwater in the area downstream of the town (Section 8.2.1).

In 2010 three sets of groundwater monitoring bores were installed in the upper bedrock aquifer adjacent to the Hotham River (HRBR1, HRBR2 and HRBR8) (Schlumberger 2013). The lithology of HRBR2 shows a 36 m deep layer of clay overlying the weathered rock (Schlumberger 2013). HRBR1 and HRBR8 show a more variable hydrogeology, with numerous beds of clayey and sandy material overlying the weathered rock at approximately 20 m depth (Schlumberger 2013).

The deeper bores display seasonal changes in groundwater levels of up to 2 m; however, average elevations have been stable and no evidence of influence from mine dewatering has been found (Figure 17; Schlumberger 2013). The HRBR1 bores consist of a paired shallow and deep bore, which display similar trends in groundwater levels (Schlumberger 2013). This could be due to either:

1. The oxidised clay layer not acting as a hydraulic barrier in this location.
2. Hydraulic connection via an adjacent drill hole that was abandoned as the plastic casing broke in weathered rock during installation. This abandoned hole could provide an artificial pathway between the shallow and weathered rock aquifers (Schlumberger 2013).

Based on the evidence, the oxidised clay layer is considered likely to act as a semi-confining layer adjacent to Hotham River; however, more investigation is required to confirm this hypothesis. NBGPL is proposing to undertake work to improve understanding of the interaction between the Hotham River and the regional aquifers, as outlined in Section 7.5.1. The impact assessment and modelling work for the PER have been undertaken on the conservative assumption that there is some interaction between the river and the upper bedrock aquifer. Consequently, the river and associated riparian vegetation are considered potentially groundwater-dependent.

Swamps

Three groundwater-dependent swamps; Round Swamp, Pillow Swamp and Boomerang Swamp, are located to the northeast of NBG (Figure 17). The swamps represent topographical low points where groundwater in the shallow groundwater system is perched on top of the clay layer and discharges to the surface (Schlumberger 2013). These swamps are; therefore, not considered as directly connected to the bedrock aquifers (Schlumberger 2013). NBGPL undertakes regular monitoring of the shallow and upper bedrock aquifers at these locations (NBGPL 2012a).

The shallow aquifer at Pillow Swamp remains saturated over most summers (Schlumberger 2013). Groundwater levels in the upper bedrock are approximately 20 m below the swamp, indicating separation between the shallow and bedrock aquifers by the clay layer (Schlumberger 2013). The upper bedrock in this location demonstrates seasonal responses to precipitation, which indicates percolation of groundwater from the Swamp to the upper bedrock aquifer (Schlumberger 2013). Since 2010, average groundwater levels in Pillow Swamp have declined by 0.7 m/year, which is greater than the background trends. This decrease may indicate the commencement of mining-related drawdown (Schlumberger 2013).

However, the extent of the drawdown from the dewatering activities does not extend to these bores, which suggests that the decrease is likely due to limited recharge reaching these deeper bores (NBG 2013). This is not observed at the other swamp locations. For example, water levels in the bores located within the vicinity of the main mining area (e.g. RNSWPZ3A at Round Swamp) were stable suggesting no impact from dewatering of the pits. The shallow aquifer below Round Swamp maintains saturation over most summers (Schlumberger 2013).

Groundwater levels in the upper bedrock aquifer are approximately 8 m below those in the shallow system, indicating that the clay layer effectively separates Round Swamp from the bedrock aquifers (Schlumberger 2013). Water levels in the upper bedrock aquifer have not been affected by dewatering at this location (Schlumberger 2013).

The higher sections of Boomerang Swamp typically dry out in the summer months, while the lower sections remain saturated (Schlumberger 2013). Groundwater levels in the shallow aquifer at Boomerang Swamp are lower than those in the upper bedrock aquifer, and respond differently to seasonal precipitation (Schlumberger 2013). This confirms the concept that the clay layer limits connection between the shallow and upper bedrock aquifers at this location (Schlumberger 2013). Mining-related drawdown has not been observed in the upper bedrock aquifer at this location (Schlumberger 2013).

7.3 Potential sources of impact

The main impacts to groundwater may arise from the following environmental aspects of the Proposal, as described by the ESD, are:

- **changes to groundwater levels** (drawdown) in the shallow and bedrock aquifers due the dewatering, resulting in a reduction in groundwater availability
- **impacts to groundwater-dependent ecosystems** including the Hotham River, as a result of groundwater drawdown and groundwater abstraction
- **contamination of groundwater** as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies.

7.4 Assessment of likely direct and indirect impacts

Assessment of the water quantity-related impacts has been undertaken through consideration of the mine water balance and the results of modelling groundwater system behaviour as discussed in Section 7.4.1.

7.4.1 Mine water balance

Modelling of the future water balance of the mine has been undertaken by Golder Associates (Golder 2013). This has resulted in a refinement of the existing water balance based on estimates of future groundwater flows and rainfall harvesting volumes (Figure 18). The water balance modelling takes into account:

- anticipated decreases in groundwater inflow to the pits
- changes to dams and other surface water infrastructure over time, as described in Section 8.4.1
- potential reductions in rainfall harvesting based on climate change (Golder 2013).

The modelling includes projections of flows in the Hotham River based on climate change predictions and licence conditions controlling the volumes of water that may be abstracted from the river (Golder 2013). The volume of water utilised through the processing plant will increase as the production rate increases.

Future inflow from the pits is estimated to be approximately 80–100 L/s as compared to an average of 127 L/s in 2011 (Schlumberger 2013). The reduction in inflows from the pits and rainfall harvesting results in a reduction in water being available to the mine. This reduction is partially compensated for by increased water capture from the new RDA. The volume of returned water from the RDA is also anticipated to increase slightly (Golder 2013). To compensate for these reduced inflows, abstraction from the Hotham River is anticipated to increase from 2-6 GL/yr to 6.4–8.5 GL/yr.

This increase in abstraction is within the current licensed limit, allowing for climate change and licence restrictions detailing when abstraction may occur. NBGPL is investigating methods to improve water conservation and/or other sources of water to minimise the need to increase abstraction from the Hotham River. Any increases to abstraction will be within the current licensed volume of 10 GL/yr.

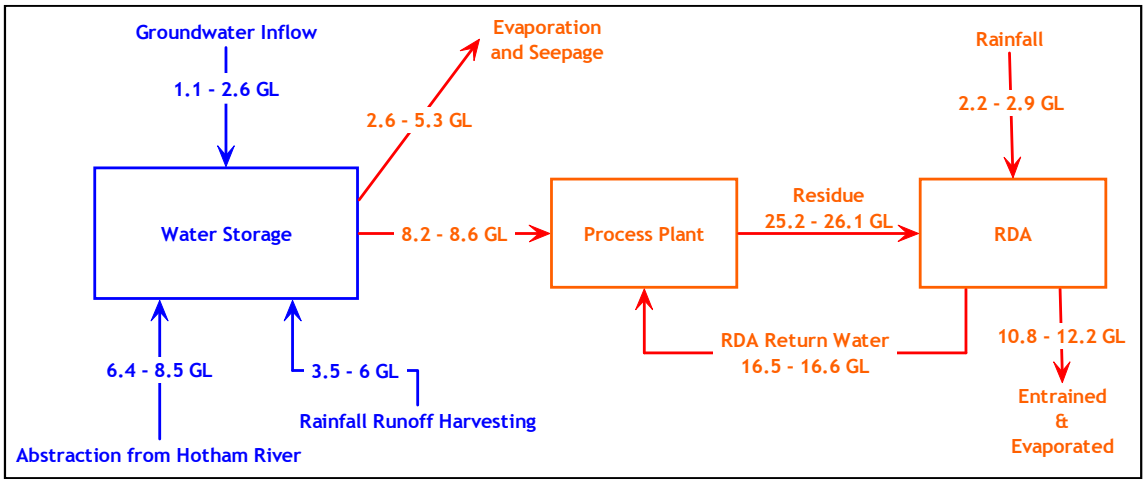


Figure 18 Proposed mine water balance

7.4.2 Groundwater dewatering and abstraction

Groundwater model

The original groundwater model for NBG was constructed by Golder in 2004, using the FEFLOW modelling program to estimate groundwater abstraction rates required for dewatering. This was necessary to inform dewatering infrastructure requirements and mine water balances (Schlumberger 2013). The model was updated by Golder in 2005 and 2011, prior to being provided to Schlumberger for recalibration, where it was used to determine the potential impacts of the Proposal on groundwater beyond the boundary of the mine site (Schlumberger 2013). This historical use has resulted in a model that has focused upon reliably predicting the local impacts of dewatering around the mine pit, rather than predicting regional changes in groundwater levels (Schlumberger 2013). However, the model can be used as a preliminary indicator of the potential regional drawdown that may be generated by the expanded mining operation. A copy of the modelling report can be found in Appendix 3.

Model description

The model consists of eight distinct layers representing the weathered zone, transition zone, upper bedrock, intermediate bedrock and lower bedrock (Table 12, Table 13). Two main zones of hydraulic parameters are defined over the model, being for the Saddleback Greenstone and the regional Gneiss (Figure 20). The greenstone contains two zones of high vertical conductivity; one running parallel to the greenstone through the site (approximately north–south) and another cutting across it (approximately east–west) to the south, near the Hotham River (Figure 20).

Watercourses can interact with groundwater in a number of ways, depending on the geology of the area and relative water levels in the watercourses and aquifers. The magnitude of interaction between a watercourse and groundwater depends on the hydraulic properties of the soil and rock underlying the watercourse. Materials with a low hydraulic conductivity, such as clay layers, will limit or prevent exchange of water between the watercourse and groundwater. High hydraulic conductivity materials such as sands and gravels would result in increased interaction between the watercourse and groundwater. Assuming that there is interaction between the watercourse and groundwater, the watercourse may:

- lose water to groundwater when and where groundwater levels are lower than levels in the watercourse (losing stream) and/or
- gain water from the aquifer when and where the groundwater levels are above those in the watercourse (gaining stream).

With the exception of the Hotham River, the model assumes all watercourses are configured as gaining streams, where water flows into the stream and out of the model (i.e. groundwater levels are higher than the riverbed. This scenario is explained in Figure 19, with arrows representing the direction of water flow. The Hotham River is set as both a gaining and losing stream, so water can flow into the model from the river if the groundwater levels are below the level of the riverbed (Schlumberger 2013).

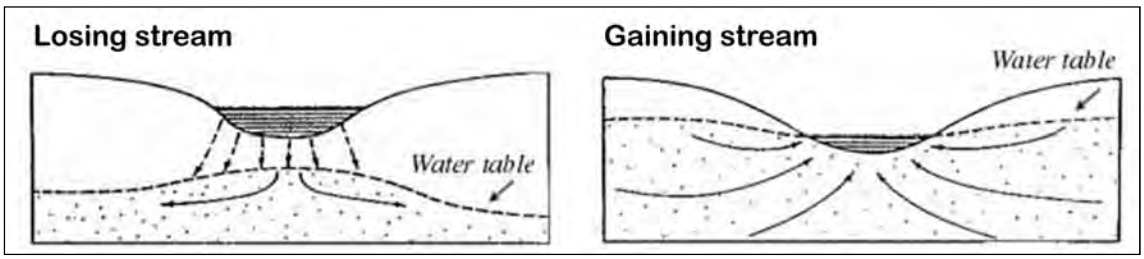


Figure 19 Losing and gaining streams

Source: US EPA 2012

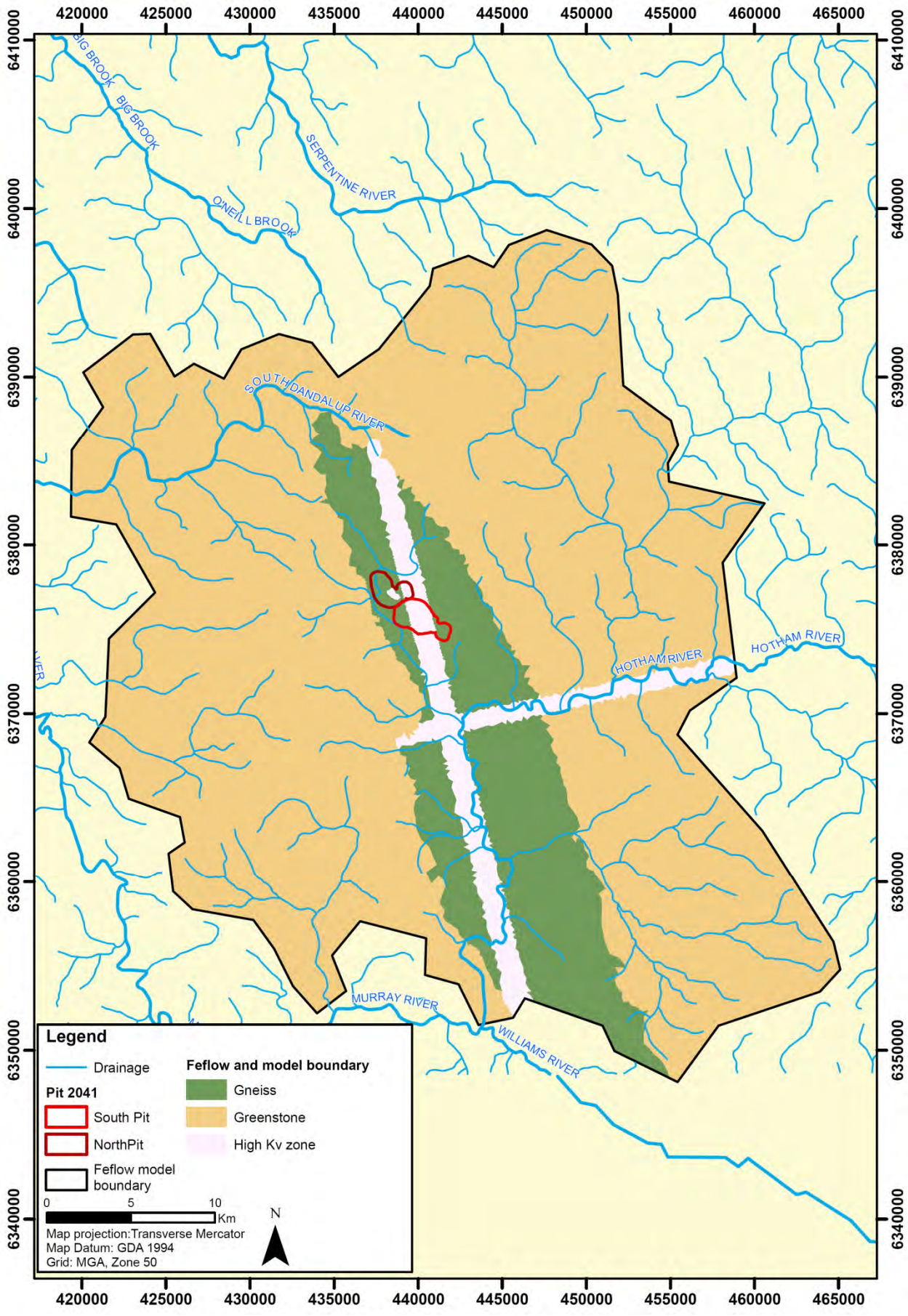
Recalibration

On taking over the model, Schlumberger undertook recalibration with an overall objective to assess and improve modal capability to simulate the regional groundwater system while accurately simulating the near pit conditions. The model was originally constructed to refine estimates of groundwater inflow volumes into the open pits over the mine life. The review of monitoring data collected to date indicated that the two major controls on the future extent of mining-related drawdown will be (Schlumberger 2013):

1. The orientation and location of the discrete zones of fracturing within the deep bedrock, which are intersected by the pits and the dewatering bores, and the regional extent and location of these fracturing zones.
2. The degree of vertical hydraulic connection between the weathered and fractured upper bedrock groundwater system that blankets the area, and the underlying deep bedrock system.

Subsequent objectives were to:

- summarise a conceptual model for groundwater flow compiled from multiple groundwater investigations
- compile groundwater monitoring data collected over range of studies into a single consistent quality-assured database
- use consolidated observations of groundwater inflow rates during mining and observations of responses to mining in monitoring bores to assess the area of influence of mine dewatering
- use the existing operational numerical groundwater model to provide preliminary estimates of maximum possible extent of future influences of the dewatering program and to explore importance of regional hydraulic properties on controlling drawdown
- incorporate new monitoring data to improve the accuracy of the model predictions
- refine various components of the model.



Note: Reproduced from Schlumberger 2013

STRATEGEN	Newmont Boddington Gold Life of Mine Expansion Project Model zones of hydrogeological parameters	Figure 20

Model aspects that were further refined during this recalibration process included:

- ensuring focus on the regional conditions and responses as opposed to conditions near the pits
- update model with latest vibrating wire piezometer (VWP) observations in the pit area (this will be utilised to refine the understanding of the structural controls in the bedrock)
- improve consistency of the relationship between the layers in the model based on review of monitoring data
- improve orientation of connectivity zone in the bedrock layers to identify better with the preferential regional drawdown identified through the monitoring data review
- the relationship between the Hotham River and underlying groundwater system.

Regarding the relationship between the Hotham River and the underlying groundwater system, the current model uses a conservative prediction of condition; however, there is a significant thick layer of clayey oxide material in some locations. This relationship is going to require on-going investigations.

Recalibration was undertaken based on the groundwater data described in Section 7.2.5 and Figure 17. This recalibration was complicated by a number of factors including:

- complex local and regional hydrogeology
- seasonal and regional trends in groundwater
- small spread of drawdown
- short duration of groundwater records for regional bores (Schlumberger 2013).

The first complicating factor was the complex nature of the geology at NBG. During monitoring, many geological features such as dykes and fractures of perhaps a few metres across have been observed in the bedrock aquifers. These features can control the propagation of drawdown away from the pit or dewatering bores (Schlumberger 2013). It is impractical to attempt to map the location and geometry of these features at a regional scale, and monitoring results may be affected because of local-scale effects of these features. This creates significant difficulties in developing an accurate regional scale groundwater model without a substantial set of time-series data.

The presence of complicating factors such as regional lowering of groundwater due to drying climate, strong seasonal trends and local geological features with very different hydraulic properties added to the difficulty in developing an accurate, calibrated regional scale model.

The recalibration was further complicated by the strong seasonal trends in the regional bore data and natural declining trends in background groundwater levels as described in Section 7.2.5. These factors cause difficulties in identifying the changes due to mining-related drawdown and those due to natural factors. As a result, determining where drawdown may have been observed is difficult. This is further complicated by the small spatial spread of drawdown observed to date, which results in few locations where mining-related drawdown can be definitely determined as having occurred (Schlumberger 2013: Figure 17).

The modelling gives weight to data where drawdown may have occurred but the evidence is not strong, which results in an assumption of a broader area of drawdown. This approach results in a calibration with high rate of drawdown spread. This higher rate of drawdown spread results in conservative predictions of larger areas of drawdown in future than may otherwise be the case (Schlumberger 2013).

This approach was taken for regional monitoring bores down-gradient (i.e. south) of the mine area, for which only two years' monitoring data was available. This did not offer a long enough period to accurately discern seasonal and long-term trends from mining influences (Schlumberger 2012b). This conservative calibration results in the selection of higher values of horizontal hydraulic conductivity and lower storativity than may actually represent the situation, which could overestimate the areal impact of dewatering. When a definitive onset of mining related drawdown has been observed in bores between the Hotham River and the open pits (as yet the drawdown seems to be below the WRDs), this will provide improved calibration points to refine the hydraulic conductivity for the regional groundwater system (Schlumberger 2013).

The final calibrated parameter values are provided in Table 13. Additional information regarding the model set up, calibration and sensitivity analysis can be found in Appendix 3.

Predicted changes to groundwater levels

Groundwater modelling has been primarily focussed on the lower and upper bedrock aquifers, as these are the aquifers in which dewatering will occur (Schlumberger 2013). The shallow aquifer at NBG is seasonal and disconnected, and modelling changes in this aquifer is consequently problematic. The impact of drawdown at given locations in the shallow aquifer depend on the drawdown in the upper bedrock aquifer located below the shallow aquifer, and the degree of connection between the two aquifers. This degree of connection will depend on the thickness and hydraulic properties of the clay oxide layer in the area. The discussion in this section focuses on the modelled drawdown in the upper and lower bedrock aquifers.

Groundwater drawdown was plotted for 2017, 2022, 2032 and 2041 (Figure 21 to Figure 24). The drawdown has been calculated as the change of groundwater level from the start of the predictive model in 2012. These plots show drawdown initially extending in predominantly northeast and southwest directions in the lower bedrock, with a broader expansion in the upper bedrock (Figure 21 to Figure 24). This is a result of the northeasterly–southwesterly alignment of the high vertical conductivity zones under the mine (Schlumberger 2013).

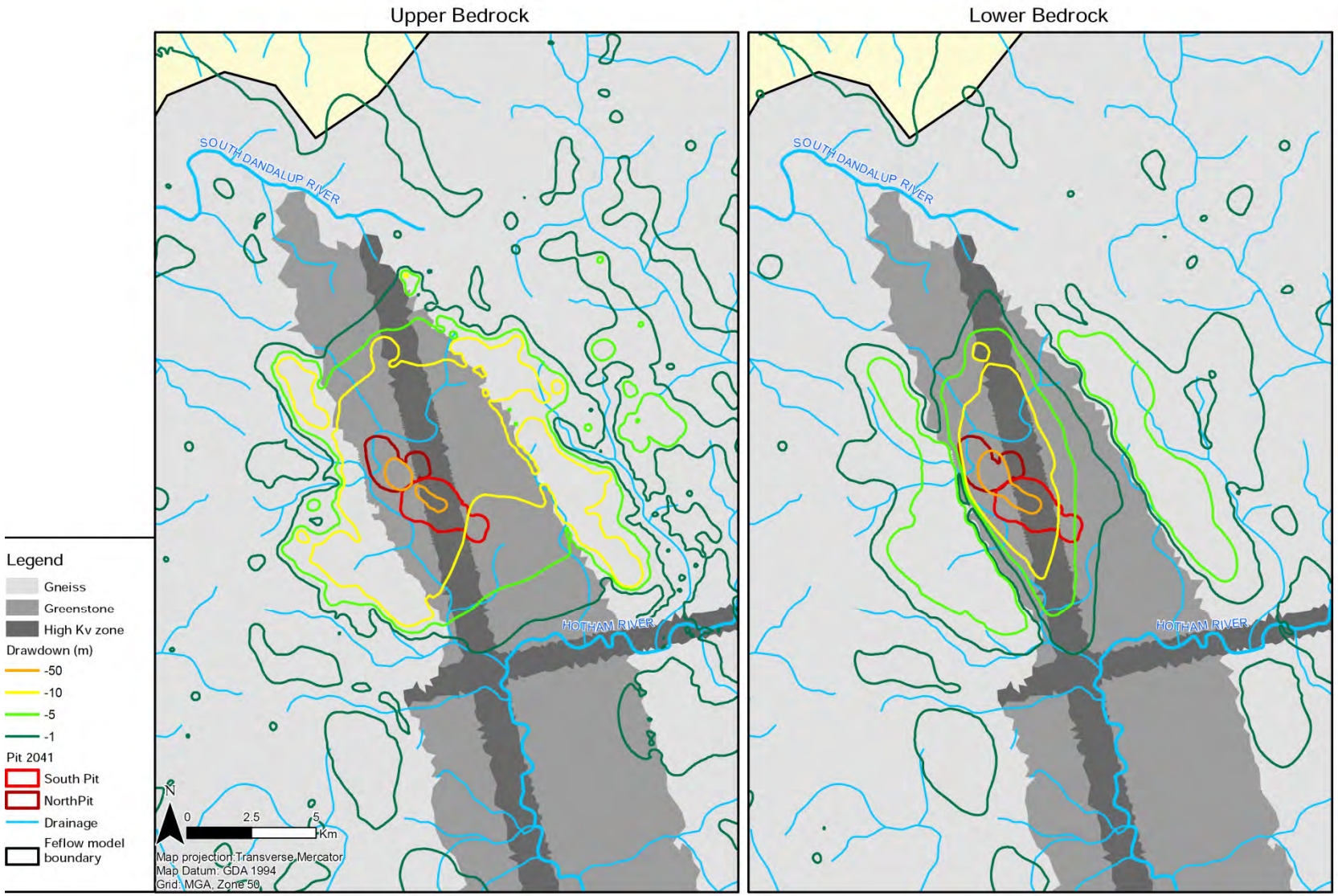
The 1 m drawdown contours in the lower and upper bedrock are anticipated to approach the Hotham River in about 2022 (Figure 22). The drawdown to the south does not change significantly after this time, and does not cross the river (Figure 23 and Figure 24). This is likely to be due to the Hotham River being modelled as a losing stream, where water from the river may enter the model. In the model, the Hotham River can be considered to control expansion of drawdown to the south of the mine (Schlumberger 2013). The extent to which this actually occurs will depend on the degree of connection between the river and the upper bedrock aquifer. If the degree of connection is low, then water from the river will not enter groundwater and the extent of drawdown to the south of the mine would be greater.

At the time of completion of mining in 2041, the modelled 5 m drawdown contour in the upper bedrock extends approximately 8 km east and west of the mine, 10 km north and 6 km south. The 5 m contour in the lower bedrock is of a similar magnitude, but a lesser eastern and western extent. Drawdown of greater than 50 m is not expected to extend substantially beyond the pits during the life of mine (Figure 24; Schlumberger 2013).

As outlined above, the model is considered to be conservative and may overemphasise the impacts of drawdown. The extents and duration of drawdown outlined above are; therefore, likely to be over-estimates.

In some cases, the drawdown plots show variable extents of drawdown in the distant regions of the model (Figure 23 and Figure 24). This is considered by the modeller to be due to the complex method of representation of layers in the model, which offers many advantages but can make drawdown estimation more difficult (Schlumberger 2013). This factor and questions regarding the reliability of the model calibration and assumptions about the interactions with the Hotham River outlined above, have led to the conclusion that while the model is broadly predictive, the actual drawdown observed may not closely relate to that outlined in the model.

The high level of geological complexity at NBG makes the practical development of a regional scale groundwater model difficult regardless of the level of investigation and data collection undertaken. However, the predictions could be improved through model refinement and recalibration with additional data gained from longer-term monitoring and construction of strategically located bores, particularly as the drawdown zone expands. NBGPL considers the modelling of NBG to be a long-term project and will address the uncertainty associated with the current level of drawdown prediction through an ongoing, adaptive groundwater management plan, as outlined in Section 7.5.1. This program includes a regular model review, refinement and recalibration component.



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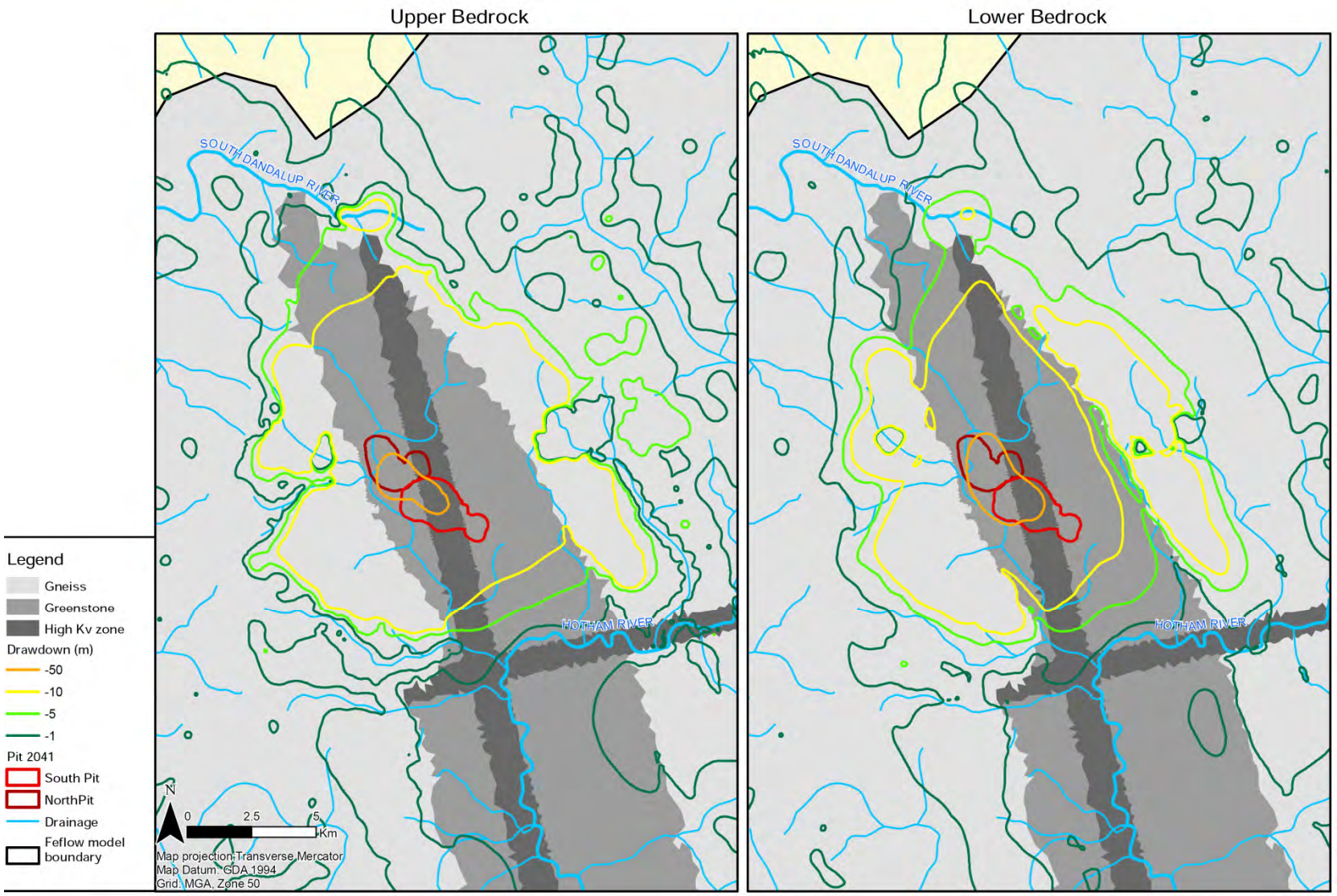
STRATEGEN

Newmont Boddington Gold Life of Mine Expansion Project

Predicted regional groundwater drawdown 2017

Figure 21



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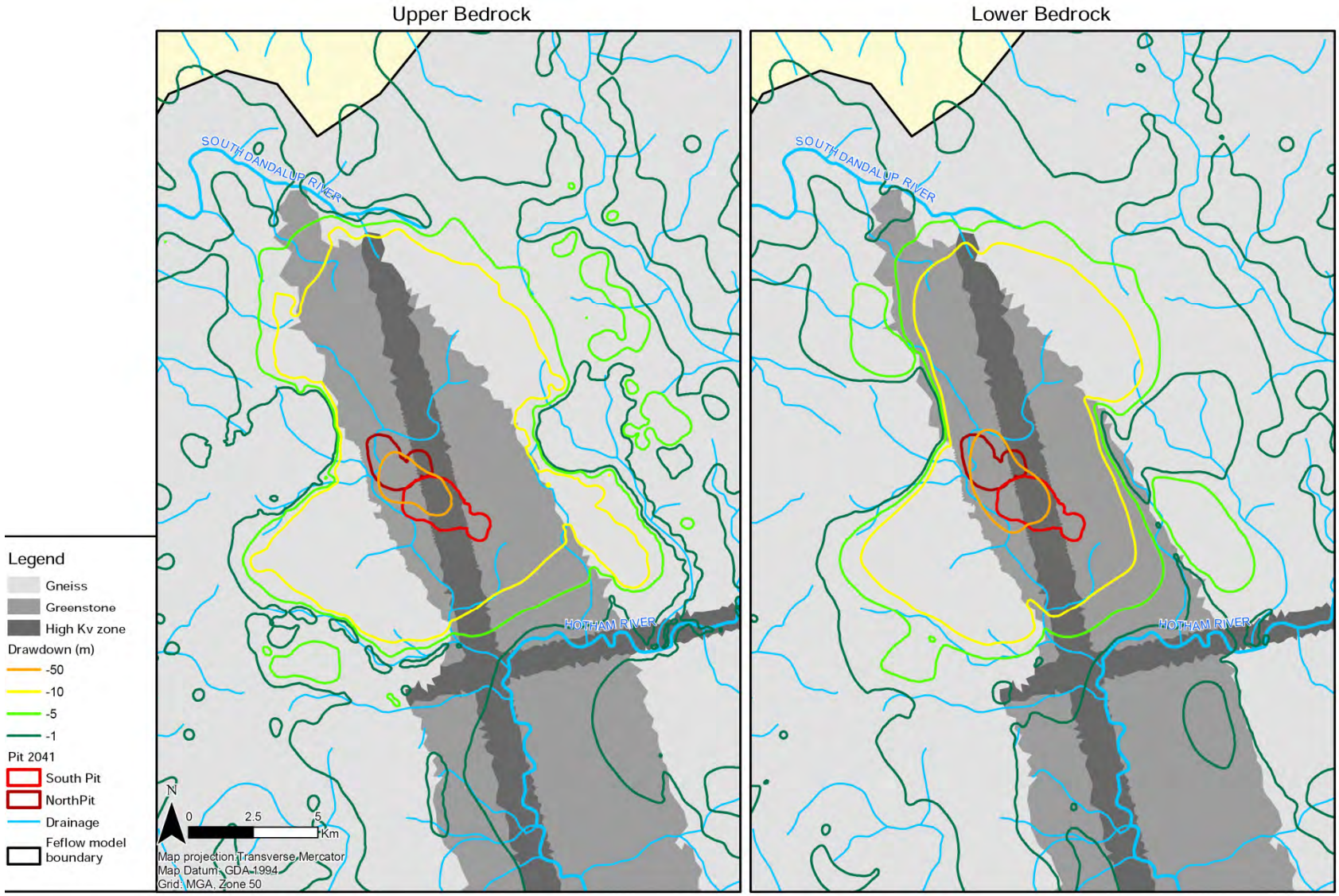
Newmont Boddington Gold Life of Mine Expansion Project

Predicted regional groundwater drawdown 2022

Figure 22



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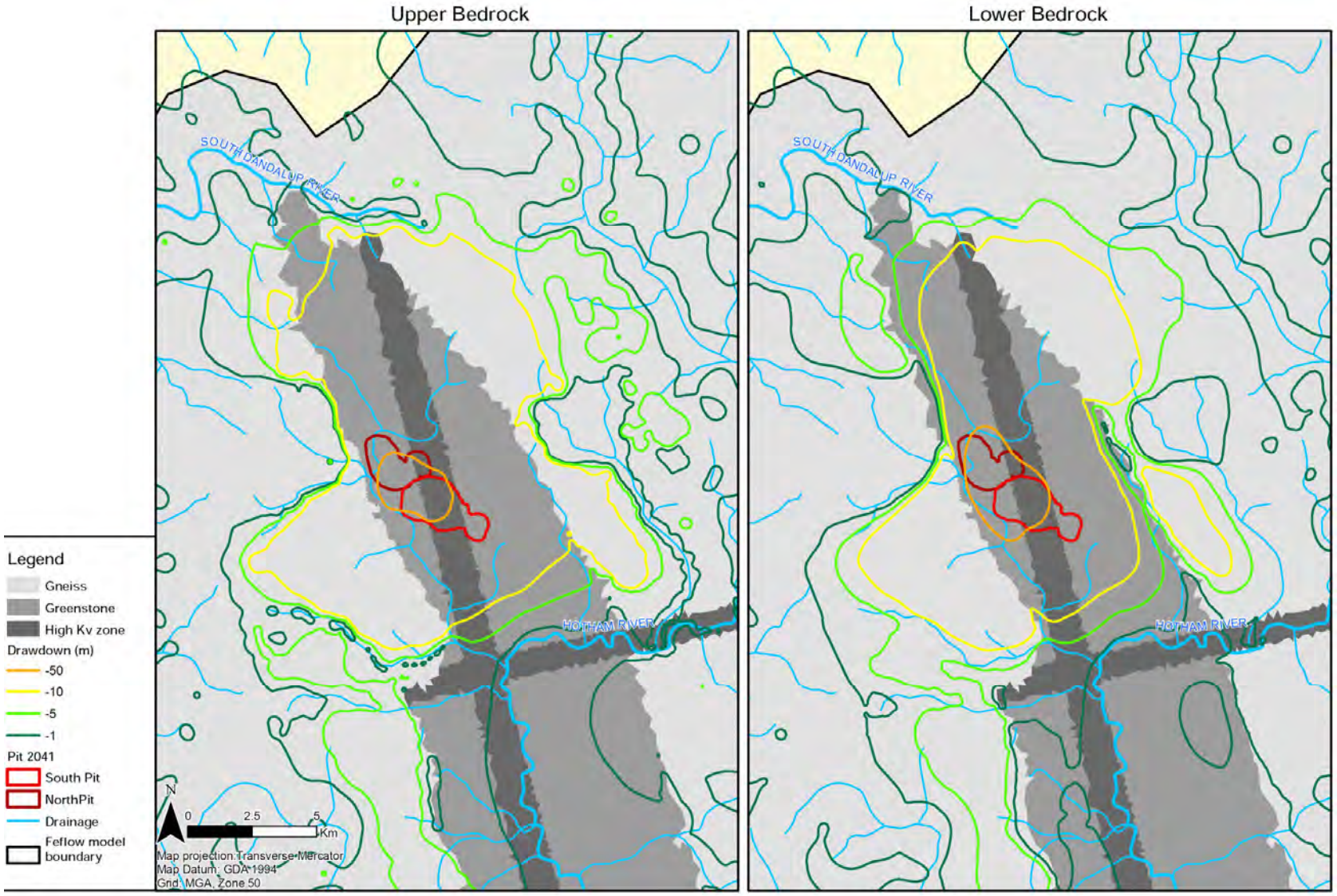
STRATEGEN	Newmont Boddington Gold Life of Mine Expansion Project Predicted regional groundwater drawdown 2032	Figure 23



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STRATEGEN

Newmont Boddington Gold Life of Mine Expansion Project

Predicted regional groundwater drawdown 2041

Figure 24

Post-closure impacts

At closure, the abstraction bores will be turned off and the upper sections of Thirty Four Mile Brook diverted into the mine pits so that the pits become lakes (Section 8.4.1). The predicted filling time for the pit lakes ranges from 44 to 127 years (Section 8.4.1). During the lake filling period, groundwater elevations within the bedrock aquifers close to the pit lake would be expected to recover at a rate similar to the rise in water levels in the pit lakes (Schlumberger 2013).

Post-closure groundwater modelling was attempted but the model provided unreliable results (Schlumberger 2012b). As a result, the duration and rate of attenuation of drawdown in the broader bedrock aquifers have not been calculated. Post-closure rates of groundwater inflow into the pits were therefore estimated using a simplified model. Estimated inflow rates varied from 89 L/s immediately after closure to outflows of approximately 7 L/s when the lakes are full. When the lakes are full, groundwater levels around the pits will be controlled by the level of the outflow of the pit lakes, which will be set at 235 mAHD (Schlumberger 2012b).

The spatial extent of drawdown in the bedrock aquifer will continue to expand post-closure and then contract as the aquifer is refilled with recharge from the shallow aquifer and inflow from the pit lakes in later years. Diverting Thirty Four Mile Brook into the pits will increase the rate at which the pits fill and decreases the amount of groundwater required to fill the pits. This diversion will result in a more rapid return of pre-mining groundwater levels in the bedrock aquifer than would otherwise occur. Should groundwater levels in the shallow aquifer also be affected, the post-closure attenuation will follow a similar trend to levels in the bedrock aquifers.

7.4.3 Potential impacts on groundwater-dependent ecosystems

Potential impacts on Hotham River flows and ecology

Groundwater modelling of proposed operations indicates that drawdown is likely to occur in the upper bedrock aquifer adjacent to the Hotham River. The extent to which this affects flows in the Hotham River will depend on the degree of interaction between the river and regional groundwater, which is not fully understood at this stage. NBGPL is proposing to undertake additional investigations to improve the understanding of these interactions, as outlined in Section 7.5.1.

Drawdown is considered unlikely to significantly affect winter flows in the Hotham River, irrespective of the connection between the groundwater and the river, as the flows are driven by rainfall at a catchment level, which would dominate the flow regime (Section 8.2.1).

Summer flows in the river may be affected by the change should the river be reliant on groundwater to maintain baseflow over these months. As outlined in Section 8.2.1, the river was ephemeral prior to construction of Lions' Weir in 1980 or 1981. The post-1980 permanency of flow downstream of the weir is considered the result of leakage through and underneath the porous weir structure (Golder 2005). The periods of no flow in the river prior to weir construction indicates that below the weir, groundwater levels dropped below the base of the river during summer. This indicates that the river was not; and is not, likely to be dependent on inputs from groundwater in the NBG area for summer baseflows (Section 8.2.1).

Studies have been undertaken by WRM (2011) into ecological water requirements (EWRs) for the Hotham River (Section 8.2.1). The study set a minimum summer flow rate of 10 L/s for riffle inundation and a requirement for no zero flow days (WRM 2011). The 10 L/s flow rate was considered to be required to maintain the summer riffle inundation necessary to provide habitat for aquatic macroinvertebrates such as crayfish at Tullis Bridge (WRM 2011). Flows below 10 L/s have occasionally occurred in the past (Section 8.2.1).

Should flows in the Hotham River decrease due to impacts of dewatering, flows below 10 L/s may occur more frequently and for a longer duration, with subsequent impacts on macroinvertebrates. Periods of no flow may also occur due to mine dewatering, predicted climate change or a mixture of both.

Minimum expected summer flows in the river have been set based on the lowest recorded average monthly flows at Marradong Bridge since weir installation in 1981 (Section 8.2.1). These flows are:

- November – 60 L/s
- December – 24 L/s
- January – 18 L/s
- February – 11 L/s
- March – 10 L/s
- April – 13 L/s
- May – 96 L/s (DoW 2012).

Should flows in the Hotham River decrease, these minimum flow requirements may not be met. The predicted drying of the climate in southwestern Australia may also result in these flows not being met, independent of potential dewatering impacts. To mitigate and manage these potential environmental and social impacts, NBGPL is proposing a series of monitoring and mitigation measures, as outlined in Section 7.5.1.

Potential impacts on South Dandalup River flows

The South Dandalup River is not considered to be groundwater-dependent (see Section 8.2.1). Drawdown is accordingly not expected to affect flows. As flows are not likely to be affected, vegetation and fauna associated with the river are not expected to be affected.

Potential impacts on swamps

As outlined in Section 7.2.6, there is considered to be little interaction between the swamps and the upper bedrock aquifer. Some flow may occur from Pillow Swamp into the upper bedrock, but the swamp is not fed from the upper bedrock aquifer. As the swamps are not dependent on the bedrock aquifers that are being dewatered, dewatering is not expected to impact upon the water levels and ecology of the swamps.

7.4.4 Groundwater quality

Potential sources of adverse groundwater quality effects at NBG are:

- storage and use of chemicals such as hydrocarbons and process chemicals, such as cyanide
- seepage from existing and new RDAs
- seepage from WRD.

Groundwater quality at NBG is managed through design and operational factors, including management plans. Management measures for groundwater quality include controlling the use and storage of potential contaminants, appropriate monitoring and clean up of spills and leaks, as described in Section 7.5.1 and EMP (Appendix 1).

RDAs pose a potential risk to groundwater quality should seepage from the RDA enter groundwater. RDA seepage may contain elevated levels of cyanide and metals. Based on geochemical characterisation studies completed to date, the physical residue to be stored in the facility is indicated to be relatively inert, and is not anticipated to generate low pH, nor low concentrations of metals (Schlumberger 2012a).

In accordance with the Newmont Environmental Standard for tailings management, and as per the existing RDA, the new RDA will be designed and constructed to prevent adverse affecting groundwater quality. A liner will be placed below the supernatant pond and a water recovery system shall be incorporated into the design and construction of the facility. Underdrainage collection ponds for the collection of potential seepage will include a primary synthetic liner, a secondary containment liner and a leak collection and recovery system. Any collected water will be returned to the process plant for reuse. Groundwater monitoring bores will be installed, initially to establish baseline groundwater conditions, and later also installed downstream to monitor for seepage from the facility.

Only minor periphery modifications are proposed for existing F1/F3 RDA. As such, the potential for adverse groundwater quality effects from this facility will not change from the approved operations.

The WRDs may potentially generate low pH seepage with elevated concentrations of metals that may adversely affect water quality if allowed to infiltrate into groundwater. As outlined in the MCP (copy presented in Appendix 1), data compiled for waste grade material analysed to date indicates that acid forming properties are only likely to occur in a small percentage of the waste rock from the expanded mine. Potentially acid forming rock will be encapsulated to reduce the potential for acidic leachate to form. To ensure that materials that require encapsulation can be segregated, NBGPL is currently undertaking further leachate testing on the bedrock material to assess this potential as part of closure planning.

The existing WRD has a perimeter drainage system for seepage collection and reuse through the processing plant, as outlined in Section 8.4.1. This system will be expanded to cover the new WRD areas, with a drainage blanket to be installed below parts of the WRDs where potentially acid forming rock may be placed (Galt Geotechnics 2012). The drainage blanket will be constructed of hard non-acid forming rock with a high void ratio (Galt Geotechnics 2012). This system will direct seepage towards the impacted water drain, where it will be collected and pumped back to the processing plant (Galt Geotechnics 2012).

Monitoring is undertaken at the existing WRD and RDAs to confirm whether groundwater quality is being adversely affected. This monitoring program will be expanded to monitor potential impacts of the new infrastructure, as outlined in the EMP (Appendix 1).

Based on modelling of water quantity and quality, detailed design has been undertaken for the post-closure management of groundwater and surface water, as outlined in Section 8.4.2. This includes covering of the WRD and RDAs to reduce infiltration and seepage (see Appendix 1). This system manages potential post-closure impacts on groundwater quality from the WRDs and RDAs produced by collecting and treating seepage to ensure a quality suitable for discharge to the environment.

7.5 Management measures and performance standards

7.5.1 Adaptive groundwater management plan

In order to monitor and manage the potential impacts of the Proposal on groundwater and the potential flow-on effect to riparian vegetation and surface water, NBGPL will develop an Adaptive Groundwater Management Plan (AGMP). The AGMP will be designed to mitigate the uncertainty regarding the potential impacts of the groundwater related aspects of project through:

- monitoring to identify potential impacts and better understand the system and its interactions
- regular revision of modelling to better understand when and where impacts may occur
- contingencies to be implemented if an impact occurs.

The AGMP will be a dynamic plan that includes:

- extension of the existing groundwater, surface water and potential groundwater-dependent vegetation monitoring programs
- decision-making process based on the monitoring to determine if an impact has occurred and if that impact is related to the NBG operations
- contingency actions to be undertaken if monitoring and study results indicate high potential for an impact to occur due to mining-related activities.

The current monitoring program will be expanded to further include monitoring of potentially groundwater-dependent vegetation in the potential zone of impact along the Hotham River, groundwater and surface water in order to:

- improve understanding of regional groundwater and validate predictions of modelling
- determine through routine monitoring if changes are occurring regionally
- assess whether any changes are due to the propagation of drawdown or external factors such as third party activities or climate change.

In addition to the ongoing monitoring program, NBGPL will undertake a groundwater investigation at the start of the monitoring program to assess the degree of interaction between the Hotham River and upper bedrock aquifer in the potential drawdown area. This will improve the level of understanding of whether the Hotham River is dependent on groundwater from the upper bedrock aquifer to support summer baseflow. These investigations will include drilling additional bores into the shallow and bedrock aquifers at multiple locations adjacent to the Hotham River. The bores will be geologically logged and tests undertaken to determine hydrogeological properties, where appropriate. These bores will be included in the long-term monitoring program.

The regular reviews of the groundwater monitoring program will include:

- review of the results from the expanded regional monitoring network
- mapping of regional groundwater monitoring results
- predictions of drawdown expansion including the timing of drawdown reaching Hotham River assisted by regular updates of the groundwater model.

The results of the monitoring programs will be reported in the NBG Annual Environmental Report (AER).

NBGPL will use the annual review of the monitoring network and modelling predictions to determine when and where additional regional groundwater monitoring bores will be required. It is envisaged that the existing program will require expansion over the next five to ten years as the area of drawdown expands and becomes more evident away from the mine site.

NBGPL will develop and undertake a baseline vegetation assessment in conjunction with subject matter experts at riparian sites within the zone of potential dewatering impact and potential control sites. This will include a detailed baseline survey of the vegetation including species distribution, community structure and health. Results of the baseline assessment will be discussed in the NBG AER, which is provided to the Environmental Management Liaison Group (EMLG).

A routine monitoring program will be developed following the baseline vegetation assessment, taking into consideration predictions from the groundwater modelling and results from the Hotham River groundwater interaction study. The monitoring program will assess potential changes in species composition, richness and/or vegetation density. This data will be used in conjunction with the groundwater monitoring data and Hotham River streamflow data to determine if changes are potentially the result of the groundwater drawdown from mine dewatering or due to external factors. The routine vegetation monitoring program will be developed in consultation with subject matter experts and will be provided to the members of the EMLG through the AER.

Review of surface water flows in the Hotham River at the DoW Marradong Bridge Gauging Station is already in place at NBG, primarily to monitor for peak flows during the winter months to ensure water abstraction complies with licence requirements. This program will be expanded to include monitoring of summer flows.

Monitoring of regional groundwater monitoring bores and the potential zone of dewatering impact on the Hotham River will continue throughout the mine life, even if the relationship study indicates that there is no relationship between the River and the upper bedrock aquifer. Monitoring will provide a feedback loop to confirm that study predictions are correct and refine the predictions of drawdown expansion.

If studies show that there is a relationship between the Hotham River and basement aquifer and that the expansion of the groundwater drawdown is likely to result in an impact to the ecological and heritage values of this system, contingency actions will be implemented following negotiation and agreement with members of the EMLG.

7.5.2 Water quality management

NBGPL is proposing to continue undertaking the management measures for groundwater quality outlined in Section 7.2.2 and Appendix 3. Annual geotechnical audits of the WRDs and RDAs will continue to be undertaken to confirm these structures are sound and not allowing excessive seepage to enter the environment (NBGPL 2011). With implementation of these measures, the potential impact of the Proposal on groundwater quality is expected to be similar to that of the currently approved Proposal.

7.6 Predicted environmental outcomes

Through the mitigation measures described above, the Proposal and the approved project are expected to result in the following outcomes in relation to groundwater:

1. Impacts associated with the Proposal are not expected to increase significantly for groundwater beyond that experienced at the current operations. Lowering of groundwater levels is anticipated to occur in the upper bedrock aquifer, with the 5 m drawdown contour in the upper bedrock predicted to extend to approximately 8 km east and west of the mine, and 10 km north and 6 km south of the mine at the cessation of mining in 2041. This area includes the upper bedrock aquifer below the Hotham River. This drawdown may affect the shallow aquifer in this area if the clay oxide layer between the lower and upper bedrock aquifers does not prevent interaction between the bedrock and shallow aquifers.
2. No changes in groundwater levels or flows at South Dandalup River, Pillow, Round or Boomerang Swamps. Impacts on groundwater-dependent ecosystems are; therefore, not expected at these locations.
3. Reduction in summer baseflows in the Hotham River may potentially occur if the river is hydrologically connected to the upper bedrock aquifer at this location. This may in turn affect riparian vegetation and aquatic fauna. With the investigations and contingency mitigation measures proposed within the AGMP, impacts on the riparian vegetation, aquatic fauna and flows in the Hotham River are expected to be satisfactorily mitigated.

In considering the outcome as described, the Proposal is expected to meet the EPA objectives for groundwater.

8. Surface water

8.1 Relevant environmental objectives, policies, guidelines, standards and procedures

8.1.1 EPA objectives

The EPA applies the following objective in assessing proposals that may affect surface water:

> *To maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.*

8.1.2 Legislation, policy, guidance

National

National guidance on surface water management includes the *National Principles for the Provision of Water for Ecosystems* (ANZECC & ARMCANZ 1996). This document also provides guidance on groundwater management and is discussed in Section 7. There is no national legislation directly relevant to the environmental aspects of surface water management.

State

Legislation

The RIWI Act makes provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes. The Proposal is within the Murray River Surface Water Area proclaimed under the RIWI Act. As such, licensing is required to abstract surface water and/or interfere with beds and banks of watercourses.

DER administers Part V of the EP Act, which among other matters regulates activities with potential to cause pollution or environmental harm. Regulation of these matters is primarily through the Works Approval and associated discharge licensing provisions of the Act and regulations.

Water resources policy and guidelines

Water resources policy and guidance in Western Australia relevant to this Proposal includes:

- *State Water Quality Management Strategy* (Government of Western Australia 2001)
- Statewide Policy No. 5 *Environmental Water Provisions Policy for Western Australia* (WRC 2000) relates to the provision of water to sustain environmental values, and is based on a concept involving ecological water requirements (EWRs) and environmental water provisions (EWPs)
- Water Quality Protection Notes and Guidelines for mining and mineral processing developed by the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP).

Two DER policy statements are relevant to regulation of the proposed development under Part V of the EP Act and associated regulations with respect to impacts on water resources. The two statements are:

- *Policy statement: Works approval, licenses and conditions for prescribed premises* (DoE 2006a)
- *Policy statement: Limits and targets for prescribed premises* (DoE 2006b).

No specific receiving water quality or other environmental criteria are prescribed in the DER policy statements.

These documents also address groundwater management and are discussed in detail in Section 7.

8.2 Current Operations

8.2.1 Water quantity

The existing NBG mine and WRD are located in the Thirty Four Mile Brook catchment, which flows into the Hotham River north of Boddington (Figure 9). The existing RDA is located in the Thirty Four Mile Brook catchment (Figure 9). The adjacent House Brook, Boggy Brook, Junglen Gully and Gringer Creek also flow into the Hotham River. The Hotham River enters the Murray River, which flows into the Peel-Harvey Estuary to the west of Pinjarra.

Four seasonally inundated areas are located near the mine; being Eight Swamp, Round Swamp, Pillow Swamp and Boomerang Swamp (Coffey 2010) (Figure 9). The three latter swamps have been identified by the Minister for the Environment as locally significant and are monitored by NBGPL (Coffey 2010).

NBG has an extensive surface water monitoring network which focuses on regular, routine sampling of surface water quality around the mining and processing operations and regionally. Compliance with the current licence conditions resulted in the collection of 3890 items of data from 22 monitoring sites in 2012. However, the NBG monitoring program extends beyond what is required by compliance and data is recorded and analysed from approximately 48 monitoring sites annually. Collected samples are analysed at an off-site, independent, NATA accredited laboratory, whilst pH, EC and TDS is recorded in the field. Data is reviewed by a third party consultant annually to assess changes in surface water quality. This assessment is provided to the OEPA, DER, DSD, DoW and DMP as part of the Annual Environmental Report. The surface water monitoring program at NBG is dynamic and undergoing regular change as required.

Hotham River

Flow in the Hotham River is very much seasonal, with high flows at Marradong Road Bridge Gauging Station averaging greater than 10 gigalitres per month (GL/month) between June and September, and little flow (mean flow less than 2 GL/month) over the summer and autumn months of December to April (DoW 2012). Average annual flow at Marradong Bridge is estimated at 102 GL/yr, although annual flows have varied between 17 GL/yr and 334 GL/yr (DoW 2012). Total catchment area of the Hotham is estimated at 4015 km^2 (WRM 2011).

Winter flows in the Hotham River are related to rainfall events, while summer flows result from groundwater baseflow and leakage from Lions Weir (Golder 2005). Until 1980, periods of no flow at Marradong Bridge occurred between the months of December and May (DoW 2012). This change in flow regime has been attributed to the construction of Lions Weir in the Boddington townsite in 1980 or 1981, which changed the flow regime in the river (Golder 2005). Construction of the rock fall weir resulted in a permanent body of water in the river. The post-1980 permanency of flow downstream of the weir is considered the result of leakage through and underneath the porous weir structure (Golder 2005).

The periods of no flow in the river prior to weir construction indicates that below the weir, groundwater levels dropped below the base of the river during summer. This indicates that the river was not dependent on groundwater for summer baseflow. Prior to weir construction, summer flows were most likely primarily due to groundwater or surface water inflows above the Boddington townsite. The current summer flows are still likely to be due to leakage from the weir, rather than local groundwater. This indicates that the river is unlikely to be dependent on inputs from groundwater in the NBG area for summer baseflows.

NBG extracts water for processing from the Hotham River at Marradong Road Bridge during the higher flow months, as outlined in Section 3.4.7.

Ecological and social water requirements

The health and vigour of riparian vegetation and aquatic fauna is maintained by the water levels and flow in the watercourses. Factors affected by flow regimes and known to influence riparian vegetation include:

- bank soil moisture content
- proximity of groundwater to the root zone
- period and season of flooding that inundates the floodplain and riparian vegetation (WRM 2011).

Aquatic fauna can be impacted by changes in flow regime and water quality within the systems they inhabit (WRM 2011).

The criteria for scenarios in which abstraction may occur from the Hotham River have been designed based on assessment of ecological water requirements (EWRs) and environmentally sustainable yields for the river (WRM 2011). The WRM study investigated EWRs for fish, frogs and aquatic invertebrates including freshwater crayfish. The study recommended a range of flow rates ranging from minimum summer flows to flood flows required on an annual basis to inundate the outer band of reeds and rushes (WRM 2011). The current surface water pumping program has been designed on the basis of these recommendations.

In addition to requirements for minimum winter flow rates, the study set a minimum summer flow rate of 10 L/s for riffle inundation and a requirement for no zero flow days (WRM 2011). The 10 L/s flow rate was considered to be required to maintain the summer riffle inundation required to provide habitat for aquatic macroinvertebrates such as freshwater crayfish at Tullis Bridge (WRM 2011).

In order to determine if these flow rates were being met, the historic flow rates at Marradong Bridge gauging station were investigated. The lowest recorded average monthly flows at Marradong Bridge since weir installation in 1981 over the summer months are:

- November – 60 L/s
- December – 24 L/s
- January – 18 L/s
- February – 11 L/s
- March – 10 L/s
- April – 13 L/s
- May – 96 L/s (DoW 2012).

Maintaining these minimum flows is considered desirable from a social perspective (community minimum flow expectations).

Apart from the minimum February result from 1988, these low flows all occurred over summer 2010/11 (DoW 2012). These values are average flows over a monthly period rather than instantaneous flows. Flows are not constant but will vary over the month. Instantaneous flow rates less than 10 L/s were recorded in:

- February and March 1988
- March 2007
- March and April 2011 (DoW 2012).

Thirty Four Mile Brook

Prior to construction of the mine and associated dams, Thirty Four Mile Brook contributed an estimated 0.4% (based on limited data) of the annual flow volume of the Hotham River, with flow occurring generally between July and September (Schlumberger 2010). Runoff rates are estimated at 8% of rainfall in the Thirty Four Mile Brook catchment (Schlumberger 2010).

The Thirty Four Mile Brook catchment at the southern mine lease boundary has an extent of approximately 78 km^2 or 7800 ha (Schlumberger 2010). This area and runoff rate results in an estimated average runoff of 4.7 GL/year. Assuming this occurs over a three month period as outlined above, the average daily flow could be estimated at 52 ML/day.

Thirty Four Mile Brook runs through the NBG in a southeasterly direction. Two main dams, the D1 and D4 Dams, have been constructed along the Brook to provide a water supply to NBG (Figure 9). The D1 Dam receives fresh water from the forested upper section of Thirty Four Mile Brook. Thirty Four Mile Brook has then been diverted around the mine. The diversion collects water from both natural tributaries and waste rock dumps. Water in the diverted section is collected in the Northern Clear Water Pond (NCWP) and D4 Dam. Water from the NCWP, D1 and D4 Dams is utilised within the mine, as outlined in Section 7.4.1.

Over the mining period these impoundments have been used to store water pumped from the Hotham River for mine water supply (Schlumberger 2010). The water management system for NBG, including the D4 Dam, is designed to prevent potentially impacted waters entering the lower sections of Thirty Four Mile Brook, as outlined in Section 8.2.3. The lower section of Thirty Four Mile Brook flows into the Hotham River.

During 2011, the upper section of Thirty Four Mile Brook flowed during August and October and was dry for the remainder of the year (NBGPL 2012a). This indicates that flow in the Brook is primarily related to storm events, with little base flow.

Hedges River Water Dam and Hotham Farm Dam are located on Hotham Farm in the western (upper) part of Junglen Gully, which flows into Thirty Four Mile Brook (Figure 9). The Hedges River Water Dam was historically used under the former owner, to store water from the Hotham River for use at the mine. Hotham Farm Dam is located below Hedges River Water Dam. Both dams are currently used for farm water supply. Hotham Farm has recently been purchased by NBGPL. As part of the proposed expansion, NBGPL will reinstate Hedges River Water Dam as storage for Hotham River water and construct a pipeline between the Dam and the mine.

Gringer Creek

NBG installed a stream flow gauge on Gringer Creek in February 2012, and measurements are available until August 2012. Gringer Creek is ephemeral, with no flow recorded early in the year (Schlumberger 2012a). Flows between May and June normally ranged between 15 ML/day and 20 ML/day, with a peak flow of approximately 115 ML/day (Schlumberger 2012a).

South Dandalup River

The Thirty Four Mile Brook catchment lies immediately east of the South Dandalup River catchment. The South Dandalup river catchment flows west into South Dandalup Dam, providing drinking water for the metropolitan area (Figure 9). South Dandalup River was permanently flowing but became ephemeral around 2002 as a result of declining rainfall. The river is generally dry between January and May, depending on rainfall (Jeevaraj C [Water Corporation] 2012, pers. comm. 6 December). The ephemeral nature of the river indicates that it is primarily fed by rainfall rather than groundwater.

The South Dandalup catchment is a Priority 1 Public Drinking Water Source Area protected under the *Metropolitan Water Supply, Sewage and Drainage Act 1909* (DoE 2005). Mining does not occur in the PDWSA. The existing RDA does not extend into the PDWSA (Figure 9). However, there is a small cleared area to the north of the F1/F3 facility that extends into the PDWSA. There are no discharges from NBG into the South Dandalup PDWSA.

8.2.2 Water quality

Hotham River

NBGPL undertakes quarterly water quality analysis on the Hotham River upstream to the confluence with Thirty Four Mile Brook. Results for 2011 indicate brackish salinity, with total dissolved solids varying between 6300 and 9600 mg/L (Table 14; NBGPL 2012a). These high salinities are considered to be due to land clearing and agricultural practices in the broader Hotham River catchment (Schlumberger 2010). The river has been saline since at least the 1970s (Department of Agriculture 2005). The pH was recorded as being neutral, between 7.11 and 7.97 (Table 14; NBGPL 2012a). ANZECC & ARMCANZ freshwater trigger values were exceeded for cadmium in April 2011 and lead in July and October (Table 14; NBGPL 2012a).

Sediment sampling in the Hotham River downstream of the mine in 2005 indicated that levels of cyanide or heavy metals downstream of the mine were below detection limits (Streamtec 2005).

Table 14 Hotham River water quality for 2011 upstream from NBG

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value (2000)	11/1/2011	6/4/2011	6/7/2011	4/10/2011
pH (std units)	6.5–8	7.57	7.97	7.4	7.11
Total dissolved solids	-	9500	8700	9600	6300
Aluminium	0.055	<0.02	<0.01	<0.02	<0.02
Arsenic	0.013	<0.001	<0.001	<0.005	<0.001
Cadmium	0.0002	<0.002	**0.01**	<0.002	<0.002
Chromium	0.001	-	-	-	-
Copper	0.0014	<0.005	<0.03	<0.005	<0.005
Lead	0.0034	<0.001	<0.001	**0.012**	**0.013**
Manganese	1.9	0.14	0.067	0.043	0.078
Nickel	0.011	<0.005	<0.03	<0.005	<0.005
Selenium	0.011	<0.001	<0.001	0.012	0.012
Zinc	0.008	<0.01	<0.05	<0.01	<0.01

Dashes (-) represent value not available

Values in bold print exceed the ANZECC & ARMCANZ freshwater 95% trigger value

Source: NBGPL 2012a

Thirty Four Mile Brook

Thirty Four Mile Brook is ephemeral and highly seasonal with considerable variation in flow and quality from year to year. Pre-mining measurements show TDS concentrations ranging from 1000 to 10 000 mg/L with higher TDS concentrations being measured in summer (average of approximately 6000 mg/L) (Schlumberger 2012b). Downstream of the mine, salinity and nutrient input increase due to the influence of current and historical agricultural activity.

The existing D4 Dam intercepts water from the mine and upper Thirty Four Mile Brook catchment and prevents it entering the lower sections of the Thirty Four Mile Brook. The dam also stores water abstracted from the Hotham River.

Historical water quality for the Wattle Hollow Brook tributary of Thirty Four Mile Brook was collated from the mine water quality database by Schlumberger (2012b). These were then compared to the trigger values for protection of 95% of freshwater species (ANZECC & ARMCANZ 2000) (Table 15). Wattle Hollow Brook is considered representative of the baseline water quality in Thirty Four Mile Brook, as it is downstream of the mine but does not receive surface water from the mine. Water quality in Wattle Hollow Brook met the irrigation trigger values but exceeded the trigger values for protection of freshwater species for aluminium, chromium, copper, nickel and zinc (Schlumberger 2012b; Table 15).

Table 15 Average water quality in Thirty Four Mile Brook tributary, Wattle Hollow Brook

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value (2000)	Summer	Winter
pH (std units)	6.5-8	6.9	7.0
Total dissolved solids	-	438	173
Aluminium	0.055	**0.21**	**0.16**
Arsenic	0.013	0.00067	0.0049
Cadmium	0.0002	Below detection limit	**0.00088**
Chromium	0.001	**0.005**	**0.011**
Copper	0.0014	**0.86**	**0.0092**
Lead	0.0034	0.00067	0.0017
Manganese	1.9	0.019	0.011
Nickel	0.011	**0.016**	**0.013**
Selenium	0.011	0.008	0.0076
Zinc	0.008	**0.017**	**0.020**

Dashes (-) represent value not available

Values in bold print exceed the ANZECC & ARMCANZ freshwater 95% trigger value

Source: Adapted from Schlumberger 2012b

Gringer Creek

The 17 450 ha Gringer Creek catchment consists of native vegetation and tree farms and has not been impacted by mining (WRM 2012a). Water quality sampling of eight sites along Gringer Creek was undertaken by Wetland Research and Management (WRM) in October 2011. Water quality in Gringer Creek was similar to that in the mined Thirty Four Mile Brook catchment, except that the Gringer Creek water was more saline and acidic.

TDS in Gringer Creek varied from 3000 to 6500 mg/L, with pH between 4.7 and 7.1 (Table 16; WRM 2012b). The waters contained concentrations of zinc above ANZECC & ARMCANZ (2000) trigger level values at all locations and manganese at two locations (Table 16; WRM 2012b).

Aluminium was above the trigger value at one monitoring site on Gringer Creek (GC4) and the pH was 4.7, below the ANZECC & ARMCANZ guideline of 6.5 (Table 16; WRM 2012b). The relatively poor water quality at GC4 was attributed to high loads of dissolved organic material and reduced water movement through this section of the watercourse, which can often result in decreased pH and dissolved oxygen (WRM 2012b). This may result in increased loads of acidic dissolved organic materials leaching into drainage lines, resulting in decreased pH and increased solubility of aluminium (WRM 2012b).

South Dandalup River

NBGPL undertakes monitoring of surface water and groundwater quality in the South Dandalup PDWSA (NBGPL 2012a). No negative impacts to groundwater and surface water quality from the existing mine have been observed (NBGPL 2012a).

8.2.3 Current operations

Surface water management

The NBG is operated from a water perspective as a closed system with both groundwater abstracted from the mine dewatering activities and rainfall runoff from operational areas being retained in a series of storages and dams to be used in the site processing plant. This water capture prevents potentially contaminated surface waters leaving the mine site. The water balance for this system, including management of abstraction from Hotham River, is discussed in Section 3.4.7.

Table 16 Water quality in Gringer Creek, October 2011

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value (2000)	GC1	GC2	GC3	GC4	GC5	GC6	GC7	GC8
pH (std units)	6.5–8	6.6	7.1	7	**4.7**	6.7	**6.3**	6.9	6.8
Dissolved oxygen (saturation %)	>90	95.4	100.3	101.4	**32.5**	**81.6**	**84.4**	**77.9**	**84.4**
Total dissolved solids	-	3600	4600	4100	3000	3900	6500	4000	4–400
Aluminium	0.055	<0.005	<0.005	<0.005	**0.33**	<0.005	<0.005	<0.005	<0.005
Arsenic	0.013	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.002
Cadmium	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002
Chromium	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0025	<0.0010	<0.0010
Copper	0.0014	0.0002	<0.0002	0.0003	<0.0002	0.0003	<0.0005	<0.0002	<0.0002
Lead	0.0034	<0.0002	<0.0002	<0.0002	0.0012	<0.0002	<0.0005	<0.0002	<0.0002
Manganese	1.9	0.82	**2.7**	1.4	0.94	0.55	**12**	0.33	0.53
Nickel	0.011	<0.002	0.003	<0.002	0.005	<0.002	0.005	<0.002	<0.002
Selenium	0.011	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005	<0.002	<0.002
Zinc	0.008	**0.019**	**0.018**	**0.019**	**0.017**	**0.018**	**0.018**	**0.015**	**0.014**

Dashes (-) represent value not available

Values in bold print exceed the ANZECC & ARMCANZ freshwater 95% trigger value

Source: WRM 2012b

Current mining activities have resulted in the following with respect to surface water quality:

1. Salinities in water storage dams D1 and D4 has increased in response to the pumping and storage of saline Hotham River Water.
2. No discharges have occurred to surface waters offsite.

Water quality assessments are provided to the Boddington Gold Mine Environmental Management Liaison Group (BGMEMLG) annually as part of the AER process.

Water management at NBG has been designed to ensure that waters from clean forested catchments are kept separate from waters impacted by mining (e.g. surface water runoff from WRDs). Metals such as copper, molybdenum and other metals may be elevated in impacted surface and dewatering water (compared to non-mineralised areas), reflecting their abundance within local mineralogy. Other potential mine related contaminants include hydrocarbons (from diesel spillage) and blast residues (from pit blasting activities). Process waters and RDAs may also contain elevated concentrations of cyanide, which is used in the gold abstraction process. Elevated sediment concentrations may also be present throughout the mine as a result of erosion. Emphasis is; therefore, placed on ensuring that these water streams are kept from contacting clean water runoff in surrounding forested areas.

Surface water sumps and storages are strategically placed within the mine to ensure that waters potentially affected by metals or cyanide from processing, interactions with waste rock or as leachate are retained on site and used for processing. Waters potentially affected by sediments are treated by storage in sumps, with clear water overflows sent to storage ponds for use as processing water.

Return water from the RDA is treated by a Caro's Acid Cyanide Destruction plant to reduce the levels of cyanide in the process water stream and in the RDA facilities. In accordance with ICMC requirements, the process water return pipeline and residue disposal pipeline has secondary containment bunding along the length of the pipeline.

The potential for chemical spillage affecting the environment is minimised through implementation of engineering solutions such as bunding of tanks and pipelines, and leak detection systems. Management measures such as scheduled inspections and spill management procedures are also in place.

Water storages within the mine footprint are operated in compliance with the Site Water Management Plan (SWMP). The SWMP specifies operational water levels for water storage on the site and stormwater management practices to prevent stormwater being affected by mining and ore processing. The SWMP also ensures that impacted water is treated and reused. The system is designed so that stormwater does not leave the site except in a controlled manner following an extreme storm event (1-in-25-year Average Return Interval (ARI), 24-hour storm event[4]). These controlled discharges would occur from the D4 Dam into the lower Thirty Four Mile Brook catchment. Such events are anticipated to occur on average once every 25 years and are considered to be planned releases.

Contingency plans have been developed for such events. Should a controlled discharge appear likely based on water levels on the site and weather forecasts, steps may be undertaken to transfer water to the RDAs or other areas to reduce the risk of overflow to Thirty Four Mile Brook. Should such a discharge be required, the volume of water discharged will be recorded and water quality sampling undertaken during and after the discharge event. Permission for discharges is sought from DoW prior to the discharge occurring.

Monitoring

NBGPL undertakes surface water monitoring for water quality, flows and levels throughout the year in accordance with the existing approvals for the mine, including Ministerial Conditions, surface water abstraction licences and prescribed premises licence. Compliance with the surface water monitoring requirements involves the collection of 4544 items of data from 23 sites annually (NBGPL 2012a).

[4] The 24-hour storm magnitude with a 1 in 25 chance of being exceeded in any given year.

Licence water quality criteria were met on all samples and parameters in 2011, except at the site 34BK9 on 6 July where the TDS criteria of 5000 mg/L was exceeded (NBGPL 2012a). The TDS of the sample collected was 7400 mg/L. TDS at 34BK9 exceeds this criterion annually, most likely due to flushing out of accumulated salts in the Thirty Four Mile Brook catchment at the start of winter flows (NBGPL 2012a). This result is not considered to represent a significant environmental impact downstream of NBG, as this value is within the range of salinities normally observed in the Hotham River to which the Brook discharges.

8.3 Potential sources of impact

The main impacts to surface water, as defined by the ESD, which may arise from the following environmental aspects of the Proposal are:

- **contamination of surface water** as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies
- **impacts to surface water flows** as a result of placement and design of new infrastructure, including alterations of existing drainage patterns of Gringer Creek and tributaries of the Hotham River.

Potential impacts to groundwater-dependent ecosystems (including the Hotham River), as a result of groundwater drawdown and groundwater abstraction are discussed in Section 7.

8.4 Assessment of likely direct and indirect impacts

The potential direct and indirect impacts of the aspects identified in Section 8.3 are discussed in the following sections.

8.4.1 Placement and design of new infrastructure

The placement of new infrastructure can alter surface water flows by:

- decreasing the catchment area and subsequent decreased flow volumes due to construction of dams or RDAs that do not drain to watercourses
- increase in runoff due to construction of infrastructure with high runoff rates
- re-routing of flow channels around infrastructure.

Infrastructure proposed to be constructed that may result in significant impact on surface water flows comprises the WRD expansion, the new D5 and D6 dams, and new RDA.

Dam construction

The WRD will ultimately be expanded to cover the D4 Dam site (Figure 9). The D4 Dam is located on Thirty Four Mile Brook and will be decommissioned and replaced with the D5 Dam in around 2016. The D5 Dam will be located on Thirty Four Mile Brook downstream from the D4 site (Section 3.4.7).

The D6 Dam will only be constructed if increased processing throughput rates are realised and therefore additional water storage will be required to achieve these processing rates. The D6 Dam will be located on Junglen Gully, downstream of the Hedges River Water Dam and the Hotham Farm Dam. The D5 and D6 Dams will be utilised to store water pumped from the Hotham River

The D5 Dam catchment will not be significantly greater than that of the D4 Dam. The D5 Dam is only 2 km further down Thirty Four Mile Brook. Wattle Hollow Brook is the only tributary that enters the Brook between the D4 and D5 Dams (Figure 9). Wattle Hollow Brook has a small catchment and as a result, the impact of the D5 Dam on downstream flows in Thirty Four Mile Brook is not anticipated to be significantly different from the impacts of the existing D4 Dam.

The D6 Dam catchment is not significantly greater than the existing Hotham Farm Dam catchment as it is only 4 km further downstream and no major tributaries enter the Gully over this distance. The impacts of this dam on downstream flows in Junglen Gully are not anticipated to be significantly different from the current situation.

Consequently construction of the D5 Dam is not expected to significantly alter surface water flows in the downstream sections of Thirty Four Mile Brook from those approved for the existing mine.

Waste Rock Dump expansion

The WRDs do not currently contribute to flows in Thirty Four Mile Brook downstream of the mine. As the WRDs are porous, most rain falling on the WRD infiltrates into the waste rock. Seepage from the WRD will continue to be collected through a series of drains and sedimentation ponds and be reused as process water.

Runoff and seepage from the WRD may be acidic and contain elevated metal concentrations due to the potential acid-forming properties of the waste rock. Potentially acid-forming waste rock is segregated to ensure that this material is encapsulated within rock considered to be non-acid forming. This reduces the risk that water will come into contact with potentially acid forming waste rock, and will therefore reduce the risk of seepage, runoff and acidification. Surface water runoff from the WRDs and stockpiles may also contain elevated levels of suspended solids. The current approved practice of collecting runoff and seepage from the WRD and treating it (if required) prior to use in the mine will continue.

Any seepage or surface water runoff from the expanded WRDs will be captured by drains and water holding structures and will not contribute to downstream flows in Thirty Four Mile Brook.

Residue disposal areas

New residual disposal area

The proposed new RDA is located in the Gringer Creek catchment (Figure 25). Design of the new RDA will include embankment heights that provide adequate freeboard to prevent runoff from the RDA entering Gringer Creek. Runoff from the RDA will evaporate or be pumped back to the mine for use as processing water, as per operation of the existing RDA.

The new RDA will have an area of 1647 ha or 9% of the total Gringer Creek catchment (Schlumberger 2012a). The potential impact of this loss of catchment area on the runoff in the catchment was modelled by Schlumberger (2012a). The model results indicate that the loss of this area of catchment will result in a 12% decrease in runoff in the Gringer Creek catchment (Schlumberger 2012a). This decrease is considered manageable given the intermittent and variable nature of flows in Gringer Creek and the surrounding catchments (Schlumberger 2012a).

The new RDA will cover a section of Gringer Creek approximately 2 km long. The creek will be diverted to the east around the RDA to maintain flows in Gringer Creek (Figure 9). A diversion channel will be required to ensure minimal ponding of natural stream flows upstream of the facility and minimise any changes in the hydrological flow regime downstream of the RDA (Schlumberger 2012a). The diversion will be designed and installed in a manner that minimises both erosion and changes to flow rates within the catchment. This diversion is anticipated to commence in 2020 and will continue post-closure (Schlumberger 2012a).

Existing residual disposal area

The footprint of the existing RDA will not be significantly altered. The area of the existing RDA is anticipated to increase by 12 ha as a result of some minor modifications required around the facility perimeter (Knight Peisold 2012). This is not anticipated to have a significant impact upon the catchments and flows of downstream watercourses.

Operational surface water management system

As part of the Proposal, the D4 Dam will be covered by WRDs. The increase in the area of WRDs, RDAs, soil/gravel stockpiles and bauxite stockpiles will result in an increase the volume of surface water runoff that will be potentially classified as mine impacted because it has come into contact with mine infrastructure. As a result, the perimeter drainage will be expanded around the extended dump with new water retaining structures being installed and some existing water storage areas being upgraded. Runoff from these areas will be captured and reused within the mine to avoid adversely affecting water quality of downstream watercourses. The increase in the area of WRDs, RDAs, soil/gravel stockpiles and bauxite stockpiles will result in an increase in volumes of runoff potentially affected by the mine. As a result, the number and area of ponds containing mine-affected water will increase. Runoff from these areas will be captured and reused within the mine to avoid adversely affecting water quality of watercourses. Impacted waters and waters from the upstream catchment of Thirty Four Mile Brook will continue to be used as processing water.

As a result of the expansion of the WRDs and stockpiles, changes will be made to the surface water management system at NBG. Permanent storages that accept affected runoff or mine dewater have been designed based on the 1-in-25-year ARI, 24-hour storm event where:

- the impact of overflow can be contained within the mine
- the impact of overflow will be controlled
- the structure is not the last storage prior to the non-mine downstream environment (Galt Geotechnics 2012).

The exception to the design criteria is in the case of the most downstream storage, where the design is based on the 1-in-100-year ARI, 24-hour storm event (Galt Geotechnics 2012). This represents a more conservative design than the current scenario, where controlled discharges of impacted water are anticipated to occur on average once every 20 years (Section 8.2.3).

The proposed layout of the revised surface water system is shown in Figure 26.

Post-closure surface water management system

The aim of the post-closure surface water management system is to ensure that water entering the environment from the closed facilities is of a quality suitable for release to the environment. To achieve this, a system will be designed that includes:

- creation of water shedding landforms for the RDAs that reduce seepage and associated water quality impacts
- treatment of seepage from the RDAs and WRD areas post-closure until water quality is suitable for release to the environment
- filling of mine pit lakes with water from the sections of the upper Thirty Four Mile Brook catchment and portions of the WRD and Existing RDA that drain in that direction
- discharge of treated water from areas of the WRD that drain towards the lower Thirty Four Mile Brook into the lower sections of the Brook (Figure 27).

At closure, the pit slopes, WRD and RDAs will be rehabilitated in a manner consistent with the MCP. The RDAs and WRD will be capped with a capping layer designed to reduce infiltration and hence reduce the amount of seepage produced. The capping of the facilities will also prevent direct contact between the runoff and stored materials, preventing potential water quality impacts. Surfaces will be designed to be stable and minimise erosion. Additional details of these landforms and lakes and their rehabilitation can be found in Section 12.5.

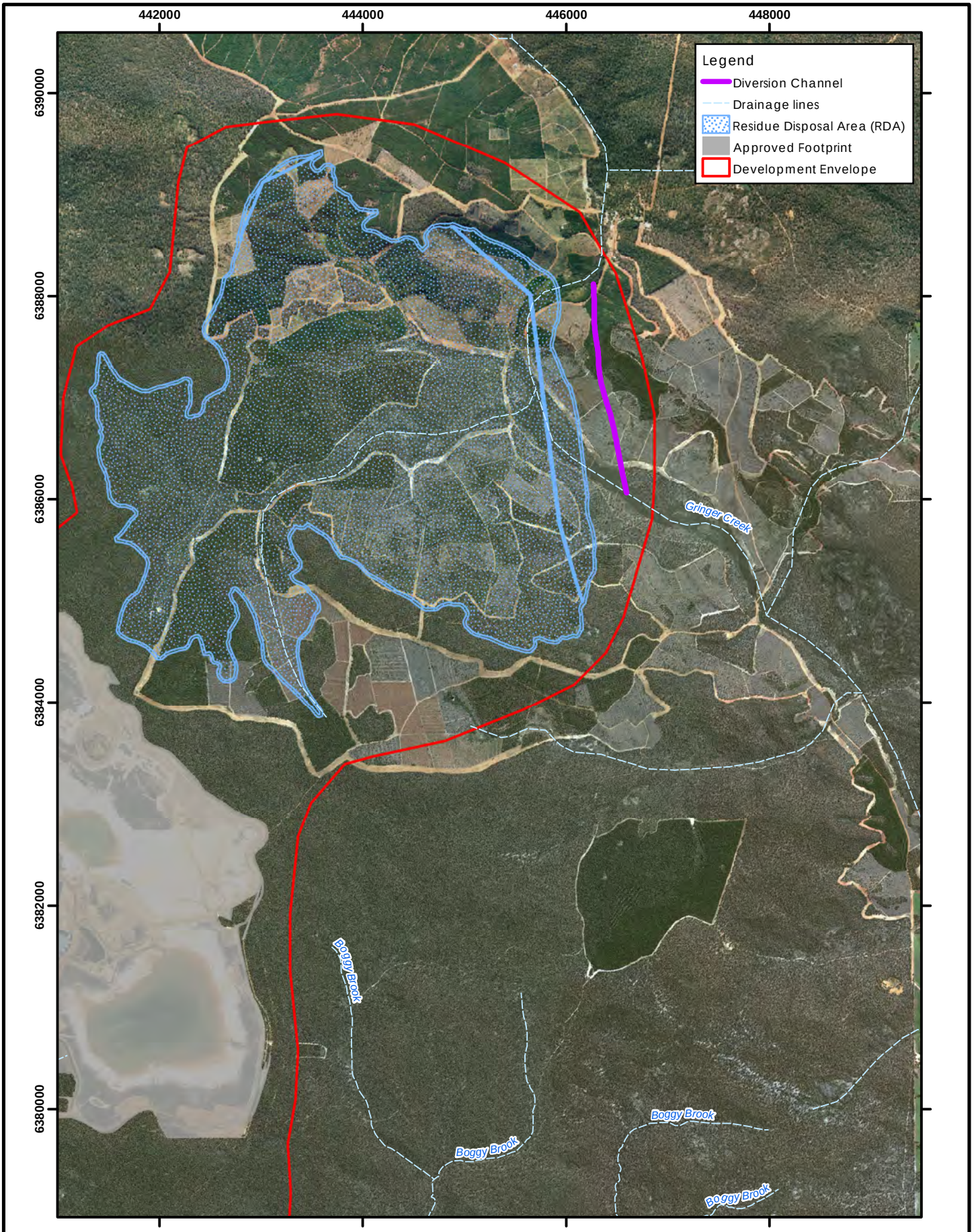

Figure 25 Location of new RDA in relation to Gringer Creek

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info@strategen.com.au
www.strategen.com.au

Scale
0 500 1,000 1,500 2,000 2,500
Meters

1:50,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F025.mxd

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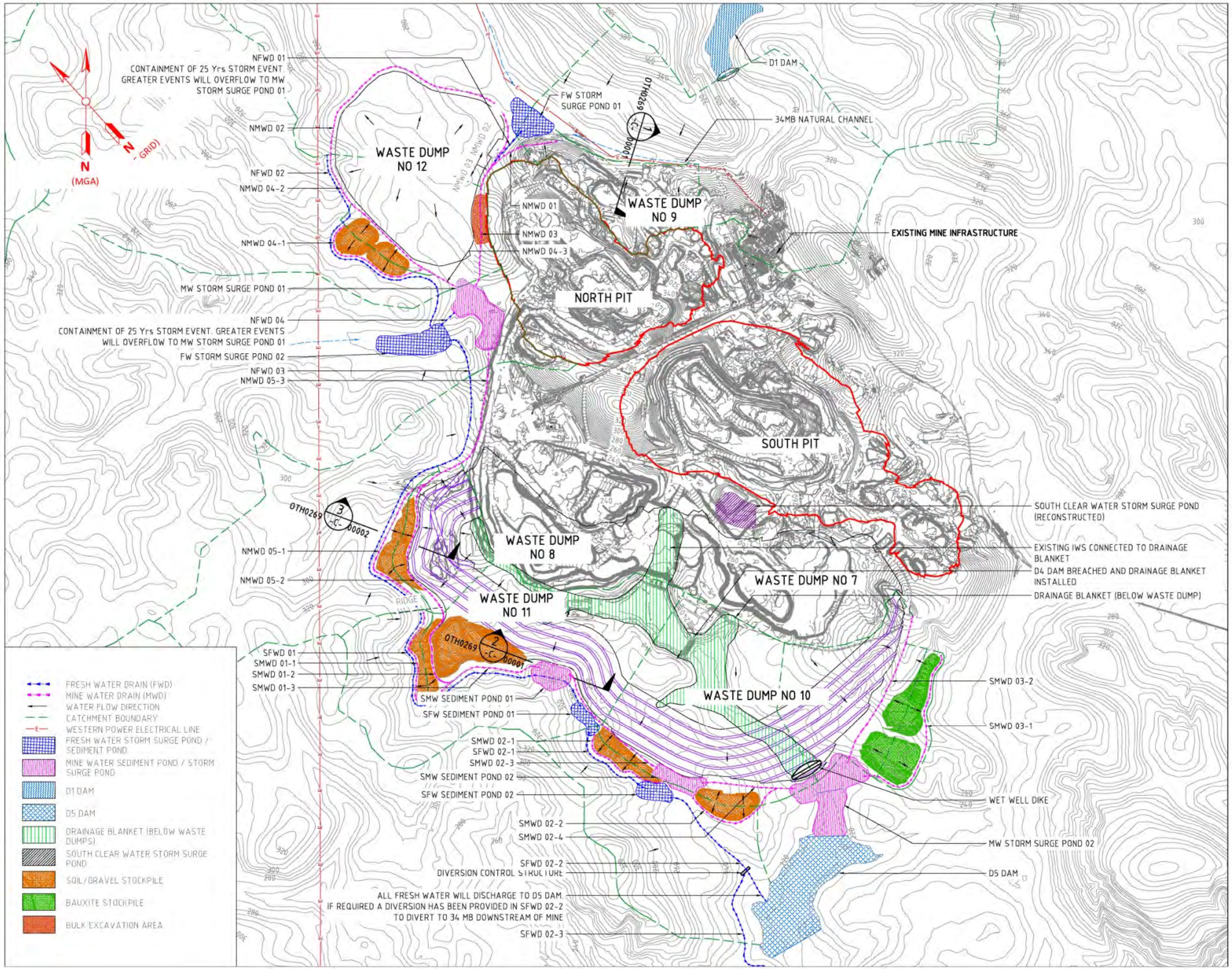

STRATEGEN

Newmont Boddington Gold Life of Mine Expansion Project

Proposed mine surface water management system

Figure 26

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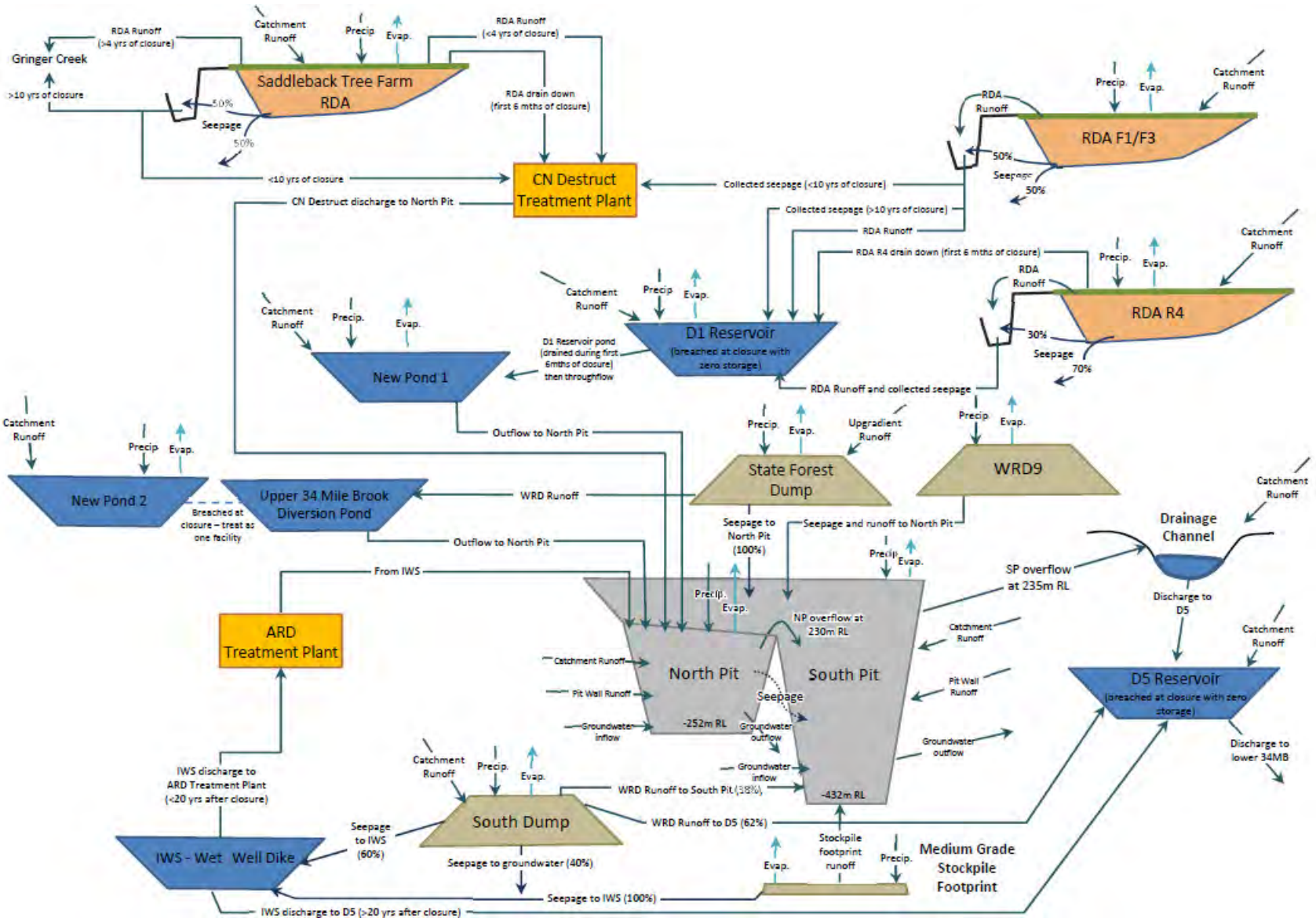

STRATEGEN

Newmont Boddington Gold Life of Mine Expansion Project

Post-closure flow diagram

Figure 27

A closure surface water management system has been developed to manage the post-closure impacts of the mine on water quality. The management system is consistent with the closure objectives outlined in the MCP. The closure surface water plan will be implemented in a number of phases, as outlined below and in Figure 27;

1. D1 Dam will be breached to allow water from the existing RDA to flow into the pit lake via the Upper Thirty Four Mile Brook Diversion Pond (U34MDP).
2. The D5 and D6 Dams will be removed and re-shaped to blend in with the surrounding topography unless there is strong community support for retaining these structures.
3. During the first year of closure, standing water on the existing RDA will be pumped to the Cyanide Destruct Plant and then into North Pit. The Cyanide Destruct Plant will be adjusted to achieve the lowest possible cyanide levels in the output. Following this, runoff and seepage from the existing RDA will be pumped via the Cyanide Destruct Plant into North Pit.
4. The southern WRDs will be hill-like landforms with one surface water catchment flowing towards the South Pit (approximately 38% of flow) and one towards Thirty Four Mile Brook downstream of the mine (approximately 62% of flow). As surface flows from the WRD areas will not come into contact with the waste rock, runoff from the rehabilitated WRDs is considered to be clean.
5. Runoff and seepage from the new RDA will be treated to remove sediment and cyanide and pumped into North Pit until the water is considered of an acceptable standard to discharge to Gringer Creek (estimated to be four years for runoff and ten years for seepage) (Schlumberger 2012b).For the first 20 years following closure, seepage from WRD 7, 8, 10 and 11 and the Medium Grade Stockpile Footprint will be directed to the Impacted Water Storage (IWS) and then pumped into the North Pit. These WRDs will contain waste rocks from the deeper portions of the mine. While waste rock from the shallower parts of the mine have a low potential for acid formation, the chemistry of the deeper rocks is not fully understood at this stage and a small percentage of it may be acid forming (Schlumberger 2012b). If the deeper waste rock is acid forming, an Acid Rock Drainage (ARD) Treatment Plant may be required to neutralise seepage from the southern WRDs (Schlumberger 2011). This unit will treat groundwater seepage to reduce acid and metal concentrations (Schlumberger 2012b). When water quality reaches a suitable standard, water from the IWS will be allowed to discharge directly into downstream sections of Thirty-Four Mile Brook. Approximately 33 years after closure, the North Pit Lake will begin to overflow into the South Pit Lake. Approximately 81 years after closure, the South Pit Lake will begin to overflow into Thirty-Four Mile Brook downstream of the mine via a drainage channel and Wattle Hollow Brook (Schlumberger 2012b). The actual time over which treatment occurs will depend on the period of time over which seepage occurs at a rate that may impact the downstream environment. These timings are estimates of when the North Pit overflows into South Pit and then when South Pit discharges to the downstream environment. At present, the closure modelling assumes treatment of acid rock drainage for 20 years post-closure.

Modelling

Post-closure modelling of the water balance and hydrochemistry of the mine was undertaken by Schlumberger (2012b) to predict flow rates between different areas and water bodies as well as the chemistry of waters at specific times and locations. Modelling reflects the best understanding of the chemistry of the materials being mined (Schlumberger 2012b).

Modelling was undertaken under a range of climate scenarios. The base case was modelled using a pseudo-synthetic daily precipitation data set based on the site data (available from January 1984 to December 2010) using a correlation to the Marradong data set (which has a data set from January 1907 to November 1997) to create a long-term data set. The pseudo-synthetic data had an average rainfall of 788 mm/yr and an average evaporation rate of 1380 mm/yr (Schlumberger 2012b). A range of five rainfall scenarios were utilised in the model with average annual rainfalls varying between 419 mm/yr (very dry scenario) and 1019 mm/yr (very wet scenario) to gain an understanding of the potential impacts of various climate regimes would have on the filling of pit lakes.

A climate change scenario representing a decrease in precipitation of 20% over 1990 values and increasing evaporation by 6% was also included (Schlumberger 2012b). This is considered to represent a high emissions climate change scenario, based on climate change predictions for southwest Australia. As a further conservative approach, pond and pit evaporation was increased to 90% of pan values. Under this climate change scenario, overflow from South Pit Lake into Thirty-Four Mile Brook is anticipated to commence approximately 127 years after closure (Schlumberger 2012b).

The modelling will be refined as mining progresses and the geochemical properties of the waters under consideration are better understood (Schlumberger 2012b). Any refinements will be included in revised MCPs as required by the DMP. The mine closure planning process is described in detail in Section 12.5.

Pit Lakes

During the pit filling period, the main sources of water are the RDAs and Thirty Four Mile Brook Catchment to the east of the mine (28% of water), the WRDs to the south of the mine (21%), direct precipitation (15%) and inflow from the Thirty Four Mile Brook Diversion Pond (13%). These remain the key sources once the pit lakes are filled, with approximately 18 GL of water entering the Pit Lakes annually (Schlumberger 2012b).

First 20 years post-closure

A portion of runoff from the southern WRDs will enter the lower sections of Thirty Four Mile Brook immediately post-closure (Figure 27). The finished surface of the rehabilitated WRDs will be sloping and designed to minimise seepage and maximise runoff. Runoff rates from the rehabilitated WRDs are estimated at approximately 45% of precipitation (Schlumberger 2012b); approximately six times the runoff rate of the Thirty Four Mile Brook catchment. Assuming that the new contributing area is approximately 18% of the catchment with six times the runoff rate, this is equivalent to an approximately 20% increase in runoff in Thirty Four Mile Brook compared to the current situation. This is considered to be manageable given the intermittent and variable nature of flows in Thirty Four Mile Brook.

20 years post-closure until South Pit Lake overtops

At 20 years post-closure, the IWS will be decommissioned and seepage from the southern WRD will enter the Thirty Four Mile Brook downstream of NBG. The seepage rate from these structures is estimated at 15% of rainfall, approximately twice the runoff rate of the natural catchment. This is a worst case scenario and seepage rates are likely to be significantly less than this, possibly as low as 2% (Schlumberger 2012b). The seepage may result in a small increase in flows in the southern section of Thirty Four Mile Brook.

Overtopping of South Pit Lake

Under the average climate scenario, the South Pit Lake is anticipated to overflow into the lower section of Thirty Four Mile Brook approximately 80 years post-closure under the base case. Modelled filling times ranged from approximately 44 years to approximately 127 years under very wet to dry climate change scenarios (Schlumberger 2012b).

The model showed that the pit will spill each year during autumn/winter. During the summer months, when evaporation from the lake surface and groundwater outflow are greater than inflows from groundwater and surface water, pit lake elevation will decline by up to 0.8 m. Average flows during the overflow period are estimated at 36 ML/day, which is similar to the estimated pre-mine average flow rate for Thirty Four Mile Brook at the southern boundary of the mine (Schlumberger 2012b).

Hotham River

Drawdown from the mine will gradually decrease as the groundwater system recovers post-mining (Section 7.4.2). If post-closure summer flows are affected by this drawdown, augmentation may be undertaken post-closure. If drawdown effects are considered to be occurring during the later stages of mining, monitoring of groundwater levels and flows in the Hotham will continue post-closure until these effects have dissipated (Section 7.4.2).

Abstraction of water from the Hotham River will cease when the mine closes, unless water is still required to augment summer flows.

Average flows in the Hotham at Marradong Bridge over late autumn and winter range from 2 GL/month or 66 ML/day in May to over 30 GL/month (1000 ML/day) in July and August (DoW 2012). The 36 ML/day increase in flow due to overflow from the mine pit lakes (Schlumberger 2012b) is; therefore, unlikely to result in a significant increase in river flows. Flows from the mine pits are related to rainfall over the pits and their catchment. As such, flows from the pit are expected to peak at a similar time to the rainfall related flows in the Hotham River.

Gringer Creek

Flows in the Gringer Creek catchment will increase when diversion of surface water flows from the new RDA for treatment and disposal to North Pit ceases about four years after closure. Diversion of seepage for treatment and disposal will cease after ten years post-closure (Schlumberger 2012b).

Runoff rates for the RDA are estimated to be approximately 30% for the first five years post-closure, decreasing to 20% after ten years post-closure (Schlumberger 2012b). These rates are respectively 4.5 and 2.5 times the estimated runoff rate of 8% for the catchment (Schlumberger 2012a). Assuming the RDA area produces 12% of the runoff from the catchment (Schlumberger 2012b), this would result in an initial approximately 42% increase in flows, reducing to an 18% increase after ten years. Given the larger variation in flows experienced in the catchment, this is considered unlikely to cause significant impacts to Gringer Creek.

8.4.2 Adverse surface water quality effects

Impacts during operation

The NBG water management system has been designed to minimise adverse effects on off-site surface water quality, as outlined in Sections 8.2.3 and 8.4.1. The mine will continue to operate as a closed system from a surface water perspective, with runoff from the mine, WRD and RDAs being recycled as process water.

Based on modelling by Galt Geotechnics (2012), overflow from NBG into Thirty Four Mile Brook below the dam is anticipated to occur with an average frequency of once every 100 years. Contaminated water will not leave the site in any higher frequency events.

Supernatant water and rainfall from the new RDA will be reused on site. The new RDA will be designed such that runoff will not enter Gringer Creek in events less than a 1-in-100-year ARI, 24-hour storm event. As such, the expansion of NBG will not impact on surface water quality in the surrounding creeks and rivers during operation.

Post-closure impacts

In the post-closure scenario, the mine may affect surface water quality and quantity through:

- alteration in surface water volumes and flow regimes due to filling and overflowing of mine pit lakes
- creation of landforms with increased runoff rates in the form of RDA and WRD areas
- discharge of potentially contaminated surface water.

The impacts of drawdown are also anticipated to continue into the post-closure period as discussed in Section 7.4.2.

Post-closure, the primary water bodies in the area will be the mine pit lakes. When the mine pit lakes overflow, this water will enter Thirty Four Mile Brook and the Hotham River.

Post-closure water quality modelling was not undertaken for Gringer Creek, as limited water quality data is available for the creek (Schlumberger 2012b). Water quality modelling will be undertaken for the creek prior to closure.

Pit lakes

Water quality was modelled by Schlumberger (2012b) for the North and South Pit Lakes, Combined Pit Lake and point of entry into Thirty Four Mile Brook. Water quality results were then compared to the current water quality criteria used on the mine and the ANZECC & ARMCANZ (2000) trigger values for protection of 95% of freshwater species.

The water quality modelling is based on the base case water balance scenario. The modelling assumes that the water bodies are fully mixed (i.e. no stratification) (Schlumberger 2012b).

Prior to overtopping

Prior to discharge occurring, modelling indicates that water quality in the pit lakes will be generally slightly alkaline (pH 7.6 – 7.8) with a brackish salinity varying between 1500 and 2500 mg/L (Table 17, Table 18) (Schlumberger 2012b). Salinity and metals in North Pit Lake are initially high due to inputs of saline water from the Cyanide Destruct Plant and the ARD Treatment Plant. The Cyanide Destruct Plant is anticipated to close approximately 10 years post-closure, with the Acid Rock Drainage (ARD) Treatment Plant closing approximately 20 years post-closure. The closing of these plants will result in reduced metal and salinity loads to the pit lakes (Schlumberger 2012b).

Table 17 Post-closure water quality in North Pit Lake

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value (2000)	2 years	10 years	33 years
pH (std units)	6.5–8.0	7.81	7.72	7.67
TDS	-	2769	1572	1218
Cyanide	0.007	-	-	-
Aluminium	0.055	<0.02	<0.02	<0.02
Arsenic	0.013	<0.0005	<0.0005	<0.0005
Cadmium	0.0002	**0.001**	**0.001**	**0.001**
Chromium	0.001	**0.002**	**0.003**	**0.002**
Copper	0.0014	**2.433**	**1.366**	**0.515**
Lead	0.0034	0.001	0.001	<0.001
Manganese	1.9	0.067	0.064	0.065
Nickel	0.011	**0.090**	**0.071**	**0.063**
Selenium	0.011	0.002	<0.001	<0.001
Zinc	0.008	**0.032**	**0.032**	**0.033**

Dashes (-) represent value not available

Values in bold exceed freshwater 95% trigger values

Source: Adapted from Schlumberger 2012b

In the North Pit Lake, modelling indicated that waters will exceed ANZECC & ARMCANZ freshwater trigger values for cadmium, chromium, copper, nickel and zinc for the first 33 years (Table 17). In the South Pit Lake, modelling indicates that waters will exceed freshwater criteria for cadmium, nickel and zinc during the first 33 years (Table 18). Concentrations of copper and nickel will decrease over time.

Table 18 Post-closure water quality in South Pit Lake

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value (2000)	2 years	10 years	33 years
pH (std units)	6.5–8.0	7.38	7.34	7.41
TDS	-	921	864	925
Cyanide	0.007	-	-	-
Aluminium	0.055	<0.02	<0.02	<0.02
Arsenic	0.013	<0.0005	<0.0005	<0.0005
Cadmium	0.0002	**0.001**	**0.001**	**0.001**
Chromium	0.001	<0.001	<0.001	<0.001
Copper	0.0014	<0.003	<0.003	<0.003
Lead	0.0034	<0.0001	<0.0001	<0.0001
Manganese	1.9	0.173	0.164	0.162
Nickel	0.011	**0.122**	**0.119**	**0.113**
Selenium	0.011	<0.001	<0.001	<0.001
Zinc	0.008	**0.055**	**0.054**	**0.052**

Dashes (-) represent value not available

Values in bold exceed freshwater 95% trigger values

Source: Adapted from Schlumberger 2012b

During overtopping

At the time of overtopping, waters from the North and South Pit Lakes will have mixed and the salinity will be below 1000 mg/L (Schlumberger 2012b; Table 19). The quality of water of the Combined Pit Lake is comparatively stable (Table 19). The model indicates that during this period, the ANZECC & ARMCANZ freshwater trigger values will be exceeded for cadmium, copper, nickel and zinc (Table 19).

Table 19 Water quality in Combined Pit Lake

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value	80 years	120 years
pH (std units)	6.5–8.0	7.56	7.51
TDS	-	980	894
Cyanide	0.007	-	-
Aluminium	0.055	<0.02	<0.02
Arsenic	0.013	<0.0005	<0.0005
Cadmium	0.0002	**0.001**	**0.001**
Chromium	0.001	<0.001	<0.001
Copper	0.0014	**0.098**	**0.021**
Lead	0.0034	<0.001	<0.001
Manganese	1.9	0.086	0.081
Nickel	0.011	**0.074**	**0.079**
Selenium	0.011	<0.001	<0.001
Zinc	0.008	**0.040**	**0.043**

Dashes (-) represent value not available

Values in bold exceed freshwater 95% trigger values

Source: Adapted from Schlumberger 2012b

Thirty Four Mile Brook

The D5 Dam location has been modelled as the point at which water leaves the pit lakes and associated mine infrastructure and enters the downstream environment. The D5 Dam location receives water from Wattle Hollow Brook, the Southern WRD and Medium Grade Stockpile prior to the Combined Pit Lake overflowing (Figure 27; Schlumberger 2012b). Once overflow occurs from the Combined Pit Lake, this will also pass through the D5 location (Schlumberger 2012b). The D5 location is approximately 3 km from the confluence of Thirty Four Mile Brook and the Hotham River (Figure 9).

The results of water quality modelling for the D5 location are provided in Table 20. The results show that the water is fresh (less than 1000 mg/TDS) and has a neutral pH (Schlumberger 2012b; Table 20). Modelled water quality exceeds the ANZECC & ARMCANZ freshwater trigger value for protection of 95% of species for:

- aluminium and chromium at two, ten and 80 years
- cadmium, copper, nickel and zinc in all years (Table 20).

The analytes with concentration levels that exceed ANZECC & ARMCANZ guidelines are the same analytes that showed exceedances in baseline water quality data from Wattle Hollow Brook (Table 20). In summary:

- aluminium: exceeds the baseline summer water concentration at two years' post-closure but not after this
- cadmium: the post-closure concentration is approximately 15% higher than the baseline winter concentration
- chromium: the maximum post-closure concentration is approximately 50% higher than the baseline winter concentration until 120 years post-closure
- copper: the maximum post-closure concentration is lower than the baseline summer concentration
- nickel: the maximum post-closure concentration is 4.5 times the baseline summer concentration
- zinc: the maximum post-closure concentration is twice the baseline winter concentration (see Table 20).

The water quality in Thirty Four Mile Brook post-closure is; therefore, generally similar to the existing water quality in Wattle Hollow Brook. The main exceptions to this are slightly elevated concentrations of chromium, nickel and zinc. Wattle Hollow Brook does not currently receive surface water inputs from the mine.

Hotham River

In the post-closure phase, flows will be managed such that impacts on riparian vegetation and aquatic fauna do not occur. Increases in flows as a result of the cessation of abstraction and in the longer term, pit outflows, may be beneficial to riparian vegetation and aquatic fauna.

The richness and type of aquatic invertebrate fauna present at a site is related to water quality factors (Davis et al. 1993). Concentrations of metals may increase in Thirty Four Mile Brook and Hotham River post-closure. This may result in some decrease in the richness of aquatic fauna in these waterways.

Groundwater and surface water monitoring will continue post-closure, as outlined in Section 7.5. These monitoring and mitigation measures will ensure that the Proposal does not impact on aquatic fauna and vegetation in Hotham River due to direct or indirect impacts of groundwater drawdown.

Table 20 Water quality at D5 Dam compared to ANZECC & ARMCANZ freshwater trigger values and baseline water quality in Thirty Four Mile Brook

Analyte (all values in mg/L unless stated)	ANZECC & ARMCANZ freshwater 95% trigger value	Baseline water quality -summer	Baseline water quality: winter	2 years	10 years	80 years	120 years
pH (std units)	6.5–8.0	6.9	7.0	7.17	7.07	7.06	7.10
TDS	-	438	173	279	229	475	803
Cyanide	0.007	-	-	-	-	-	-
Aluminium	0.055	**0.21**	**0.16**	**0.232**	**0.183**	**0.071**	<0.02
Arsenic	0.013	0.00067	0.0049	0.007	0.005	0.002	<0.0005
Cadmium	0.0002	Below detection limit	**0.00088**	**0.001**	**0.001**	**0.001**	**0.001**
Chromium	0.001	**0.005**	**0.011**	**0.015**	**0.011**	**0.005**	0.001
Copper	0.0014	**0.86**	**0.0092**	**0.086**	**0.068**	**0.035**	**0.025**
Lead	0.0034	0.00067	0.0017	0.002	0.002	0.001	<0.001
Manganese	1.9	0.019	0.011	0.016	0.013	0.033	0.07
Nickel	0.011	**0.016**	**0.013**	**0.019**	**0.015**	**0.033**	**0.070**
Selenium	0.011	0.008	0.0076	0.011	0.009	0.003	0.001
Zinc	0.008	**0.017**	**0.020**	**0.028**	**0.022**	**0.027**	**0.040**

Dashes (-) represent value not available

Values in bold exceed freshwater 95% trigger values

Source: Adapted from Schlumberger 2012b

8.5 Management measures and performance standards

NBGPL is implementing a plan for surface water management on the site (NBGPL 2009). The management of surface water at NBG is based on the principle of retaining potentially impacted runoff on site and reusing it for ore processing. This practice has been successful in maintaining water quality in Thirty Four Mile Brook.

Management of potential impacts on surface water from this Proposal are also addressed in the Surface Water Management Plan in the EMP (Appendix 1) and includes the following:

- managing process water quality through Caro's Acid Cyanide Destruction circuit
- conducting inspections of sediment control structures to prevent silt laden water entering the environment as per site monitoring plan
- removing sediment from sediment pumps
- collecting all runoff from WRDs, RDAs, soil/gravel stockpiles and bauxite stockpiles in storage ponds and reuse as process water
- segregating clean and potentially contaminated runoff (runoff from WRDs)
- treating runoff and seepage from WRDs if required
- continuing to manage the staged construction of the F1/F3 RDA to prevent migration of diffuse seepage into the South Dandalup catchment
- managing storage capacities in water holding facilities in accordance with the following:
    - each facility to be designed with a capacity for a 1-in-25-year ARI storm event of 24-hours duration in addition to a freeboard allowance
    - where the facility is the last storage before discharge to the lower sections of Thirty Four ARI storm event of 24 hours duration.
- discharging of water from the mine site to Thirty Four Mile Brook to only occur in rainfall events greater than 1-in-100 year average return interval, 24-hour event
- undertaking abstraction of water from the Hotham River in accordance with DoW licence conditions
- submitting detailed design of Gringer Creek diversion to DoW and DER
- Management of potential impacts to the Hotham River from groundwater drawdown are discussed in Section 7.5.

8.6 Predicted environmental outcomes

Through the mitigation measures described above, the Proposal is expected to result in the following outcomes in relation to surface water:

1. No impact on surface water quality or volumes in the South Dandalup PDWSA.
2. Minor reductions in flow volumes in Gringer Creek (approximately 15%) during the life of the Proposal. No significant alteration to flow volumes in Thirty Four Mile Brook is anticipated.
3. Volumes of water abstracted from Hotham River are expected to remain within the current licensed allocation. Potential impacts on water levels in Hotham River due to drawdown will be mitigated through stream augmentation over the summer months, should these occur.
4. Construction of two pit lakes that will overflow into Thirty Four Mile Brook approximately 81 years after the closure of the mine, with an average overflow rate of approximately 36 ML/day during autumn and winter.
5. Increases in flow volumes following pit lakes overtopping is considered unlikely to impact on downstream flow rates.

6. No significant impact to quality of surface water flows is anticipated during operations. Surface water quality in Thirty Four Mile Brook post-closure will be generally similar to current water quality, with some increase in concentrations of chromium, nickel and zinc.
7. No impacts to riparian vegetation health and aquatic fauna are anticipated during the operation of the Proposal.

The Proposal is not anticipated to adversely impact the quantity of surface water available to maintain existing and potential environmental values. The Proposal may result in alterations to water quality in the lower sections of Thirty Four Mile Brook post-closure due to increases in concentrations of chromium, nickel and zinc to above current levels. These changes are not expected to significantly affect water quality in comparison of that within the region area. In considering the outcome as described, the Proposal is expected to meet the EPA objectives for surface water.

9. Flora and vegetation

9.1 Relevant environmental objectives, policies, guidelines, standards and procedures

9.1.1 EPA objective

The EPA applies the following objective to assessment of proposals that may affect vegetation and flora:

> To maintain the conservation status, diversity, and productivity of flora and vegetation at species and ecosystems levels through the avoidance or management of adverse impacts and improvements in knowledge.

9.1.2 Legislation, policy, guidance

State protection

In a legislative context, the preservation and conservation of flora and ecological communities is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950* (WC Act)
- *Conservation and Land Management Act 1984* (CALM Act)
- *Environmental Protection Act 1986* (EP Act) (Part IV)

The DPaW (Nature Conservation Division) Priority Flora List also nominates conservation species from Priority 1 to 5 (Table 21).

Table 21 Categories of conservation significance

Priority	Description
Priority 1	Poorly Known Taxa: taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2	Poorly Known Taxa: taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
Priority 3	Poorly Known Taxa: taxa which are known from several populations and the taxa are not believed to be under immediate threat.
Priority 4	Rare Taxa: taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors.
Priority 5	Conservation dependent taxa: Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Threatened ecological communities (TEC), as listed by the DPaW are of high significance. Ecological communities with insufficient information available to be considered a TEC, or which are rare but not currently threatened, are placed on the Priority list and referred to as priority ecological communities (PEC).

Australian Government protection

The Australian Government EPBC Act protects species listed under Schedule 1 of the Act. In 1974, Australia became a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). An official list of these endangered species is prepared and is regularly updated by DSEWPaC. The current list differs from the various State lists; however, some species are common to both.

EPA Position Statement No. 2

EPA Position Statement No. 2 *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation, with Particular Reference to the Agricultural Area* (EPA 2000) provides an overview of the EPA position on the clearing of native vegetation in Western Australia. In assessing a proposal, the EPA consideration of biological diversity will include the following basic elements:

- comparison of project scenarios, or options, to evaluate biodiversity protection at the species and ecosystems levels, and demonstration that all reasonable steps have been taken to avoid disturbing native vegetation
- no known species of plant or animal is caused to become extinct as a consequence of the project and the risks to threatened species are considered to be acceptable
- no association or community of indigenous plants or animals ceases to exist as a result of the project
- there is a comprehensive, adequate and secure representation of scarce or endangered habitats within and/or in areas biologically comparable to the project area, protected in secure reserves
- if the proposal is large (in the order of 10–100 ha or more, depending on where in the State) the project area itself should include a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity are secure and protected
- the on-site and off-site impacts of the project are identified and the proponent demonstrates that these impacts can be managed.

EPA Position Statement No. 3

EPA Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002a) discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in Western Australia.

EPA Guidance Statement No. 51

EPA Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a), provides guidance on standards and protocols for terrestrial flora and vegetation surveys, particularly those undertaken for the EIA of proposals.

9.2 Findings of surveys and investigations

9.2.1 Terrestrial vegetation

Flora and vegetation surveys of the Development Envelope, including regional, site-specific, and targeted rare and threatened flora surveys, have been undertaken over a period of 20 years. This survey work was summarised in a detailed review by Mattiske (2005).

Surveys and investigations specific to this Proposal include the following:

- a desktop flora and vegetation assessment of the Saddleback Tree Farm (previously Sotico) plantation area for the RDA (Mattiske 2011)
- a targeted threatened and priority flora assessment of the Hotham pipeline and Hedges dam area (Mattiske 2012a)
- a detailed survey of the Saddleback Tree Farm plantation area (Mattiske 2012b)
- a flora and vegetation survey of the proposed waste rock dump and dam options (Mattiske 2012c).

Field surveys were conducted according to standards set out in Guidance Statement 51 (Environmental Protection Authority 2004a). The vegetation types were mapped at the regional (vegetation complexes)

and local (vegetation units) scale and any threatened or priority flora found were counted and mapped. Key flora and vegetation surveys of the Boddington area are shown in Table 22.

Table 22 Vegetation and flora surveys of the Boddington area

Survey	Reference
Review of Flora and Vegetation Located in the Boddington Gold Mine and Hedges Lease Areas, unpublished report prepared for Worsley Alumina.	Mattiske 2005
Assessment of the Wetlands on the Boomerang, Pillow and Round Swamps, unpublished report prepared for Newmont Boddington Gold Mine.	Mattiske 2010
Desktop Flora and Vegetation Survey of Sotico Survey Area June 2011, unpublished report prepared for Newmont Boddington Gold Mine.	Mattiske 2011
Threatened and Priority Flora Assessment of the Hotham Pipeline and Hedges Dam, unpublished report prepared for Newmont Boddington Gold Mine.	Mattiske 2012a
Flora and Vegetation of the Sotico Survey Area, unpublished report prepared for Newmont Boddington Gold Mine.	Mattiske 2012b
Flora and Vegetation of the Proposed Waste Rock Dump and Dam Options, unpublished report prepared for Newmont Boddington Gold Mine.	Mattiske 2012c

Vegetation condition

Vegetation condition throughout the Boddington lease areas is variable from completely degraded to excellent. Large areas of intact native forest surround the existing pits and RDA, with vegetation condition generally ranging from very good to excellent. Approximately half of the disturbance for the RDA (i.e. 860 ha out of 1650 ha) is located on the Saddleback Tree Farm timber plantation. The area within the timber plantation affected by the RDA includes pine plantations, bluegum and fallow land. These cleared areas and the areas in proximity to agricultural land to the east have some invasion of weed species. However, areas of intact remnant vegetation remain within the plantation, particularly to the northeast and southeast of the RDA. Overall, the vegetation condition for the Saddleback Tree Farm study area varies from completely degraded to excellent (Mattiske 2012b).

The area south of the WRD on Hotham Farm has a long history of pastoral use. Much of this area is either completely cleared or consists of disturbed grasslands with occasional isolated trees. Some remnant vegetation remains along the creek lines and swamps and along the old Boddington Railway corridor.

Vegetation complexes

NBG is located within the Darling Botanical District of the Southwest Botanical Province and is largely characterised by open forests of *Eucalyptus marginata* (Jarrah). Other dominant species include *Corymbia calophylla* (Marri) and *Eucalyptus wandoo* (Wandoo). The diversity of the area is somewhat greater than western jarrah forest areas as the flora reflects the interface between eastern sections of the northern jarrah forest and the Wheatbelt region (Mattiske 2005, 2011).

Wide-ranging landform and soil types play an important role in plant distribution and increased species diversity. Site conditions range from clay-loam valley systems to upland lateritic hills to shallow granitic soil associated with the Saddleback greenstone belt (Mattiske 2005, 2011).

Local flora and vegetation types recorded at NBG are generally well represented at a regional scale. However, species comprising plant communities associated with shallow granitic soil are restricted in the Boddington area and are considered to be of local and regional significance (Mattiske 2005, 2012b).

Nine vegetation complexes have been defined for the NBG vegetation survey areas. Although most are well represented in the WA conservation estate, the easternmost systems have been cleared for agricultural purposes and are less well represented. Vegetation complexes and their total percentage of pre-European representation, along with percentage of pre-European representation within the conservation estate, are shown in Table 23.

Of these complexes, Michibin and Williams have less than 30% of their pre-European extent remaining and have less than 10% retained within the conservation estate.

Table 23 Regional vegetation complexes

Vegetation complex	Description	Total % Pre-European extent	% in conservation estate
Cooke	Mosaic of open forest of *Eucalyptus marginata* subsp. *marginata–Corymbia calophylla* (subhumid zone) and open forest of *Eucalyptus marginata* subsp. *thalassica-Corymbia calophylla* (semiarid and arid zones) and on deeper soils adjacent to outcrops, closed heath of Myrtaceae-Proteaceae species and lithic complex on granite rocks and associated soils in all climate zones, with some *Eucalyptus laeliae* (semiarid), and *Allocasuarina huegeliana* and *Eucalyptus wandoo* (mainly semiarid to perarid zones). This vegetation complex is well represented in the conservation estate.	85.0	28.7
Coolakin	Woodland of *Eucalyptus wandoo* with mixtures of *Eucalyptus patens* (Swan River Blackbutt), *Eucalyptus marginata* subsp. *thalassica* and *Corymbia calophylla* on the valley slopes in arid and perarid zones. This vegetation complex is less well represented in the conservation estate as these eastern areas have been largely cleared for agricultural activities.	43.9	14.3
Dwellingup 4	Open forest of *Eucalyptus marginata* subsp. *thalassica–Corymbia calophylla* on lateritic uplands in semiarid and arid zones. This vegetation complex is well represented in the conservation estate.	88.0	23.6
Michibin	Open woodland of *Eucalyptus wandoo* over *Acacia acuminata* with some *Eucalyptus loxophleba* on valley slopes, with low woodland of *Allocasuarina huegeliana* on or near shallow granite outcrops in arid and perarid zones. This vegetation complex is less well represented in the conservation estate as these eastern areas have been largely cleared for agricultural activities.	29.5	5.7
Pindalup	Open forest of *Eucalyptus marginata* subsp. *thalassica–Corymbia calophylla* on slopes and open woodland of *Eucalyptus wandoo* with some *Eucalyptus patens* (Swan River Blackbutt) on the lower slopes in semiarid and arid zones. This vegetation complex is well represented in the conservation estate.	81.2	26.3
Swamp	Mosaic of low open woodland of *Melaleuca preissiana-Banksia littoralis*, closed scrub of Myrtaceae spp., closed heath of Myrtaceae spp. and sedgelands of *Baumea* and *Leptocarpus* spp. on seasonally wet or moist sand, peat and clay soils on valley floors in all climatic zones. This vegetation complex is well represented in the conservation estate.	86.7	29.9
Williams	Mixture of woodland of *Eucalyptus rudis–Melaleuca rhaphiophylla*, low forest of *Casuarina obesa* and tall shrubland of *Melaleuca* spp. On major valley systems in arid and perarid zones. This vegetation complex is poorly represented in the conservation estate as these eastern areas have been largely cleared for agricultural activities.	27.0	0.5
Yalanbee 5	Mixture of open forest of *Eucalyptus marginata* subsp. *thalassica–Corymbia calophylla* and woodland of *Eucalyptus wandoo* on lateritic uplands in semiarid to perarid zones. This vegetation complex is well represented in the conservation estate.	67.2	22.5
Yalanbee 6	Woodland of *Eucalyptus wandoo-Eucalyptus accedens*, less consistently open forest of *Eucalyptus marginata* subsp. *thalassica-Corymbia calophylla* on lateritic uplands and breakaway landscapes in arid and perarid zones. This vegetation complex is well represented in the conservation estate.	50.8	21.5

Vegetation units

Over 20 years of survey work across the NBG tenements and nearby areas has been compiled and summarised by Mattiske (2005). This has been supplemented with a recent, detailed survey of the Saddleback Tree Farm site (Mattiske 2012b). The total area subject to Level 2 botanical surveys covers more than 26 700 h and is referred to as the Survey Area (shown in Figure 29).

To date, 36 site vegetation units have been described. A total of 660 vascular plant taxa were identified in the Mattiske (2005) vegetation review and 539 taxa were identified during the Saddleback Tree Farm survey (Mattiske 2012b). The majority of taxa recorded were representative of the Fabaceae (encompassing families formerly known as Papilionaceae and Mimosaceae), Asteraceae, Myrtaceae, Proteaceae, Ericaceae and Cyperaceae families. Vegetation types consist predominantly of *Eucalyptus marginata* (Jarrah) –*Corymbia calophylla* (Marri) open forest to woodland, and *Eucalyptus wandoo* (Wandoo) woodland. Site vegetation units are detailed in Table 24.

Table 24 Site vegetation units

Vegetation unit	Description
A	Tall shrubland of *Melaleuca lateritia, Hakea varia, Melaleuca viminea* and *Melaleuca incana* subsp. *incana* on clay-loams in seasonally wet valley floors.
A2	Low open woodland of *Melaleuca rhaphiophylla* over *Astartea scoparia* and low herbs on seasonally water-logged clays and clay loams in seasonally wet valley floors.
A3	Open woodland of *Eucalyptus rudis, Eucalyptus patens* (Swan River Blackbutt) and *Eucalyptus wandoo* over *Melaleuca lateritia*, *Hakea varia, Taxandria linearifolia* and *Hypocalymma angustifolium* over herbs and sedges on clay-loams in seasonally wetter valley floors.
AD	Low open woodland of *Eucalyptus rudis* and *Eucalyptus marginata* over *Banksia littoralis, Hakea prostrata* and *Pericalymma ellipticum* over low shrubs and herbs on leached sands over sandy-gravel on lower slopes.
AX	Open woodland of *Eucalyptus rudis* over *Acacia saligna, Melaleuca incana* subsp. *incana* and *Hypocalymma angustifolium* on clay-loams on valley floors.
AY	Open woodland of *Eucalyptus rudis* and *Eucalyptus wandoo* over *Acacia saligna, Hakea prostrata* and *Hypocalymma angustifolium* on clay-loams on valley floors.
B	Open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Mesomelaena tetragona, Adenanthos obovatus* and *Babingtonia camphorosmae* on sandy-loam soils on moist lower slopes.
D	Open forest of *Corymbia calophylla* and *Eucalyptus marginata* over *Hakea lissocarpha, Macrozamia riedlei, Acacia alata, Babingtonia camphorosmae, Hypocalymma angustifolium* and *Phyllanthus calycinus* on clay-loams on lower slopes.
DG	Open forest of *Corymbia calophylla* and *Eucalyptus marginata* over *Hakea lissocarpha, Macrozamia riedlei, Pericalymma ellipticum, Grevillea bipinnatifida, Allocasuarina humilis, Acacia alata, Babingtonia camphorosmae, Hypocalymma angustifolium* and *Phyllanthus calycinus* on clay-loams on lower slopes with localised patches of outcropping.
E	Open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Mesomelaena tetragona, Kingia australis, Leptospermum erubescens* and *Babingtonia camphorosmae* on sandy to sandy-loam soils on slopes.
G1	Open heath of Proteaceae spp. and Myrtaceae spp. with emergent patches of *Eucalyptus drummondii* on shallow soils associated with outcrops on slopes.
G2	Mosaic of open woodland of *Allocasuarina huegeliana,* closed heath of Proteaceae spp. and Myrtaceae spp. and lithic complex on exposed or shallow granite outcrops.
G3	Open heath of *Banksia squarrosa* subsp. *squarrosa, Hakea incrassata, Hakea undulata, Petrophile heterophylla* and *Petrophile serruriae* on shallow soils over granite outcrops on slopes with occasional emergent *Eucalyptus drummondii.*
G4	Open scrub and tall shrubland of *Hakea trifurcata* and *Hakea undulata* with admixtures of mallee species including *Eucalyptus latens* and *Eucalyptus aspersa* on clay to clay-loam soils over outcrops on slopes.
G5	Low woodland of Eucalypt mallee species such as *Eucalyptus aspersa, Eucalyptus latens, Eucalyptus longicornis* and *Eucalyptus drummondii* with occasional *Eucalyptus wandoo* over low shrubs of *Allocasuarina humilis, Hakea incrassata*, *Synaphea damopsis* and herbs on clay loams and sandy-loams on slopes.

Vegetation unit	Description
H	Open forest to woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Petrophile striata, Daviesia decurrens, Daviesia longifolia* and *Daviesia rhombifolia* on sandy loam to sandy gravels on slopes and ridges.
H2	Open forest to open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Banksia dallanneyi* var. *dallanneyi. Banksia sphaerocarpa* var. *sphaerocarpa, Bossiaea ornata, Daviesia decurrens, Hakea ruscifolia* and *Gastrolobium spinosum* on sandy soils on lower and mid slopes.
HG	Open forest to woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Petrophile striata, Daviesia decurrens, Daviesia longifolia, Pericalymma ellipticum, Grevillea bipinnatifida* and *Allocasuarina humilis* on sandy loam to sandy gravels on slopes and ridges with localised patches of outcropping.
J	Open woodland of *Eucalyptus marginata—Corymbia calophylla*. Other indicator species include *Conospermum stoechadis, Patersonia rudis* and *Babingtonia camphorosmae.*
L	Open woodland of *Eucalyptus patens* (Swan River Blackbutt) with some *Eucalyptus wandoo*. Other indicator species include *Xanthorrhoea preissii, Macrozamia riedlei, Trymalium ledifolium, Acacia saligna* and *Hakea prostrata.*
LG	Open woodland of *Eucalyptus patens* (Swan River Blackbutt) and *Eucalyptus wandoo* over *Hypocalymma angustifolium, Xanthorrhoea preissii, Grevillea bipinnatifida, Allocasuarina humilis* and *Babingtonia camphorosmae* over herbs and sedges on clay-loams on seasonally moister lower slopes with patches of outcropping.
M	Open woodland of *Eucalyptus wandoo* over *Trymalium ledifolium, Macrozamia riedlei* and *Hakea lissocarpha* on clay loams with some gravel on mid to upper slopes and ridges.
M2	Woodland to open woodland of *Eucalyptus accedens*, *Eucalyptus wandoo, Eucalyptus marginata, Corymbia calophylla* over *Hakea lissocarpha, Macrozamia riedlei, Banksia squarrosa* subsp. *squarrosa, Hypocalymma angustifolium, Babingtonia camphorosmae, Grevillea bipinnatifida* and *Allocasuarina humilis* on clay-loams over shallow granite outcropping on mid to upper slopes and ridges.
MG	Open woodland of *Eucalyptus wandoo* over *Trymalium ledifolium, Macrozamia riedlei, Pericalymma ellipticum, Hypocalymma angustifolium, Grevillea bipinnatifida, Allocasuarina humilis* and *Hakea lissocarpha* on clay-loams over shallow granite on mid to upper slopes and ridges.
O	Open forest to woodland *of Eucalyptus marginata* and *Corymbia calophylla over Daviesia decurrens, Daviesia preissii* and *Bossiaea ornata* on sandy-gravels on slopes.
P	Open forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* with admixtures of *Corymbia calophylla* and *Banksia grandis* over *Lasiopetalum cardiophyllum, Lasiopetalum floribundum, Lechenaultia biloba* and *Ptilotus drummondii* var. *drummondii* on sandy to sandy-gravel soils on slopes and ridges.
PS	Open forest of *Allocasuarina fraseriana, Eucalyptus marginata, Corymbia calophylla* and *Banksia grandis* over *Adenanthos barbiger, Leucopogon capitellatus* on gravels and sandy gravels on slopes and ridges.
PW	Open forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* with admixtures of *Corymbia calophylla* and *Banksia grandis* over *Lasiopetalum cardiophyllum, Lechenaultia biloba* and *Hypocalymma angustifolium* on seasonally moister sandy-gravels on slopes.
R	Open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Trymalium ledifolium, Phyllanthus calycinus* and *Hypocalymma angustifolium* on sandy-gravels associated with nearby shallow outcropping.
S	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* with admixtures of *Allocasuarina fraseriana, Banksia grandis* and *Persoonia longifolia over Acacia celastrifolia, Hovea chorizemifolia, Daviesia preissii, Leucopogon capitellatus* and *Styphelia tenuiflora* on sandy-gravels on slopes and ridges.
SP	Open forest of *Eucalyptus marginata, Corymbia calophylla* and *Allocasuarina fraseriana* with admixtures of *Banksia grandis* over *Lasiopetalum cardiophyllum, Acacia celastrifolia, Styphelia tenuiflora, Daviesia decurrens* and *Trymalium ledifolium* on sandy-gravel to gravel soils on slopes and ridges.
ST	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* with admixtures of *Allocasuarina fraseriana, Persoonia longifolia* and *Banksia grandis* over *Stylidium dichotomum, Acacia urophylla, Acacia celastrifolia, Leucopogon verticillatus, Clematis pubescens* and *Leucopogon capitellatus* on sandy-loam gravel soils on slopes and ridges.
SW	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* over *Hypocalymma angustifolium, Babingtonia camphorosmae, Acacia celastrifolia, Hovea chorizemifolia, Daviesia preissii, Leucopogon capitellatus* and *Styphelia tenuiflora* on seasonally moister sandy-gravels on slopes.
W	Open forest of *Corymbia calophylla, Eucalyptus marginata* and *Eucalyptus patens* (Swan River Blackbutt) *over Hakea lissocarpha, Hypocalymma angustifolium, Acacia extensa* and *Synaphea petiolaris* on loam soils on lower slopes.
Y	Open woodland of *Eucalyptus wandoo* over *Gompholobium marginatum, Acacia nervosa, Babingtonia camphorosmae, Hypocalymma angustifolium, Macrozamia riedlei, Phyllanthus calycinus* and *Gastrolobium calycinum* on clay and clay-loam soils on lower slopes.

Vegetation unit	Description
YG	Open woodland of *Eucalyptus wandoo* over *Gompholobium marginatum, Acacia nervosa, Babingtonia camphorosmae, Hypocalymma angustifolium, Macrozamia riedlei, Pericalymma ellipticum, Grevillea bipinnatifida, Allocasuarina humilis, Phyllanthus calycinus* and *Gastrolobium calycinum* on clay and clay-loam soils with localized outcropping on lower slopes.
Z	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* over *Macrozamia riedlei, Xanthorrhoea preissii, Hakea lissocarpha* and *Phyllanthus calycinus* on sandy-loam to sandy-loam gravel soils on slopes.

Source: Mattiske (2005, 2012b)

9.2.2 Conservation significant vegetation units

No threatened communities listed under the EPBC Act have been identified on site. No PECs or TECs have been identified within the Survey Area. Table 25 summarises the eight vegetation units considered to be of local conservation significance by Mattiske (2012b).

Table 25 Vegetation units of conservation significance

Vegetation units	Description
G1, G2, G3 and G4	Associated with shallow or exposed granites. These vegetation types support a range of structural and floristic communities that provide a variety of biodiversity values in the local area. In addition, these communities support a range of the priority species including *Acacia gemina* (P2), *Darwinia thymoides* subsp. ?St Ronans (J.L. Alford & G J Keighery 64) (P4). Vegetation types support stands of the mallee eucalypts (*Eucalyptus aspersa*, *Eucalyptus decurva* and *Eucalyptus drummondii*). These mallee species have been recorded previously in the Boddington area and generally are relatively restricted in extent to small patches.
L	A mixture of *Eucalyptus patens* (Swan River Blackbutt) and *Eucalyptus wandoo* over low shrubs and herbs. This community has been largely cleared for agricultural activities and as such is locally restricted in occurrence.
M2	A mixture of *Eucalyptus accedens* and *Eucalyptus wandoo* over low shrubs on clay-loams on breakaways and upper slopes. This community reflects the more easterly Wheatbelt communities and, as such, provides coverage of a community that is relatively restricted in the conservation estate and forest estate as a result of its soil preferences and occurrence on the fringes of the eastern Jarrah forest.
A, A2 and A3	Associated with the range of extensive swamps and valley floors which support structural and floristic variations in the local area and also in a regional context. Although these swamps are well represented in many of the conservation estates in the southwest forests, the variety of structure and diversity of seasonal proliferation of herbs provide a different value to the areas.

9.2.3 Riparian vegetation

Riparian vegetation was surveyed by Mattiske (2005) along cross-sections used for surveying channel morphology, to define vegetation complexes, their zonation and their elevation relative to water level on each cross-section, with comment on their differing water requirements.

Riparian vegetation in the Boddington area is dominated by tall shrublands of *Melaleuca* spp. and open woodlands of *Eucalyptus wandoo* and *E. rudis*; specifically vegetation units A, A2, A3, AY, AX and Y.

In general, the health and vigour of riparian vegetation is maintained by the flow regime. Biotic factors affected by flow regimes and known to influence riparian vegetation include the following:

- bank soil moisture content
- proximity of groundwater to the root zone
- period and season of flooding that inundates the floodplain and riparian vegetation (WRM 2011).

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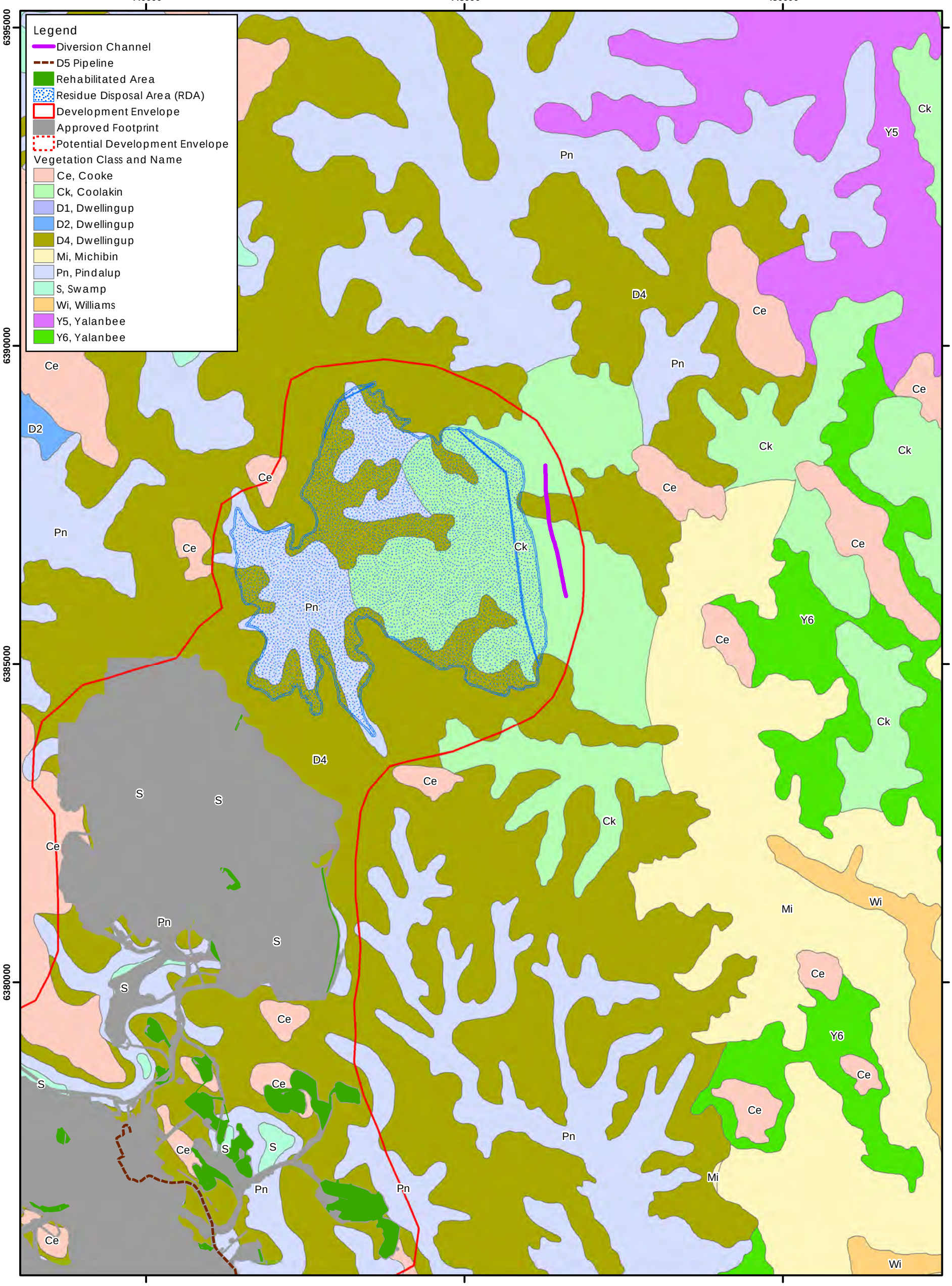

Figure 28a Vegetation complexes

STRATEGEN

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www.strategen.com.au

Scale

0 1 2 3 4
Kilometers

1:60,000
at A3

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Aerial image and mine layout: Client 2012. Vegetation: Regional Forest Agreement Mapping, Mattiske & Havel 1998.
Note that positional errors may occur in some areas

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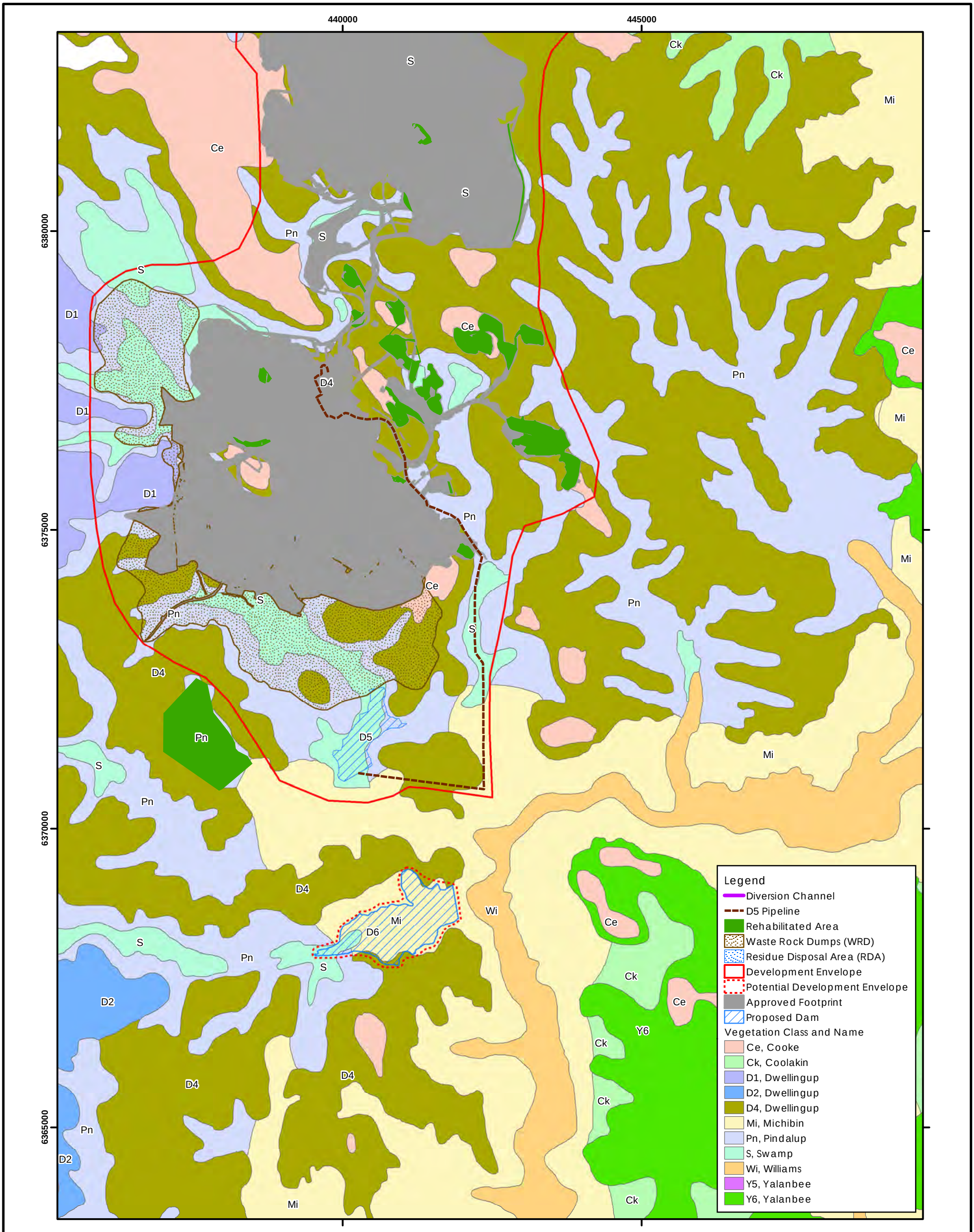

Figure 28b Vegetation complexes

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Scale

0 1 2 3 4
Kilometers

1:60,000
at A3

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Aerial image and mine layout: Client 2012. Vegetation: Regional Forest Agreement Mapping, Mattiske & Havel 1998.
Note that positional errors may occur in some areas

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440000 445000 450000

6395000 6390000 6385000 6380000

Legend
- Diversion Channel
- D5 Pipeline
- Development Envelope
- Residue Disposal Area (RDA)
- Rehabilitated Area
- Approved Footprint

Figure 29a Vegetation units

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Scale
0 1 2 3 4
Kilometers

1:60,000
at A3

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F029a_A3.mxd

440000

445000

6380000

6375000

6370000

6365000

Legend

- Diversion Channel
- D5 Pipeline
- Development Envelope
- Potential Development Envelope
- Waste Rock Dumps (WRD)
- Rehabilitated Area
- Approved Footprint
- Proposed Dam

Figure 29b Vegetation units

STRATEGEN

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Scale

0 1 2 3 4
Kilometers

1:60,000
at A3

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F029b_A3.mxd

9.2.4 Conservation significant species

The Mattiske (2005) review identified that nine priority flora species had been recorded in the Survey Area (Table 26). These species were recorded in native bushland and three are also known from rehabilitation areas across the mining leases (Mattiske 2005). Subsequent review of the conservation status of two species (*Eucalyptus latens* and *Stenanthemum coronatum*) indicates that these species are no longer considered to be of conservation significance.

Surveys for this Proposal recorded two new priority flora (*Acacia cuneifolia* and *Grevillea manglesii* subsp. *dissectifolia*) in the Saddleback Tree Farm survey area (Mattiske 2012b), and *Gastrolobium* sp. Prostrate Boddington was identified in the proposed Hotham pipeline and Hedges dam survey area (Mattiske 2012a).

No threatened flora species pursuant to Schedule 1 of the WC Act have been recorded within the NBG vegetation survey areas.

No threatened species listed under the EPBC Act have been identified on site, although *Verticordia fimbrilepis* subsp. *fimbrilepis* (Shy Featherflower) is listed as potentially occurring within the area.

Table 26 Priority flora

Species	Conservation status	Occurrence/distribution
Gastrolobium sp. Prostrate Boddington (M. Hislop 2130)	P1	Located in C-site vegetation types downstream of the Hedges Gold Mine tailings dam on the fringes of the Hotham River. Located along the proposed Hotham pipeline route.
Acacia gemina	P2	Recorded in a range of vegetation types in the Boddington area. Most nearby collections are either from within or near the Boyagin Rock Nature Reserve or the Saddleback Timber Reserve. Species present within the NBG leases in rehabilitated areas where it has been seeded, and has been identified at two locations within the Saddleback Tree Farm survey area.
Chordifex gracilior	P3	Recorded at one location east of the existing mine, outside the Development Envelope in State Forest.
Grevillea manglesii subsp. *dissectifolia*	P3	Located at several locations within the Saddleback Tree Farm survey area, often on gravelly loam and moist sites and sometimes found on roadsides.
Hakea oldfieldii	P3	Recorded at four locations northeast of the NBG project area, outside of the Development Envelope in State Forest
Halgania corymbosa	P3	Recorded in a range of site-vegetation types within the NBG project area, including one location in the Saddleback Tree Farm survey area.
Stylidium marradongense	P3	Recorded from several locations; however, this species is very restricted and warrants further research.
Acacia cuneifolia	P4	Prefers sand, clay or loam over granite and was located at two sites in the Saddleback Tree Farm survey area.
Lasiopetalum cardiophyllum	P4	Recorded in relatively large numbers; however, this species is geographically restricted to the eastern jarrah forest. Previous studies of this species in the eastern Jarrah forest have indicated that populations occur south and north of the NBG areas and this species also occurs in conservation reserves to the south of Boddington. This species has been recorded in low numbers in NBG rehabilitation areas and at 73 locations within the Saddleback Tree Farm survey area.
Senecio leucoglossus	P4	Recorded in NBG areas and occurs throughout the northern jarrah forest. Species is not locally restricted.
Templetonia drummondii	P4	This species occurs as isolated plants and has been recorded in NBG areas and within rehabilitation areas. It was recorded at 129 locations in the Saddleback Tree Farm survey area.

9.2.5 Plant pathogens

The plant disease known as 'dieback' is caused by infestation of an introduced pathogen *Phytophthora cinnamomi.* It affects a vast and diverse range of plant species in the southwest region of Western Australia. The disease enters through the plant roots, eventually causing them to rot, affecting the plants ability to transport water and nutrients throughout the plant. Some species which are susceptible to dieback (such as Jarrah) may show some resistance to the disease and appear to gradually die back (hence the name). However, most species susceptible to *P. cinnamomi* experience a 'sudden death' where all of the plant dies at once (Glevan 2011).

A recent survey was undertaken by Glevan (2011) to assess the presence of *P. cinnamomi* within native vegetation of the Development Envelope. One new and four known infestations of *P. cinnamomi* were identified during the assessment. One area was classified as 'uninterpretable' due to a lack of indicator species, and one small infestation (1.5 ha) of root rot caused by *Armillaria luteobubalina* was identified on the northern boundary of the Study Area (Table 27).

The previously identified infestations of *P. cinnamomi* were all associated with relatively small creek lines that do not appear to have been inundated for a considerable length of time. Lack of water appears to have resulted in the pathogen spreading relatively slowly. However, spread of the disease has the potential to increase significantly if these areas become inundated.

While most of the current spread of the disease appears to be associated with creek lines and water flow, some *P. cinnamomi* infestation appears to be associated with vehicle movement along Wells Formation Road and the presence of a drainage pipe that discharges water collected from in and around the Wells Terminal construction site (Glevan 2011). The Wells Formation Road is maintained by Western Power and is not restricted to NBGPL operations.

Table 27 Dieback assessment results

Category	Area (ha)	% of area surveyed
Infested	102.0	8.0
Uninterpretable	66.0	5.2
Uninfested (*P. cinnamomi* free)	1103.5	86.7
Armillaria luteobubalina	1.5	0.1
Total	**1237.0**	

9.2.6 Weeds and exotic species

Over 100 exotic species have been identified within the NBG vegetation Survey Area. These species are predominantly grasses of the family Poaceae and herbs, shrubs and trees of the families Fabaceae, Geraniaceae and Asteraceae. Exotic species grown in plantation include *Pinus* sp., *Eucalyptus globulus* (Tasmanian Bluegum) and *Eucalyptus resinifera* (Red Mahogany).

Many weed species are a product of disturbance and are concentrated in areas where disturbance is greatest. This includes areas adjacent to farmland, plantation areas and where the patches of remnant vegetation are the smallest (Mattiske 2012b).

Two identified species: *Moraea flaccida* (Cape Tulip) and *Gomphocarpus fruticosus* (Cotton Bush) are Declared Plants under the *Agriculture and Related Resources Protection Act 1976*. Priority listings for Declared Plants indicate management requirements for the species rather than their level of significance. Cape Tulip, recorded at 16 locations in the southeast corner of the Saddleback Tree Farm, is listed as Priority 1 (P1) for the whole state and Priority 4 (P4) for the Shires of Boddington and Wandering. Cotton Bush was located in the proposed Hotham pipeline and Hedges dam survey area and is listed as both P1 and P4 for the Shires of Boddington and Wandering (Mattiske 2012b; DAFWA 2013).

9.3 Potential sources of impact

The following aspects of the Proposal may affect flora and vegetation values:

- **clearing of vegetation** for the pit expansion, WRDs, RDA and associated infrastructure will reduce the extent of vegetation communities and potentially disturb threatened flora
- mining activities such as **vehicle movement and site disturbance** associated with the Proposal have the potential to result in the spread of weeds and pathogens including dieback within and outside the project area
- potential impacts to groundwater dependent ecosystems including the Hotham River, as a result of **groundwater drawdown and abstraction**.

9.4 Assessment of likely direct and indirect impacts

9.4.1 Clearing of vegetation

Clearing native vegetation will reduce the local extent of vegetation communities and potentially disturb threatened flora species.

As described in Section 4, the Proposal has been located to minimise the requirement to clear native vegetation. This has been achieved by locating the WRD within areas of cleared farmland and the RDA primarily with an existing timber plantation. The Proposal will require additional clearing of up to 1755 ha of native vegetation within the total additional footprint of up to 2895 ha.

The impact of clearing in this PER is considered in terms of vegetation complexes and vegetation units. Vegetation complexes are a relatively broad vegetation mapping system. This system is used to describe the impact of clearing at the regional scale, as it takes into account pre-European vegetation extent. Vegetation units represent site-specific vegetation mapping developed as a result of Level 2 vegetation surveys. Vegetation units are used in this assessment to describe the effect of clearing at a local scale.

Vegetation complexes

Clearing will be primarily located within the Coolakin, Dwellingup and Pindalup vegetation complexes. Table 28 shows the clearing of each vegetation complex, expressed as a percentage of the total mapped area for each complex; are all less than 1%.

As identified in Table 23, the Michibin and Williams vegetation complexes are poorly represented in the conservation estate as a result of historical clearing for agricultural activities. These vegetation complexes are located at the eastern edge of the study area. No clearing is expected in either the Williams or Michibin vegetation complexes. The Proposal is not expected to significantly reduce the extent of any vegetation complex.

Table 28 Extent of clearing vegetation complexes

Habitat	Total mapped vegetation complex area (ha)	Total % Pre-European extent	Total clearing (ha)	Clearing as % of Total Mapped Area
Cooke	35 312	85.0	24	0.07
Coolakin	133 889	43.9	734	0.55
Dwellingup 1	208 273	88.0	9	0.00
Dwellingup 4	132 416	88.0	755	0.57
Michibin	134 546	29.5	0	0.00
Pindalup	166 696	81.2	805	0.48
Swamp	53 657	86.7	386	0.72

Vegetation units

The majority of cleared native vegetation will be within jarrah-marri forest and wandoo woodland. None of the vegetation units within the Development Envelope are restricted to the Boddington area; all are located within vegetation complexes that are well represented in the conservation estate within the northern and eastern jarrah forest.

The extent of clearing will be limited in the eight vegetation units considered to be of local or regional conservation significance. As shown in Table 29, clearing within all units will be restricted to below 20% of that recorded in the Survey Area, with the exception of five vegetation units; A3 (40.6%), AD (24.5%), AX (28.2%), O (100%) and Z (20.2%). Of these units only A3 is considered to be of local conservation significance, which, as described in Table 25, is associated with swamps and valley floor vegetation communities (which support a range of structural and floristic variations). The A3 vegetation unit is associated with an ephemeral drainage line within the plantation area that is predicted to be disturbed during the formation of the new RDA from 2022. Although the A-type vegetation units are well represented in many of the conservation estates in the southwest forest, there is diversity in structure and herbs which provide a different value to these areas (Mattiske 2012b).

The total extent of vegetation units AD and O is limited to only 9.4 ha for unit AD and 8.1 ha for unit O. The limited distribution of these units is considered likely to be a result of these units being transitional ecotone vegetation units and not because they are particularly unique. Vegetation unit O is well represented in the adjacent State Forest areas (Mattiske 2012c). As described in Table 24, unit AX is a woodland of *Eucalyptus rudis* (Flooded Gum), unit AD is a woodland of *Eucalyptus rudis* (Flooded Gum) and *Eucalyptus marginata* (Jarrah) and units O and X are open forest to woodland of Jarrah and *Corymbia calophylla* (Marri). The majority of the Survey Area is covered by woodland or forest of Flooded Gum (e.g. units M and AY) Jarrah (e.g. unit H) and Marri (e.g. unit D). Based on the amount of disturbance to the units AX, AD and O and given that these represent transitional units between well represented units, it is considered unlikely that native vegetation clearance for the Proposal will significantly affect regional or local diversity.

Table 29 accounts for 1540 ha of clearing of native vegetation. An additional 215 ha for drainage and other earthworks is also requested as part of this Proposal. This may also include roads and powerline or pipeline corridors. This clearing is anticipated to be in close proximity to the proposed disturbance footprint and will avoid swamp areas and vegetation units of conservation significance.

Hotham Farm

Two new water supply storage dams, D5 and D6 (Figure 4) are proposed for development in Hotham Farm, along with the installation of a pipeline and associated stockpiles. The proposed extension to the WRDs also extends into Hotham Farm. The vast majority of Hotham Farm is cleared agricultural land with some degraded and highly fragmented remnant vegetation. Mattiske (2012c) mapped the condition of remnant vegetation in Hotham Farm; only 7 ha of the area to be developed for the Proposal was assessed as being in 'Good' condition according to the Keighery (1994) scale. The remainder of the proposed impact areas on Hotham farm was assessed as in 'Degraded' or 'Completely Degraded' condition (Mattiske 2012c).

In 'Completely Degraded' and 'Degraded' vegetation, there is little or no vegetation structure remaining and the area is severely impacted by disturbance (Keighery 1994). Vegetation in 'Good' condition may also be altered by obvious signs of multiple disturbances, but retains basic vegetation structure or the ability to regenerate it (Keighery 1994). Based on this assessment, only areas mapped as in 'Good' condition on Hotham Farm were included in the impact assessment.

Plantation

In order to reduce the extent of native vegetation clearing required, the preferred location for the new RDA is within timber plantation areas. Approximately 860 ha of the 1650 ha RDA is located in the plantation area. Within the plantation area, this includes:

- pine plantation: 276 ha
- bluegum plantation: 130
- fallow land: 454 ha.

Table 29 Extent of vegetation clearance of vegetation units with local or regional significance

Unit	Conservation significance	Summarised description	Total mapped area (ha)	Total clearing (ha)	Clearing as % of total mapped area
A	✓	Tall shrubland to open heath of *Melaleuca lateritia*, *Hakea varia*, *Melaleuca viminea* and *Melaleuca incana* subsp. *incana*	539	94.6	17.6
A2	✓	Low open woodland of *Melaleuca rhaphiophylla* over *Astartea scoparia* and low herbs	3	0.5	14.4
A3	✓	Open woodland of *Eucalyptus rudis, Eucalyptus patens* (Swan River Blackbutt) and *Eucalyptus wandoo* over *Melaleuca lateritia*, *Hakea varia, Taxandria linearifolia* and *Hypocalymma angustifolium* over herbs and sedges	13	5.4	40.6
AD	✗	Low open woodland of *Eucalyptus rudis* and *Eucalyptus marginata* over *Banksia littoralis, Hakea prostrata* and *Pericalymma ellipticum* over low shrubs and herbs	9	2.3	24.5
AX	✗	Open woodland of *Eucalyptus rudis* over *Acacia saligna, Melaleuca incana* subsp. *incana* and *Hypocalymma angustifolium*	296	83.2	28.2
AY	✗	Open woodland of *Eucalyptus rudis* and *Eucalyptus wandoo* over *Acacia saligna, Hakea prostrata* and *Hypocalymma angustifolium*	661	45.9	7.0
B	✗	Open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Mesomelaena tetragona, Adenanthos obovatus* and *Babingtonia camphorosmae*	6	0.0	0.0
D	✗	Open forest of *Corymbia calophylla* and *Eucalyptus marginata* over *Hakea lissocarpha, Macrozamia riedlei, Acacia alata, Babingtonia camphorosmae, Hypocalymma angustifolium* and *Phyllanthus calycinus*	748	90.9	12.2
DG	✗	Open forest of *Corymbia calophylla* and *Eucalyptus marginata* over *Hakea lissocarpha, Macrozamia riedlei, Pericalymma ellipticum, Grevillea bipinnatifida, Allocasuarina humilis, Acacia alata, Babingtonia camphorosmae, Hypocalymma angustifolium* and *Phyllanthus calycinus*	32	0.0	0.0
E	✗	Open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Mesomelaena tetragona, Kingia australis, Leptospermum erubescens* and *Babingtonia camphorosmae*	10	0.0	0.0
G1	✓	Open heath of Proteaceae spp. and Myrtaceae spp. with emergent patches of *Eucalyptus drummondii*	107	2.6	2.5
G2	✓	Mosaic of open woodland of *Allocasuarina huegeliana,* closed heath of Proteaceae spp. and Myrtaceae spp.	179	0.0	0.0
G3	✓	Open heath of *Banksia squarrosa* subsp. *squarrosa, Hakea incrassata, Hakea undulata, Petrophile heterophylla* and *Petrophile serruriae*	73	1.7	2.3
G4	✓	Open scrub and tall shrubland of *Hakea trifurcata* and *Hakea undulata* with admixtures of mallee species including *Eucalyptus latens* and *Eucalyptus aspersa*	7	0.0	0.0
G5	✗	Low woodland of Eucalypt mallee species including *Eucalyptus aspersa, Eucalyptus latens, Eucalyptus longicornis* and *Eucalyptus drummondii* with occasional *Eucalyptus wandoo* over low shrubs of *Allocasuarina humilis, Hakea incrassata*, *Synaphea damopsis* and herbs	7	0.0	0.0
H	✗	Open forest to woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Petrophile striata, Daviesia decurrens, Daviesia longifolia* and *Daviesia rhombifolia*	4618	347.1	7.5
H2	✗	Open forest to open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Banksia dallanneyi* var. *dallanneyi. Banksia sphaerocarpa* var. *sphaerocarpa, Bossiaea ornata, Daviesia decurrens, Hakea ruscifolia* and *Gastrolobium spinosum*	134	4.9	3.7

Unit	Conservation significance	Summarised description	Total mapped area (ha)	Total clearing (ha)	Clearing as % of total mapped area
HG	✗	Open forest to woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Petrophile striata, Daviesia decurrens, Daviesia longifolia, Pericalymma ellipticum, Grevillea bipinnatifida* and *Allocasuarina humilis*	76	0.0	0.0
J	✗	Open woodland of *Eucalyptus marginata and Corymbia calophylla* over *Conospermum stoechadis, Patersonia rudis* and *Babingtonia camphorosmae*	4	0.0	0.0
L	✓	Open woodland of *Eucalyptus patens* (Swan River Blackbutt) with some *Eucalyptus wandoo* over *Xanthorrhoea preissii, Macrozamia riedlei, Trymalium ledifolium, Acacia saligna* and *Hakea prostrata*	233	20.1	8.6
LG	✗	Open woodland of *Eucalyptus patens* (Swan River Blackbutt) and *Eucalyptus wandoo* over *Hypocalymma angustifolium, Xanthorrhoea preissii, Grevillea bipinnatifida, Allocasuarina humilis* and *Babingtonia camphorosmae* over herbs and sedges	2	0.0	0.0
M	✗	Open woodland of *Eucalyptus wandoo* over *Trymalium ledifolium, Macrozamia riedlei* and *Hakea lissocarpha*	2398	85.3	3.6
M2	✓	Woodland to open woodland of *Eucalyptus accedens*, *Eucalyptus wandoo, Eucalyptus marginata* and *Corymbia calophylla* over *Hakea lissocarpha, Macrozamia riedlei, Banksia squarrosa* subsp. *squarrosa, Hypocalymma angustifolium, Babingtonia camphorosmae, Grevillea bipinnatifida* and *Allocasuarina humilis*	502	0.0	0.0
MG	✗	Open woodland of *Eucalyptus wandoo* over *Trymalium ledifolium, Macrozamia riedlei, Pericalymma ellipticum, Hypocalymma angustifolium, Grevillea bipinnatifida, Allocasuarina humilis* and *Hakea lissocarpha*	225	8.4	3.7
O	✗	Open forest to woodland *of Eucalyptus marginata* and *Corymbia calophylla over Daviesia decurrens, Daviesia preissii* and *Bossiaea ornata*	8	8	100
PS	✗	Open forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* with admixtures of *Corymbia calophylla* and *Banksia grandis* over *Lasiopetalum cardiophyllum, Lasiopetalum floribundum, Lechenaultia biloba* and *Ptilotus drummondii* var. *drummondii*	2541	95.1	3.7
PW	✗	Open forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* with admixtures of *Corymbia calophylla* and *Banksia grandis* over *Lasiopetalum cardiophyllum, Lechenaultia biloba* and *Hypocalymma angustifolium*	13	0.0	0.0
R	✗	Open woodland of *Eucalyptus marginata* and *Corymbia calophylla* over *Trymalium ledifolium, Phyllanthus calycinus* and *Hypocalymma angustifolium*	9	0.0	0.0
S	✗	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* with admixtures of *Allocasuarina fraseriana, Banksia grandis* and *Persoonia longifolia over Acacia celastrifolia, Hovea chorizemifolia, Daviesia preissii, Leucopogon capitellatus* and *Styphelia tenuiflora*	2408	164.5	6.8
SP	✗	Open forest of *Eucalyptus marginata, Corymbia calophylla* and *Allocasuarina fraseriana* with admixtures of *Banksia grandis* over *Lasiopetalum cardiophyllum, Acacia celastrifolia, Styphelia tenuiflora, Daviesia decurrens* and *Trymalium ledifolium*	1307	66.4	5.1
ST	✗	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* with admixtures of *Allocasuarina fraseriana, Persoonia longifolia* and *Banksia grandis* over *Stylidium dichotomum, Acacia urophylla, Acacia celastrifolia, Leucopogon verticillatus, Clematis pubescens* and *Leucopogon capitellatus*	334	0.0	0.0
SW	✗	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* over *Hypocalymma angustifolium, Babingtonia camphorosmae, Acacia celastrifolia, Hovea chorizemifolia, Daviesia preissii, Leucopogon capitellatus* and *Styphelia tenuiflora*	96	18.9	19.6
W	✗	Open forest of *Corymbia calophylla, Eucalyptus marginata* and *Eucalyptus patens* (Swan River Blackbutt) *over Hakea lissocarpha, Hypocalymma angustifolium, Acacia extensa* and *Synaphea petiolaris*	7	0.0	0.0

Unit	Conservation significance	Summarised description	Total mapped area (ha)	Total clearing (ha)	Clearing as % of total mapped area
Y	✘	Open woodland of *Eucalyptus wandoo* over *Gompholobium marginatum, Acacia nervosa, Babingtonia camphorosmae, Hypocalymma angustifolium, Macrozamia riedlei, Phyllanthus calycinus* and *Gastrolobium calycinum*	1554	173.4	11.2
YG	✘	Open woodland of *Eucalyptus wandoo* over *Gompholobium marginatum, Acacia nervosa, Babingtonia camphorosmae, Hypocalymma angustifolium, Macrozamia riedlei, Pericalymma ellipticum, Grevillea bipinnatifida, Allocasuarina humilis, Phyllanthus calycinus* and *Gastrolobium calycinum*	436	9.6	2.2
Z	✘	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* over *Macrozamia riedlei, Xanthorrhoea preissii, Hakea lissocarpha* and *Phyllanthus calycinus*	1042	210.9	20.2
		Total	20 674	1540	

Priority flora

Four flora species of conservation significance have been recorded within the Development Envelope, comprising one Priority 1, one Priority 2 and two Priority 4 species.

The Priority 1 species, *Gastrolobium* sp. Boddington Prostrate, was recorded at seven locations on Hotham Farm (Mattiske 2012a). They were located within a small area of remnant vegetation near the old railway corridor in the eastern end of the proposed pipeline route (Figure 30). Large populations have also been recorded in the south eastern portion of the Acquired Lands. This species will not be impacted by the Proposal (Table 30).

Table 30 Extent of clearing of priority flora species

Species	Occurrence in NBG survey areas	Occurrences to be cleared	Proportion to be cleared	Comment
Gastrolobium sp. Prostrate Boddington (M. Hislop 2130) (P1)	223	None	0%	No impact
Acacia gemina (P2)	9	None	0%	No impact
Chordifex gracilior (P3)	1	None	0%	No impact
Grevillea manglesii subsp. *dissectifolia* (P3)	27	None	0%	No impact
Hakea oldfieldii (P3)	4	None	0%	No impact
Halgania corymbosa (P3)	19	None	0%	No impact
Stylidium marradongense (P3)	undetermined	None	0%	No impact
Acacia cuneifolia (P4)	22	None	0%	No impact
Lasiopetalum cardiophyllum (P4)	348	None	0%	No impact
Senecio leucoglossus (P4)	41	None	0%	No impact
Templetonia drummondii (P4)	149	30	20%	Affected by proposed RDA

The Priority 2 species, *Acacia gemina*, is located outside of the proposed RDA footprint in the Saddleback Tree Farm area (Figure 30). This species will not be affected by the Proposal (Table 30).

The Priority 4 species, *Senecio leucoglossus*, is located east of the existing RDA, within the Development Envelope. This species will not be affected by the Proposal (Table 30).

The Priority 4 species, *Templetonia drummondii,* is located within the proposed RDA footprint and it is likely that several individuals will be affected by the Proposal (Figure 30). However, this species occurs as scattered plants throughout the eastern Jarrah forest and many individuals are located outside of the RDA footprint. The species has also been recorded within rehabilitation sites in the Boddington area and is not considered threatened by the proposed expansion because of the low numbers potentially affected, and the apparent ability to re-establish on rehabilitation. Of the total mapped population in NBG survey areas, approximately 20 % will be cleared by the Proposal (Table 30).

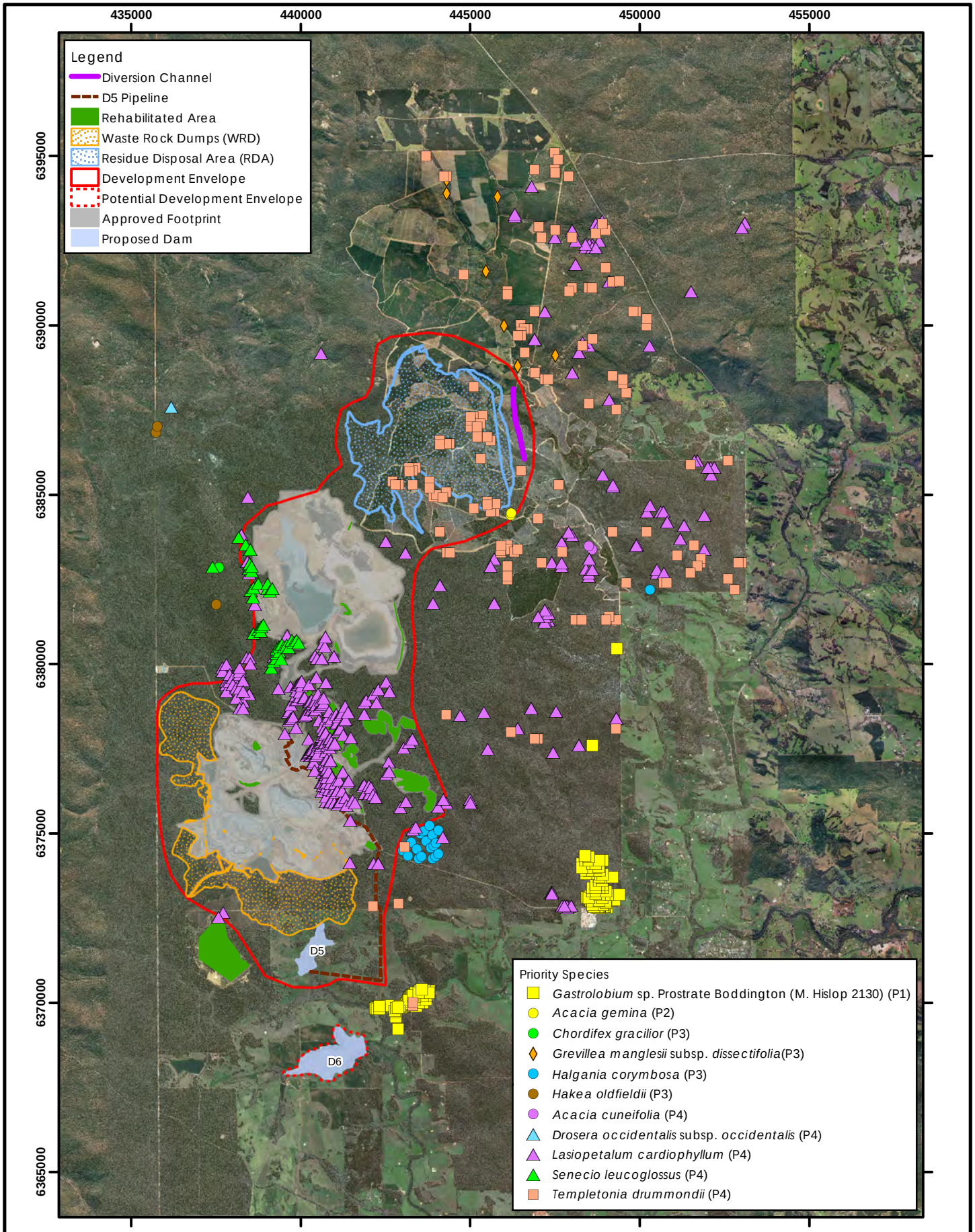

Figure 30 Priority flora recorded within Development Envelope

STRATEGEN
info@strategen.com.au
www.strategen.com.au

Scale
0 1 2 3 4
km

1:150,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F030.mxd

9.4.2 Vehicle movement and site disturbance

Vehicle movements and earthworks have the potential to increase the risk of introducing and/or spreading weed species and pathogens, including dieback.

Forest hygiene

Access tracks intersect known dieback areas at several locations within the area. The expanded waste dumps will intersect at least two areas of identified dieback. Movement of vehicles, heavy machinery, soil, and plant material during the clearing process has the potential to increase the spread of *P. cinnamomi* to uninfested areas of native vegetation. Forest hygiene management is currently undertaken according to the site Land and Biodiversity Management Plan, which is being updated to include appropriate management measures for the Proposal (i.e. survey and access protocols). Spread of dieback in the area is not expected to be significantly affected by the Proposal.

Weeds

Two Declared Plants were identified within the Development Envelope. Movement of these plants or seed is prohibited across the state and infested areas must be managed in a way that prevents movement of these species within and from the property (DAFWA 2013).

Strict weed hygiene measures will be implemented to reduce the risk of weed introduction into adjacent uncleared areas and areas that are largely weed-free. Measures will be implemented to target the control of the Declared Plant species, Cape Tulip and Cotton Bush. Weed management will be undertaken according to the site Land and Biodiversity Management Plan.

9.4.3 Dewatering

The potential impacts of groundwater drawdown on flora and vegetation is discussed in Section 7.

9.5 Management measures and performance standards

Comprehensive internal procedures regarding vegetation clearing, forest disease management, controlled burning and fauna management have been in place for many years at NBG. The potential impacts associated with the Proposal will be managed and mitigated through the implementation of the Vegetation and Flora Management Plan (Appendix 1). This plan integrates existing management measures to provide a consolidated list of management actions.

Key measures in the Vegetation and Flora Management Plan include:

- providing information to all employees and contractors (through the site induction process) on vegetation management requirements (e.g. forest disease, weed management and clearing requirements)
- using the NBG internal Environmental Disturbance Application process for all areas requiring clearing to ensure activity is in line with internal and external standards and regulations
- demarcating clearing boundaries with flagging tape to ensure minimal area is impacted and trees of significance are avoided
- conducting post-clearing inspections to determine compliance with NBG Environmental Disturbance Application and preparation for rehabilitation (if applicable)
- completing pre-clearing forest disease surveys to determine if forest disease is present and if additional management protocols are required to limit spread of disease
- where forest disease is identified in an area to be cleared, management boundaries are to be determined and control protocols communicated
- implementing control protocols such as management of drains, topsoil and gravel stockpiling and vehicle washdown

- identifying single entry and exit points should crossing of a disease infested area be unavoidable
- implementing vehicle washdown protocols at entry into forest areas at all times
- restricting access to forest areas when rainfall exceeds 5 mm in 24 hours
- inspecting all vehicles prior to entering to site for soil and vegetative material
- mapping known Declared Weeds locations
- undertake weed management such as spraying and manual removal as required
- rehabilitating areas no longer required for mining purposes.

9.6 Predicted environmental outcomes

After application of mitigation measures described above, the Proposal is expected to result in the following outcomes in relation to vegetation and flora:

1. Clearing of up to 1755 ha of native vegetation within a total footprint of up to 2895 ha. Clearing represents less than 1% of the total mapped area of all regional vegetation complexes.
2. Proposed clearing will not significantly affect the local or regional distribution of any vegetation unit of conservation significance. Clearing of conservation significant vegetation units within the DE will affect less than 20% of their extent within the Survey Area (with the exception of transitional ecotone vegetation unit A3, of which 40.6 % will be affected due to construction of the second RDA commencing in 2022).
3. There will be a loss in the local abundance of some priority flora but no change in the conservation status of these species will occur as a result of the Proposal
4. Residual impacts resulting from implementation of the Proposal will be offset in accordance with EPA and DSEWPaC requirements, within a strategy as discussed in Section 14.
5. Indirect impacts on flora and vegetation (from groundwater drawdown) as discussed in Section 7 will be managed through the AGMP (Adaptive Groundwater Management Plan, Appendix 1) and are not considered significant.

As demonstrated, the Proposal will not result in a change in the status of plants of conservation significance; will not represent a significant clearing of vegetation complexes; and, will not significantly affect the regional distribution of flora and vegetation species. Geographical distribution, productivity, and ecosystems will be maintained through management and mitigation measures. Where residual impacts are expected to occur, offset measures will be implemented as discussed in Section 14.

In considering the outcome as described, the Proposal is expected to meet the EPA objectives for flora and vegetation.

10. Terrestrial fauna

10.1 Relevant environmental objectives, policies, guidelines, standards and procedures

10.1.1 EPA objectives

The EPA applies the following objective in its assessment of proposals that may affect fauna:

> *To maintain the conservation status, diversity, and productivity of fauna and its habitat at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.*

10.1.2 EPA guidance and position statements

EPA Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection

EPA Position Statement No. 3 (EPA 2002a) discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in Western Australia. The position statement is intended to:

- promote and encourage the significance of biodiversity and the need to develop and implement best practice in terrestrial biological surveys
- define the principles the EPA will use when assessing projects that may impact on biodiversity values.

EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia 2004

EPA Guidance Statement No. 56 (EPA 2004c) provides guidance on standards and protocols for terrestrial fauna surveys, particularly those undertaken for the EIA of proposals. It identifies minimum requirements for terrestrial fauna surveys including:

- approaches, resources and standards required
- stage when surveys should be conducted
- who should lead and undertake fauna surveys
- timing of surveys
- type and extent of survey
- survey sampling design and intensity.

EPA Guidance Statement No. 12 Consideration of Subterranean Fauna in Environmental Impact Assessment in Western Australia

EPA Guidance Statement No. 12 (EPA 2013) provides guidance on how subterranean fauna are considered during the EIA process and the level of survey and information required. The guidance also sets out how results should be interpreted. The guidance does not provide prescriptive advice on sampling and analysis techniques (EPA 2013). This guidance replaced Guidance Statement 54 (EPA 2003) in June 2012.

EPA Guidance Statement No. 20 Sampling of Short-Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia

EPA Guidance Statement No. 20 (EPA 2009) provides guidance on standards and protocols for surveys of short-range endemic (SRE) fauna, particularly those undertaken for the EIA of proposals. Assessment of SREs is required if a proposal could potentially have a significant impact on SRE taxa by:

- clearing of vegetation or habitats with known or potential to support SRE
- altering hydrology or fire regimes, introducing weeds or soil pathogens or indirectly affecting such habitats
- directly affecting known populations of SRE fauna.

10.1.3 Legislation

State Government

In a legislative context, the preservation and conservation of fauna is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950* (WC Act)
- *Conservation and Land Management Act 1984* (CALM Act).

In Western Australia, rare or endangered species are protected by the Wildlife Conservation (Specially Protected Fauna) Notice 2012, under the WC Act. Schedules 1 and 4 in this notice are relevant to this assessment, providing a listing of those species protected by this notice.

The DPaW (Nature Conservation Division) Priority Fauna List also nominates conservation species from Priority 1 to 5. It is expected that the potential impacts of a proposal to these Priority listed species should be managed such that the species do not meet the IUCN criteria for threatened species, as a result of this proposal.

Australian Government

The EPBC Act provides for the protection of MNES including listed threatened and migratory fauna species and requires assessment of proposed actions likely to have a significant impact on MNES. An assessment of the potential impacts of the proposal on MNES is addressed in Section 11.

10.1.4 International agreements

Australia is a signatory to the Japan–Australia (JAMBA), Republic of Korea–Australia (ROKAMBA) China–Australia (CAMBA) Migratory Bird Agreements and the Convention on the Conservation of Migratory Species of Wild Animals. JAMBA and CAMBA require the parties to protect migratory birds by:

- limiting circumstances under which migratory birds are taken or traded
- protecting and conserving important habitats
- exchanging information
- building cooperative relationships.

The ROKAMBA agreement provides a basis for collaboration on the protection of migratory shorebirds and their habitat.

10.2 Findings of surveys and investigations

10.2.1 Terrestrial vertebrate fauna

Studies undertaken

The following vertebrate fauna studies have been undertaken and used to inform this impact assessment:

1. Ninox Wildlife Consulting (Ninox 2003) conducted baseline surveys in autumn, winter and spring of 1984 which defined bird, mammal, amphibian and reptile communities in relation to vegetation and soil types for the NBG. Further detailed surveys were undertaken in 2001 and 2002 to provide additional baseline data for the NBG area and to compare species numbers with those recorded in the original 1984 survey. The report includes a summary of data from the original baseline study, a comparison with the new results and a review of conservation significant fauna.
2. Environmental Management and Research Consultants (1998) conducted a fauna survey on Hotham Farm land and areas adjacent to Hedges Gold Mine. The aim of the survey was to identify areas of important fauna habitat and identify if any rare or uncommon species were present in the area.
3. Biota Environmental Sciences (Biota 2003) conducted a Level 1 desktop fauna assessment in the plantation area which has been identified as the preferred location for the second RDA.
4. Ninox Wildlife Consulting conducted a Level 2 vertebrate fauna survey of the proposed WRD expansion (Ninox 2012a). The survey consisted of ten sampling sites that were sampled over two seasons (autumn and summer[5]) during 2011/2012 (Ninox 2012a) (Figure 31). Sampling sites comprised three previously sampled locations and seven new sites. Site selection ensured that all major fauna habitats were represented by the sampling sites and some of the 2001–2002 sites that had been affected by a wildfire were also replicated.
5. A Level 2 survey was also conducted for the new RDA location in the Saddleback Tree Farm area to the northeast of the current operation (Ninox 2012b). The RDA survey consisted of seven sites sampled over two seasons (summer and autumn) during 2012 (Figure 31). While much of the survey area consisted of pine and eucalyptus plantations, there were areas of native vegetation, mainly Wandoo woodland and an area of low-lying valley/creekline community. The sampling sites were established throughout areas of native vegetation to accurately represent the range of fauna habitats in the area. The survey program targeted the area around the existing site and ensured that the survey included all habitat types that may be affected by the Proposal. The Ninox Statement of Study Limitations identifies that the survey intensity was adequate to define major fauna habitats and the potential for these habitats to support faunal assemblages. The survey was considered to be adequate to satisfy the requirements of a Level 2 Comprehensive Survey and to assess the potential for fauna of conservation significance to be present.
6. Finn (2011) undertook a black cockatoo habitat assessment in the area to the east of the NBG mine-site (eastern acquired lands). The area was assessed for its value as feeding and breeding habitat for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris),* Baudin's Black-Cockatoo (*Calyptorhynchus baudinii*) and Forest Red-tailed Black-Cockatoo *(Calyptorhynchus banksii naso*).
7. An ecological baseline study of black cockatoos in the NBG mining tenements and adjacent areas was undertaken by Lee et al. (2012a). The study consisted of a general distribution survey and behavioural observations to determine:
    - group sizes including seasonal changes
    - habitat type and use
    - food plants used
    - occupancy patterns including seasonal and inter-annual changes.

[5] A field survey was planned for early December 2011; however, an extraordinary storm event closed tracks due to forest disease control measures delaying the commencement of the field work until January 2012

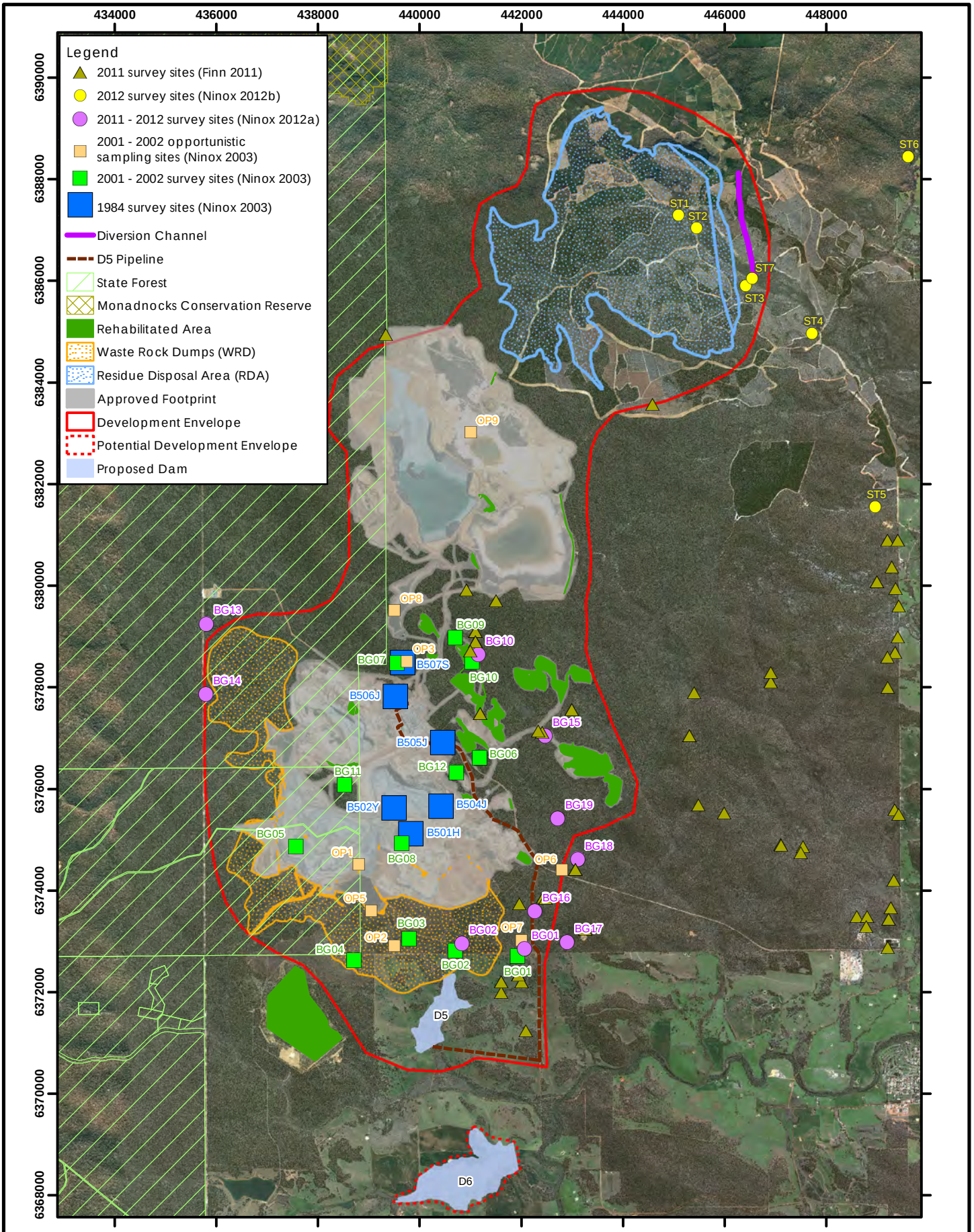

Figure 31 Location of fauna sampling sites

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F031.mxd

Sampling methodology for both Level 2 surveys (Ninox 2012a, 2012b) consisted of the following at each sampling site:

- trap lines including 32 pitfall traps, 12 Elliott traps and four cage traps in each location (eight sets of funnel traps were also incorporated with the trap lines)
- two Anabat bat echolocation devices
- bird observations (sightings and bird calls) between dawn and 11 am, with 45 minutes being spent within each site over a five day period
- opportunistic avifauna sampling in alternate locations within the study area assessing the presence and activity of three species of black cockatoo.

The WRD survey comprised 8960 trap nights over ten survey sites and the survey in the RDA comprised 5642 trap nights over seven survey sites. As discussed in Ninox (2012a), these surveys consisted of a greater intensity of sampling and included the addition of funnel traps.

Habitat types

Eleven dominant fauna habitat types have been identified, based on vegetation and flora surveys conducted to date (Henry J [Ninox Wildlife Consulting] 2012, pers. comm. 13 December). The vegetation units were broken into habitat types with consideration of their key habitat values for fauna which relate to vegetation structure, dominant species, soil type and position in the landscape. These are:

1. Eucalypt/paperbark on seasonally wet valley floors (comprising A, A2 and A3 vegetation units).
2. Yarri-Wandoo on wetter lower slopes (comprising L and LG vegetation units).
3. Eucalypt woodlands on wetter lower slopes (comprising W, AD, AX and AY vegetation units).
4. Jarrah–Marri woodland forest over heath understorey (comprising DG, HG, H, H2 and SW vegetation units).
5. Mixed Wandoo/Jarrah/Marri over heath understorey (comprising M2 and MG vegetation units).
6. Mallee heath (comprising G1, G3 and G4 vegetation units).
7. Heath and rock Sheoak on granite outcrops (comprising G2 vegetation unit).
8. Wandoo woodland (comprising M, Y and YG vegetation units).
9. Jarrah/Marri forest over Sheoak/Banksia (comprising P, PS, PW, S, SP and ST, vegetation units).
10. Jarrah/Marri woodland/forest (comprising B, D, E, Z, J, O and R vegetation units).
11. Timber plantations.

The distribution of the eleven habitat types is illustrated in Figure 32.

Occurrence of vertebrate fauna

The 2011/2012 surveys (Ninox 2012a, 2012b) recorded 16 and 15 species of native mammals in the WRD and RDA areas respectively (including six species of bat). Eight of the non-volant species were common to both the RDA and WRD areas in the 2011/2012 surveys. Locations of where conservation significant species were found are detailed in Figure 33. The Brushtail Possum (*Trichosurus v. vulpecular)* was the most abundant species recorded with Mardos (*Antechinus flavipes leucogaster*) also relatively common. Of the six bat species, five were identified with a high degree of confidence; however, one species (*Nyctophilus* sp.) could not be determined to species level.

Eleven (11) frog species were recorded, with five species being common to both the WRD and RDA survey locations. Frogs were most abundant in site ST5 from the RDA survey, which was located in proximity to a small watercourse, with large numbers of the small Gunther's Toadlet (*Pseudophryne guentheri*) and Bleating Froglet recorded (*Crinia pseudinsignifera*). Frogs were generally recorded in habitat types low in the landscape, which retained water after rainfall longer than other sites.

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435000 440000 445000 450000 455000

6395000 6390000 6385000 6380000 6375000 6370000 6365000

Legend

Diversion Channel
D5 Pipeline
State Forest
Monadnocks Conservation Reserve
Development Envelope
Potential Development Envelope
RehabAreas_20130522
Waste Rock Dumps (WRD)
Residue Disposal Area (RDA)
Approved Footprint
Proposed Dam

Habitat

Eucalypt woodlands on wetter lower slopes
Eucalypt/paperbark on seasonally wet valley floors
Heath and rock Sheoak on granite outcrops
Jarrah-Marri forest over Sheoak-Banksia
Jarrah-Marri woodland-forest
Jarrah-Marri woodland-forest over heath understorey
Mallee heath
Mixed Wandoo/Jarrah/Marri over heath understorey
Wandoo woodlands
Yarri-Wandoo on wetter lower slopes
Timber Plantations

Figure 32 Distribution of fauna habitat

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Scale

0 1 2 3 4 5
Kilometers

1:100,000
at A3

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F032_A3.mxd

435000 440000 445000 450000

6390000 6385000 6380000 6375000 6370000

Legend

- Woylie
- Forest Red-tailed Black-cockatoo
- Carnaby's Black-cockatoo
- Baudins Black-cockatoo
- Chuditch
- Rainbow Bee-eater
- Dell's Skink
- Western Brush Wallaby
- Brush-tailed Phascogale
- Southern Brown Bandicoot
- Diversion Channel
- D5 Pipeline
- State Forest
- Monadnocks Conservation Reserve
- Development Envelope
- Potential Development Envelope
- Rehabilitated Areas
- Waste Rock Dumps (WRD)
- Residue Disposal Area (RDA)
- Approved Footprint
- Proposed Dam

0 50100 200 300 400 500 m

Figure 33 Records of fauna of conservation significance

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Scale

0 1 2 3 4 5
Kilometers

1:70,000
at A3

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Fauna: Ninox 2003, 2012a, 2012b, Finn 2011. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F033_A3.mxd

Twenty nine (29) species of reptile were recorded during the surveys, with 22 species common to both surveys. Two skinks; *Cryptoblepharus buchananii* and *Lerista distinguenda* were the most abundant. Six reptile species were added to the area inventory as a result of these surveys. This increased success was attributed to the increased trap intensity and funnel traps that were utilised in the 2011/12 surveys (Ninox 2012a, 2012b).

A total of 59 species of native birds were registered with 39 recorded in both the RDA and WRD surveys.

Three introduced species were recorded in the 2011/2012 survey including the Laughing Kookaburra (*Dacelo noveaguineae*), House Mouse (*Mus musculus*) and Pig (*Sus scrofa*).

Vertebrate species of conservation significance

In total, 23 conservation significant terrestrial vertebrate fauna species are currently listed as potentially occurring in the area (based on DPaW records and the DSEWPaC Species Profile and Threats (SPRAT) database). These species comprise ten mammals, 11 birds (including seven migratory species) and two reptiles. Table 31 identifies habitat requirements and likelihood of occurrence of these species. Of the 21 species, only 12 have been recorded during fauna surveys (Figure 33) and a further two may potentially occur at NBG.

The habitat types utilised by each of the fourteen conservation significant species considered likely to occur are outlined in Table 32. This is based on actual recordings between 1984 and 2012 and on the known habitat preferences of each species.

Table 31 Conservation significant species potentially occurring or confirmed near or on NBG mine site

Species	Conservation significance			Habitat preference*	Likelihood of occurrence
	WC Act	EPBC Act	DPaW		
Mammals					
Woylie/Brush-tailed Bettong *Bettongia penicillata ogilbyi*	Schedule 1	Endangered	-	Occurs in a variety of habitats including dense undergrowth, logs and rock cavities and seeks refuge in *Gastrolobium* thickets. Occurs in Jarrah forest and isolated populations occur in National Parks. Home range is generally small and dispersal distance short (Pacioni et al. 2010). Recorded ranges vary from 7.5 ha to 35 ha.	Recorded within Development Envelope to the east of WRD and approved footprint (Ninox 2012a).
Chuditch *Dasyurus geoffroii*	Schedule 1	Vulnerable	-	Prefers hollow logs or earth burrows in eucalypt forest, dry woodland and mallee shrublands. Does not undertake seasonal movements; however, occupies large home ranges and will travel long distances (DEC 2012b). Trapping success generally low due to sparse distribution.	Recorded within RDA and northeast and northwest of WRD (Ninox 2012a; 2012b).
Quenda *Isoodon obesulus fusciventer*	-	-	P5	Prefers heathland, shrubland, sedgeland, heath open forest and woodland. They are usually associated with infertile, sandy and well drained soils, but can be found in a range of soil types.	Recorded within RDA and to the east of the WRD (Ninox 2012a; 2012b).

Species	Conservation significance			Habitat preference*	Likelihood of occurrence
	WC Act	EPBC Act	DPaW		
Western Brush Wallaby *Macropus irma*	-	-	P4	Occurs in open forest or woodland, favouring seasonally wet flats with low grasses and scrubby thickets. Its distribution is restricted to the southwest of Western Australia from north of Kalbarri to Cape Arid.	Recorded to the north of the WRD and in the RDA (Ninox 2012a; 2012b).
Brush-tailed Phascogale *Phascogale tapoatafa* subsp. ssp. (WAM M434)	Schedule 1	-	-	Inhabits dry sclerophyll forests and open woodlands containing hollow bearing trees and sparse ground cover in the southwest of Western Australia. Females occupy large home ranges, varying from 20 — 70 ha.	Recorded to the east of the WRD (Ninox 2012a).
Water-rat *Hydromys chrysogaster*	-	-	P4	Occurs in close proximity to permanent water, including fresh, brackish or marine waters. It builds nests in logs or tunnels dug into banks.	Not recorded but may potentially occur in watercourses in the vicinity.
Numbat *Myrmecobius fasciatus*	Schedule 1	Vulnerable	-	Occurs in eucalypt forests and woodlands dominated by Jarrah, Marri and Wandoo. Two remnant native populations occur at Dryandra and Perup and reintroduced populations occur at Boyagin Nature Reserve, Tutanning Nature Reserve, Batalling block and Karroun Hill Nature Reserve.	Unlikely to occur. The site is outside the known distribution of this species.
Red-tailed phascogale *Phascogale calura*	Schedule 1	Endangered	-	Occurs in *Allocasuarina* woodlands with hollow containing eucalypts and *Gastrolobium* spp. Populations are now restricted to remnants of vegetation in the Wheatbelt of Western Australia.	Unlikely to occur. The site is outside of the known distribution of this species.
Western ringtail possum *Pseudocheirus occidentalis*	Schedule 1	Vulnerable	-	Occurs in and near coastal Peppermint tree forest and Tuart forest dominated by Peppermint tree understorey. It also occurs in Jarrah and Jarrah–Marri forest associated with Peppermint tree near Collie and near the Harvey River, east of Harvey.	Unlikely to occur. The site is outside of the known distribution of this species.
Quokka *Setonix brachyurus*	-	Vulnerable	-	Occurs on two offshore islands, Rottnest Island and Bald Island and in a number of sites in the southwest of Western Australia. On the mainland it occurs in dense streamside vegetation and also heaths and shrublands on the coast.	Unlikely to occur. The site is outside of the known distribution of this species.

Species	Conservation significance			Habitat preference*	Likelihood of occurrence
	WC Act	EPBC Act	DPaW		
Birds					
Forest Red-tailed Black-Cockatoo *Calyptorhynch-us banksii naso*	Schedule 1	Vulnerable	-	Inhabits dense Jarrah, Karri and Marri forests receiving more than 600 mm rainfall annually. It occurs in the southwest, Swan south coast, Avon and northern agricultural natural resource management regions in Western Australia.	Recorded (Ninox 2012a, 2012b). Resident year-round but distribution shifts periodically, most likely in response to the availability of food sources and, in summer, to the presence of reliable water sources.
Baudin's Black-Cockatoo *Calyptorhynch-us baudinii*	Schedule 1	Vulnerable	-	Known to forage and roost in the central and northern Jarrah–Marri forest and adjacent areas of the Swan Coastal Plain before migrating southwards to the southern Jarrah–Marri forest and Karri forests to breed in spring.	Recorded (Ninox 2012a, 2012b).
Carnaby's Black-Cockatoo *Calyptorhynch-us latirostris*	Schedule 1	Endangered	-	Breeds in Jarrah–Marri, Salmon Gum and Wandoo woodland and forages in kwongan heathland dominated by Hakea, Banksia and Grevillea. It also feeds in exotic pines and Jarrah, Marri and Karri forests.	Recorded (Ninox 2012a, Lee et al. 2012a).
Peregrine Falcon *Falco peregrinus*	Schedule 4	-	-	Prefers coastal and inland cliffs and open woodlands near water.	Recorded (Ninox 2003).
Rainbow Bee-eater *Merops ornatus*	-	Migratory	-	Occurs in open forests and woodlands, shrublands and cleared or semi-cleared habitats. It also occurs in inland and coastal dune systems.	Recorded in one location to the east of the WRD (Ninox 2012a).
Fork-tailed Swift *Apus pacificus*	-	Migratory	-	Occurs over inland plains, foothills and coastal areas, and including over dry or open habitats, riparian woodland, swamps, scrub, heathland, saltmarsh and urban areas.	May potentially occur but not recorded.
Malleefowl *Leipoa ocellata*	Schedule 1	Vulnerable Migratory	-	Occurs in semi-arid and arid zones of temperate Australia in shrublands and low woodlands that are dominated by mallee vegetation.	Unlikely to occur.
Australian Painted Snipe *Rostratula australis*	Schedule 1	Vulnerable Migratory	-	Occurs in shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans.	Unlikely to occur.
Great Egret *Ardea alba*	-	Migratory	-	Occurs in a range of wetland habitats including swamps, marshes, margins of rivers and lakes, damp grassland and agricultural lands.	Unlikely to occur.

Species	Conservation significance			Habitat preference*	Likelihood of occurrence
	WC Act	EPBC Act	DPaW		
Cattle Egret *Ardea ibis*	-	Migratory	-	Occurs in tropic and temperate grasslands, wooded lands and terrestrial wetlands.	Unlikely to occur.
White-bellied Sea Eagle *Haliaeetus leucogaster*	-	Migratory	-	Occurs in coastal habitats and around terrestrial wetlands in temperate and tropical regions.	Unlikely to occur.
Reptiles					
Dell's Skink *Ctenotus delli*		-	P4	Occurs in the vicinity of dead grass trees (*Xanthorrhoea* spp.) and granite boulders. It occurs in the Darling Range from Darlington and Mundaring south to Collie. It is patchily distributed within its range.	Recorded in one location to the east of the WRD (Ninox 2012a).
Carpet Python *Morelia spilota imbricata*	Schedule 4	-		Occurs in rock piles and hollow branches and logs, and is broadly distributed across much of the southwest.	Recorded in 1984 survey (Ninox 2003).

*Source: DSEWPaC 2013

Woylie habitat assessment

This species was once widespread across mainland Australia but is now restricted largely to southwest Western Australia, with some translocated populations in South Australia and New South Wales (DEC 2012). Past threats for this species have included predation by feral animals (foxes and cats), altered fire regimes and habitat destruction (SPRAT 2012). Translocated populations have had mixed success but the species appears to respond quickly to changes in their environment, such as removal of predators (e.g. wide scale fox baiting under Western Shield led to an increase in distribution and abundance of the Woylie).

Woylies are known to occur in seven nature reserves, 14 national parks, eight state forest areas, one timber reserve and two conservation parks (SPRAT 2012). Woylie populations have also been established within fenced wildlife sanctuaries.

Under the Woylie Recovery Plan (DEC 2012) habitat considered critical to the survival of the Woylie includes:

- Tall eucalypt forest and woodland
- Dense myrtaceous shrubland
- Proteaceous or mallee heath.

A common characteristic in habitats where Woylie are found in Western Australia is the presence of *Gastrolobium* thickets. This vegetation could act as a refuge from introduced predators by providing a physical hiding place for Woylie but also through poisoning. *Gastrolobium* is known to contain monofluoroacetic acid, which is present as sodium monofluoroacetate in toxic 1080 bait (commonly used for fox baiting) (SPRAT 2012). *Gastrolobium* is present around NBG with dense patches occurring in remnant vegetation located on Hotham Farm and in the native vegetation to the east of the operation. However, Gastrolobium was not present at the locations where Woylie were recorded in the 2011/12 survey.

Based on this information, there is extensive suitable Woylie habitat surrounding NBG in both private and State Forest.

Translocations of Woylies were conducted by the DEC in the mid 1990s as part of Operation Foxglove. The vegetation to the east of NBG was used as a release point for Woylie during this time. There has been no monitoring of this translocation area but the species would appear to be persisting. Woylies were not recorded at NBG in past surveys (1984 and 2001/02) but were recorded in the latest 2011/12 survey close to the mining operations due to the translocation of the species and short dispersal distances commonly observed for this species (Pacioni et a. 2010).

All three Woylies were trapped in cage traps with one female with a pouch joey trapped in autumn and two adults (sex was not determined) in summer. All three were found to the east of mining operation, one towards the south and the other two in the vegetation between the mine operation and the F1/F3 RDA. The native vegetation (State and private forest) surrounding NBG has undergone regular fox baiting by the DEC as part of the Western Shield program since the mid 1990s and this has most likely contributed greatly to the persistence of the species in this area.

Woylies feed on hypogenous fruiting bodies of ectomycorrhizal fungi (SPRAT 2012) and therefore threats that may impact on fungal communities could include the root pathogen *Phytophthora cinnamomi* (DEC 2012) and feral pigs (which disturb extensive areas of ground and potentially spread *P. cinnamomi*). To date, one infestation of *P. cinnamomi* has been detected to the east of NBG as well as three small patches of *Armillaria luteobubalina* infestation to the east of NBG. However, this area has been largely classified as uninfested or uninterpretable (areas where too few indicator plants are present to determine the presence or absence of forest disease).

Chuditch habitat assessment

Chuditch are quite generalist in their habitat use, ranging from forest to woodland and desert. They are generally found in low densities, capable of travelling long distances and have relatively large home ranges (DEC 2012). The nomadic and solitary lifestyle makes the population difficult to estimate, however, it appears the species is now restricted to Western Australia with around 75% of the remaining population occurring in eucalypt forests and woodlands and mallee health and shrublands of southwest WA (DEC 2012).

The main threats attributed to the decline of this species include land clearing, predation by introduced species, accidental and deliberate poisoning or hunting (as they may interact with farmers) and roadkill (SPRAT 2012). Areas where fox control is implemented seem to have higher densities of Chuditch (SPRAT 2012).

Important factors for Chuditch habitat appear to be the presence of suitable dens resources (such as hollow logs, burrows or rock crevices), adequate prey and large enough areas for large home ranges (DEC 2012).

Chuditch have been recorded in all surveys completed at NBG, however, trapped numbers have varied considerably during this time with two recorded in 1984, 47 in 2001/02 and a total of 19 in the most recent 2011/12 survey (eight in the WRD area and 11 in the RDA area). Similar results have been seen at the Boddington Bauxite Mine south of NBG (Ninox 2012a). Fox baiting as part of Western Shield has most likely contributed greatly to the success of the local population since its implementation in the mid-1990s. Due to their Chuditch have the potential to inhabit all of the habitat types within the native vegetation surrounding NBG.

Due to the need for large areas of habitat, this species is most likely restricted in fragmented habitats.

Brush-tailed Phascogale habitat assessment

Inhabits dry sclerophyll forests and open woodlands containing hollow bearing trees and sparse ground cover in the southwest of Western Australia. Females occupy large home ranges, varying from 20 — 70 ha.

Recorded to the east of the WRD (Ninox 2012a) although based on possible habitat types (listed in Table 32), potential habitat for the species is widespread in the area.

Table 32 Usage of habitat types for species of conservation significance potentially occurring in the Development Envelope

Habitat types	Eucalypt/ Paperbark on seasonally wet valley floors	Yarri-Wandoo on wetter lower slopes	Eucalypt woodlands on wetter lower slopes	Jarrah-Marri woodland-forest over heath understorey	Mixed Wandoo/Jarrah/ Marri woodland over heath understorey	Mallee Heath	Heath & rock Sheoak on granite outcrops	Wandoo woodland	Jarrah-Marri forest over Sheoak-Banksia	Jarrah-Marri woodland-forest
Vegetation units within habitat type	A, A2, A3	L, LG	W, AD, AX, AY	DG, HG, H, H2, SW	M2, MG	G1, G3, G4	G2	M, Y, YG	P, PS, PW, S, SP, ST	B, D, E, Z, J, O, R
Chuditch *Dasyurus geoffroii*	S	P	S	S	P	S	P	S	S	S
Brush-tailed Phascogale *Phascogale tapoatafa*		P	S	S	P		P	S	S	
Southern Brown Bandicoot/Quenda *Isoodon obesulus fusciventer*	S	S	S			S		S	S	S
Woylie/Brush-tailed Bettong *Bettongia penicillata ogilbyi*						S		S	S	
Western Brush-wallaby *Macropus irma*		S	S	S	P	S		S	S	S
Water-rat *Hydromys chrysogaster*	P									
Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*	S	S	S	S	P	S		S	S	S
Baudin's Black-Cockatoo *Calyptorhynchus baudinii*		P	P	S	P			S	S	P
Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*	S	S	P	S	P	P	P	S	S	S
Peregrine Falcon *Falco peregrinus*	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only
Rainbow Bee-eater *Merops ornatus*	S	P	S	S	P	S	P	S	S	P
Fork-tailed Swift *Apus pacificus*	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only	P Aerial only
Dell's Skink *Ctenotus delli*		P	P	P	P	S		S	S	
Carpet Python *Morelia spilota imbricata*	P	P	P	P	P	P	P	P	P	P

(S = Suitable; P = Potential)

Black cockatoo habitat

Three species of black cockatoo occur in southwestern Australia (Baudin's Black-Cockatoo, Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoo). All three species have been recorded foraging within the Development Envelope and Carnaby's Black-Cockatoos and Forest Red-tailed Black-Cockatoos are known to breed within the area (Lee et al. 2012a). Seasonal surveys at NBG for black cockatoos between 2007 and 2010 found that black cockatoos generally consisted of small groups of birds, with low numbers of Baudin's Black-Cockatoos recorded and higher numbers of Carnaby's and Forest Red-tailed Black-Cockatoos being recorded (Lee et al. 2012a). Each species showing different seasonal population patterns with Forest Red-tailed Black-Cockatoos recorded in similar numbers year round whilst Carnaby's populations peaked in spring and summer but were present year round and as expected, Baudin's were less common in the summer breeding season (Lee et al. 2012a).

Table 33 provides a summary of occupancy, foraging and breeding utilisation of the area by black cockatoos.

Table 33 Summary of habitat utilisation by three species of black cockatoo

Species	Occupancy	Foraging utilisation	Breeding utilisation
Baudin's Black-Cockatoo	Utilises native forest and rehabilitation areas, during non-breeding season from March/April to September/October. Few very large flocks of Baudin's Black-Cockatoos were observed, with group size ranging from two to 107, with a mean of 14.5 +/- 3.5 and 78.1% of groups consisting of less than 20 individuals (Lee et al. 2012a).	Forages predominantly on Marri but is likely to also utilise other species present at NBG	No breeding within the Development Envelope
Carnaby's Black-Cockatoo	Occupies native forest and woodland year-round with higher numbers in spring and summer indicating migrating or transient flocks and some year-round residents. Few very large flocks of Carnaby's Cockatoos were observed, with group size ranging from one to 90, with a mean of 10.1 +/- 1.3 and 85.3% of groups consisting of less than 20 individuals (Lee et al. 2012a). Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) suggest that eastern acquired lands could contain between 20–50 breeding pairs, with the number breeding varying from year to year (Finn 2011).	Forages on Jarrah, Marri, timber plantation and proteaceous shrubs	Breeds in both Jarrah–Marri and Wandoo woodland
Forest Red-tailed Black-Cockatoo	Occupies native forest and woodland year-round. Few very large flocks of Forest Red-tailed Black-Cockatoos were observed, with group size ranging from one to 45, with a mean of 7.4 +/- 0.6 and 92.1% of groups consisting of less than 20 individuals (Lee et al. 2012a). The total local Forest Red-tailed Black-Cockatoo population associated with the eastern acquired lands and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011).	Forages on Jarrah and Marri	Breeds in both Jarrah-Marri and Wandoo woodland

The ecological baseline study of black cockatoos within NBG mining tenements and adjacent areas (Lee et al. 2012a) determined the following:

The native vegetation within the Development Envelope is utilised as foraging habitat for all three species of black cockatoos. Studies of black cockatoo foraging habits in the area found that feeding activity was generally greater in anthropogenic habitats (pine plantations and mine site rehabilitation sites) than in native forest (Lee et al. 2012b). Carnaby's Black-Cockatoos and Baudin's Black-Cockatoos have been observed feeding in mine site rehabilitation areas (Lee et al. 2012b). Although Forest Red-tailed Black-Cockatoos were not observed feeding in rehabilitation areas, feeding residues from this species were present in rehabilitation areas at NBG indicating that some feeding activity occurs (Lee et al. 2012b).

Systematic sampling of vegetation within the southern half of the Development Envelope and an area immediately to the east of the Development Envelope (referred to as the eastern acquired lands) identified 55 potential hollow-bearing trees within 21 plots (425 plots in native vegetation were surveyed in total) (Finn 2011) as shown in Figure 34. Of the potential hollow- bearing trees identified, 29 were outside the Development Envelope, 23 were inside the Development Envelope but unlikely to be affected and three were likely to be affected by the Proposal.

Post-felling inspections of trees identified with potential nesting hollows (determined from ground-based surveys) found that only 31.5% of potential hollows in Jarrah were actually large enough for nesting. However, these proportions were higher for Marri (55.6%) and Wandoo (66.7%) (Finn 2011). Application of these proportions gives potential black cockatoo nest hollow distribution estimates of 38 per km^2 for Jarrah, 27 per km^2 for Marri and 18 per km^2 for Wandoo (Finn 2011). Similar distributions of potential nest hollows would be expected within the remnant vegetation within the Development Envelope. These estimates are conservative, and Finn (2011) states that these densities should be viewed with care as other factors for suitable nesting should be considered, such as (a) black cockatoos appear to rarely nest within Jarrah in the Jarrah-Marri forest, and (b) nest-site suitability is almost certainly linked to food availability and the presence of permanent water sources. Therefore, it is most likely that nesting activity is restricted to Marri and Wandoo hollows located near to sumps, swamps and farm dams.

The ecological baseline study of black cockatoos within NBG mining tenements and adjacent areas (Lee et al. 2012a) determined the following:

Baudin's Black-Cockatoos were mainly recorded in native forest areas but were also observed utilising mine site rehabilitation habitats for roosting and foraging. Baudin's Black-Cockatoos utilise the NBG site during the non-breeding season from April to September and were found to predominantly feed on marri at NBG (Lee et al. 2012a), including marri in rehabilitated areas at NBG within eight years of establishment (Finn 2011). Few very large flocks of Baudin's Black-Cockatoos were observed, with group size ranging from two to 107, with a mean of 14.5 +/- 3.5 (78.1% of groups consisted of less than 20 birds) (Lee et al. 2012a). NBG is more than 50 km from the 'predicted breeding location' as defined by DSEWPaC (2013).

Although the NBG site lies to the north of this species' known breeding range, (which includes the southern Jarrah–Marri forest and Karri forests [Lee et al. 2012; DEC 2007]), the presence of small numbers of birds during the summer period (breeding season) could indicate that the area is being used by non-breeding juveniles or adults or potentially breeding pairs. This indicates that the breeding area may be shifting (Finn 2011; Lee et al. 2012a).

Carnaby's Black-Cockatoos were recorded utilising a variety of habitats (including native vegetation, mine site rehabilitation and pine plantation) and feeding on a broad range of plants, including Pine, Jarrah, Marri and proteaceous species. While observations indicate that Jarrah is an important food source, no vegetation type accounted for more than 20% of feeding observations for this species. Finn (2011) noted that there appeared to be evidence of intensive feeding residues on proteaceous shrubs in the vegetation to the east of the mine, particularly towards the eastern border and southeastern corner. This was the most abundant black cockatoo species recorded in a survey immediately to the east of the survey area and was the second-most common species at NBG (after Forest Red-tailed Black-Cockatoos). Finn (2011) noted that this species appears to utilise the NBG area in several ways, including short term feeding habitat for transiting flocks, longer term feeding habitat and as breeding habitat.

Carnaby's Black-Cockatoos were recorded at NBG year-round and breeding pairs were observed but numbers peaked in spring and summer (Lee et al. 2012a). Few very large flocks of Carnaby's Cockatoos were observed, with group size ranging from one to 90, with a mean of 10.1 +/- 1.3 (85.3% of groups consisted of less than 20 individuals) (Lee et al. 2012a). These observations indicate that Carnaby's Black-Cockatoos breed in the area in low numbers and higher numbers utilise the area predominantly for foraging.

Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) suggest that eastern acquired lands could contain between 20–50 breeding pairs, with the number breeding varying from year to year (Finn 2011).

Forest Red-tailed Black-Cockatoos were primarily recorded utilising native forest and woodland areas, with paddocks also providing habitat for feeding (in isolated remnant trees) and drinking. This species was not recorded in mine site rehabilitation areas; however, feeding residues of this species have been identified in rehabilitation areas, indicating that some feeding activity occurs (Lee et al. 2012b). The availability of water in anthropogenic sources may be particularly important for this species as it has the highest basal metabolic rate and evaporative water loss of the black cockatoo species occurring in southwestern Australia.

The Forest Red-tailed Black-Cockatoo feeds mostly on Marri and Jarrah, but may feed on other plants such as Sheoak and Yarri if Marri and Jarrah are limited. This species occurs year round at NBG and was not observed to undertake seasonal changes in occupancy (i.e. group sizes were consistent across seasons), suggesting a resident population. Few very large flocks of Forest Red-tailed Black-Cockatoos were observed, with group size ranging from one to 45, with a mean of 7.4 +/- 0.6 (92.1% of groups consisted of less than 20 birds) (Lee et al. 2012a). This species appears reliant on the general NBG area for year-round food availability as they are present over the course of the entire year and compared to the other species that utilise the area, their ecology comprises relatively small, defined home ranges (Finn 2011).

The total local Forest Red-tailed Black-Cockatoo population associated with the eastern acquired lands and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011).

10.2.2 Introduced species

Three introduced species were recorded in the 2011/2012 survey including the Laughing Kookaburra (*Dacelo noveaguineae*), House Mouse (*Mus musculus*) and Pig (*Sus scrofa*) (Ninox 2012a). Although not recorded in the most recent survey, exotic predators such as foxes (*Vulpes vulpes*) and cats (*Felis catus*) have been recorded in the past in the NBG mine area, as have rabbits (*Oryctolagus cuniculus*).

Foxes and cats present a threat to wildlife including conservation significant mammal species. Control of these animals through baiting programs has been an ongoing management priority regionally through the State Government Western Shield program. Feral pigs are also a significant conservation threat and predation, habitat degradation, competition and disease transmission by feral pigs was listed as a key threatening process under s 168 of the EPBC Act in 2002. As such, NBGPL contributed funding to the Hotham Declared Species Group, which undertakes an annual feral pig-trapping program and is also trialling a 1080 baiting program for feral pigs.

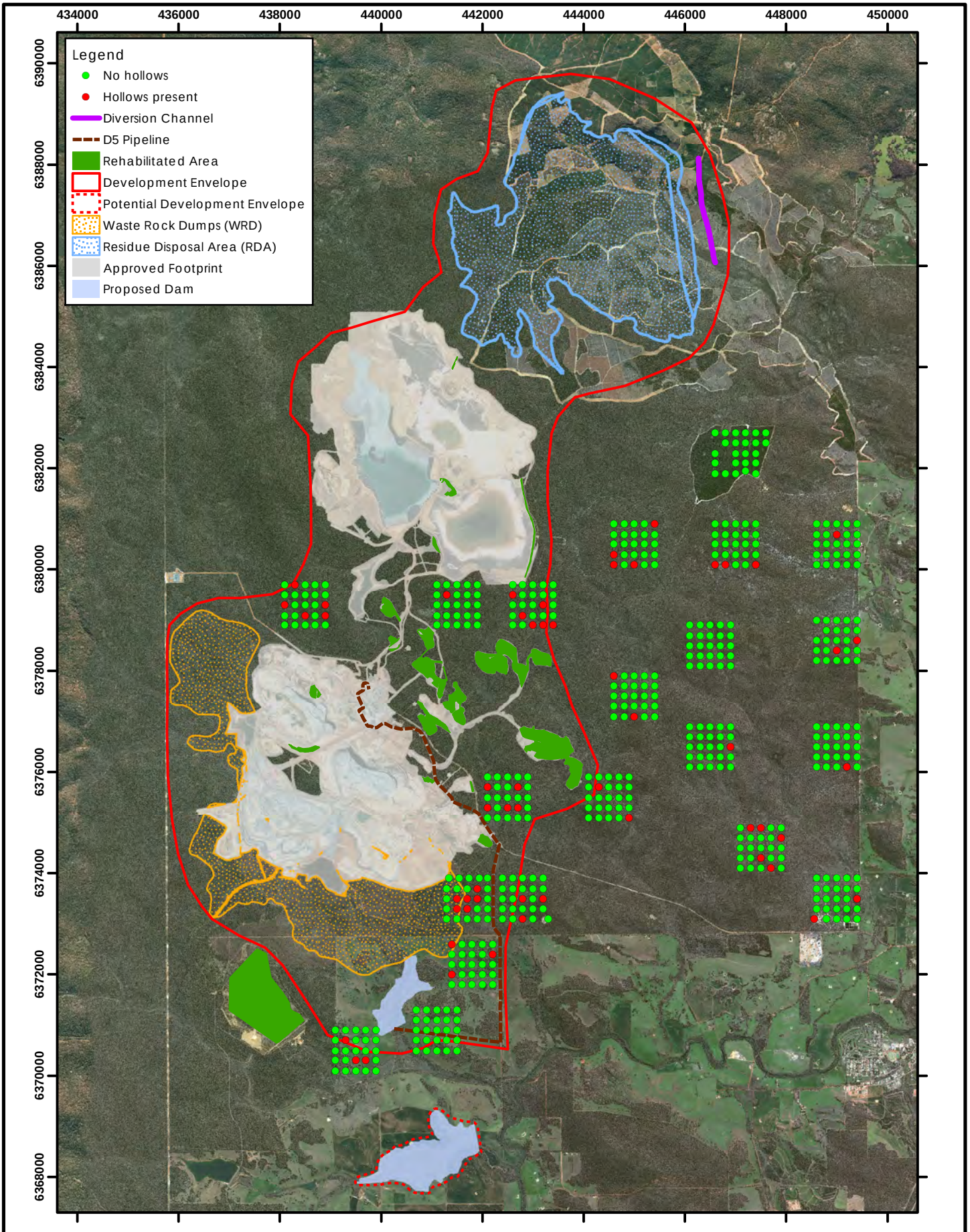

Figure 34 Systematic tree hollow survey

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Scale
0 1 2 3 4
Kilometers

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Aerial image &mine layout: Client 2012. Tree hollows: Finn 2011.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F034.mxd

10.2.3 Aquatic fauna

The following aquatic fauna studies have been undertaken and have been used to inform this impact assessment:

1. Wetland Research and Management undertook a survey in spring 2009 and autumn 2010 to determine the ecological water requirements of the Hotham River and Thirty Four Mile Brook (WRM 2011). This survey included macroinvertebrate, fish and crayfish sampling at two sites along Thirty Four Mile Brook and seven sites along the Hotham River to the southeast (downstream) of the proposed WRD.
2. WRM conducted aquatic fauna sampling at eight sites across two reaches along Thirty Four Mile Brook in September 2010 and August 2011 (WRM 2012a). Three sites were located between the RDA and pit area; five sites were located downstream of the pit area, three of which were within the proposed WRD area.
3. As the RDA will require realignment of approximately 2 km of Gringer Creek, aquatic fauna sampling of Gringer Creek for macroinvertebrates, crayfish and fish was conducted in October 2011 (WRM 2012b). Existing water-dependent ecological values of the wetland were assessed to provide benchmark data that can be used to monitor any future mine-related responses in water quality and/or aquatic fauna. This survey comprised eight wetland/pool sites along the main channel in the upper reaches of the seasonal tributary, located immediately adjacent to the proposed RDA (upstream and downstream) with one site within the RDA boundary.
4. Further study of the tributaries located on Hotham Farm (four sites along Thirty Four Mile Brook and five sites along Junglen Gully) (all south of the Development Envelope) was undertaken by WRM in September 2012 (WRM 2012c) to assess water quality (ions, nutrients and metals) and composition of aquatic fauna species (macroinvertebrates, crayfish and fish).
5. A study of three ephemeral watercourses (Boggy Brook, House Brook and Wattle Hollow Brook) in the Acquired Lands was undertaken in August 2011 by WRM to assess the conservation significance of the fauna, document baseline water quality conditions, and provide baseline data for monitoring changes in water quality and aquatic fauna (WRM 2012d).

Aquatic fauna sampling of the Hotham River and Thirty Four Mile Brook in spring 2009 and autumn 2010 (WRM 2011) recorded the following:

1. 111 taxa of macroinvertebrates; 99 taxa from the Hotham River (seven sites over two seasons) and 58 taxa from Thirty Four Mile Brook (two sites in spring and one in autumn). Ten (approximately 9%) of these taxa were endemic to the southwest including the freshwater crayfish *Cherax quinquecarinatus* (Gilgie) and *Cherax preissii* (Koonac).
2. Five native freshwater fish species including *Pseudogobius olorum* (Swan River Goby), *Nannoperca vittata* (Western Pygmy Perch) *Galaxias occidentalis* (Western Minnow), *Bostockia porosa* (Nightfish) and *Tandanus bostocki* (Freshwater Cobbler) and two introduced species (including *Gambusia holbrooki* (Mosquitofish) and *Perca fluviatilis* (Redfin Perch)).
3. Other aquatic fauna recorded included the *Litoria moorei* (Motorbike Frog) and *Chelodina oblonga* (Long-necked Turtles).

Targeted aquatic fauna sampling in Thirty Four Mile Brook in September 2010 and August 2011 (WRM 2012a) recorded the following:

1. A combined total of 111 macroinvertebrate taxa (13% endemic to the southwest of WA) dominated by taxa tolerant of elevated salinities.
2. Four native freshwater species (Western Minnow, Pygmy Perch, Nightfish and Freshwater Cobbler) and one introduced species (Mosquitofish).
3. Two species of native crayfish (Koonac and Gilgie).
4. None of the species recorded were of conservation significance.

Further study (WRM 2012c) of the tributaries located on Hotham Farm (Thirty Four Mile Brook and Junglen Gully) recorded the following:

1. 91 macroinvertebrate taxa (8% endemic); 70 taxa at Junglen Gully and 59 taxa from Thirty Four Mile Brook.
2. Macroinvertebrate richness was comparable at both sites.
3. Of the total macroinvertebrate fauna recorded across the study, 8% were considered to be endemic or likely endemic to the southwest of Western Australia, with the remainder of species being cosmopolitan (occurring worldwide), indeterminate, or endemic to Australasia or all of Western Australia.
4. A higher number of endemic macroinvertebrate fauna were recorded at Junglen Gully than at Thirty Four Mile Brook.
5. A number of insect taxa indicative of ecosystem health (Ephemeroptera Plecoptera Trichoptera [EPT] taxa) that were recorded at Junglen Gully were absent at Thirty Four Mile Brook; however, this may reflect the physical differences in the two waterways rather than differences in health.
6. Three freshwater crayfish were recorded from Thirty Four Mile Brook including the native Koonac and Gilgie and one introduced species, *Cherax destructor* (Yabby).
7. One species of freshwater crayfish (Gilgie) was recorded at Junglen Gully.
8. Three fish species were collected across the study area including Western Minnow, Western Pygmy Perch and Nightfish, with Western Pygmy Perch recorded at Junglen Gully only.
9. None of the recorded species of crayfish or fish is of conservation significance.

Mean taxa richness at Junglen Gully and Thirty Four Mile Brook was higher than that in previous studies undertaken by WRM on nearby watercourses including Gringer Gully, House Brook, Boggy Brook, Wattle Hollow Brook and Thirty Four Mile Brook D4 reach (WRM 2012c). However, the macroinvertebrate diversity of the Thirty Four Mile Brook and Junglen Gully is considered low when compared regionally to studies on Jarrah forest streams within the southwest of Western Australia including Marbling Brook, Augustus River, Helena River and Boronia Gully (WRM 2012c). Historic, widespread secondary salinisation throughout the catchment is likely to have led to the loss of many of the more sensitive macroinvertebrate taxa (WRM 2012a).

Sampling of Gringer Creek for aquatic macroinvertebrates, crayfish and fish in October 2011 (WRM 2012b) recorded the following:

1. Forty seven (47) macroinvertebrate taxa, dominated by Diptera, in particular Chironomids.
2. A total of 102 crayfish comprising three native species (*Cherax cainii* [Smooth Marron], Gilgie and Koonac) and one introduced species (Yabby).
3. Three (3) native species of fish and one introduced fish species (Mosquitofish).
4. No crayfish or fish species of conservation significance.

Sampling of three ephemeral watercourses within the Acquired Lands in August 2011 (WRM 2012d) recorded the following:

1. Thirty five (35) macroinvertebrate taxa of which 5% were considered endemic or likely endemic to the southwest of Western Australia with the remainder of species being cosmopolitan (occurring world-wide), indeterminate, or endemic to Australasia or all of Western Australia.
2. There were no statistically significant differences between macroinvertebrate species assemblages of each of the three watercourses.
3. There were statistically significant differences between the macroinvertebrate species assemblages of the Acquired Lands watercourses, Gringer Creek and Thirty Four Mile Brook sub-catchments; however, this was not unexpected as at the time of sampling the Acquired Lands watercourses were reduced to a series of pools without any surface flows, as such, some major macroinvertebrate groups were absent therein.
4. No native crayfish species were recorded from any of the Acquired Lands watercourse sites, likely due to lack of surface flow.

5. Koonac were considered to potentially occur in the Acquired Lands watercourses but individuals or burrows were not observed during sampling.
6. No native fish species were recorded from any of the Acquired Lands watercourse sites, likely due to low water levels at the time of sampling, the channel morphology of the watercourses, and the fact that highly ephemeral flows do not offer significant breeding or feeding habitat for native fish species.

10.2.4 Short-range endemics

The following terrestrial short-range endemic (SRE) invertebrate fauna studies have been undertaken and used to inform this impact assessment:

1. A desktop assessment for SRE invertebrate fauna was undertaken by Outback Ecology (2011) over an area that included the proposed WRDs and RDA. The desktop review included database searches and a review of all available flora and fauna surveys.
2. A Level 2 SRE invertebrate fauna survey was undertaken between August and September 2011 (Outback Ecology 2012a). The survey included wet pitfall trapping, leaf litter processing in Tullgren funnels, soil sieving, targeted searching and habitat assessment. The habitat assessment involved characterising habitat according to condition, complexity and suitability for invertebrate taxa prone to short-range endemism.

The desktop assessment (Outback Ecology 2011) identified eight species of SRE invertebrate fauna as likely to occur in the area, including the Scorpion Fly (*Austromerope poultoni*), which is listed a Priority 2 species. The Schedule 1 *Idiosoma nigrum* (Shield-backed Trapdoor Spider) was identified as possibly occurring.

A total of 69 identifiable species of invertebrate fauna were recorded during the 2011 survey, of which 24 were considered to be potential SRE species (Outback Ecology 2012a). Of these species, 16 (including 13 species of earthworm) had not been previously recorded. The potential SRE species recorded were:

1. Mygalomorph spiders: Aganippe 'MYG187' and *Synothele Mullaloo.*
2. Scorpion: Urodacus planimanus.
3. Millipedes: *Antichiropus* 'sp. Boddington'; *Antichiropus* 'sp. Goldmine'; *Antichiropus* 'sp. Marradong' and *Antichiropus* 'sp. Saddleback 1'.
4. Slaters: *Acanthodillo* sp. Nov. A and *Trichorhina* sp. Nov.
5. Snails: Luinodiscus cf. repens and Bothriembryon cf. serpentines.
6. Earthworms: 'sp. 009'; 'sp. 010'; 'sp. 013'; sp. 015'; 'sp. 016'; 'sp. 020'; 'sp. 025'; 'sp. 027'; 'sp. 032'; 'sp. 034'; 'sp. 035'; 'sp. 036' and 'sp. 037'.

The granite outcrop and *Melaleuca* swampland habitats were considered to have a high potential of supporting SRE species with *Allocasuarina* and Wandoo woodland habitats considered to have a medium potential. The remaining habitats were considered to have low potential of supporting SRE species.

10.2.5 Subterranean fauna

A desktop assessment of the potential for subterranean fauna to occur in the vicinity of the NBG was undertaken by Outback Ecology (2012b). The assessment included database searches and a literature review for the area and broader region in order to assess the likely presence of subterranean fauna and their habitat. The project area is dominated by a granite geology that contains both a seasonal shallow aquifer and a deeper, permanent bedrock aquifer with an absence of karst geologies, vuggs (small to medium-sized cavities within rock) and voids within suitable geologies. Outback Ecology (2012b) concluded it is unlikely that rich subterranean communities would occur on the basis of the geological setting and hydrogeological information.

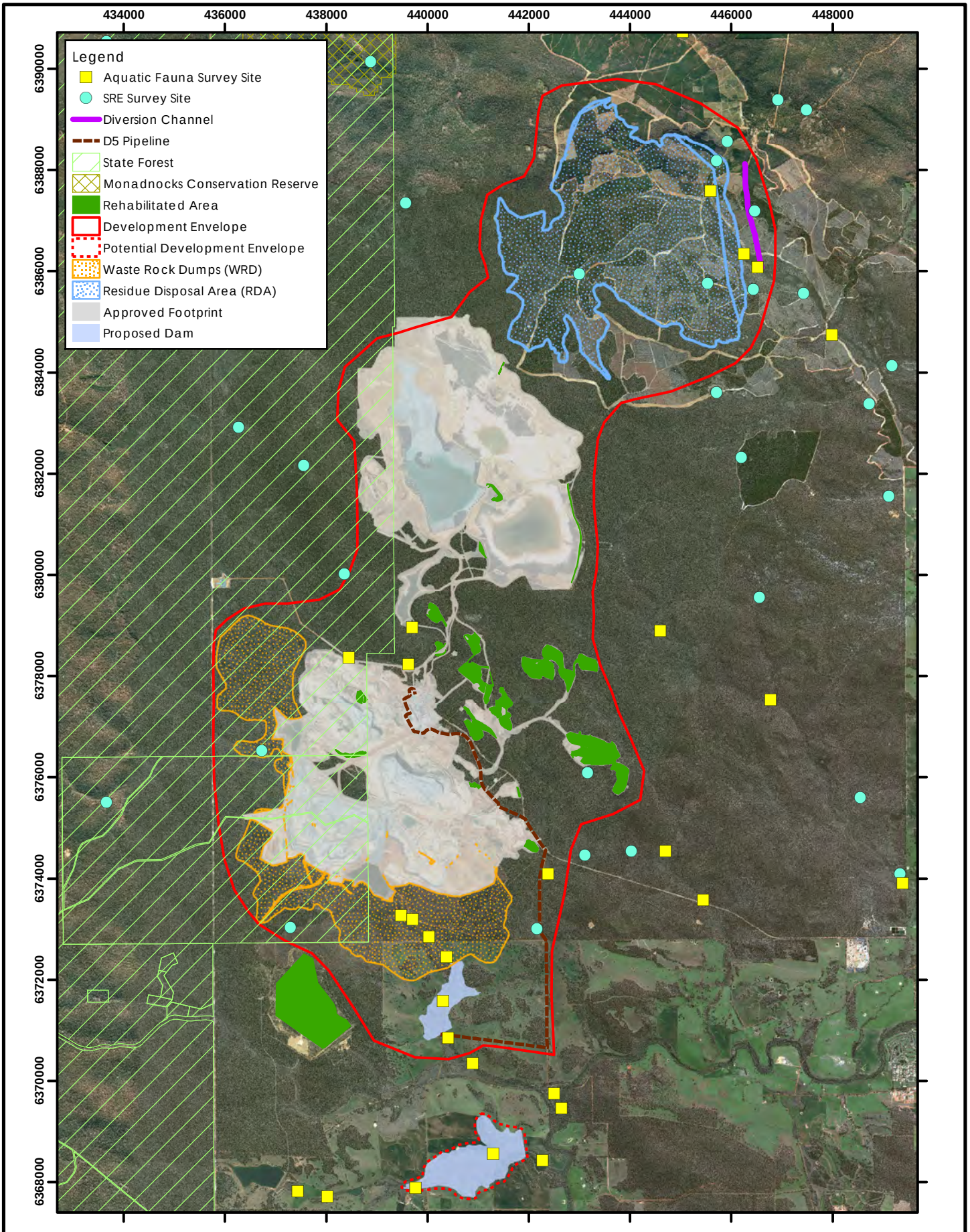

Figure 35 Location of survey sites for SRE and aquatic fauna surveys

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Scale
0 1 2 3 4
Kilometers

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Aerial image &mine layout: Client 2012. Tree hollows: Finn 2011.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F035.mxd

10.3 Potential sources of impact

The following aspects of the proposal may affect fauna values:

- **clearing of vegetation** resulting in the loss or fragmentation of fauna habitat and consequent displacement of fauna
- **vehicle and heavy machinery movements** during clearing and construction, may result in fauna strike causing injury or death to individuals.

The potential effect of dewatering and earthworks (including the diversion of Gringer Creek) on the hydrological regime of the creeks and their aquatic fauna is assessed in Section 7.

The proposed WRDs and RDA do not involve removal or excavation of substantial volumes of material, and mainly involve land clearing (surface disturbance), which is unlikely to affect subterranean fauna habitat. While the proposal will extend dewatering activities, additional impacts from the increase in the extent of drawdown are considered negligible to subterranean fauna in comparison to the existing proposal (Outback Ecology 2012b). Therefore, the potential effect of the Proposal on subterranean fauna is considered negligible and is not considered further in this assessment.

10.4 Assessment of likely direct and indirect impacts

10.4.1 Clearing of Vegetation

Habitat loss

Approximately 1755 ha of native vegetation clearing will be required for the Proposal with approximately 1540 ha of clearing for the RDA and WRD areas (Table 34) and approximately 215 ha of clearing for supporting infrastructure (as described in Table 5). The location of supporting infrastructure has not yet been finalised but will be within the Development Envelope (Figure 4). Clearing of vegetation will directly reduce the extent of available fauna habitat in the local area. With the exception of some of the transitional ecotone A-type vegetation units, all vegetation units recorded within the Development Envelope extend beyond the boundaries of the area surveyed and are well represented in the State Forest that occurs to the west. The A-type vegetation units are well represented in many of the conservation estates in the southwest forest, although there is diversity in structure and herbs which provide different value to these areas (Mattiske 2012b).

Table 34 Extent of fauna habitat to be cleared for WRD expansion, new RDA, stockpiles and pit expansion

Habitat type	Habitat within area subject to detailed Level 2 vegetation survey (ha)	Proposed clearing (ha)	% of total
Eucalypt/paperbark on seasonally wet valley floors	556	101	18.1
Yarri–Wandoo on wetter lower slopes	235	20	8.6
Eucalypt woodlands on wetter lower slopes	972	131	13.5
Jarrah–Marri woodland–forest over heath understorey	4956	371	7.5
Mixed Wandoo/Jarrah/Marri woodland over heath understorey	726	8	1.2
Mallee heath	192	4	2.3
Heath & Rock Sheoak on granite outcrops	179	0	0
Wandoo woodland	4388	268	6.1
Jarrah–Marri forest over Sheoak–Banksia	6603	326	4.9
Jarrah–Marri woodland–forest	1827	310	17.0
Total mapped extent of habitat in native vegetation	**20 635**	**1540**	**-**

The proposed clearing represents <1% of the total mapped extent of any one vegetation complex and no clearing is proposed within any vegetation complex that is poorly represented in reserves or has less than 30% of the pre-European extent remaining. Consequently, the fauna assemblages recorded within the Development Envelope are considered highly likely to be well represented within the surrounding forest and unlikely to be restricted to the Development Envelope.

The extent of each mapped habitat type (shown on Figure 32) within the area subject to detailed Level 2 vegetation survey and that proposed to be cleared is shown in Table 34. All habitat types are well represented outside the Development Envelope with no more than 20% of the surveyed extent of any one habitat type proposed to be cleared within the mapped extent. Therefore, all fauna habitats will continue to be well represented in the local area and no local extinctions would be expected as a result of the Proposal. There will be some additional clearing required for ancillary infrastructure such as roads, powerlines and pipelines that require re-routing as a result of the WRDs extension and new RDA. This infrastructure will fall within the Development Envelope and avoid sensitive swamp communities as per current operational practices.

The effect of clearing was determined in Table 35 using the data from the identification of habitat types for each species (Table 32) and calculation of clearing within each of these habitat types (Table 34). The reduction in habitat type for all species of conservation significance was less than 10% of that available within the area subject to detail Level vegetation mapping (more than 26 700 h) with the exception of potential (i.e. foraging only) habitat for Baudin's Black-Cockatoo, which is 12.4%.

The habitat mapping for each of these species has been presented in Figure 38 to Figure 41 along with records of where the species have been recorded.

Table 35 Area of habitat for black cockatoos, Woylie, Chuditch and Brush-tailed Phascogale within mapped extent of habitat in native vegetation (20 635 ha)

Species	Habitat	Habitat within area subject to detailed Level 2 vegetation survey (ha (ha)	Extent of habitat to be cleared (ha)	% habitat to be cleared within mapped extent
Chuditch	Suitable	19 477	1514	7.8%
	Potential	1158	37	3.2%
Woylie/Brush-tailed Bettong	Suitable	11 183	584	5.2%
Forest Red-tailed Black-cockatoo	Suitable	19 712	1534	7.8%
	Potential	744	17	2.2%
Baudin's Black-cockatoo	Suitable	15 947	972	6.1%
	Potential	3812	474	12.4%
Carnaby's Black-cockatoo	Suitable	18 547	1398	7.5%
	Potential	2093	153	7.3%
Brush-tailed Phascogale	Suitable	17 122	1303	4.3%
	Potential	1143	31	0.1%

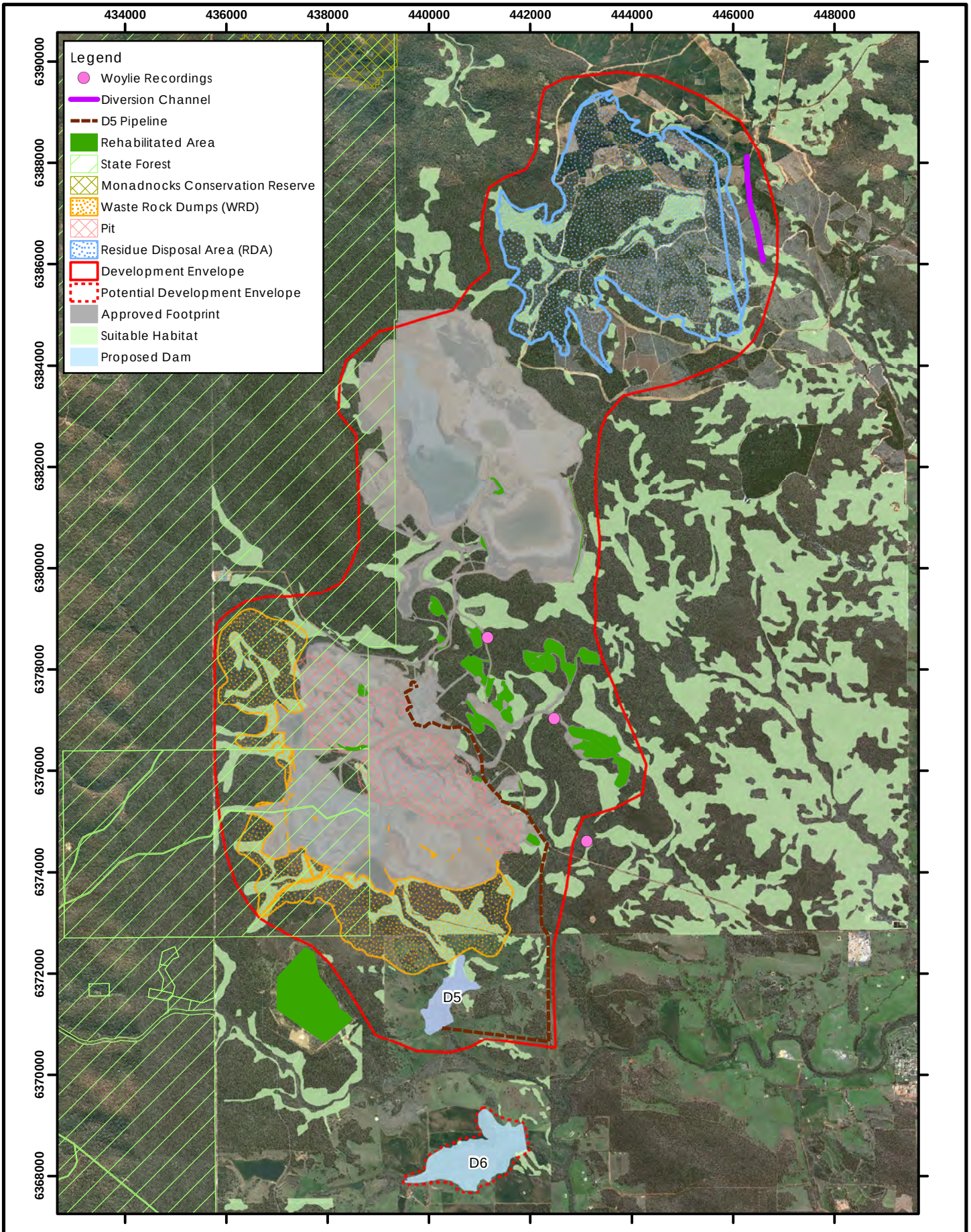

Figure 36 Known records and distribution of habitat for Woylie/Brush-tailed Bettong

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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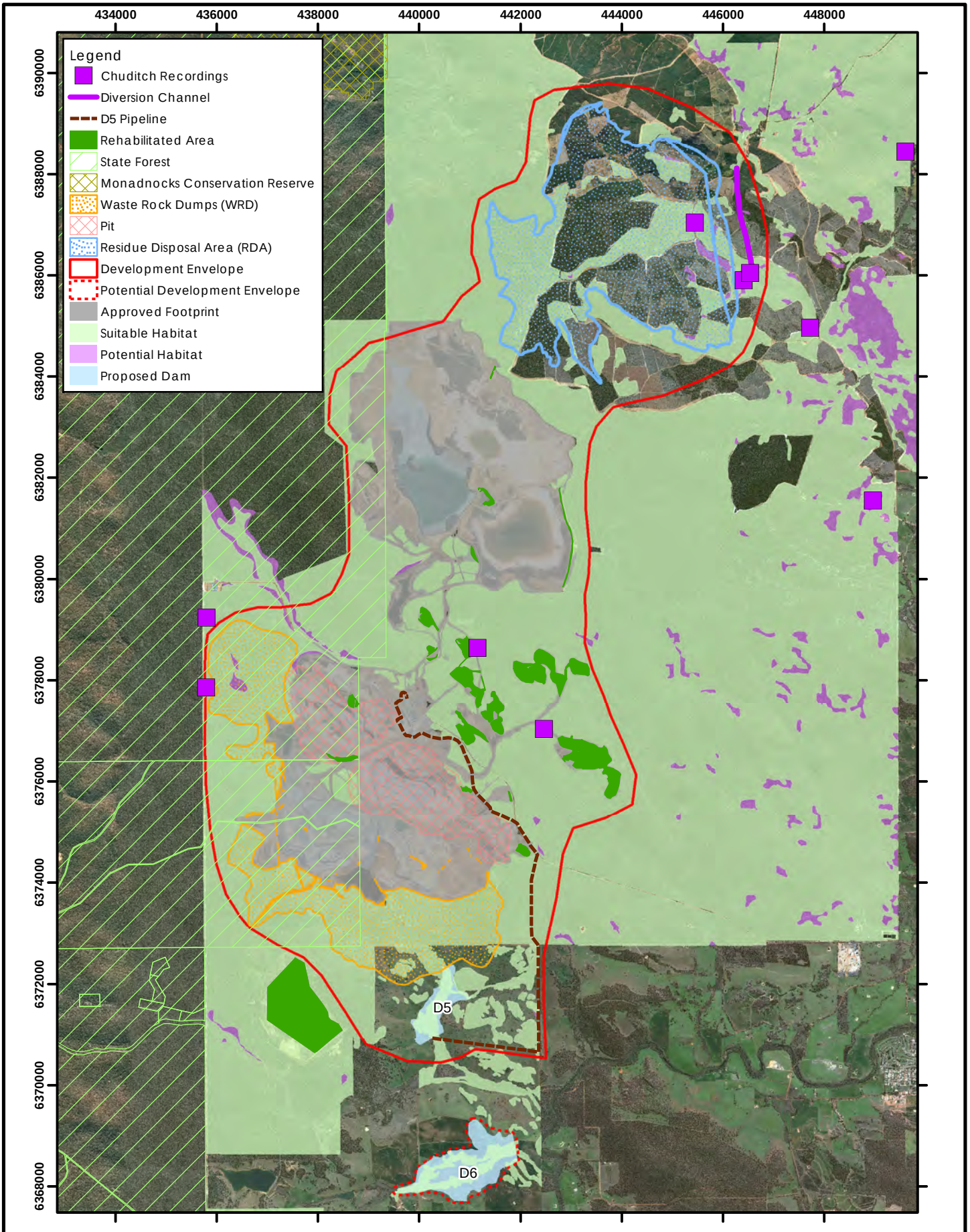

Figure 37 Known records and distribution of habitat for Chuditch

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Scale
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km

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at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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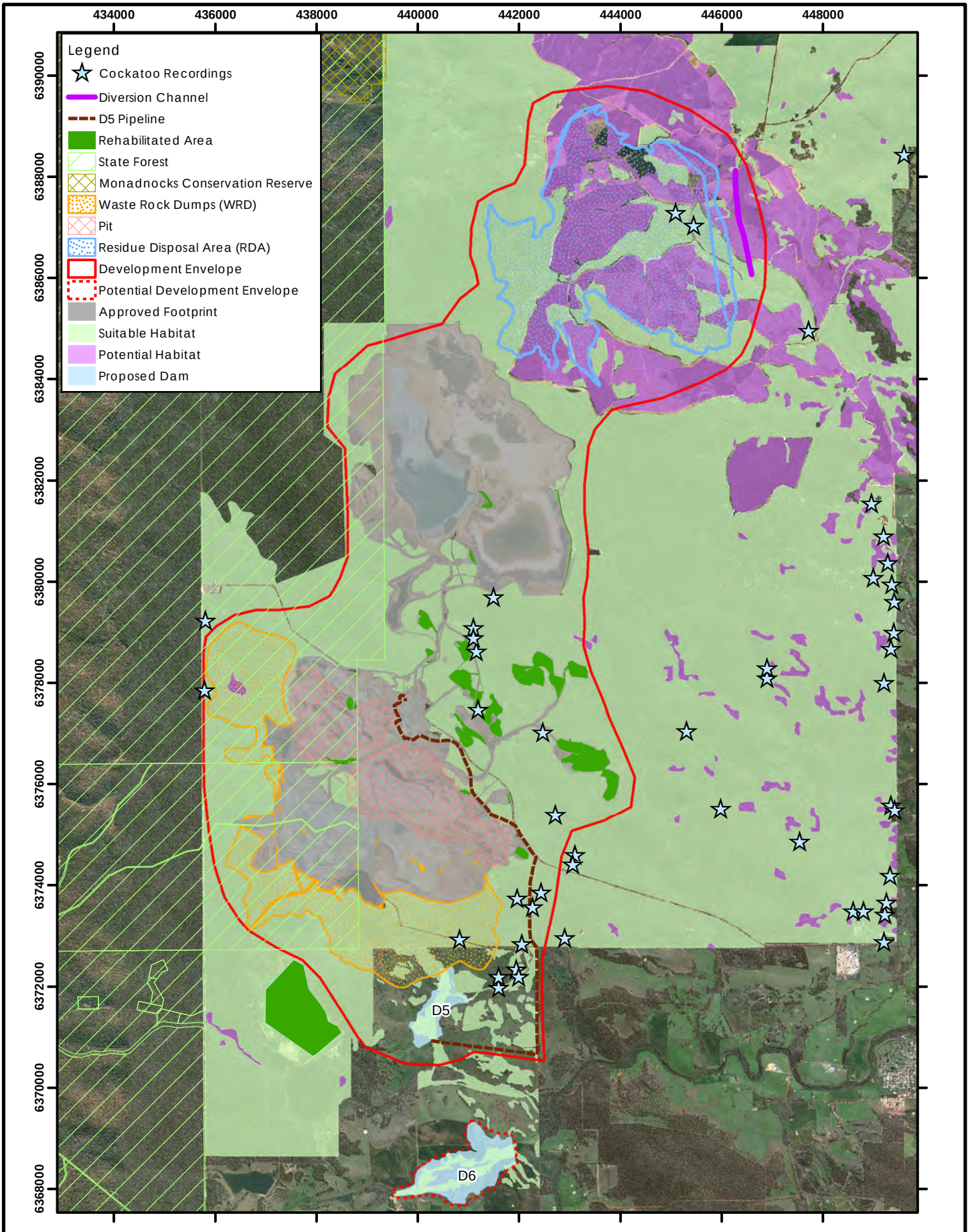

Figure 38 Known records and distribution of habitat for Forest Red-tailed Black-cockatoo

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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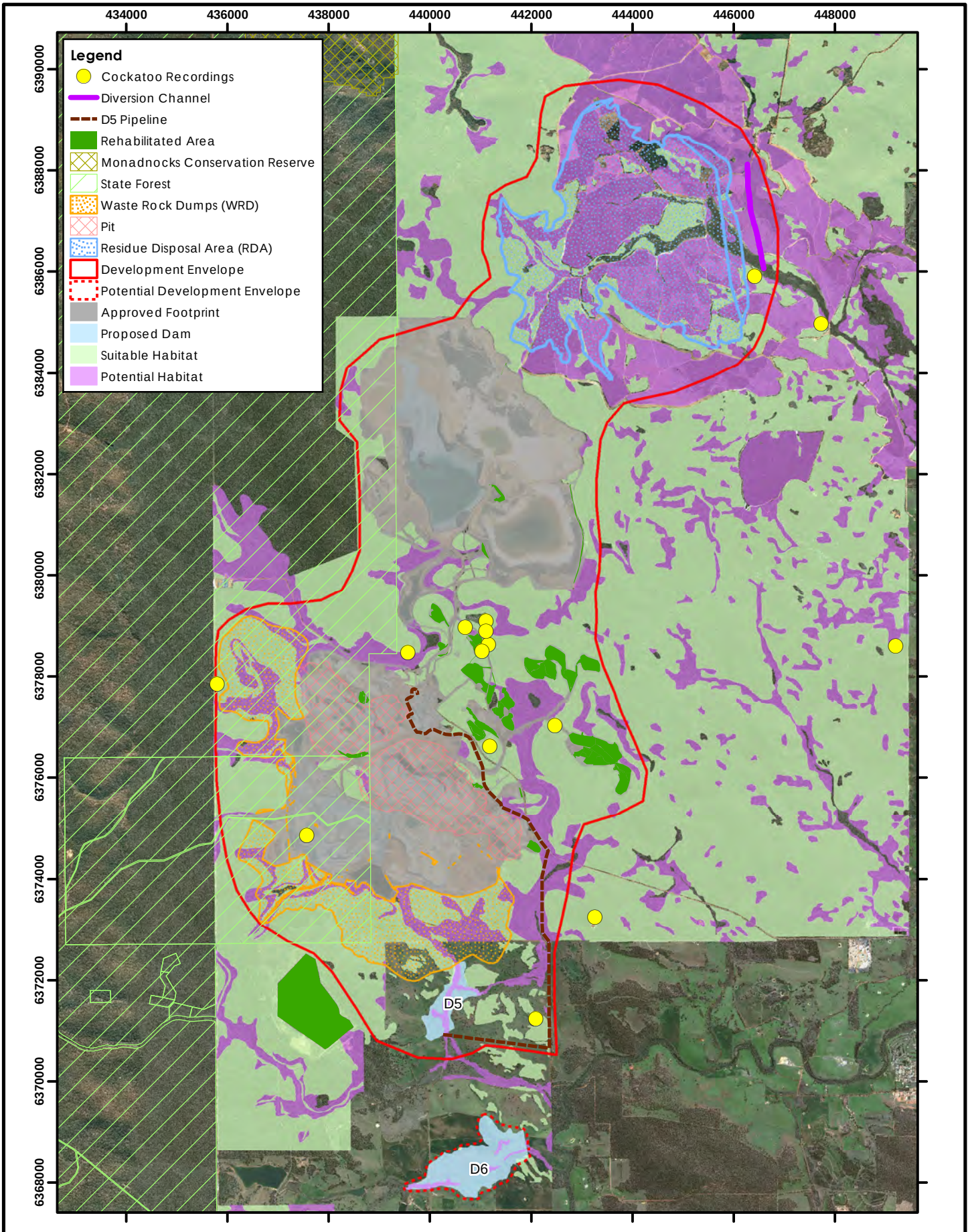

Figure 39 Known records and distribution of habitat for Baudin's Black-cockatoo

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Scale
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km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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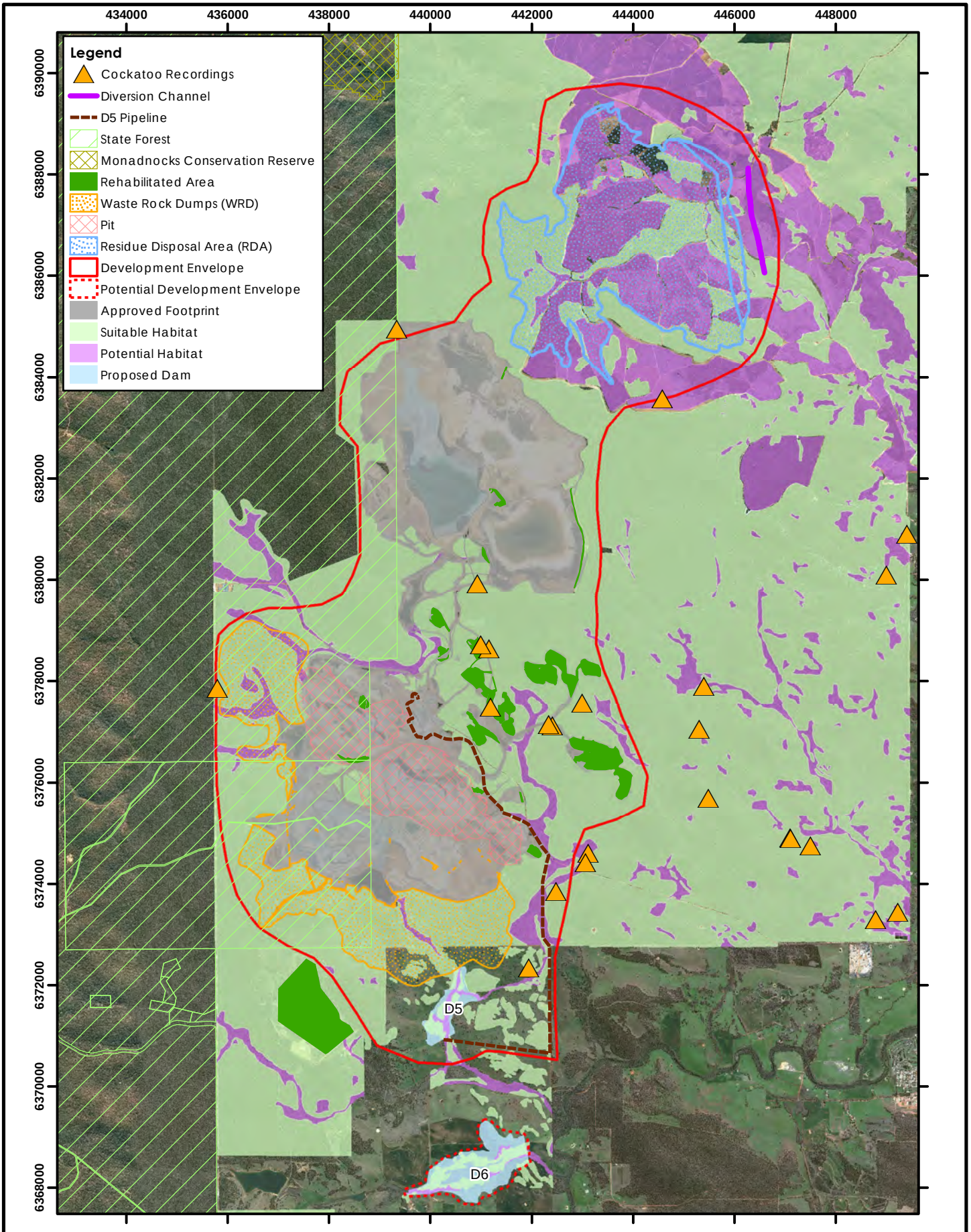

Figure 40 Known records and distribution of habitat for Carnaby's Black-cockatoo

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Scale

0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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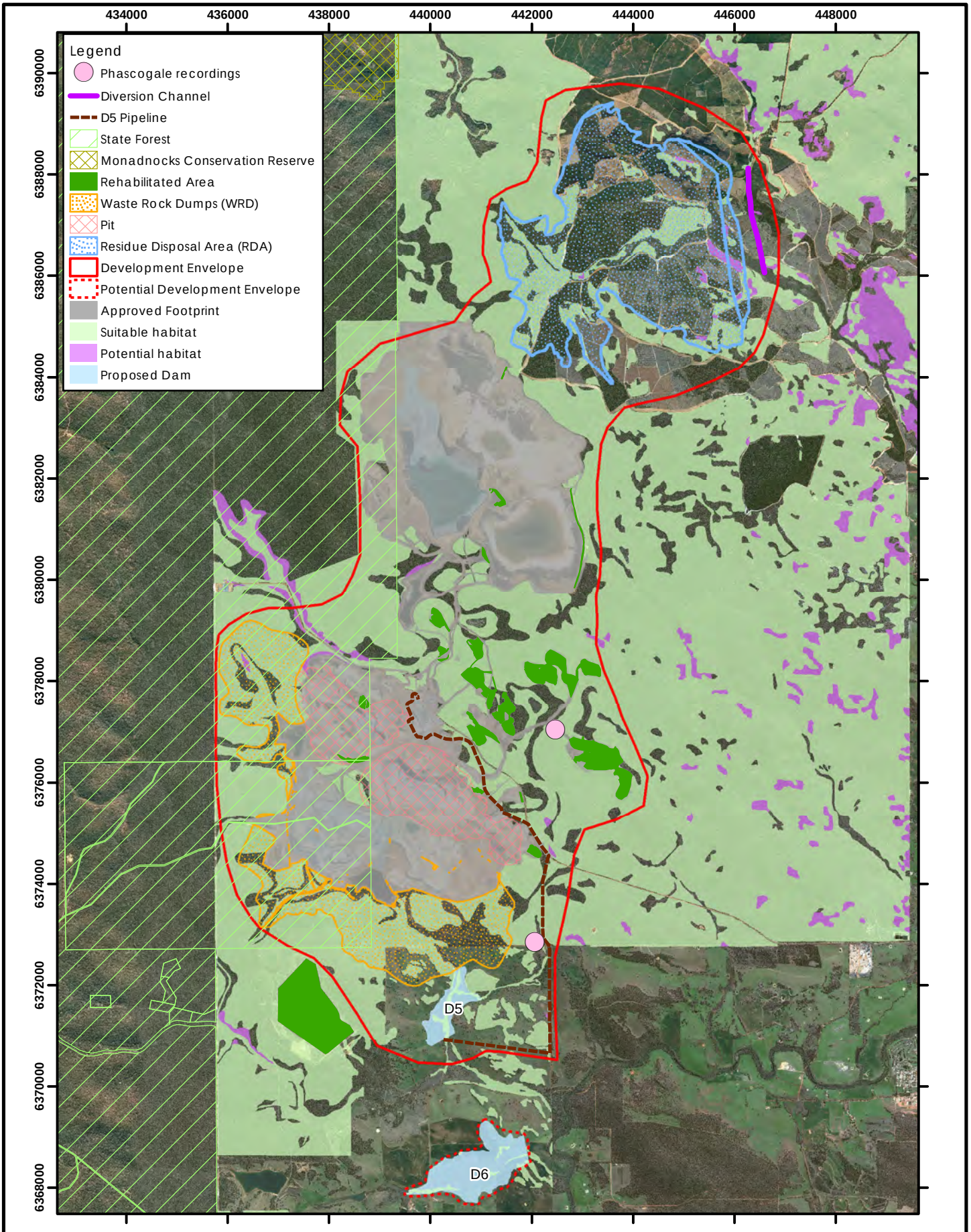

Figure 41 Known records and distribution of habitat for Brush-tailed Phascogale

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F041.mxd

Fragmentation effects

In addition to direct removal of potential foraging or breeding habitat in the immediate area around the operation mine site, the Proposal has the potential to also fragment local habitats to the east of the operation. To the east of the Development Envelope, there is an area of over 5000 ha of native vegetation that is bounded by:

- cleared farmland to the east and south
- plantations to the north
- the NBG site to the west, which is connected to extensive areas of native vegetation to the west and northeast by a number of linkages (Figure 4).

The southern extension of the WRD has the potential to increase fragmentation by removing one of the native vegetation corridors between this eastern vegetation and the Dwellingup State Forest to the west. However, this extension south was determined to be the best option for the expansion as the alternative (expansion into native vegetation to the east) would impact on areas where species of conservation significance (including Woylies) have been found during surveys (Ninox 2012a, 2012b).

Woylies and Quenda were recorded in the area east of the existing operations. This area contains Gastrolobium thickets, which are known to provide a refuge habitat for Woylies as the dense growth habit of Gastrolobium thickets provide shelter from predators such as foxes and Gastrolobium also contains monofluoroacetic acid which is the compound present as sodium monofluoroacetate in the toxic bait '1080' used to control exotic predators such as foxes and cats. Vegetation surveys (Mattiske 2012a) recorded *Gastrolobium* sp. in the H2, Y and YG vegetation units, which is sparsely distributed primarily to the east of the Development Envelope. No exotic predators such as foxes or cats were recorded in this area (Ninox 2012b).

The linkages to be maintained include the area between the existing mining operations and the F1/F3 RDA area. There is some infrastructure located within this area including a road and pipelines but it is broad (approximately 500 m at its narrowest point to 2 km at its widest) and still likely to be utilised by fauna to some extent (Figure 4). Historical oxide pits in this area have been rehabilitated improving the quality of vegetation in this area. A second linkage will remain between the existing F1/F3 RDA and the proposed RDA (partially in the timber plantations) where a 170 m width band of native vegetation will be maintained between the two RDAs, although this linkage will also be crossed by a road and pipeline.

Species recorded during the 2011/2012 fauna survey in this area included Woylies, Quenda and the Western Brush Wallaby, indicating that this area may already be utilised as a corridor to the western State Forest. This corridor will not be affected by the Proposal. As this area is already highly fragmented, the key issues for further fragmentation is the maintenance of a genetic connection with potential fauna populations in the jarrah forest to the west and the maintenance of a connection that will allow recolonisation of the area should local extinctions occur due to fire or disease. NBGPL will consult with experts to identify appropriate mitigation actions that will allow this connection to be maintained. Mitigation actions that may be adopted include fauna egress areas, periodic trapping and relocation of animals and population monitoring.

Predicted impacts of vegetation clearing on species of conservation significance are identified in Table 36.

Table 36 Predicted impact of vegetation clearing on conservation significant species recorded or likely to occur within the NBG mine site

Species	Predicted impact from vegetation clearing
Woylie/Brush-tailed Bettong *Bettongia penicillata ogilbyi*	On a species scale, the Woylie has undergone recent dramatic population declines (estimated to be 80%). These have been largely attributed to threats including predation by foxes and cats, disease, habitat loss and modification as well as altered fire regimes (DEC 2012). Individuals typically have small home ranges and short distances are often observed from dispersal events (Pacioni et al. 2010). Vegetation around the current mining operations is consistent with habitat suitable for the Woylie with tall eucalypt forest and woodlands with dense shrubby undergrowth (DEC 2012). Woylies were translocated to the area east of the current operation in the mid-1990s as part of Operation Foxglove. Three woylies were recorded to the east of the existing mine during the 2011/2012 surveys, including one record within 1 km of the existing mine operations (Ninox 2012a). The key habitat types for the Woylies locally are the Wandoo woodland and the Jarrah/Marri forest over Sheoak/Banksia (DSEWPaC 2013). One of the key habitat values for the Woylie in this area is the presence of dense understorey species such as *Gastrolobium* spp., which provide protection from feral predators. In addition, there appears to be limited presence of the root pathogen *Phytophthora cinnamomi* in the habitat to the east of the operation. This root pathogen has a negative impact on the fungal communities that are a direct food source for Woylie. Additional management measures in this area include fox baiting by government departments, the existing local programs conducted by the BGM Environmental Department (e.g. feral pig management and forest hygiene management). The vegetation to the east of the existing mine is around 4000 to 5000 ha in area but is largely isolated from the Jarrah forest to the west of the operation by farmland, the existing mine and plantations. Increased fragmentation of fauna in this area may occur and mitigation measures will be developed to ensure that some east–west connection is maintained. The fauna habitats that may be affected by the Proposal are not restricted locally or regionally. The localised vegetation clearing is, therefore, not expected to significantly affect the species population. However, the additional clearing required for the Proposal may affect some local individuals by further restricting movement from the vegetation east of the operation to Dwellingup State Forest in the west. This may increase the isolation of the species in this area to other external threatening processes. However, in recognition of the importance of all populations of this species, given recent severe declines in the population, NBGPL recognises the potential residual effect on the species associated with increased fragmentation as a result of the Proposal and this is addressed with the offset package described in Section 14.
Chuditch *Dasyurus geoffroii*	This species has been recorded in all surveys since 1984, with numbers fluctuating from two in 1984, to 47 in 2001–2002 to 20 in 2011–2012 (eight near the mining operations and 12 around the plantation area) (Ninox 2012a, 2012b). Similar 'boom and bust' type results have been observed in the surveys conducted for Boddington Bauxite Mine since the 1980s (Ninox 2012a). This may be influenced by climate conditions impacting available local food resources. Chuditch are solitary animals for the majority of their lifetime and occupy relatively large home ranges (males >15 km^2 and females 3–4 km^2). However, home ranges may be smaller where population densities are greater and foxes are controlled. The Chuditch occurs throughout the southwest of Western Australia predominantly in Jarrah forest. The extent of occupancy was estimated in 2006 to be between 13 800 km^2 and 45 625 km^2 (DSEWPaC 2013). Chuditch are known to utilise a wide variety of habitats and although regularly trapped in the jarrah forest (e.g. as part of Western Shield monitoring), trap success is typically low due to the sparse distribution of the species and seasonal changes (DSEWPaC 2013). Chuditch are well represented on conservation estates with the largest populations monitored under the Western Shield program in nature reserves. Threats for this species include land clearing, predation by and competition with foxes and cats, deliberate and accidental poisoning, trapping, and road kill (DEC 2012). This species is expected to utilise all habitats found within and outside of the Development Envelope. This Proposal is expected to result in some local individuals being displaced into surrounding vegetation. NBGPL recognises the need to maintain corridors between vegetation to the east and west of the operation and to continue with management plans including control of feral species and forest hygiene. None of the habitats that may be cleared as part of the Proposal is restricted locally or regionally. However, in recognition of the importance of all populations of this species (as per the Species Recovery Plan), NBGPL recognises the potential residual effect on the species associated with increased fragmentation as a result of the Proposal and this is addressed with the offset package described in Section 14.

Species	Predicted impact from vegetation clearing
Southern Brown Bandicoot/Quenda *Isoodon obesulus fusciventer*	This species is widespread throughout the southwest of Western Australia and is often recorded in close proximity to developed areas. Five and nine individuals were recorded during the 2011/2012 WRD and RDA surveys respectively (Ninox 2012a, 2012b). The proposed clearing is not expected to significantly reduce the availability of potential habitat available to this species in the local area. Quenda were recorded in the area south and east of the existing mine pit as well as throughout the potential RDA area. Mitigation measures will ensure that some east–west connection is maintained.
Western Brush wallaby *Macropus irma*	Low numbers of this species were recorded in the WRD and RDA surveys and scats were also observed (Ninox 2012a, 2012b). The Western Brush Wallaby is distributed across the southwest of Western Australia from north of Kalbarri to Cape Arid. Although, the distribution of the species is fragmented due to clearing for agriculture, the proposed clearing is not expected to significantly reduce the availability of potential habitat available as extensive habitat exists in neighbouring State Forest and surrounding vegetation.
Brush-tailed Phascogale *Phascogale tapoatafa* subsp. ssp. (WAM M434)	Low numbers of this species were recorded in the WRD survey area and none were recorded in the RDA (although it could occur there as there is similar habitat) (Ninox 2012a, 2012b). This species is known to occur from Perth to south of Albany, and at low densities in the northern Jarrah forest. The proposed clearing is not expected to significantly reduce the availability of potential habitat available as extensive habitat exists in neighbouring State Forest and surrounding vegetation.
Water-rat *Hydromys chrysogaster*	This species has not been recorded in surveys complete for NBG; however, there were historical records from 1981-in-the DEC NatureMap database from the Boddington area. The fauna habitat unit 'eucalypt/paperbark on seasonally wet valley floors' is expected to be habitat for this species and thus it could be present in the local area. However, as this species has not been recorded within the Development Envelope, it is considered unlikely that any significant community exists or that the Proposal will affect this species.
Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*	Small year–round population likely to occupy the area, but the area is unlikely to support large transient or migratory flocks (Lee et al. 2012a). Group size ranges from one to 45, with a mean of 7.4 +/- 0.6 and 92.1% of groups consisting of less than 20 birds (Lee et al. 2012a). The total local Forest Red-tailed Black-Cockatoo population associated with the eastern acquired lands and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011). Distribution likely to be associated with distance to available water, which is influenced by farm dams in summer. Feeds almost exclusively on Marri and Jarrah within the area and not timber plantations. Species relies on very old Marri and Wandoo for breeding. Clearing will result in reduction of the local habitat available and may displace individuals form the local populations into the surrounding Jarrah–Marri forest. Within a 10 km radius of the mine, approximately 75% of the area consists of native vegetation, and the operation is bordered to the west by the 180 000 ha Dwellingup State Forest. On a regional scale, the Proposal is not expected to significantly reduce the extent of Marri or Jarrah vegetation in the region and will not reduce the availability of permanent water sources. Rehabilitation of the majority of the mine envelope will be undertaken over time and will focus on providing foraging habitat for black cockatoos within ten years and breeding habitat in the long-term. The residual effect on the species of local habitat loss is addressed with the offset package described in Section 14.
Baudin's Black-Cockatoo *Calyptorhynchus baudinii*	This species has a north–south migration pattern that moves through the area in autumn, remaining (if intermittently) through winter, and departing in spring. This species utilises the Development Envelope for foraging but is unlikely to use the area for breeding as it is outside the current known breeding range (although some birds have been seen during summer and although these could be non-breeding individuals or adults, they could also be breeding pairs). Group size ranges from two to 107, with a mean of 14.5 +/- 3.5 (Lee et al. 2012a). This species main feeding source in the area is Marri (Lee et al. 2012a). Clearing will result in local habitat loss and may displace individuals from the local population into the surrounding Jarrah–Marri forest. Within a 10 km radius of the mine, 75% of the area consists of native vegetation and the operation is boarded to the west by the 180 000 ha Dwellingup State Forest. On a regional scale, the Proposal is not expected to significantly reduce the extent of Marri and Jarrah in the region. Rehabilitation of the majority of the mine footprint will be undertaken over time and will focus on providing foraging habitat for black cockatoos within eight to ten years. Suitable foraging habitat is widespread in the Jarrah forest and the Proposal is not expected to significantly reduce availability of any foraging resource. The residual effect on the species of local habitat loss is addressed with the offset package described in Section 14.

Species	Predicted impact from vegetation clearing
Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*	This species utilises the majority of habitat types in the Development Envelope for both breeding and foraging. This species feeds on a wide variety of food sources, including pine plantations, Jarrah, Marri and proteaceous shrubs and is known to breed in the area (Lee et al. 2012a). Group size ranges from one to 90, with a mean of 10.1 +/- 1.3 and 85.3% of groups consisted of less than 20 birds (Lee et al. 2012a). Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) suggest that eastern acquired lands could contain between 20–50 breeding pairs, with the number breeding varying from year to year (Finn 2011). The proposed clearing will result in local habitat loss and may displace individuals from the local population into the surrounding Jarrah–Marri forest, but is not expected to significantly reduce habitat availability regionally. Rehabilitation of the majority of the mine footprint will be undertaken over time and will focus on providing foraging habitat for black cockatoos within eight to ten years and also provide breeding habitat in the long-term. The residual effect on the species from local habitat loss is addressed with the offset package described in Section 14.
Peregrine Falcon *Falco peregrinus*	One record of Peregrine Falcon exists from the 2001/2002 survey (Ninox 2003). Species prefers coastal and inland cliffs and while it is not common anywhere, its distribution ranges across Australia. The species is considered unlikely to be reliant on the area for foraging habitat.
Rainbow Bee-eater *Merops ornatus*	The Proposal does not affect any area of 'important habitat' as defined by the EPBC Act as supporting an ecologically significant proportion of the population of the species, and/or habitat that is of critical importance to the species at particular life-cycle stages, and/or habitat which is at the limit of the species range, and/or habitat within an area where the species is declining, nor does it impact an 'ecologically significant proportion' of the population given the small numbers recorded and believed to occur compared to the species' range and abundance across Western Australia and national Australia.
Fork-tailed Swift *Apus pacificus*	The Proposal does not affect any area of 'important habitat' as defined by the EPBC Act as supporting an ecologically significant proportion of the population of the species, and/or habitat that is of critical importance to the species at particular life-cycle stages, and/or habitat which is at the limit of the species range, and/or habitat within an area where the species is declining, nor does it impact an 'ecologically significant proportion' of the population given the small numbers recorded and believed to occur compared to the species' range and abundance across Western Australia and national Australia.
Dell's Skink *Ctentus delli*	Only one individual was recorded in the vicinity of the NBG mine site in Wandoo woodland in the recent survey (Ninox 2012b). Although previous records exist from 1998 and 2004, this area is unlikely to support a significant population or that the species is reliant on the area.
Carpet Python *Morelia spilota imbricata*	This species has not been recorded in the area since 1984. It is unlikely that this area supports a significant population or that the species is reliant on the area.

10.4.2 Vehicle and heavy machinery movements

Increased movement of vehicles and heavy machinery during the clearing and construction phases of the Proposal has the potential to result in vehicle strike, causing injury or death to individuals. During 2012, 74 incidents of fauna mortality, attributable to vehicle strike, were recorded, with the majority of these along the site access road (Gold Mine Road). The majority of these incidents involved kangaroos and wallabies with a few possums, bandicoots and snakes; however, there were two Chuditch and one Woylie death attributed to vehicle interactions on Gold Mine Road in 2012. Given the relatively minor increase in production rates proposed, no significant increase in vehicle movements is expected over the life of the operation and therefore the incidence of fauna strike is unlikely to increase significantly from current levels. Vehicle strike is unlikely to affect the viability of local populations.

10.5 Management measures and performance standards

The potential impacts associated with the Proposal will be managed and mitigated through the implementation of the Black-Cockatoo Management Plan and Terrestrial Fauna Management Plan (Appendix 1). This plan integrates existing management measures to provide a consolidated list of management actions.

Key measures in the Black-Cockatoo Management Plan include:

- providing information to all employees and contractors (through the site induction process)on Black cockatoos and any other factors that may have a direct or indirect impact on populations
- communicating requirements of black cockatoo management at neighbouring schools and community meetings
- including black cockatoo theme topics in World Environment Day activities
- demarcating areas on-ground prior to clearing to ensure foraging and habitat trees of significance are avoided
- surveying potential habitat trees in clearing area to determine if any nestlings are present
- waiting until nestlings have left the nest before felling any potential habitat trees in the disturbance area
- installing and maintaining drinking points near known breeding and feeding areas
- maintaining permanent drinking water on the site of higher water quality (naturally more attractive to birds) than RDAs
- destruct WAD-cyanide
- utilising Wildlife Observers to monitor wildlife accessing F1 RDA and new RDA
- ensure noise levels are managed in accordance with the Noise Regulations
- ensure lighting is directed to minimise light spill outside the mining area
- maintaining roads and tracks to prevent formation of water holding structures
- ensuring food plant and hollow-producing tree species are used in rehabilitation seed mixes
- clearly demarcating areas to be retained for conservation (i.e. protected from mining activities) to ensure the habitat remains of high quality for black cockatoos
- ensuring areas selected for conservation for black cockatoos contain high-value habitat and/or breeding trees
- control feral bees in and around the mine site
- investigating the benefit of using artificial nest hollows in remnant forest areas
- ensure actions are consistent with existing black cockatoo recovery plans
- continuing research into habitat use by black cockatoos to improve understanding of potential impacts and continuously improve mitigation and rehabilitation methodologies to best support these species.

Key measures in the Terrestrial Fauna Management Plan include:

- providing information to all employees and contractors (through the site induction process) on fauna management requirements (e.g. speed limits, how to manage injured fauna etc)
- installing relevant signage on roads and entry points to the mine noting presence of fauna
- conduct fauna trapping and relocation prior to areas being cleared
- implementing a phased clearing approach for area the Proposal
- ensure all access roads are clearly signposted with speed limits
- conduct regular spot checks of vehicle speed in and around the mining operation
- restricting access to forest areas through signage and closure of tracks
- displaying maps and photographs of fauna through fact sheets and information bulletins in the workplace to raise awareness and facilitate identification and on-the-ground management
- report all observations of protected fauna to the Site Environmental Department who will maintain records
- giving native animals encountered on-site the opportunity to move on if there is no threat to personnel safety in doing so
- if sick or injured animals are encountered, contacting local carers to assess possible rehabilitation of the animal

- ensuring food waste is not accessible to attract native fauna or feral animals
- prohibiting pets and firearms on the NBG leases
- ensuring some connectivity between the eastern and western vegetated areas of the mine site through implementing fauna access and egress ability across roads and pipelines, and/or undertaking periodic trapping and relocation of fauna
- reporting all observations of feral animals to the Site Environmental Department who will maintain records
- restricting access to NBGPL–owned property for apiarists
- working with DPaW and/or local conservation groups to continue to control feral pigs, cats and foxes in and around the mine site
- continuing research into habitat use by key species of conservation significance to improve understanding of potential impacts and continuously improve mitigation and rehabilitation methodologies to best support these species.

10.6 Predicted environmental outcomes

After application of the above management measures, it is predicted that the Proposal will result in the following environmental outcomes.

- clearing of up to 1755 ha of native vegetation, which will reduce the extent of available fauna habitat in the local area but will not have a significant effect on regional fauna habitat availability. Habitat types within the Development Envelope are widespread and well represented in the large areas of jarrah forest to the west of the operation
- minor increased fragmentation of the 5000 ha of vegetation to the east of the Development Envelope and increased monitoring and management of the remaining east–west linkages to maintain connections that will allow genetic mixing and recolonisation potential in the event of a fire or disease in the eastern area that could affect local populations
- clearing of up to 1755 ha of black cockatoo habitat which is utilised as foraging habitat for all three species of black cockatoo and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoos; rehabilitation will be targeted at providing appropriate foraging species for black cockatoos and eventually providing additional habitat trees
- no significant increase in vehicle strike during the life of operation.

The Proposal is highly unlikely to result in a change in status of conservation for any species and will not significantly impact regional distribution of fauna habitat availability. Geographical distribution and productivity of fauna at species and ecosystem levels will be maintained through management and mitigation measures. The significant residual impacts of fauna habitat loss generally, and black cockatoo habitat specifically, will be addressed through the offset package outlined in Section 14.

In considering the outcome as described, the Proposal is expected to meet the EPA objectives for fauna.

11. Matters of National Environmental Significance

11.1 Relevant environmental objectives, policies, guidelines, standards and procedures

11.1.1 EPBC Act objectives

The EPBC Act objectives are to:

- *provide for the protection of the environment, especially Matters of National Environmental Significance (MNES)*
- *promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources.*

11.1.2 Legislation, policy, guidance

Australian Government Protection

The Australian Government EPBC Act protects species listed under Schedule 1 of the Act. In 1974, Australia became a signatory to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, an official list of endangered species was prepared and is regularly updated. This listing is administrated through the EPBC Act. The current list differs from the various State lists; however, some species are common to both.

The EPBC Act aims to prevent significant impacts occurring to MNES, including threatened species, through assessment of proposed actions against the Matters of National Environmental Significance: Impact Guidelines (DEWHA 2009).

International Agreements

Australia is party to the Japan-Australia (JAMBA), China-Australia (CAMBA), Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements and the Convention on the Conservation of Migratory Species of Wild Animals. Most of the birds listed in these agreements are associated with saline wetlands of coastal shorelines and have little relevance to the Development Envelope; however, some migratory birds not associated with water are also listed on these international treaties.

11.2 Findings of surveys and investigations

Based on previous surveys (described in Section 10.2.1), the DSEWPaC Species Profile and Threats (SPRAT) database (DSEWPaC 2013) and literature searches (including from within 10 km of the area), there are seven Threatened fauna species, one Threatened flora species and five Migratory bird species listed under the EPBC Act that may occur in the Development Envelope (Table 37). Several of these species have been recorded within or adjacent to the Development Envelope during previous fauna surveys (Table 37 and shown in Figure 38 to Figure 37).

Of the 13 EPBC Act listed species identified as potentially occurring in the area, six have been recorded on or near the mine site. These species are:

- Birds:
  - Forest Red-tailed Black-Cockatoo: Vulnerable
  - Baudin's Black-Cockatoo: Vulnerable
  - Carnaby's Black-Cockatoo: Endangered
  - Rainbow Bee-eater – Migratory

- Mammals:
  - Brush-tailed Bettong (Woylie) – Endangered
  - Chuditch – Vulnerable.

Table 37 Likelihood of occurrence of MNES

Species	EPBC Status	Likelihood of occurrence
Threatened birds		
Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*	Vulnerable	Recorded (Ninox 2012a, 2012b). Resident year-round but distribution shifts periodically, most likely in response to the availability of food sources and, in summer, to the presence of reliable water sources. Group size ranges from one to 45, with a mean of 7.4 +/- 0.6 and 92.1% of groups consisting of less than 20 individuals (Lee et al. 2012a). Known to forage and breed in the area.
Baudin's Black-Cockatoo *Calyptorhynchus baudinii*	Vulnerable	Recorded (Ninox 2012a, 2012b). Group size ranging from two to 107, with a mean of 14.5 +/- 3.5 and 78.1% of groups consisting of less than 20 individuals (Lee et al. 2012a). Known to forage in the area. No evidence of breeding has been detected but some individuals were seen in the area during the breeding season.
Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*	Endangered	Recorded (Ninox 2012a, Lee et al. 2012a). Group size ranges from one to 90, with a mean of 10.1 +/- 1.3 and 85.3% of groups consisting of less than 20 individuals (Lee et al. 2012a). This species utilised the greatest variety of habitat types in the area.
Malleefowl *Leipoa ocellata*	Vulnerable Migratory	Unlikely to occur. This species occurs in semi-arid and arid zones of temperate Australia in shrublands and low woodlands that are dominated by mallee vegetation, and has not been recorded in the local area.
Australian Painted Snipe *Rostratula australis*	Vulnerable Migratory	Unlikely to occur. This species requires shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby.
Threatened mammals		
Woylie/Brush-tailed Bettong *Bettongia penicillata ogilbyi*	Endangered	Recorded within Development Envelope to the east of WRD and approved footprint (Ninox 2012a).
Chuditch *Dasyurus geoffroii*	Vulnerable	Recorded within RDA and northeast and northwest of WRD (Ninox 2012a; 2012b).
Red-tailed Phascogale *Phascogale calura*	Endangered	Unlikely to occur. This species occurs in *Allocasuarina* woodlands with hollow containing eucalypts and *Gastrolobium* spp. Populations are now restricted to remnants of vegetation in the Wheatbelt of southwestern Western Australia (DSEWPaC 2013). The NBG mine site is outside the known distribution of this species.
Quokka *Setonix brachyurus*	Vulnerable	Unlikely to occur. The Quokka occurs on two offshore islands; Rottnest Island and Bald Island and in a number of sites in the southwest of Western Australia (DSEWPaC 2013). On the mainland, it occurs in dense streamside vegetation and also heaths and shrublands on the coast.
Migratory birds		
Rainbow Bee-eater *Merops ornatus*	Migratory	Recorded in one location to the east of the WRD (Ninox 2012a). Occurs in open forests and woodlands, shrublands and cleared or semi-cleared habitats. It also occurs in inland and coastal dune systems.
Fork-tailed Swift *Apus pacificus*	Migratory	May potentially occur, but not recorded. They occur mainly over inland plains, foothills and coastal areas, and dry or open habitats, riparian woodland, swamps, scrub, heathland, saltmarsh and urban areas (DSEWPaC 2013).
Great Egret *Ardea alba*	Migratory	Unlikely to occur. This species occurs in a range of wetland habitats including swamps, marshes, margins of rivers and lakes, damp grassland and agricultural lands (DSEWPaC 2013).

Species	EPBC Status	Likelihood of occurrence
Cattle Egret *Ardea ibis*	Migratory	Unlikely to occur. Typical habitat includes tropical and temperate grasslands, wooded lands and terrestrial wetlands (DSEWPaC 2013).
White-bellied Sea Eagle *Haliaeetus leucogaster*	Migratory	Unlikely to occur. This species occurs in coastal habitats and around terrestrial wetlands in temperate and tropical regions (DSEWPaC 2013).
Threatened flora		
Shy Featherflower *Verticordia fimbrilepis* subs. *fimbrilepis*	Endangered	This species occurs in low-lying shallow grey sand and yellowish-white sandy loam over gravel, sometimes with clay, in heath and open Wandoo woodland (DSEWPaC 2013). This species has not been recorded by any survey and is considered unlikely to occur.

11.2.1 Habitat types

Based on vegetation and flora surveys conducted to date, 11 dominant fauna habitat types have been identified (Henry J [Ninox Wildlife Consulting] 2012, pers comm. 13 December). The vegetation units were broken into habitat types with consideration of their key habitat values for fauna, which relate to vegetation structure, dominant species, soil type and position in the landscape. These are:

1. Eucalypt/paperbark on seasonally wet valley floors (comprising A, A2 and A3 vegetation units).
2. Yarri–Wandoo on wetter lower slopes (comprising L and LG vegetation units).
3. Eucalypt woodlands on wetter lower slopes (comprising W, AD, AX and AY vegetation units).
4. Jarrah–Marri woodland forest over heath understorey (comprising DG, HG, H, H2 and SW vegetation units).
5. Mixed Wandoo/Jarrah/Marri over heath understorey (comprising M2 and MG vegetation units).
6. Mallee heath (comprising G1, G3 and G4 vegetation units).
7. Heath and rock Sheoak on granite outcrops (comprising G2 vegetation unit).
8. Wandoo woodland (comprising M, Y and YG vegetation units).
9. Jarrah/Marri forest over Sheoak/Banksia (comprising P, PS, PW, S, SP and ST, vegetation units).
10. Jarrah/Marri woodland/forest (comprising B, D, E, Z, J, O and R vegetation units).
11. Timber plantations.

The distribution of the eleven habitat types is illustrated in Figure 32.

Woylie habitat assessment

This species was once widespread across mainland Australia but is now restricted largely to southwest Western Australia, with some translocated populations in South Australia and New South Wales (DEC 2012). Past threats for this species have included predation by feral animals (foxes and cats), altered fire regimes and habitat destruction (SPRAT 2012). Translocated populations have had mixed success but the species appears to respond quickly to changes in their environment, such as removal of predators (e.g. wide scale fox baiting under Western Shield led to an increase in distribution and abundance of the Woylie).

Woylies are known to occur in seven nature reserves, 14 national parks, eight state forest areas, one timber reserve and two conservation parks (SPRAT 2012). Woylie populations have also been established within fenced wildlife sanctuaries.

Under the Woylie Recovery Plan (DEC 2012) habitat considered critical to the survival of the Woylie includes:

- Tall eucalypt forest and woodland
- Dense myrtaceous shrubland
- Proteaceous or mallee heath.

A common characteristic in habitats where Woylie are found in Western Australia is the presence of *Gastrolobium* thickets. This vegetation could act as a refuge from introduced predators by providing a physical hiding place for Woylie but also through poisoning. *Gastrolobium* is known to contain monofluoroacetic acid, which is present as sodium monofluoroacetate in toxic 1080 bait (commonly used for fox baiting) (SPRAT 2012). *Gastrolobium* is present around NBG with dense patches occurring in remnant vegetation located on Hotham Farm and in the native vegetation to the east of the operation. However, Gastrolobium was not present at the locations where Woylie were recorded in the 2011/12 survey.

Based on this information, there is extensive suitable Woylie habitat surrounding NBG in both private and state forest.

Translocations of Woylies were conducted by the DEC in the mid 1990s as part of Operation Foxglove. The vegetation to the east of NBG was used as a release point for Woylie during this time. There has been no monitoring of this translocation area but the species would appear to be persisting. Woylies were not recorded at NBG in past surveys (1984 and 2001/02) but were recorded in the latest 2011/12 survey close to the mining operations due to the translocation of the species and short dispersal distances commonly observed for this species (Pacioni et a. 2010).

All three Woylies were trapped in cage traps with one female with a pouch joey trapped in autumn and two adults (sex was not determined) in summer. All three were found to the east of mining operation, one towards the south and the other two in the vegetation between the mine operation and the F1/F3 RDA. The native vegetation (State and private forest) surrounding NBG has undergone regular fox baiting by the DEC as part of the Western Shield program since the mid 1990s and this has most likely contributed greatly to the persistence of the species in this area.

Woylies feed on hypogenous fruiting bodies of ectomycorrhizal fungi (SPRAT 2012) and therefore threats that may impact on fungal communities could include the root pathogen *Phytophthora cinnamomi* (DEC 2012) and feral pigs (which disturb extensive areas of ground and potentially spread *P. cinnamomi*). To date, one infestation of *P. cinnamomi* has been detected to the east of NBG as well as three small patches of *Armillaria luteobubalina* infestation to the east of NBG. However, this area has been largely classified as uninfested or uninterpretable (areas where too few indicator plants are present to determine the presence or absence of forest disease).

Chuditch habitat assessment

Chuditch are quite generalist in their habitat use, ranging from forest to woodland and desert. They are generally found in low densities, capable of travelling long distances and have relatively large home ranges (DEC 2012). The nomadic and solitary lifestyle makes the population difficult to estimate, however, it appears the species is now restricted to Western Australia with around 75% of the remaining population occurring in eucalypt forests and woodlands and mallee health and shrublands of southwest WA (DEC 2012).

The main threats attributed to the decline of this species include land clearing, predation by introduced species, accidental and deliberate poisoning or hunting (as they may interact with farmers) and roadkill (SPRAT 2012). Areas where fox control is implemented seem to have higher densities of Chuditch (SPRAT 2012).

Important factors for Chuditch habitat appear to be the presence of suitable dens resources (such as hollow logs, burrows or rock crevices), adequate prey and large enough areas for large home ranges (DEC 2012).

Chuditch have been recorded in all surveys completed at NBG, however, trapped numbers have varied considerably during this time with two recorded in 1984, 47 in 2001/02 and a total of 19 in the most recent 2011/12 survey (eight in the WRD area and 11-in-the RDA area). Similar results have been seen at the Boddington Bauxite Mine south of NBG (Ninox 2012a). Fox baiting as part of Western Shield has most likely contributed greatly to the success of the local population since its implementation in the mid-1990s. Due to their Chuditch have the potential to inhabit all of the habitat types within the native vegetation surrounding NBG.

Due to the need for large areas of habitat, this species is most likely restricted in fragmented habitats.

Black cockatoo habitat assessment

Three species of black cockatoo occur in southwestern Australia (Baudin's Black-Cockatoo, Carnaby's Black Cockatoo and Forest Red-tailed Black-Cockatoo). All three were found to forage in this area, with feeding activity greater in anthropogenic habitats (i.e. the timber plantations and mine site rehabilitation sites) than in native forest (Lee et al. 2012b). Carnaby's and Forest Red-tailed Black Cockatoos are known to breed in the local area.

Table 38 provides a summary of occupancy, foraging and breeding utilisation of the area by black cockatoos.

Table 38 Summary of habitat utilisation by three species of black cockatoo

Species	Occupancy	Foraging utilisation	Breeding utilisation
Baudin's Black-Cockatoo	Utilises native forest and rehabilitation areas, during non-breeding season from March/April to September/October. Few very large flocks of Baudin's Black-Cockatoos were observed, with group size ranging from two to 107, with a mean of 14.5 +/- 3.5 and 78.1% of groups consisting of less than 20 individuals (Lee et al. 2012a).	Forages predominantly on Marri but is likely to also utilise other species present at NBG	No breeding within the Development Envelope
Carnaby's Black-Cockatoo	Occupies native forest and woodland year-round with higher numbers in spring and summer indicating migrating or transient flocks and some year-round residents. Few very large flocks of Carnaby's Cockatoos were observed, with group size ranging from one to 90, with a mean of 10.1 +/- 1.3 and 85.3% of groups consisting of less than 20 individuals (Lee et al. 2012a). Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) suggest that eastern acquired lands could contain between 20–50 breeding pairs, with the number breeding varying from year to year (Finn 2011).	Forages on Jarrah, Marri, timber plantation and proteaceous shrubs	Breeds in both Jarrah–Marri and Wandoo woodland
Forest Red-tailed Black-Cockatoo	Occupies native forest and woodland year-round. Few very large flocks of Forest Red-tailed Black-Cockatoos were observed, with group size ranging from one to 45, with a mean of 7.4 +/- 0.6 and 92.1% of groups consisting of less than 20 individuals (Lee et al. 2012a). The total local Forest Red-tailed Black-Cockatoo population associated with the eastern acquired lands and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011).	Forages on Jarrah and Marri	Breeds in both Jarrah-Marri and Wandoo woodland

The ecological baseline study of black cockatoos within NBG mining tenements and adjacent areas (Lee et al. 2012a) determined the following:

Baudin's Black-Cockatoos

Baudin's Black-Cockatoos were mainly recorded in native forest areas but were also observed utilising mine site rehabilitation habitats for roosting and foraging. Baudin's Black-Cockatoos utilise the NBG site during the non-breeding season from April to September and found to feed predominantly on Marri at NBG (Lee et al. 2012a), including Marri in rehabilitated areas at NBG within eight years of establishment (Finn 2011). Few very large flocks of Baudin's Black-Cockatoos were observed, with group size ranging from two to 107, with a mean of 14.5 +/- 3.5 and 78.1% of groups consisting of less than 20 individuals (Lee et al. 2012a). The NBG site is outside of this species' known breeding range, which includes the southern Jarrah–Marri forest and Karri forests (Lee et al 2012a; DEC 2007).

Carnaby's Black-Cockatoos

Carnaby's Black-Cockatoos were recorded utilising a variety of habitats (including native vegetation, mine site rehabilitation and pine plantation) and feeding on a broad range of plants, including Pine, Jarrah, Marri and proteaceous species. While observations indicate that Jarrah is an important food source, no vegetation type accounted for more than 20% of feeding observations for this species. This species was the most abundant species recorded in a survey immediately to the east of the survey area and was the second-most common species at NBG (after Forest Red-tailed Black-Cockatoos).

Carnaby's Black-Cockatoos were recorded at NBG year-round and breeding pairs were observed but numbers peaked in spring and summer (Lee et al. 2012a). Few very large flocks of Carnaby's Cockatoos were observed, with group size ranging from one to 90, with a mean of 10.1 +/- 1.3 and 85.3% of groups consisting of less than 20 individuals (Lee et al. 2012a). These observations indicate that Carnaby's Black-Cockatoos breed in the area in low numbers and higher numbers utilise the area predominantly for foraging. Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) suggest that eastern acquired lands could contain between 20–50 breeding pairs, with the number breeding varying from year to year (Finn 2011).

Forest Red-tailed Black-Cockatoos

Forest Red-tailed Black-Cockatoos were primarily recorded utilising native forest and woodland areas, with paddocks also providing habitat for feeding (in isolated remnant trees) and drinking. This species was not recorded in mine site rehabilitation areas; however, feeding residues of this species have been identified in rehabilitation areas, indicating that some feeding activity occurs (Lee et al. 2012b). The availability of water in anthropogenic sources may be particularly important for this species as it has the highest basal metabolic rate and evaporative water loss of the black cockatoo species occurring in southwestern Australia. The Forest Red-tailed Black-Cockatoo feeds mostly on Marri and Jarrah, but may feed on other plants such as Sheoak and Yarri should Marri and Jarrah be limited.

This species occurs year round and was not observed to undertake seasonal changes in occupancy, suggesting a resident population. Few very large flocks of Forest Red-tailed Black-Cockatoos were observed, with group size ranging from one to 45, with a mean of 7.4 +/- 0.6 and 92.1% of groups consisting of less than 20 individuals (Lee et al. 2012a). The total local Forest Red-tailed Black-Cockatoo population associated with the eastern acquired lands and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011).

Systematic sampling of vegetation within the southern half of the Development Envelope and an area immediately to the east of the Development Envelope (referred to as the eastern acquired lands) identified 55 potential hollow-bearing trees within 21 plots (425 plots in native vegetation were surveyed) (Finn 2011) as shown in Figure 34. Of the potential hollows identified, 29 were outside the Development Envelope, 23 were inside the Development Envelope but unlikely to be affected and three were likely to be affected by the Proposal.

Post-felling inspections of trees identified with potential nesting hollows (determined from ground-based surveys) found that only 31.5% of potential hollows in Jarrah were actually large enough for nesting. However, these proportions were higher for Marri (55.6%) and Wandoo (66.7%) (Finn 2011). Application of these proportions gives potential black cockatoo nest hollow distribution estimates of 38 per km^2 for Jarrah, 27 per km^2 for Marri and 18 per km^2 for Wandoo (Finn 2011). Similar distributions of potential nest hollows would be expected within the remnant vegetation within the Development Envelope. These estimates are conservative, and Finn (2011) states that these densities should be viewed with care as other factors for suitable nesting should be considered, such as (a) black cockatoos appear to rarely nest within Jarrah in the Jarrah-Marri forest, and (b) nest-site suitability is almost certainly linked to food availability and the presence of permanent water sources. Therefore, it is most likely that nesting activity is restricted to Marri and Wandoo hollows located near to sumps, swamps and farm dams.

11.3 Potential sources of impact

The main impacts to MNES will arise from the following environmental aspects of the proposal:

- **clearing of vegetation** resulting in the loss or fragmentation of fauna habitat and consequent displacement of fauna
- **vehicle and heavy machinery movements** during clearing and construction, may result in fauna strike causing injury or death to individuals.

11.4 Assessment of likely direct and indirect impacts

11.4.1 Clearing of vegetation

As described in Section 10, up to 1755 ha of native vegetation clearing will be required for the Proposal with approximately 1540 ha of clearing for the RDA and WRD areas (Table 39) and approximately 215 ha of clearing for supporting infrastructure (as described in Table 5). The location of the supporting infrastructure has not yet been finalised but will be within the Development Envelope (Figure 4) and will be located so as to avoid vegetation areas of conservation significance.

Clearing of vegetation will directly reduce the extent of available fauna habitat within the local area surrounding the existing mine site. All vegetation communities recorded within the Development Envelope extend beyond the boundaries of the area surveyed and are well represented in the State Forest that occurs to the west. The proposed clearing represents <1% of any one vegetation complex and no clearing is proposed within any vegetation complex that is poorly represented in reserves or has less than 30% of the pre-European extent remaining. Consequently, the fauna assemblages recorded within the Development Envelope are considered highly likely to be well represented within the surrounding forest and unlikely to be restricted to the Development Envelope.

The extent of each mapped habitat type (shown on Figure 32) within the area subject to detailed Level 2 vegetation survey and area proposed to be cleared is shown in Figure 4, Section 1.5. All habitat types are well represented outside the Development Envelope with no more than 20% of the surveyed extent of any one habitat type being proposed to be cleared. Therefore, all fauna habitats will continue to be well represented in the local area and no local extinctions would be expected as a result of the Proposal.

Table 39 Extent of fauna habitat to be cleared

Habitat type	Habitat within area subject to detailed Level 2 vegetation survey (ha)	Proposed clearing (ha)	% of total
Eucalypt/paperbark on seasonally wet valley floors	556	101	18.1
Yarri–Wandoo on wetter lower slopes	235	20	8.6
Eucalypt woodlands on wetter lower slopes	972	131	13.5
Jarrah–Marri woodland-forest over heath understorey	4956	371	7.5
Mixed Wandoo/Jarrah/Marri woodland over heath understorey	726	8	1.2
Mallee Heath	192	4	2.3
Heath & rock Sheoak on granite outcrops	179	0	0
Wandoo woodland	4388	268	6.1
Jarrah–Marri forest over Sheoak–Banksia	6603	326	4.9
Jarrah–Marri woodland-forest	1827	310	17.0
Total mapped extent of habitat in native vegetation	**20 635**	**1540**	**-**

Ninox 2012b identifies that the occurrence of species within the fragmented areas of Wandoo woodland between the plantations is due to the presence of several relatively narrow corridors of native vegetation. Both Chuditch and Woylie may forage on the margins of plantations, but they are unlikely to find primary shelter sites in a plantation (Bamford M [Bamford Consulting Ecologists] 2013, pers. comm. 7 June).

In addition to direct removal of potential foraging or breeding habitat in the immediate area around the operation mine site, the Proposal has the potential to also fragment local habitats to the east of the operation. To the east of the Development Envelope, there is an area of over 5000 ha of native vegetation that is bounded by:

- cleared farmland to the east and south
- plantations to the north
- the NBG site to the west, which is connected to extensive areas of native vegetation to the west and northeast by a number of linkages (Figure 4).

The southern extension of the WRD has the potential to increase fragmentation by removing one of the native vegetation corridors between this eastern vegetation and the Dwellingup State Forest to the west. However, this extension south was determined to be the best option for the expansion as the alternative (expansion into native vegetation to the east) would impact on areas where species of conservation significance (including Woylies) have been found during surveys (Ninox 2012a, 2012b).

Woylies were recorded in the area east of the existing operations. This area contains Gastrolobium thickets that are known to provide a refuge habitat for Woylies as the dense growth provides shelter from predators such as foxes and Gastrolobium also contains monofluoroacetic acid which is the compound present as sodium monofluoroacetate in the toxic bait '1080' used to control exotic predators such as foxes and cats. Vegetation surveys (Mattiske 2012b) recorded *Gastrolobium* spp. in the H2, Y and YG vegetation units, which is sparsely distributed primarily to the east of the Development Envelope. No exotic predators such as foxes or cats were recorded in this area (Ninox 2012b).

Chuditch have been recorded during fauna surveys of the area since 1984; however, numbers have varied greatly during this time indicating a boom and bust type nature to the local population. Similar results have been found at the nearby Boddington Bauxite Mine (BBM) (Ninox 2012a). The State Forest and private forest around the mine has been a focus area for fox baiting as part of Operation Foxglove since the 1990s. This program has most likely greatly contributed to the maintenance of the Chuditch population in the area (considering low numbers were recorded in the 1980s, with higher numbers in the 2001/02 and then reasonable numbers in a 1996/97 survey (BBM) and the 2011/12 survey at NBG.

The linkages to be maintained include the area between the existing mining operations and the F1/F3 RDA area. There is some infrastructure located within this area including a road and pipelines but is broad (approximately 500 m at its narrowest point to 2 km at its widest) and still likely to be utilised by fauna to some extent (Figure 4). Historical oxide pits in this area have been rehabilitated improving the quality of the vegetation in this area. A second linkage will remain between the existing F1/F3 RDA and the proposed RDA (partially in the timber plantations) where a 170 m width band of native vegetation will be maintained between the two RDAs, although this linkage will also be crossed by a road and pipeline.

Woylies and Chuditch have been recorded in the 2011/12 fauna survey within 1 km of operations between the existing mine pits and the existing RDA, indicating that this area may already be utilised as a corridor to the western State Forest. This corridor will not be affected by the proposal. As this area is already highly fragmented, the key issues for further fragmentation is the maintenance of a genetic connection with potential fauna populations in the jarrah forest to the west and the maintenance of a connection that will allow recolonisation of the area should there be local extinctions due to fire or disease. NBGPL will consult with experts to identify appropriate mitigation actions that will allow this connection to be maintained and if further mitigation measures such as fauna egress areas are required.

11.4.2 Vehicle and heavy machinery movements

Increased movement of vehicles and heavy machinery during the clearing and construction phases of the Proposal has the potential to result in vehicle strike, causing injury or death to individuals. During 2012 year, 74 incidents of fauna mortality, attributable to vehicle strike were recorded, with the majority of these along the site access road (Gold Mine Road). The majority of these incidents involved kangaroos and wallabies with a few possums, bandicoots and snakes, however, there were two Chuditch and one Woylie death attributed to being hit by vehicles on Gold Mine Road in 2012. Given the relatively minor increase in production rates proposed, no significant increase in vehicle movements is expected over the life of the operation and therefore the incidence of fauna strike is unlikely to increase significantly from current levels. Vehicle strike is unlikely to affect the viability of local populations.

11.4.3 Significant impact criteria

Significant impact criteria, established by the former DEWHA (now DSEWPaC) (2009) are intended to assist in determining whether the predicted impacts of a proposed action on any MNES are likely to be significant impacts. Criteria are established for each category of MNES and each level of threat, for listed threatened species.

An assessment of the significance of potential impacts to each MNES relevant to this Proposal is provided in Table 40 to Table 45 below.

Table 40 Assessment of significance of potential impact to Forest Red-tailed Black-Cockatoo: Vulnerable

Criteria	Assessment
Is the action likely to:	
Lead to a long-term decrease in the size of an important population?	**Possible short-term impact to local population.** A small year-round population is likely to occupy the area, which will be affected by local habitat loss. Few very large flocks of Forest Red-tailed Black-Cockatoos were observed, with group size ranging from one to 45, with a mean of 7.4 +/- 0.6 (92.1% of all groups consisted of less than 20 birds) (Lee et al. 2012a). The total local Forest Red-tailed Black-Cockatoo population associated with the eastern Acquired Lands and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011). The species is highly mobile so is expected to relocate to nearby available habitat but could undergo some short-term disruption due to the loss of habitat. This short-term disruption to the local population is proposed to be offset through the offset package described in Section 14. The Development Envelope is not expected to support large transient or migratory flocks (Lee et al. 2012a).
Reduce the area of occupancy of an important population?	**Possibly.** This species primarily occupies Jarrah–Marri forest and also utilises paddocks for feeding and drinking in the NBG area. Vegetation clearing will result in some local habitat loss; however, large areas of similar habitat exist to the south, west and north of the Development Envelope.
Fragment an existing important population into two or more populations?	**Unlikely.** The Development Envelope is near the eastern edge of the northern Jarrah forest and the proposed clearing will not fragment black cockatoos in the area as the species is highly mobile and commonly crosses cleared areas.
Adversely affect habitat critical to the survival of a species?	**Unlikely.** Extensive suitable habitat is available to the south, west and north of the Development Envelope.
Disrupt the breeding cycle of an important population?	**Possibly.** The Development Envelope is considered unlikely to support large populations of this species. Clearing may result in a short-term disruption to some breeding pairs that utilise nesting hollows within the proposed disturbance footprint. Nesting hollows are not considered to be locally limiting and any individuals currently nesting in the Development Envelope are likely to find alternative hollows in adjacent protected forests, which are known to provide breeding habitat for this species.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	**Unlikely.** The Proposal will result in the local loss of foraging and breeding habitat suitable for this species; however, extensive suitable habitat occurs to the east, west and north of the Development Envelope in State Forest and on privately held land.

Criteria	Assessment
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	**Unlikely.** European honeybees occur throughout the Forest Red-tailed Black-Cockatoos range and are known to compete with black cockatoos for hollows and also cause injury or death of nesting females and chicks (DSEWPaC 2013). The Proposal is unlikely to result in an increase in numbers of European honeybees in the vicinity of the Development Envelope. Apiarists are not permitted to operate on NBG-owned land.
Introduce disease that may cause the species to decline?	**Unlikely.** While disease is not considered to be a threat to this species (DEC 2007), recent research supported by NBGPL has shown that Psittacine Beak and Feather virus (BFDV) and Avian Polyomavirus (APV) are present in wild populations (Warren et al. 2011). This work is ongoing and the disease status of populations around the Boddington area is still unknown. NBGPL will consider the results and impacts of this research as they become available; however, based on current knowledge the Proposal is unlikely to introduce a disease that may cause this species to decline.
Interfere with the recovery of the species?	**Unlikely.** Given the extensive availability of suitable habitat outside the Development Envelope, it is unlikely that this Proposal will interfere with the recovery of the species.

Table 41 Assessment of significance of potential impact to Baudin's Black-Cockatoo: Vulnerable

Criteria	Assessment
Is the action likely to:	
Lead to a long–term decrease in the size of an important population?	**Unlikely.** Baudin's Black-Cockatoos utilise the NBG area as foraging habitat; NBG is outside of the species known breeding range. As Jarrah/Marri forest foraging habitat is extensive to the north, west and south of the Development Envelope, the local habitat loss is not expected to decrease the numbers of Baudin's Black-Cockatoos in the area. Few very large flocks of Baudin's Black-Cockatoos were observed, with group size ranging from two to 107, with a mean of 14.5 +/- 3.5 (78.1% of groups consisted of less than 20 birds) (Lee et al. 2012a). This species has a north–south migration pattern whereby birds move through the area in autumn, remaining intermittently through winter and departing in spring. The species uses the area primarily for foraging on Marri. Extensive suitable alternative foraging habitat is available in the Jarrah/Marri forest to the north, west and south of the Development Envelope. There may be a potential short term impact to some individuals that breed in the area but due to the larger home ranges and highly mobile nature of this species, this will be a very localised and temporary impact.
Reduce the area of occupancy of an important population?	**Unlikely.** This species exhibits migratory behaviour, moving from northern feeding grounds in autumn–winter to southern Jarrah–Marri forests for breeding in spring (Lee et al. 2012a). The Development Envelope provides foraging habitat for this species; however, extensive suitable alternative foraging habitat occurs outside of the Development Envelope.
Fragment an existing important population into two or more populations?	**Unlikely.** Clearing is unlikely to fragment an important population given widespread availability of foraging habitat outside of the Development Envelope and the highly mobile nature of this species.
Adversely affect habitat critical to the survival of a species?	**Unlikely.** While the Development Envelope provides suitable foraging habitat for this species, extensive alternative foraging habitat occurs outside the Development Envelope. The Development Envelope occurs outside the known breeding range for this species; therefore, the Proposal will not impact breeding habitat.
Disrupt the breeding cycle of an important population?	**Highly unlikely.** The Development Envelope occurs outside of the known breeding range for this species; therefore, the Proposal will not impact breeding habitat. Whilst small groups have been seen in the area during the breeding season, no evidence of breeding has been observed during systematic surveys whilst breeding pairs of Carnaby's and Forest Red-tailed Black-Cockatoos have been located. It is possible that these birds were breeding pairs but it is also plausible that these were non-breeding juveniles or adults.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	**Unlikely.** The Proposal will result in the loss of foraging habitat for this species; however, extensive suitable alternative foraging habitat is widespread outside of the Development Envelope and local habitat loss is unlikely to affect the species overall numbers.

Criteria	Assessment
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	**Unlikely.** European honeybees occur throughout the Baudin's Black-Cockatoo range and are known to compete with black cockatoos for hollows and also cause injury or death of nesting females and chicks (DSEWPaC 2013). The Proposal is unlikely to result in an increase in numbers of European honeybees in the vicinity of the Development Envelope. Apiarists are not permitted to operate on NBGPL owned land.
Introduce disease that may cause the species to decline?	**Unlikely.** While disease is not considered to be a threat to this species (DEC 2007), recent research supported by NBGPL has shown that Psittacine Beak and Feather virus (BFDV) and Avian Polyomavirus (APV) are present in wild populations (Warren et al. 2011). This work is ongoing and the disease status of populations around the Boddington area is still unknown. NBGPL will consider the results and impacts of this research as they become available; however, based on current knowledge the Proposal is unlikely to introduce a disease that may cause this species to decline..
Interfere with the recovery of the species?	**Unlikely.** Given the extensive availability of suitable habitat outside the Development Envelope, it is unlikely that this Proposal will interfere with the recovery of the species.

Table 42 Assessment of significance of potential impact to Carnaby's Black-Cockatoo: Endangered

Criteria	Assessment
Is the action likely to:	
Lead to a long–term decrease in the size of a population?	**Possibly.** This species uses a wide variety of habitats in the area including rehabilitation areas and forages on a wide variety of food sources including Pine plantations (Lee et al. 2012a). Few very large flocks of Carnaby's Cockatoos were observed, with group size ranging from one to 90, with a mean of 10.1 +/- 1.3 (85.3% of groups consisted of less than 20 birds) (Lee et al. 2012a). Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) suggest that eastern Acquired Lands could contain between 20–50 breeding pairs, with the number breeding varying from year to year (Finn 011). Suitable alternative habitat is widespread outside the Development Envelope. The species is highly mobile so is expected to relocate to nearby available habitat but there could be some small population decline due to the habitat loss. This loss is proposed to be offset through the offset package described in Section 14.
Reduce the area of occupancy of the species?	**Possibly.** This species is known to forage and breed in the area and is recorded in all months of the year. Recordings fluctuate seasonally in the area, with highest numbers recorded in spring and summer (Lee et al. 2012a). While some habitat will be removed as part of this Proposal, suitable habitat is widespread outside of Development Envelope.
Fragment an existing population into two or more populations?	**Unlikely.** Clearing is unlikely to fragment an important population due to the widespread availability of foraging habitat outside the Development Envelope and the highly mobile nature of this species.
Adversely affect habitat critical to the survival of a species?	**Unlikely.** While the Development Envelope provides suitable foraging and breeding habitat for this species, alternative habitat occurs outside of the Development Envelope.
Disrupt the breeding cycle of a population?	**Possibly.** The Development Envelope is considered unlikely to support large populations of this species. Clearing may disrupt the breeding cycle of breeding pairs that utilise nesting hollows within the proposed disturbance footprint. This may cause displacement to forest areas to the east, west and north, including the eastern Acquired Lands, which are known to provide breeding habitat for this species (Lee et al. 2012a). Mitigation measures targeted at black cockatoo species will include habitat tree surveys being undertaken prior to clearing to determine if there is any breeding activity in an area and any trees being utilised for breeding will be left uncleared (including a buffer) until the chicks have left the nest.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	**Unlikely.** The Proposal will result in the loss of suitable habitat for this species within the immediate area surrounding the mine; however, suitable habitat is widespread outside of the Development Envelope and therefore species decline as a result of this proposal is considered unlikely.

Criteria	Assessment
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	**Unlikely.** European honeybees are known to occur throughout the Carnaby's Black-Cockatoo range and compete with black cockatoos for hollows and also cause injury or death of nesting females and chicks (DSEWPaC 2013). The Proposal is unlikely to result in an increase in numbers of European honeybees in the vicinity of the Development Envelope. Apiarists are not permitted to operate on NBGPL owned land.
Introduce disease that may cause the species to decline?	**Unlikely.** While disease is not considered to be a threat to this species (DEC 2007), recent research supported by NBGPL has shown that Psittacine Beak and Feather virus (BFDV) and Avian Polyomavirus (APV) are present in wild populations (Warren et al. 2011). This work is ongoing and the disease status of populations around the Boddington area is still unknown. NBGPL will consider the results and impacts of this research as they become available; however, based on current knowledge the Proposal is unlikely to introduce a disease that may cause this species to decline.
Interfere with the recovery of the species?	**Unlikely.** Given the extensive availability of suitable habitat outside the Development Envelope, it is unlikely that this Proposal will interfere with the recovery of the species.

Table 43 Assessment of significance of potential impact to Rainbow Bee-eater – Migratory

Criteria	Assessment
Is the action likely to:	
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	**Unlikely.** This species is highly adaptable to a variety of habitats including cleared and semi-cleared areas. This species has been recorded in the vicinity of the Development Envelope in low numbers, with only one sighting of two birds during the 2011–2012 fauna survey in the WRD area and eight individuals sighted over four sites in the RDA area (Ninox 2012a). Given this species' large range and population size across WA and Australia, the Development Envelope is unlikely to be important habitat.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	**Unlikely.** The only identified national threat to this species is the introduced Cane Toad (which does not occur in southwest WA); however, introduced predators such as foxes, dingoes and other feral dogs may prey upon this species (DSEWPaC 2013). The Proposal is implementing control and other mitigation actions to ensure that it is unlikely to result in an increase in any of these invasive species.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	**Unlikely.** This species is absent from the forest areas in autumn and winter and arrives around September for the breeding season. It is not known whether the species breeds within the current NBG area, but the lack of suitable sandy areas in which to construct their breeding burrows may prevent breeding (Ninox 2012a). Given this species' large range and population size across WA and Australia, the Development Envelope does not support an ecologically significant proportion of the population.

Table 44 Assessment of significance of potential impact to Woylie: Endangered

Criteria	Assessment
Is the action likely to:	
Lead to a long–term decrease in the size of a population?	**Unlikely.** To date this species has been recorded to the east of the current operation, which will not be impacted by vegetation clearing for this Proposal. However, there is potential habitat that will be disturbed as a result of the Proposal, particularly in the State Forest to the west. Given that there is extensive suitable habitat surrounding the proposal, it is unlikely that there will be a long-term decrease in the size of the local population. Three individuals were trapped in Jarrah and Wandoo woodland including a female with a pouch joey and two other individuals (Ninox 2012a). The area of vegetation east of NBG was a site of translocation for Woylie in the mid 1990s as part of Operation Foxglove. It is likely that this species has persisted in the area due to the presence of suitable habitat in an area where fox baiting has occurred (on private and State Forest land) since the mid 1990s.
Reduce the area of occupancy of the species?	**Possibly.** This species has been recorded to the east of the Development Envelope. This coincides with the presence of *Gastrolobium* spp. within vegetation unit H2, Y and G, which is known to provide refuge from feral predators. Some suitable habitat will be lost, particularly to the west; however, suitable habitat is not limited locally or regionally (to the west).
Fragment an existing population into two or more populations?	**Possibly.** Three individuals have been recorded to the east of the mine operation, within the Development Envelope. This area is already fragmented by farmland, plantations and the existing mine and operations. Increased fragmentation may occur with the expansion of the WRD further south. However, the central corridor between the mine operation and the F1/F3 RDA will not be further impacted by the Proposal.
Adversely affect habitat critical to the survival of a species?	**Possibly.** This species has been recorded east of the mining operation, within the Development Envelope, and although these areas are not to be impacted by the Proposal, there is potential suitable Woylie habitat that will be cleared, especially to the west in the State Forest.
Disrupt the breeding cycle of a population?	**Unlikely.** Breeding likely occurs in suitable habitat to the east of the mining operation, within the Development Envelope. Most trapped individuals were within close proximity to the existing mining operation, including a female with a pouch joey, which may indicate that the presence of the operation is not impacting breeding of the local population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	**Unlikely.** Low numbers of this species have been recorded east of the mining operation within the Development Envelope. This species was recorded for the first time in the area in the 2011/2012 fauna surveys. While some suitable habitat will be lost through vegetation clearing, given the low numbers likely present, and the commitment by NBGPL to maintain fauna habitat connections, it is unlikely that there will be any detectable decline in the species in the local area.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?	**Unlikely.** Introduced predators such as foxes and cats are a likely threat to this species; however, the Proposal is unlikely to result in the introduction or spread of existing or new predators or invasive species. The species habitat is also under risk from Dieback; however, the current operation has strict requirements around forest disease mitigation and the area undergoes regular monitoring by external experts for the presence of the disease.
Introduce disease that may cause the species to decline?	**Unlikely.** It is considered unlikely that the further expansion of the mine operation will result in the introduction of disease that will cause a decline in this species. Disease has been implicated by the Woylie Conservation Research Project as a possible threat to this species (DEC 2012). Diseases such as Trypanosomes and *Toxoplasma* have been found in the Upper Warren populations but are absent, or in low prevalence at other sites. Identifying whether or not disease is a contributing factor to the decline of this species is important and whilst the individuals recorded in this survey were considered to be in good health (i.e. no skin conditions or fur loss), any further survey work shall include screening for disease.
Interfere with the recovery of the species?	**Unlikely.** Given that low numbers of this species have been recorded to the east of the mining operation, within the Development Envelope, and the availability of suitable alternative habitat in the vicinity, it is unlikely that the Proposal will interfere with the recovery of the species.

Table 45 Assessment of significance of potential impact to Chuditch: Vulnerable

Criteria	Assessment
Is the action likely to:	
Lead to a long–term decrease in the size of an important population?	**Unlikely.** This species has been recorded in all fauna surveys since 1984 with numbers fluctuating from two in 1984 to 47 in 2001–2002 to eight in the WRD area and 11-in-the RDA area in the 2011–2012 surveys (Ninox 2012a, 2012b). This species is likely to be resident within the area and utilises Jarrah forest in both moist, dense undergrowth and dry, open forest in either steep or gently sloping terrain (DSEWPaC 2013). Vegetation clearing will result in removal of habitat; however, suitable habitat is widespread within and outside the Development Envelope.
Reduce the area of occupancy of an important population?	**Possibly.** Clearing will result in loss of Chuditch habitat. While individuals are known to occupy large home ranges, most recaptures in the 2012 surveys (Ninox 2012a; 2012b) occurred in the original capture location. It is possible that clearing may reduce the area of occupancy of the local population.
Fragment an existing important population into two or more populations?	**Possibly.** In the 2012 WRD survey (Ninox 2012a), Chuditch were recorded in four sampling locations to the northwest and northeast of the WRD location and in six of the seven sampling locations in the RDA area (Ninox 2012b). This species has been recorded in all surveys completed around the operation to date including 1984 (two individuals) and 2001/02 (47 individuals). Individuals are largely solitary in nature with relatively large home ranges. They may inhabit a wide variety of habitat types however habitat that appear key for this species include adequate den and prey resources as well as sizable areas (>20 000 ha) (DEC 2012). There is extensive suitable habitat within and surrounding the development envelope for this species. The surrounding private and State Forest has also been a focus for fox baiting under the Western Shield project since the 1990s, meaning that this risk is lowered in surrounding areas. NBGPL is committed to maintaining established fauna connections to ensure fauna movement between areas of habitat is maintained.
Adversely affect habitat critical to the survival of a species?	**Possibly.** The Proposal will result in some localised habitat loss; however, this species is expected to utilise all habitats found within and outside of the Development Envelope and these are not limited locally or regionally. The surrounding private and State Forest has been a focus of fox baiting activities since the 1990s and these activities are anticipated to continue in the long-term. Even in high quality habitat, Chuditch are known to be patchily distributed at low densities throughout their range (DEC 2012).
Disrupt the breeding cycle of an important population?	**Possibly.** This species is likely to breed in the vicinity of the existing mine operation as evidenced by the trapping of a female with a distended pouch and enlarged teats in January 2012 (Ninox 2012a). Any impact to the breeding cycle is anticipated to be short-term in nature and limited to the local population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	**Unlikely.** The Proposal will result in habitat loss; however, suitable alternative habitat is widespread in the jarrah forest within and outside of the Development Envelope. This is anticipated to be restricted locally and have a short-term impact in the immediate area. This is unlikely to result in a species decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	**Unlikely.** Predators such as foxes and cats are known threats to the Chuditch; however, the Proposal is unlikely to result in the introduction or spread of these or new invasive or predatory species. In addition, NBGPL undertakes ongoing feral animal control and has agreements in place with the DPaW for fox baiting to occur in surrounding State and private forest.
Introduce disease that may cause the species to decline?	**Unlikely.** Disease is not a known threat to the Chuditch.
Interfere with the recovery of the species?	**Unlikely.** Given the presence of Chuditch in close proximity to the existing operation and the recording of Chuditch in the majority of sampling locations, it is unlikely that the Proposal will interfere with the recovery of the species.

11.5 Management measures and performance standards

The potential impacts associated with the Proposal will be managed and mitigated through the implementation of the Black-Cockatoo Management Plan and Terrestrial Fauna Management Plan (Appendix 1). These plans integrate existing management measures to provide a consolidated list of management actions.

Key measures in the Black-Cockatoo Management Plan include:

- providing information to all employees and contractors (through the site induction process)on Black cockatoos and any other factors that may have a direct or indirect impact on populations
- communicating requirements of black cockatoo management at neighbouring schools and community meetings
- including black cockatoo theme topics in World Environment Day activities
- demarcating areas on-ground prior to clearing to ensure foraging and habitat trees of significance are avoided
- surveying potential habitat trees in clearing area to determine if any nestlings are present
- waiting until nestlings have left the nest before felling any potential habitat trees in the disturbance area
- installing and maintaining drinking points near known breeding and feeding areas
- maintaining permanent drinking water on the site of higher water quality (naturally more attractive to birds) than RDAs
- destruct WAD-cyanide
- utilising Wildlife Observers to monitor wildlife accessing F1 RDA and new RDA
- ensure noise levels are managed in accordance with the Noise Regulations
- ensure lighting is directed to minimise light spill outside the mining area
- maintaining roads and tracks to prevent formation of water holding structures
- ensuring food plant and hollow-producing tree species are used in rehabilitation seed mixes
- clearly demarcating areas to be retained for conservation (i.e. protected from mining activities) to ensure the habitat remains of high quality for black cockatoos
- ensuring areas selected for conservation for black cockatoos contain high-value habitat and/or breeding trees
- control feral bees in and around the mine site
- investigating the benefit of using artificial nest hollows in remnant forest areas
- ensure actions are consistent with existing black cockatoo recovery plans
- continuing research into habitat use by black cockatoos to improve understanding of potential impacts and continuously improve mitigation and rehabilitation methodologies to best support these species.

Key measures in the Terrestrial Fauna Management Plan include:

- providing information to all employees and contractors (through the site induction process) on fauna management requirements (e.g. speed limits, how to manage injured fauna etc)
- installing relevant signage on roads and entry points to the mine noting presence of fauna
- conduct fauna trapping and relocation prior to areas being cleared
- implementing a phased clearing approach for area the Proposal
- ensure all access roads are clearly signposted with speed limits
- conduct regular spot checks of vehicle speed in and around the mining operation
- restricting access to forest areas through signage and closure of tracks
- displaying maps and photographs of fauna through fact sheets and information bulletins in the workplace to raise awareness and facilitate identification and on-the-ground management
- report all observations of protected fauna to the Site Environmental Department who will maintain records
- giving native animals encountered on-site the opportunity to move on if there is no threat to personnel safety in doing so
- if sick or injured animals are encountered, contacting local carers to assess possible rehabilitation of the animal

- ensuring food waste is not accessible to attract native fauna or feral animals
- prohibiting pets and firearms on the NBG leases
- ensuring some connectivity between the eastern and western vegetated areas of the mine site through implementing fauna access and egress ability across roads and pipelines, and/or undertaking periodic trapping and relocation of fauna
- reporting all observations of feral animals to the Site Environmental Department who will maintain records
- restricting access to NBGPL–owned property for apiarists
- working with DPaW
- and/or local conservation groups to continue to control feral pigs, cats and foxes in and around the mine site
- continuing research into habitat use by key species of conservation significance to improve understanding of potential impacts and continuously improve mitigation and rehabilitation methodologies to best support these species.

11.6 Predicted environmental outcomes

After application of management measures, the Proposal is expected to result in the following outcomes for species listed as MNES:

1. Clearing of up to 1755 ha of black cockatoo habitat which is utilised as foraging habitat for all three species of black cockatoo and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoos; rehabilitation will be targeted at providing appropriate foraging species for black cockatoos and eventually providing additional habitat trees.
2. Minor increased fragmentation of the 5000 ha of vegetation to the east of the Development Envelope and increased monitoring and management of the remaining east–west linkages to maintain connections that will allow genetic mixing and recolonisation potential in the event of a fire or disease in this eastern area that could affect local populations.
3. Clearing of up to 1755 ha of native vegetation, which will reduce the extent of habitat available to fauna including Chuditch and Woylies in the local area but will not have a significant effect on regional fauna habitat availability. Habitat types within the Development Envelope are widespread and well represented in the large areas of jarrah forest to the west of the operation

The Proposal will not result in a change conservation status of any species and will not significantly impact regional distribution of fauna habitat availability. Geographical distribution and productivity of fauna at species and ecosystem levels will be maintained through management and mitigation measures. The residual impacts of habitat loss for fauna habitat on a local scale as well as potential fragmentation effects will be addressed through the offset package outlined in Section 14.

12. Other environmental factors

The ESD identified six other environmental factors the EPA considers should be addressed. Specifically, the ESD identifies that the PER should detail how these factors will be mitigated and the extent to which other statutory decision making processes can regulate potential impacts in order to meet EPA objectives for the following factors:

1. Public amenity with particular regard to the Bibbulmun Track: this section should give particular consideration to visual impacts to users of the Bibbulmun Track associated with mine operations, and provide options to determine the most appropriate realignment of the track. Options should be determined in consultation with DPaW.
2. Water use and supply: this should include a detailed water balance for the entire site over the predicted life of mine.
3. Indigenous heritage: this should include information on the outcomes of Indigenous heritage surveys of the project area and any agreements with Traditional Owner groups.
4. Noise: this section should provide details of an environmental noise study, including:
    - a map showing the locations of all noise-sensitive premises within 3 km of the expansion boundaries
    - environmental noise monitoring at all representative noise-sensitive premises within the buffer distance (i.e. 3 km of proposed WRD expansion area and RDAs to ensure current compliance status)
    - noise predictions of future operations.
5. Air emissions: this section should provide a brief description of air emissions associated with the Proposal, including information on the likely magnitude of mercury emissions and indicate how the potential environmental impacts of these emissions will be monitored and managed.
6. Closure and rehabilitation: the MCP required by DMP should be appended to the PER if possible. At a minimum, the PER should contain a framework for mine closure demonstrating that impacts associated with mine closure can be managed, including modelling predictions of the likely water quality in final pit voids.

Water supply and use and modelling predictions of the likely water quality in final pit voids have been covered in Section 7.4.

12.1 Public amenity

The *Guide to EIA Environmental Principles, Factors and Objectives* (EPA 2010) does not specify public amenity as a potential environmental factor. For the purpose of this impact assessment, public amenity is interpreted to comprise visual amenity and recreation.

The EPA applies the following objectives to assessment of proposals that may affect visual amenity and recreation:

> *To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as reasonably practicable.*
>
> *To ensure that existing and planned recreational uses are not compromised.*

For the purpose of this document, impact on public amenity considers the character of the landscape, the characteristics of the Proposal and the potential for it to be viewed by sensitive receptors and/or affect recreational use. Unique elements of the landscape, where relevant, are also taken into consideration.

12.1.1 Potential sources of impact

The proposal will alter the landscape through: land clearing, excavation of mine pits, ore processing, vehicle movements, construction of waste rock landforms, construction of the RDA, water storage options and diversion of a watercourse.

The proposal will also affect recreation values through realignment of the Bibbulmun Track.

12.1.2 Impact on public amenity

A visual impact assessment was undertaken of the RDA and WRDs by Ecoscape (2012) to:

- assess landscape values of the study area
- identify changes to potential visibility of the RDA and WRD from the Bibbulmun Track, Albany Highway, Bannister–Marradong Road and Pinjarra–Williams Road through "viewshed" analysis and photo montages
- assess impact of changes to visibility.

The Darling Plateau is characterised by an expansive undulating landscape with green forest vegetation and occasional rocky outcrops and peaks. Surrounding land uses include State Forests, plantations, farming, mining and residential development. Changes to amenity are greatest in areas with a high perceived scenic amenity value and are visible from public locations, such as roads, walk trails and lookouts.

The existing operation is visible from public roads, the Bibbulmun Track and a number of elevated locations. The viewshed analysis identified whether the Proposal will be visible or has an increased visibility. The viewshed analysis was based on the 'largest possible' option, which includes a 1000 Mt capacity RDA. This is larger than is specified in the Proposal, which has a 600 Mt capacity RDA. The visibility of the RDA is consequently likely to be less than predicted by the visual impact assessment.

Bibbulmun Track users generally experience an enclosed and canopied view, with the exception of high points along the track where canopy vegetation reduces and views extend across the landscape. This occurs at the three granite hills: Boonering Hill, Kimberling Hill and Mt Wells. The existing operations are visible from these locations, although the views from these locations are currently dominated by 'rolling forest' (Ecoscape 2012). The mining operations will become a more dominant feature of the landscape from Boonering Hill and Kimberling Hill, particularly during construction activities. The Proposal is mainly visible from the southern end of the ridgeline of Kimberling Hill. In the north, the track is positioned west of the ridgeline, preventing open views of the proposal to the east and southeast (Ecoscape 2012). While the Bibbulmun Track does not traverse directly over Boonering Hill, an optional track leads to its summit.

Ecoscape (2012) identified that assessment of visual impact from these locations is influenced by:

1. Distance from the site: closer proximity resulted in a prominent impact compared to further distance resulting in a blending impact variable landform: undulating landform helps to screen the proposal from view.
2. Vegetation screening: tall forest vegetation screens the proposal from view at many locations.
3. Similar visual characteristics to surrounding landscape such as line and form help the proposal blend at some locations.
4. Contrasting visual characteristics such as colour and texture of the RDAs result in a more prominent impact from panoramic view locations.

Table 46 presents a summary of the potential impacts of the assessed RDA and WRD options on visual amenity at key view locations as assessed by Ecoscape (2012).

The visual amenity is not expected be significantly affected by the proposal. The Proposal will affect the view experiences from Boonering Hill and Kimberling Hill from the increased prominence from these two locations. At these two locations the 'largest possible' proposal was assessed as 'Prominent'. Ecoscape (2012) determined that it is unlikely that there will be visual impacts for observers walking along the trail as the forest vegetation creates an enclosed view experience and screens views towards the Proposal.

For the travel routes assessed (Pinjarra Williams Road and Bannister Marradong Road), the potential visual impact was assessed as minimal to no impact (Ecoscape 2012).

Table 46 Visual impact level at key view locations

Key view location	Potential visual impact
Boonering Hill	Increased prominence during the construction and operational stage
Kimberling Hill	Increased prominence during the construction and operational stage
Mt Wells (east facing view)	Not evident
Mt Wells (south facing view)	Blending impact due to enclosed views from forest vegetation
Pinjarra–Williams Road	Minimal visual impact
Bannister–Marradong Road	Little to no visual impact

12.1.3 Key mitigation and management measures

Management measures that will address potential impacts to public amenity and landscape character include:

- implementing the Air Quality Management Plan during construction and operation
- minimising the area cleared for the Proposal to maintain vegetative buffers
- planting of vegetation along boundaries to assist in screening the operations
- progressively rehabilitating vegetated embankments with native species as part of each lift (RDA and WRDs), where practicable
- integrating mine landforms with the surrounding landscape, with the exception of mine voids, in accordance with Mine Closure Planning
- realignment of the Bibbulmun Track (Figure 13).

Realignment of the Bibbulmun Track is being designed in consultation with stakeholders to minimise potential impacts. The realignment is not expected to significantly affect its recreation values.

Following consultation with DPaW, two years notice will be provided to DPaW prior to the need to relocate the Bibbulmun Track. Costs associated with relevant surveys and relocation aspects of the realignment will be covered by NBGPL. During realignment construction, access along the existing alignment will be maintained to prevent any interruption to Bibbulmun Track users.

12.1.4 Outcome

Public amenity is not expected to be significantly affected by the Proposal.

12.2 Indigenous heritage

The EPA applies the following objective to assessment of proposals that may affect Aboriginal heritage:

> *To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.*

The *Cultural Heritage Due Diligence Guidelines* (DIA 2011) provide guidance to assist in meeting statutory obligations under the *Aboriginal Heritage Act 1972* (WA) (AH Act). The guidelines are intended to identify activities that may adversely impact on Aboriginal heritage. This is a guiding document for decision-making during the planning and implementation of this Proposal.

12.2.1 Potential sources of impact

The primary aspects of the Proposal that may affect Aboriginal heritage values include physical disturbance to land, dewatering, discharges of surplus water and alteration of surface drainage.

12.2.2 Impact on Indigenous heritage

The area is within the Gnaala Karla Booja Native Title claim boundaries (WAG 6274/98; WC 98/58) recognised under the *Native Title Act 1993*.

The majority of the area over which the NBG operations are located have been the subject of previous Aboriginal heritage surveys, including the mine pit and WRD expansion areas and the proposed water storage dam D5 (Figure 42).

In 2012, NBGPL commissioned Yates Heritage Consulting to undertake additional archaeological and ethnographic surveys of areas relevant to the Proposal that had not been previously surveyed: the RDA and D6 Dam. No new sites within the definitions and criteria of the AH Act were identified as a result of the additional surveys; however, it was noted that there is potential for sub-surface artefactual material associated with stratified soils (Yates 2012a; 2012b).

The Proposal will directly affect Registered Site 27935 Hotham River, which includes the Hotham River and its tributaries (i.e. Thirty Four Mile Brook).

Approvals (Section 18 permits) to disturb sites protected under the AH Act have been granted for use of the land described as ML264SA(2), M70/1031, M70/21, M70/22, M70/24 (Figure 43). Some areas of the Proposal are located outside of the current Section 18 permit area (Figure 43); as such additional applications will be made under the AH Act where identified sites will be disturbed.

Indirect impacts to Registered Site 27935 Hotham River may also result from ongoing dewatering and alteration of surface drainage (discussed in Section 7).

All sites, either known or undiscovered, will be managed in accordance with the AH Act.

12.2.3 Key mitigation and management measures

A Community Partnership Agreement (CPA) between Gnaala Karla Booja (Native Title Party), the South West Aboriginal Land and Sea Council (SWALSC) and NBGPL was authorised on the 16 August 2006. The CPA is a negotiated regional native title agreement that promotes effective stakeholder engagement, the preservation of Aboriginal heritage and defines a process to facilitate the joint management of Aboriginal heritage within the NBG area of operations. Specifically, the Preservation of Aboriginal Heritage Agreement (PAHA) sets out the process to be followed for management of Aboriginal heritage. It applies to ground-disturbing activities within a defined area of influence referred to as the Heritage Area of Influence (HAI) and the Heritage Agreement Project Area (HAPA).

Management of Aboriginal heritage in relation to the Proposal is addressed within agreements between all parties associated with the Native Title Claim in the Proposal area. Key measures included in the PAHA include:

- protection of heritage, including agreed procedures for survey, supervision of ground disturbance and protocols to apply in the event of matters of heritage significance (i.e. discovery of archaeological matters) being identified
- training of staff and contractors in heritage and cultural matters of significance
- ongoing consultation.

The Indigenous Heritage Management Plan contained within the EMP (Appendix 1) identifies that if during any operation a previously unknown site is identified, the following actions must be taken:

1. All work within the immediate vicinity is to stop immediately.
2. Contact is to be made with the Manager Social Responsibility or Senior Advisor Social Responsibility (Operations) who make contact with the Traditional Owners, the South West Aboriginal Land and Sea Council and the Department of Indigenous Affairs to confirm further requirements.
3. Work is not to recommence until the site Social Responsibility Department provide advice that it is appropriate to do so.

In areas where the existing AH Act Section 18 consent to disturb does not apply, further applications under Section 18 of the AH Act will be submitted, which involves consultation with Traditional Owners prior to disturbance. Those sites that are not to be disturbed by the Proposal would remain protected through demarcation, signage and education for the life of the operation.

12.2.4 Outcome

The Proposal will comply with the provisions of the AH Act. The Proposal would also be carried out in accordance with EPA Guidance Statement No. 41, *Assessment of Aboriginal Heritage* (EPA 2004b) through implementation of the proposed management measures, relevant project Aboriginal heritage agreements and the Cultural Heritage Management Plan. NBGPL will undertake to identify, manage and mitigate disturbance to any potential sites of Aboriginal significance wherever practicable. Where disturbance to a site of heritage significance cannot be avoided, applications will be made under Section 18 of the AH Act.

The predicted environmental outcome is expected to be limited to impacts on Aboriginal heritage sites to the extent permitted under the AH Act Section 18 consent to disturb.

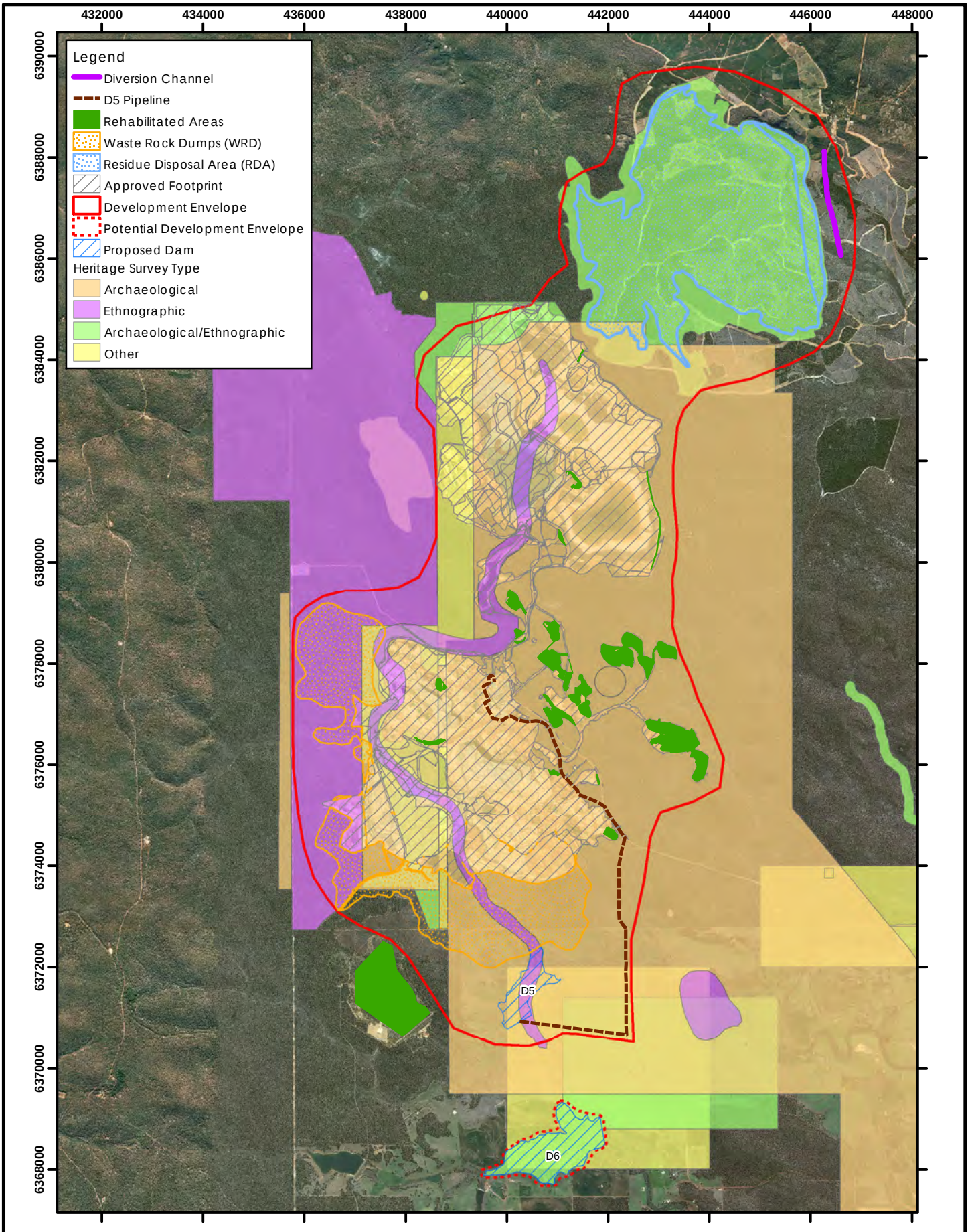

Figure 42 Archaeological and ethnographic survey coverage

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

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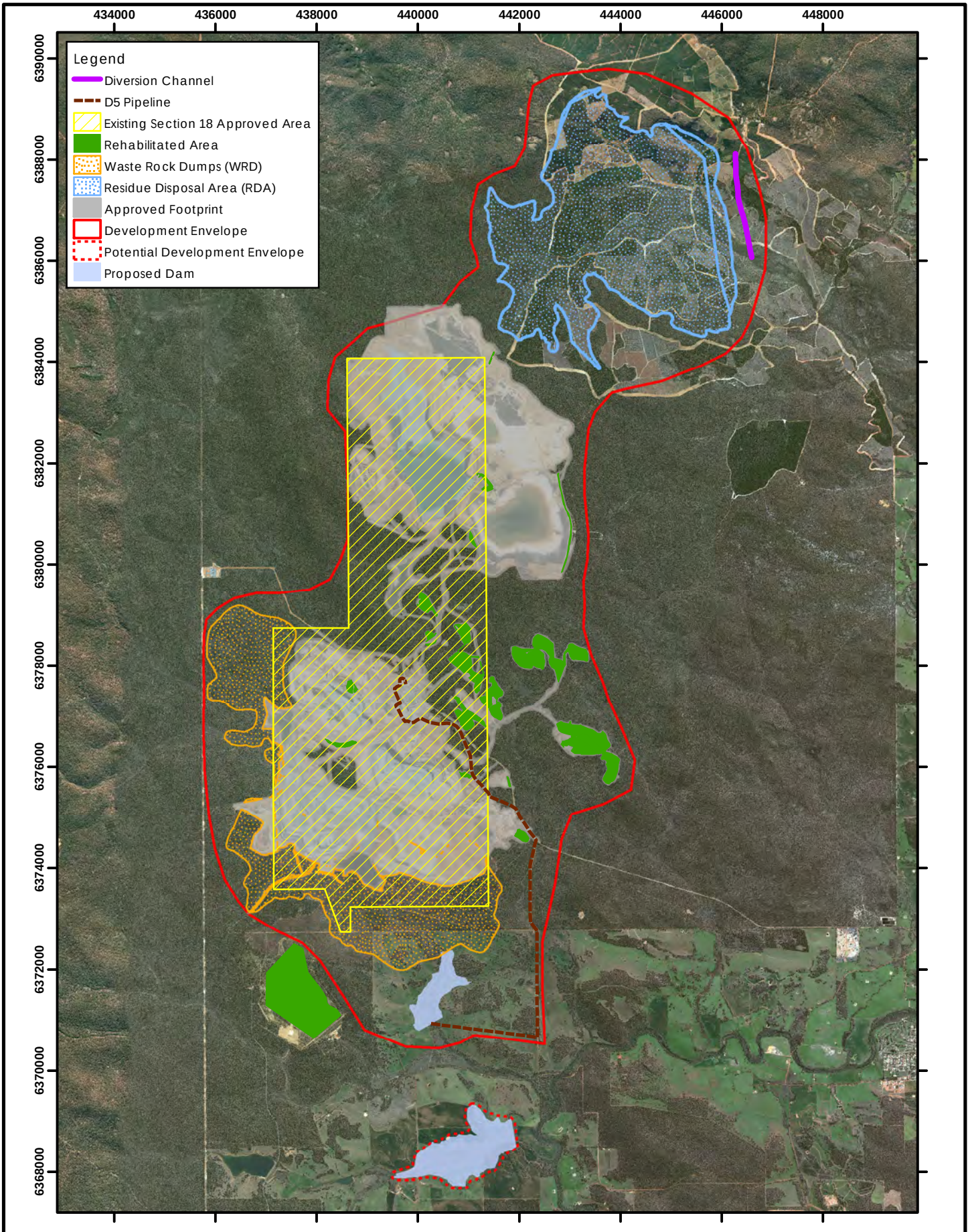

Figure 43 Area subject to existing section 18 approvals under the AH Act

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Scale
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at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Client 2011-2012.
Note that positional errors may occur in some areas

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12.3 Noise

The EPA applies the following objective to assessment of proposals that may cause noise impacts:

> *To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.*

Environmental noise in Western Australia is governed by the EP Act, through the Environmental Protection (Noise) Regulations 1997 (Noise Regulations).

12.3.1 Potential sources of impact

Noise would be generated by implementation of the Proposal through construction activities, blasting and excavation, haulage of ore and waste rock, ore processing, waste rock disposal activities, audible warning signals, off-site transport activities, operations at the accommodation village. Specifically, the use of audible warning signals can result in noise impact to nearby premises. These include reversing alarms on dump trucks, dozers and signals.

The nearest residences are within a predominantly rural area with no major roads located to the northeast, east, southeast and south of the Proposal. These residences are assumed to have limited background noise and an influencing factor of 0 dB (LGA 2013). The closest privately owned residence to the expanded operation is located northeast of the proposed RDA and is the only sensitive receptor located within 3 km of the Proposal.

12.3.2 Impact of noise

The Noise Regulations set noise limits (assigned levels) for various types of receiving premises and buildings associated with noise-sensitive uses. The assigned noise levels are shown in Table 47.

Table 47 Assigned Noise Levels

Time of day	Assigned level (dB)		
	L_{A10}	L_{A1}	L_{Amax}
0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor

Lloyd George Acoustics (LGA) undertook a noise impact assessment for the Proposal in 2012 (LGA 2013) (included in Appendix 3). Computer modelling was undertaken based on worst-case conditions, prior to the application of mitigation measures, to predict future noise levels at 19 noise sensitive receptors. The assessment was based on the expected expansion footprint, mining fleet and with consideration of wind and atmospheric stability. The model was calibrated using detailed measurement data collected in April 2012 from the existing operation. While noise impacts on recreational areas are not addressed by the Noise Regulations, the Mt Wells Camp Site associated with the Bibbulmun Track was included in this assessment.

The noise predictions represent noise occurring for more than 10% of the time and the L_{A10} criteria shown in Table 47 are therefore applicable. Based on measurement data, noise from the operations is likely to have tonal characteristics. The results have therefore been adjusted by +5 dB in accordance with the Noise Regulations.

The impact assessment predicts that noise levels from the Proposal, when adjusted for tonality, will exceed the night criteria assigned under the Noise Regulations, during worst case wind direction, at up to seven noise-sensitive premises for night-time noise at five of the 19 identified noise sensitive receptors in 2021, six in 2031 and three in 2041. In 2021 the highest predicted noise level at any receptor exceeds the criteria by 3 dB, in 2031 the it will exceed the criteria by 4 dB and in 2041will exceed the criteria by 2 dB.

The higher noise levels (up to 39 dB) are predicted to occur in 2031 when the mine is operating at the maximum expanded footprint and activities are occurring close to the edges of the extended WRDs. These calculations used the worst case meteorological conditions (wind direction) for noise propogation which are anticipated to occur for more than 2% of the time. Noise sensitive premises at or greater than 5 km from the Development Envelope did not record exceedances under the modelled scenarios.

While the Noise Regulations do not apply to recreational areas such as the Mt Wells Camp, modelling predicted that the night noise criteria may be marginally exceeded at this location from the start of construction of WRD 12 until 2028 when this is completed. However, the development of this dump has been pushed back further in the mine plan since the noise modelling work was completed.

12.3.3 Key mitigation and management measures

Through its Noise Management Group, NBGPL will continue to investigate methods to reduce noise emissions in accordance with best practice and to take corrective action in response to complaints regarding noise and blast vibrations. A Noise and Vibration Management Plan is in place for the current operations and will be updated to address noise emissions from of the Proposal.

NBGPL will ensure that noise from the Proposal complies with the requirements of the Noise Regulations through implementation of the Noise Management Plan including the following management actions:

- provide information on the importance and requirements for noise and vibration management to all employees prior to commencing work on site, as part of the site induction process
- investigate and implement methods to reduce noise emissions in accordance with best practice
- carry out all construction work in accordance with Section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites and inform all personnel (including contractors) of their responsibilities and the importance of managing noise levels
- schedule blasting activities only during daylight hours and avoid blasting on public holidays
- implement noise control measures for vehicles and other equipment install smart reversing alarms[6] in Caterpillar mining fleet (trucks and ancillary equipment) to reduce tonal noise impacts
- establish preventative maintenance schedules for all vehicles, heavy equipment and plant
- site noise management committee to investigate and provide recommendations on noise mitigation strategies throughout the mine life
- liaise with residents and interested stakeholders on the noise aspects of the operations and obtain feedback on operations and performance.

12.3.4 Outcome

Noise emissions associated with the expansion Proposal will be controlled as described in the Noise Management Plan along with proposed management measures, such that they would not be expected to result in significant impacts. Noise emissions from the operations will be managed in accordance with the Noise Regulations.

In view of the above, it is expected that the environmental objective for this factor can be met.

[6] Smart reversing alarms are self-adjusting alarms that constantly measures ambient noise and adjust sound levels accordingly.

12.4 Air emissions

The EPA applies the following objective to assessment of proposals that may affect air quality:

> *To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.*

12.4.1 Potential sources of impact

Air emissions can affect both amenity and land uses if not managed correctly. Current operations at NBG produce air emissions in the form of dust, sulphur dioxide, carbon monoxide and nitrogen oxides (NBGPL 2012a). Small amounts of metals, organic and sulphur compounds are also produced at the processing plant and monitored under conditions of the DER operating licence (NBG 2012a). The main air emission of potential community concern at NBG is dust produced from both mining and processing operations.

Dust and chemical compounds from point source emissions are required to be monitored as a condition of the Part V licence issued by the DER under the EP Act for the operation of NBG. Dust monitoring also occurs at the boundary of the NBG premises through a series of Osiris monitoring units (NBGPL 2012a).

Dust emissions

Dust is generally characterised by three size ranges: less than 50 micrometers (µm) in diameter, less than 10 µm and less than 2.5 µm with the particulate matter (PM) in each range abbreviated as PM_{50}, PM_{10} and $PM_{2.5}$ respectively. PM_{50} is also referred to as Total Suspended Particulates (TSP).

Generation of dust from construction and mining operations depends on:

- types of dust generating activities
- frequency of dust generating activities
- meteorological conditions, including wind speed and precipitation
- composition of dust, including particle size distribution, particle density and moisture content
- condition of the source (dry or otherwise).

Mining can generate dust, which may adversely impact environmental values, as well as create a nuisance for workers and nearby land users.

The Proposal may generate dust during construction activities from mining activities, haulage and light traffic on unsealed roads, wind erosion in areas where vegetation has been cleared, and dust lift-off from stockpiles. These dust emissions have the potential to create a dust nuisance for workers and adjacent land users. Dust may also have physical effects on plants, although this is likely to be restricted to immediate peripheral vegetation. Intermittent rainfall events are expected to remove dust deposited on leaves.

Particulate emissions also occur from mobile and stationary equipment powered by diesel engines. These particulates tend to be in the finer size fractions (PM_{10} and $PM_{2.5}$). Their composition is predominately carbonaceous (soot) compared with the mineral composition of dust generated from crustal sources.

Some particulate emissions are discharged to atmosphere from the Carbon Regeneration Kilns stacks and Gold Furnace Room stack, as well as from the Secondary and Tertiary Crushing vents and the Coarse Screening vent.

The nearest townsite (Boddington) is 12 km southeast of the Development Envelope, and will not be affected by dust generated during construction or mining activities. The closest sensitive receptors that may be affected by dust emissions are residences within a predominantly rural area located to the northeast, east, southeast and south of the Development Envelope. The closest privately owned residence is located approximately 4.5 km to the northeast of the proposed RDA and the area between the RDA and residence is largely plantation and native vegetation.

Sulphur dioxide, carbon monoxide and nitrogen oxides emissions

The primary source of sulphur dioxide (SO_2), carbon monoxide (CO) and nitrogen oxides (NO_X) emissions are from combustion of diesel fuel in light and heavy earthmoving vehicles and stationary sources such as generators. Smaller amounts of these pollutants are discharged to atmosphere from the Carbon Regeneration Kilns stacks and Gold Furnace Room stack. NO_X and CO emissions also arise from blasting activities.

Mercury emissions

NBGPL adopts modern gold processing technologies for concentrating or purifying gold. The technologies do not include mercury amalgamation; however, the release of mercury to the environment may occur through the gold recovery process where mercury minerals are naturally distributed throughout a gold ore source. At NBG, naturally occurring mercury minerals are expected to be recovered either to the copper concentrate (during the flotation process), or be leached during the gold cyanidation process and be adsorbed onto activated carbon. For this reason NBGPL have been proactively monitoring these streams during operation, with the following observations noted:

- mercury has been measured in copper concentrate at levels of less than 1 g/t
- stack testing conducted in 2011 and 2012 from the carbon regeneration kiln did not detect mercury in stack gas emissions from the kilns[7]
- occupational exposure monitoring detected mercury levels well below the recommended Australian 8-Hour Time Weighted Average (TWA) and Short Term Exposure Limit for inorganic mercury of 0.1 and 0.03 mg/m^3, respectively.

Based on the low levels of mercury in the ore sources and mineral processing technologies undertaken, it is unlikely that NBG is a significant source of mercury emissions.

Greenhouse gas emissions

The primary sources of greenhouse gas (GHG) emissions from the Proposal are:

- electricity production and consumption
- combustion of diesel and LPG
- use of explosives
- clearing of vegetation.

Sequestration of carbon is assisted by progressive revegetation of disturbed areas at the end of mining.

Greenhouse gas emissions for 2011 were 904 759 tonnes CO_2 equivalents (e). This represents approximately 70% of the 1.284 Mt of $CO_{2\text{-}e}$/annum identified in Schedule 1 of Statement 591.

The significant majority of greenhouse emissions from the expansion are produced as a result of production and consumption of electrical power. The power consumption from 1 200 000 MWh/a to 1 400 000 MWh/a for the Proposal will result in an equivalent increase in annual greenhouse emissions.

[7] Mercury is not included in the environmental license as one of the emissions parameters to be monitored from the Carbon Regeneration Kiln stack emissions

12.4.2 Impact of air emissions

The potential impact of air emissions from the proposed expansion has been assessed using atmospheric dispersion modelling of the respective emission parameters and comparison of the predicted ground level concentrations at sensitive receptors with relevant air quality standards. The process involved in this assessment is summarised as follows:

- identification of air emissions parameters and sources of those emissions
- development of an emissions inventory that includes emission rates for those parameters and sources
- assembly of synoptic and prognostic meteorological data, as well as topographical and other relevant information for dispersion modelling
- dispersion modelling using CALPUFF, which is a three dimensional non-steady state dispersion model
- identification of appropriate air quality standards for the assessment
- comparison of the predicted ground level concentrations from the modelling with the standards to determine the potential for unacceptable impact from emissions
- consideration of existing air quality (if monitoring data are available) and assessment of cumulative impacts of predicted ground level concentrations and background concentrations of emission parameters.

The dispersion modelling and impact assessment has been carried out by Engineering Air Science (2013).

Air quality standards from National Environmental Pollution Measures (NEPM) (NEPC 2003) have been used for the assessment of potential impacts from emissions of PM_{10}, $PM_{2.5}$, SO_2, CO and NO_X (Table 48). A NEPM is not available for TSP so the standards from the Kwinana Environmental Protection Policy (EPP) (WA Government 1999) were used for the assessment of this parameter. The dust deposition criteria from the NSW Office of Environment and Heritage (NSW OEH 2005) were used for assessment of particulate deposition rates.

Table 48 Air quality standards used

Emission parameter	Source of standard	Averaging period	Concentration limit
TSP	Kwinana EPP	24 hour	90 µg/m^3 (Buffer, residential and rural zones)
		24 hour	150 µg/m^3 (Industrial zone)
PM_{10}	NEPM	24 hour	50 µg/m^3
$PM_{2.5}$	NEPM	24 hour	25 µg/m^3
SO_2	NEPM	1 hour	0.2 ppm
		24 hour	0.08 ppm
		1 year	0.02 ppm
CO	NEPM	8 hour	9.0 ppm
NO_X	NEPM	1 hour	0.12 ppm
		1 year	0.03 ppm
Dust deposition	NSW OEH	1 month	4 g/m^2 (soluble dust)

12.4.3 Predicted ground level concentrations and impact assessment

The modelling has calculated ground level concentrations for a total of 34 receptors, including 28 sensitive receptors located predominately to the east of the NBG lease and six receptors to the west of the lease.

Meteorological data from March 2007 to February 2008 and March 2010 to February 2011 was chosen for investigations. The 2007 to 2008 year recorded higher daytime and lower nocturnal wind speeds than for the 2010 to 2011 year. The 2010 -2011 year was the driest year on long-term records and was considered in order to understand potential particulates under worst-case conditions (ECS 2013).

Modelling considered the mitigation of emission rates due to rainfall effects and plume decay from particle deposition.

Analysis of wind conditions suggests that air emissions from the Proposal will generally not travel in the direction of sensitive receptors around the mine. However, there is potential for emissions to be carried by drainage flows in the gullies, within which mining activities are located, towards Hotham and Bannister river valleys, during late autumn, winter and early spring. In addition, fugitive particulate emissions will likely be lower during the winter wet months (ECS 2013).

Wind speed and frequency were monitored from 2007 to 2012. Winds were predominantly from the east to southeast or the southwest to western sectors and generally of moderate strength. Very low or calm winds are very infrequent (ECS 2013).

Particulates as PM_{10}

The predicted ground level concentrations of PM_{10}, using the above defined meteorological conditions, are mostly below the NEPM Guidelines. However, the results predicted ground level concentrations in 2035 will be higher when modelled using the March 2007 to February 2008 data than with March 2010 to February 2011 data. A total of nine exceedances of NEPM guidelines across seven receptors were predicted based on 2007 to 2008 data, with no more than two exceedances at any one receptor. One exceedance was recorded for the 2010 to 2011 data.

The number of predicted exceedances is greater than the allowable number of exceedances of the NEPM (less than five exceedances for all receptors for both periods). These exceedances occur under conditions of extreme meteorology, which occur on a small number of occasions and as suggested by the results, do not occur in every year. Specifically, the predicted results identified that the exceedances were more likely to occur when using the wetter rainfall model and observed during the wetter winter months. However, the ECS (2013) identify that the emissions estimation method did not incorporate potential variability in emission rates due to variation in meteorological conditions, and in particular, rainfall and its effect on soil moisture. Based on higher soil moisture of winter in winter the actual number of exceedances is likely to be lower.

The modelling is inherently conservative and prediction of a small number of higher concentration events is considered of no significance in regards to overall impacts on air quality.

Particulates as $PM_{2.5}$

The modelling predicted ground level concentrations of $PM_{2.5}$ in 2035 will be using the 2007 to 2008 data, with single exceedances of the NEPM $PM_{2.5}$ advisory standard predicted at four receptors. No exceedances of the NEPM advisory standard are predicted using the March 2010 to February 2011. Again, higher impacts were predicted to occur during the wetter winter months and are therefore unlikely to occur in reality.

Particulates as TSP

A single exceedance of the Kwinana EPP standard for TSP was predicted for one receptor using the March 2010 to February 2011 data. All other predicted ground level concentrations were below that standard. The 98.5th percentiles, which equates to the 5th highest concentration predicted for the modelling periods are typically one third of the maximum concentrations, highlighting the relatively rare and extreme meteorology required to provide these concentrations of TSP. TSP tends to fall out from the air column more rapidly than the finer particulate fractions and the predicted rapid decline in concentrations reflects that phenomenon.

Particulates deposition

Particulate deposition rates in the town of Boddington and rural residences to the south and east of the NBG operations are predicted to be insignificant, with increased deposition of around or below 0.1 g/m^2/month. This increase in deposition rate represents approximately 5% of the allowable increase and 2.5% of the maximum total deposition rate from the New South Wales Office of Environment and Heritage (NSW OEH) criteria (NSW OEH 2003).

Higher increases of 0.4 to 0.6 g/m^2/month in deposition rates are predicted for the residences to the west of the mining operations, with the highest observed for the 2010 to 2011 meteorology when winds from the east were very dominant throughout the year. These increases are well below the NSW OEH guidelines of 2.0 g/m^2/month allowable increase and maximum of 4.0 g/m^2/month.

Combustion gases

Modelling predicted the peak ground level concentrations of combustion gases at nearest receptors for the two simulated years of meteorology using an average emissions simulation. Two scenarios are provided for NO_X, with the first being the predicted maximum ground level concentration based on total conversion of NO in the emissions to NO_2 in the atmosphere and the second based on conversion that is limited by the available ozone in the atmosphere (so-called ozone limiting method or OLM). The OLM calculations involve assumptions that 10% of the NO_X emissions are NO_2 and 90% are NO, and the ambient air ozone concentration is 0.05 ppm.

The results show that the assumption of full conversion of NO to NO_2 leads to a maximum predicted ground level concentration of 0.24 ppm (at receptor 4), which is double the NEPM standard of 0.12 ppm (for 1 hour average). Exceedances of the NEPM were predicted for a total of 12 receptors. However, the use of the OLM for conversion of NO to NO_2 results in a highest predicted ground level concentration of 0.074 ppm (at receptor 4), which is below the NEPM. The predicted annual average concentration 0.0010 ppm is well below the NEPM (0.03 ppm, annual average).

The modelling was repeated using the peak emissions simulation for the 2007 to 2008 modelling year for the two NO_X conversion scenarios. No exceedances of the NEPM air quality standards were predicted for SO_2 and CO. The maximum predicted hourly average ground level concentrations for NO_X exceeded the NEPM at 14 receptors, with the highest value of 0.38 ppm predicted for receptor 4. No exceedances of the NEPM were predicted when the OLM was used for the modelling.

12.4.4 Key mitigation and management measures

The primary source of air emissions for the proposed expansion is the mining operation that includes drilling, blasting, excavation and haulage of mined materials.

An Air Quality Management Plan is in place for the current operations and will be updated at regular intervals to account for changes in conditions or operations, including changes associated with the Proposal. The Air Quality Management Plan summarises the requirements under Licence conditions (L8306/2008/1) and monitoring is conducted in accordance with these conditions. The key management aspects relating to dust identified within the Air Quality Management Plan include:

- communicate air quality management to employees and long-term contractors through the site induction (focussing on dust suppression and identification and reporting of excessive dust through the site hazard identification process)
- limit the extent of clearing through effective planning and clearly demarcated areas
- seal all permanent access roads and those roads identified as high traffic with the potential to generate excessive dust
- spray haul road and ROM pad areas with water for dust suppression
- establish and enforce vehicle speed limits for unsealed roads
- manage residue deposition on current and future RDAs in a rotational fashion across the facility to reduce fugitive emission generation
- conduct on-site depositional monitoring as required (e.g. the current depositional monitoring trial commencing around the F1/F3 RDA)
- topsoil and gravel stockpiles present for the life of the operation to be vegetated or sprayed with hydromulch where possible
- maintain water sprayers (mist and deluge) to reduce the generation of dust from crushing and conveying activities
- fabric filter bag house are fitted where appropriate (e.g. secondary crushing, coarse screening and fine ore bins)
- utilise fresh air ventilation where required in confined workspaces (e.g. primary crusher and coarse ore stockpile reclaim tunnels)
- establish preventative maintenance schedules for all vehicles, heavy equipment and plant.

Gaseous and particulate emissions from light and heavy vehicle engine exhausts will be minimised by the use of current generation diesel engine technology for new plant and equipment and servicing and maintenance of the fleet as per manufacturer's specifications.

NBG operates a series of bag houses that filter emissions at the secondary crushing, coarse screening, tertiary crushing and fine ore bin facilities. The Air Quality Management Plan includes specifications for routine maintenance and performance testing of the bag houses to ensure optimal performance is provided at all times.

Gaseous and particulate air emissions from processing facilities will be subject to controls imposed through an environmental licence issued under Part V of the EP Act.

NBGPL has an Energy and Greenhouse Gas Management Plan adopted to explain the systems and processes involved for:

- accounting and reporting of energy consumption and greenhouse gas emissions
- continued identification, assessment, implementation and monitoring of energy efficiency improvements and GHG emission reductions
- compliance with various regulatory, external and internal reporting obligations including the National Greenhouse and Energy Reporting Scheme (NGERS), Energy Efficiency Opportunities (EEO) program, and NBGPL commitments and annual public sustainability reporting requirements.

The calculation of GHG emissions associated with activities at NBG is conducted within the NBG NGERS Inventory and is described in the Energy and Greenhouse Gas Management Plan. These methods are in accordance with EPA Guidance Statement No. 12, *Guidance Statement for Minimising Greenhouse Gas Emissions* (EPA 2002b).

The ongoing identification, assessment and implementation of measures to improve energy efficiency and reduce GHG emissions is aligned with NBG participation in the Australian Government EEO program and is described in the Energy and Greenhouse Gas Management Plan.

GHG emissions (both in absolute terms and in the form of performance indicators per unit of production) are monitored regularly. Raw data collection involves documentation of energy (fuel) consumption and cost data for each energy source and production data, entered at the same frequency as the energy and cost data. Data is obtained from fuel invoice or delivery records as required under NGERS and are entered into the site's Energy and GHG Inventory, which calculates energy consumption and greenhouse gas emissions based on methods provided by the NGERS Measurement Determination.

12.4.5 Outcome

The assessment of predicted impacts on air quality from the proposed expansion has indicated that, after the application of management measures, the Proposal is not expected to exceed air quality guidelines. Air emissions of the current operation are subject to the conditions of an environmental licence issued under Part V of the EP Act.

Similarly, air emissions for the Proposal will be subject to the conditions of a new environmental licence to be issued under Part V of the EP Act, the EEO program and the NGERS. NBGPL will also comply with National Environment Protection Measures and relevant state legislation through reporting all emissions that trigger reporting thresholds to the National Pollutant Inventory and NGERS.

Air emissions of the Proposal will be managed through the application of existing management measures including the Air Quality Management Plan and the Energy and Greenhouse Gas Management Plan. Consequently emissions are not expected to result in significant impacts. Therefore, it is expected that the environmental objective for this factor will be met.

12.5 Closure and rehabilitation

The EPA applies the following objectives to assessment of proposals relevant to closure:

> *To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.*
>
> *To maintain the abundance, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.*

MCPs are required to be developed as a result of recent amendments to the *Mining Act 1978*. The EPA and DMP have recently prepared *Guidelines for Preparing Mine Closure Plans* (DMP & EPA 2011). These guidelines require more detailed closure planning earlier in the mine life cycle than was previously the case. The NBG MCP has been updated and submitted to the DMP after taking the additional following requirements into account:

- closure specific stakeholder consultation regarding end land use, particularly final void for the new pit extent
- domain based rehabilitation plans
- methodology of determining closure costs
- post-closure land use determination
- detailed risk assessment
- delineation of knowledge gaps and planned studies/field trials.

Additional guidelines and codes of practice relevant to mine closure include the following:

- *Strategic Framework for Mine Closure* (ANZMEC & MCA 2000)
- *Mine Closure and Completion, Leading Practice Sustainable Development Program for the Mining Industry* (DITR 2006a)
- *Mine Rehabilitation, Leading Practice Sustainable Development Program for the Mining Industry* (DITR 2006b)
- *Planning for Integrated Mine Closure: Toolkit* (ICMM 2008)
- *Environmental Notes on Mining – Waste Rock Dumps* (DMP 2009).

NBGPL has a MCP for the NBG. As part of the expansion project, NBGPL has reviewed the closure plan to reflect the Proposal and address the recent guidelines. This plan was provided to the DMP in December 2012 in accordance with mine tenement conditions. A copy of the draft amended MCP can be found in Appendix 1.

The strategy is based on the following components, which are discussed in more detail in the following sections:

- identification of closure obligations and commitments
- closure data
- stakeholder consultation
- post-mining land use and closure objectives
- development of completion criteria
- identification and management of closure issues
- financial provisioning processes
- closure implementation, including unexpected closure
- closure monitoring and maintenance
- information management and reporting.

12.5.1 Identification of closure obligations and commitments

Rehabilitation and closure of the Proposal will be undertaken in a manner and to a level of performance that satisfies the legal obligations in place at the time of relinquishment of the mining tenements. In addition to the applicable legislation, there are legally binding commitments and conditions arising from the various environmental approvals and permits that will apply to the Proposal. The closure objectives and completion criteria described in the MCP would be derived from these commitments and conditions.

12.5.2 Closure data

Baseline studies for the NBG operations commenced in 2005. Since that time, additional local and regional biological and cultural surveys, hydrologic studies and geochemical characterisation assessments have been conducted.

Information gaps have been identified through the closure planning process and actions required to address information gaps have been prioritised based on risk. These are described in the draft MCP presented in Appendix 1.

12.5.3 Stakeholder consultation

NBGPL has undertaken detailed consultation with relevant stakeholders in accordance with its Stakeholder Consultation Strategy. The draft MCP identifies the relevant stakeholders and lists inputs relevant to the plan. This section of the plan will be continually updated as new stakeholders or concerns arise.

12.5.4 Post-mining land use and closure objectives

The post-mining land use for the NBG operations has not yet been finalised and will continue to be refined as part of the ongoing closure planning process. It is unlikely that a single land use option will be suitable for the area. A flexible approach, in which changing preferences and attitudes for land use can be accommodated, is required due to the long life of mine, rapid population growth in the region and changing priorities of stakeholders over time.

The anticipated end land uses will be reviewed regularly throughout the life of the project in consultation with key stakeholders. The anticipated final land uses will be similarly determined as part of the final mine design plan. This will ensure that the value from progressive rehabilitation is maximised.

The provisional closure objectives for NBG have been developed to support a framework of aspects for which management is fundamental in order to ensure effective closure of the operations; the details of which are outlined in the draft MCP in Appendix 1. The framework incorporates a number of physical, biological and post-closure aspects. The closure objectives are general goals relating to each aspect, which provide a guiding set of principles for progressive rehabilitation and mine closure planning. The provisional objectives are supported by completion criteria and a measurement approach and will be subject to ongoing review in consultation with key closure stakeholders.

Further information regarding post-mining land use and closure objectives can be found in the draft MCP in Appendix 1.

12.5.5 Development of completion criteria

Completion criteria provide the basis on which successful rehabilitation and mine closure are determined, as well as achievement of closure objectives are determined (DMP & EPA 2011). Completion criteria have been developed for the mine operations and accommodation village, taking the following into account:

- closure objectives and post-mining land use
- physical environment and consequences of permanent changes to landforms, soils and hydrology
- existing completion criteria
- legal requirements and obligations
- NBGPL environmental policy and standards
- feedback from stakeholders
- completion criteria of other sites in the southwest region of WA, such as the Ludlow and Jarrahdale mines.

The completion criteria relate to:

- community and other stakeholders
- geotechnical stability
- infrastructure removal
- topography and drainage
- managing mine wastes
- access
- surface stability
- forest disease
- soil fertility and surface profile
- fauna habitat
- vegetation
- ecosystem function
- management after closure.

The post-mining land use for NBG operations has not yet been finalised and will continue to be refined as part of the ongoing closure planning process. Development of completion criteria for NBG will be an iterative process and will continue to be reviewed and refined over the life of mine. Agreement with stakeholders on the development of quantitative standards will be reached through ongoing consultation, refinement of the MCP and resubmission every three years.

12.5.6 Decommissioning strategies

Mining and establishment of associated infrastructure at NBG will result in clearing of vegetation and disturbance to soil profiles and landforms. Aspects that require rehabilitation at closure will include:

- mine pits
- WRDs and RDAs
- water storages
- other infrastructure including processing plants, roads and accommodation areas.

The mine closure objectives are to ensure that closure planning and rehabilitation are undertaken in a coordinated, progressive manner and are integrated with mine planning. The intention is to prevent adverse environmental impacts and to create a stable and self-sustaining natural ecosystem or an alternative land use based on an agreed set of end-use objectives.

Further information regarding decommissioning strategies can be found in the draft MCP in Appendix 1.

12.5.7 Identification and management of closure issues

A risk assessment approach was used to identify risks and opportunities related to closure. A risk register has been developed and is updated on an annual basis in accordance with the principles outlined in AS/NZS ISO 31000:2009 *Risk Management – Principles and Guidelines*. The major risk areas identified for closure of the Boddington operations and associated key management measures are outlined in the draft MCP presented in Appendix 1.

12.5.8 Financial provisioning processes

NBGPL recognises the importance of ensuring that all costs associated with closure and rehabilitation are systematically, accurately and consistently evaluated and reported. Closure costs are reviewed and refined annually taking into account:

- inflation
- additional site data collected as part of the monitoring program, trials, investigations and studies
- site experience with closure and rehabilitation activities
- improvements in industry knowledge and practices
- modifications to the Plan and work requirements
- changes to regulatory or financial reporting requirements.

12.5.9 Closure implementation, including unexpected closure

To facilitate the planning of closure activities and the development of Closure Implementation Plans, the site has been divided into nine domains referred to as Closure Management Units (CMUs):

1. Whole of operations: incorporating all of site, exploration drill holes.
2. Mining areas: including main open pits, satellite pits, Jarrah Decline.
3. Residue disposal areas: R4 RDA, F1/F3 RDA, New RDA.
4. Waste rock landforms: including waste rock landforms 7, 8, 9 and Q3 South.

5. Infrastructure: including mill, primary crusher, conveyor, workshops, offices, security gate, fuel farm, magazine, explosives/emulsion batching plant, core yard, laydown areas, roads and tracks, warehouse, landfill, monitoring bores, production bores, booster pump station, Caro's acid plant.
6. Water management structures: including water supply reservoirs, pit lake outflow channel, Hotham River pump station, dams and turkeys nests, drainage control structures.
7. Services: incorporating power lines, water lines (including residue delivery and decant recovery lines).
8. Accommodation village: encompassing the accommodation village and sewage treatment plant.
9. Temporary stockpiles: bauxite, gravel, oxide and topsoil stockpiles, medium grade stockpile, ROM pad.
10. Concentrate storage shed located at Bunbury Port.

The preliminary closure implementation plans for each closure domain cover the following areas:

- a description which includes:
  - features of the CMU
  - area of disturbance
  - current status
  - closure date
  - key potential closure risks
  - potential final land use
  - closure strategy
  - landform design (where applicable)
  - rehabilitation prescription
  - completion criteria.
- closure implementation program for the following activities:
  - planning and reporting
  - construction
  - rehabilitation
  - decommissioning.
- unplanned closure activities.

12.5.10 Closure monitoring and maintenance

The successful and timely relinquishment of the NBG tenements no longer required for the purposes of mining requires suitable demonstration that the agreed land use objective(s) has been or can be met, as evidenced by records that show closure criteria have been met. This necessitates development and implementation of a closure and rehabilitation monitoring program that tracks the status of closure implementation as well as the performance of rehabilitation, decommissioning and other closure mitigation measures.

The post-closure monitoring period has been nominated as 20 years; however, monitoring will be conducted until such time as it can be established that there are no significant ongoing impacts from the site. Closure monitoring and maintenance is addressed in the MCP presented in Appendix 1.

12.5.11 Information management and reporting

Contemporary mine closure guidelines, including the joint DMP & EPA guidelines (DMP & EPA 2011), place a high value on the effective collection and storage of project records, including site knowledge. The guidelines emphasise that such information should be both comprehensive and easily retrieved, usually through the auspices of a dedicated information and/or knowledge management framework.

A Progressive Rehabilitation and Closure (PRAC) system will be utilised at NBG to manage documentation relating to rehabilitation and closure and planned rehabilitation and closure activities.

Documentation relevant to closure and rehabilitation is stored within the PRAC system to provide an information database. Relevant documentation and information will continue to be uploaded to the PRAC system as it becomes available.

13. Summary of likely environmental measures and controls

13.1 Environmental management framework

NBGPL will minimise environmental impacts through the implementation of ongoing management measures, which include:

- maintaining certification to the International Standard for Environmental Management Systems (EMS) through implementation of the Integrated Management System (IMS), which covers Environment, Social Responsibility and Health and Safety implementing an Environmental Management Plan (EMP) for the Proposal
- developing environmental improvement plans for high and extreme risks tracked quarterly through the site risk register
- improving mechanisms to measure water and energy use, and greenhouse gas emissions
- improving the efficiency of water resource use
- updating plans and research and development studies for disturbance and closure, progressively rehabilitating and measuring success
- ensuring all personnel complete relevant environmental awareness and training programs
- ensuring that community views are sought, respected and considered
- reporting regularly to stakeholders on performance.

NBGPL acknowledges the environmental protection principles listed in s 4A of the EP Act through its strong commitment to sustainable development and environmental management at its operations.

13.1.1 Environmental Policy

The Newmont Environmental Mission Statement states “Newmont and our affiliates (Newmont) intend to set standards of excellence with regard to environmental matters.” To achieve this:

1. Newmont will, at all times, operate our facilities in compliance with applicable laws and regulations.
2. Newmont will adopt and adhere to standards that are protective of both human health and the environment at the facilities we build and operate.
3. Each Newmont operation will develop, during the design phase, and implement during operations and closure, a closure and reclamation plan that provides for long-term environmental stability and suitable post-mining beneficial land uses

13.1.2 Environmental Management System

NBGPL also operates an environmental management system (EMS) which is certified under ISO14001 (the International Standard for Environmental Management Systems). The EMS is implemented as part of the Integrated Management System (IMS) in conjunction with Health, Safety and Loss Prevention and Community Relations. ISO14001 is an internationally recognised continuous improvement model, the key elements of which include assessing environmental risk and legal requirements, developing objectives and targets for improvement, training, operational control, communication, emergency response, corrective actions, audits and review.

NBGPL was certified to ISO14001-in-2011. To maintain ISO14001 certification, the NBG site is required to successfully complete regular external independent surveillance audits.

13.1.3 Environmental Management Plan

The environmental aspects of the Proposal will be primarily managed through the EMP, a copy of which is provided in Appendix 1. This plan has been prepared and will be implemented to manage specific environmental issues arising from the Proposal. The purpose of the EMP is to document environmental management objectives and strategies in relation to the Proposal, including:

- environmental factors potentially affected by the construction and operational phases of the Proposal
- measures to prevent, minimise, mitigate and manage any potential environmental impacts of the Proposal
- details of the timing and persons responsible for implementation of these measures
- monitoring and reporting procedures.

The following management plans have been developed as part of the EMP:

- Groundwater Quality Management Plan
- Adaptive Groundwater Management Plan
- Surface Water Management Plan
- Vegetation and Flora Management Plan
- Terrestrial Fauna Management Plan
- Black-cockatoo Management Plan
- Indigenous Heritage Management Plan
- Noise Management Plan
- Air Quality Management Plan.

The EMP identifies existing management and monitoring components of the environmental activities associated with NBG that will continue as part of the Proposal but also identifies new commitments that have been made specifically in regards to this Proposal.

13.2 Summary of likely environmental control instruments

Table 49 outlines the controls that either currently exist or will be put in place to ensure appropriate management of the Proposal for each key environmental factor and other factors identified within the ESD. The controls include:

- implementation conditions as per any Statement issued by the Minister for the Environment
- conditions of the DER Works Approval (under Part V of the EP Act) for construction of works on prescribed premises
- conditions of the DER Licence (under Part V of the EP Act) for the operation of activities on prescribed premises (ore processing, landfill and sewage facility)
- conditions of the Licences to 'Take Water' and disturbance to bed and banks (under the RIWI Act)
- relevant NBGPL Environmental Standards and guidelines.

Proponent management controls that will be regularly reviewed and that will apply to the Proposal include measures and/or actions contained within the following documents:

- EMP
- Annual Environmental Report
- Closure Plans.

Table 49 Statutory and environmental management controls for the Proposal

Factor	Topic	Potential Statement Conditions (Part IV)	EMP/ Closure Management Plan	Works Approval/ Licence (Part V)/ regulation	Other relevant legislation and regulations
Key environmental factors					
Groundwater	Groundwater drawdown and abstraction	✓	✓		✓ Licence under RIWI Act
	Adverse groundwater quality effects	✓	✓	✓	
Surface water	Placement and design of infrastructure		✓	✓	✓ Bed and Bank licence under RIWI Act
	Adverse surface water quality effects	✓	✓	✓	
Vegetation and flora	Clearing	✓	✓		
	Spread of weeds and pathogens including dieback	✓	✓		
Terrestrial fauna	Clearing of vegetation	✓	✓		
	Rare and endangered fauna		✓		✓ WC Act ✓ EPBC Act
	Vehicle movements		✓		
Other management considerations					
Public amenity	Visual impact		✓		
	Realignment of Bibbulmun Track		✓		
Indigenous heritage	Disturbance to Aboriginal heritage sites		✓		✓ AH Act
Noise	Emissions of noise		✓	✓	
Air emissions	Dust generation		✓	✓	
	Mercury emissions		✓		
	Greenhouse gases		✓		✓ Carbon Pollution Reduction Scheme ✓ NGER Act
Closure and rehabilitation	Decommissioning, decontamination/ remediation, monitoring and rehabilitation	✓	✓		✓ Mining Act

13.3 Summary of proposed management commitments and environmental outcomes

13.3.1 Groundwater

NBGPL will also continue to undertake the following current management measures for groundwater quality:

- maintaining certification with the International Cyanide Management Code
- ensuring WRD expansion areas are equipped with perimeter drainage and ensure that any seepage would report to the Impacted Water Drainage Blanket for collection and use through the processing plant
- designing, constructing and operating the new RDA with seepage mitigation measures and solution recovery systems
- installing a drainage blanket on lower parts of the WRDs where potentially acid forming rock may be dumped and where drainage would no longer report to the existing impacted Water Sump
- constructing the drainage blanket of hard non-acid forming rock with a high void ratio and designed to direct seepage towards perimeter drains
- designing and constructing the new RDA to include a liner below the supernatant pond and solution recovery systems.

The current monitoring program will be further expanded to cover monitoring of potentially groundwater-dependent vegetation in the potential zone of impact along the Hotham River, groundwater and surface water in order to:

- improve understanding of regional groundwater and validate predictions of modelling
- determine through routine monitoring if changes are occurring regionally
- assess whether any changes are due to the propagation of drawdown or external factors such as third party activities or climate change.

In addition to the ongoing monitoring program, at the start of the new monitoring program NBGPL will undertake an initial groundwater investigation to assess the degree of interaction between the Hotham River and upper bedrock aquifer in the potential drawdown area.

NBGPL has developed an Adaptive Groundwater Management Plan (AGMP). The AGMP is designed to mitigate the uncertainty regarding the potential impacts of the groundwater-related aspects of project through:

- monitoring to identify potential impacts and better understand the system and its interactions
- regular revision of modelling to better understand when and where impacts may occur
- contingencies to be implemented should an impact occur.

The AGMP is a dynamic plan that includes:

- extension of the existing groundwater, surface water and potential groundwater-dependent vegetation monitoring programs
- decision-making process to determine if an impact has occurred based on the monitoring and if that impact is related to the NBG operations
- contingency actions to be undertaken if an impact is confirmed as having occurred as a result of mining-related activities.

13.3.2 Surface water

Management measures in the Surface Water Management Plan include:

- managing process water quality through Caro's Acid Cyanide Destruction circuit
- conducting inspections of sediment control structures to prevent silt laden water entering the environment as per site monitoring plan
- removing sediment from sediment pumps
- collecting all runoff from WRDs, RDAs, soil/gravel stockpiles and bauxite stockpiles in storage ponds and reuse as process water
- segregating clean and potentially contaminated runoff (runoff from WRDs)
- treating runoff and seepage from WRDs if required
- continuing to manage the staged construction of the F1/F3 RDA to prevent migration of diffuse seepage into the South Dandalup catchment
- managing storage capacities in water holding facilities in accordance with the following:
  - each facility to be designed with a capacity for a 1-in-25-year Average Recurrence Interval storm event of 24 hours duration in addition to a freeboard allowance
  - where the facility is the last storage before discharge to the lower sections of Thirty Four Mile Brook or Gringer Creek, the facility shall be designed with capacity for a 1-in-100-year Average Recurrence Interval storm event of 24 hours duration.
- discharging of water from the mine site to Thirty Four Mile Brook to only occur in rainfall events greater than 1-in-100 year average return interval, 24 hour event
- undertaking abstraction of water from the Hotham River in accordance with DoW licence conditions and as described in Section 5.4.2
- submitting detailed design of Gringer Creek diversion to DoW and DER.

13.3.3 Vegetation and flora

Key measures in the Vegetation and Flora Management Plan include:

- providing information to all employees and contractors (through the site induction process) on vegetation management requirements (e.g. forest disease, weed management and clearing requirements)
- using the NBG internal Environmental Disturbance Application process for all areas requiring clearing to ensure activity is in line with internal and external standards and regulations
- demarcating clearing boundaries with flagging tape to ensure minimal area is impacted and trees of significance are avoided
- conducting post-clearing inspections to determine compliance with NBG Environmental Disturbance Application and preparation for rehabilitation (if applicable)
- completing pre-clearing forest disease surveys to determine if forest disease is present and if additional management protocols are required to limit spread of disease
- where forest disease is identified in an area to be cleared, management boundaries are to be determined and control protocols communicated
- implementing control protocols such as management of drains, topsoil and gravel stockpiling and vehicle washdown
- identifying single entry and exit points should crossing of a disease infested area be unavoidable
- implementing vehicle washdown protocols at entry into forest areas at all times
- restricting access to forest areas when rainfall exceeds 5 mm in 24 hours
- inspecting all vehicles prior to entering to site for soil and vegetative material
- mapping known Declared Weeds locations
- undertake weed management such as spraying and manual removal as required
- rehabilitating areas no longer required for mining purposes.

13.3.4 Terrestrial fauna

Key measures in the Black-Cockatoo Management Plan include:

- providing information to all employees and contractors (through the site induction process)on black cockatoos and any other factors that may have a direct or indirect impact on populations
- communicating requirements of black cockatoo management at neighbouring schools and community meetings
- including black cockatoo theme topics in World Environment Day activities
- demarcating areas on-ground prior to clearing to ensure foraging and habitat trees of significance are avoided
- surveying potential habitat trees in clearing area to determine if any nestlings are present
- waiting until nestlings have left the nest before felling any potential habitat trees in the disturbance area
- installing and maintaining drinking points near known breeding and feeding areas
- maintaining permanent drinking water on the site of higher water quality (naturally more attractive to birds) than RDAs
- destruct WAD-cyanide
- utilising Wildlife Observers to monitor wildlife accessing F1 RDA and new RDA
- ensure noise levels are managed in accordance with the Noise Regulations
- ensure lighting is directed to minimise light spill outside the mining area
- maintaining roads and tracks to prevent formation of water holding structures
- ensuring food plant and hollow-producing tree species are used in rehabilitation seed mixes
- clearly demarcating areas to be retained for conservation (i.e. protected from mining activities) to ensure the habitat remains of high quality for black cockatoos
- ensuring areas selected for conservation for black cockatoos contain high-value habitat and/or breeding trees
- control feral bees in and around the mine site
- investigating the benefit of using artificial nest hollows in remnant forest areas
- ensure actions are consistent with existing black cockatoo recovery plans
- continuing research into habitat use by black cockatoos to improve understanding of potential impacts and continuously improve mitigation and rehabilitation methodologies to best support these species.

Key measures in the Terrestrial Fauna Management Plan include:

- providing information to all employees and contractors (through the site induction process) on fauna management requirements (e.g. speed limits, how to manage injured fauna etc)
- installing relevant signage on roads and entry points to the mine noting presence of fauna
- conduct fauna trapping and relocation prior to areas being cleared
- implementing a phased clearing approach for area the Proposal
- ensure all access roads are clearly signposted with speed limits
- conduct regular spot checks of vehicle speed in and around the mining operation
- restricting access to forest areas through signage and closure of tracks
- displaying maps and photographs of fauna through fact sheets and information bulletins in the workplace to raise awareness and facilitate identification and on-the-ground management
- report all observations of protected fauna to the Site Environmental Department who will maintain records
- giving native animals encountered on-site the opportunity to move on if there is no threat to personnel safety in doing so

- if sick or injured animals are encountered, contacting local carers to assess possible rehabilitation of the animal
- ensuring food waste is not accessible to attract native fauna or feral animals
- prohibiting pets and firearms on the NBG leases
- ensuring some connectivity between the eastern and western vegetated areas of the mine site through implementing fauna access and egress ability across roads and pipelines, and/or undertaking periodic trapping and relocation of fauna
- reporting all observations of feral animals to the Site Environmental Department who will maintain records
- restricting access to NBGPL–owned property for apiarists
- working with DER and/or local conservation groups to continue to control feral pigs, cats and foxes in and around the mine site
- continuing research into habitat use by key species of conservation significance to improve understanding of potential impacts and continuously improve mitigation and rehabilitation methodologies to best support these species.

13.4 Proposed environmental conditions

As part of this process, NBGPL will be reviewing and proposing changes to the relevant key characteristics table (Table 1, Schedule 1 of Statement 591).

NBGPL will review the existing Environmental Conditions and Procedures provided for the approved operations in Statement 591, and following receipt of public comments, will propose new environmental conditions for the operation, so that the Proposal and existing operations can be defined under a single statement. NBGPL commitments listed in Schedule 2 of Statement 591 will also be reviewed as part of this process. NBGPL considers there are a number of conditions and Proponent commitments in the existing Statement that are either not auditable or no longer relevant. In reviewing the conditions and commitments under Statement 591, NBGPL will propose new conditions in accordance with the draft EPA Environmental Assessment Guideline No. 4 'Towards Outcome-based Conditions (EPA 2009) in that they will:

- reasonably relate to the Proposal
- be for the purposes of achieving the objectives of the EP Act and relevant government policy
- be reasonable, final and certain
- be unambiguous and clear
- be placed only on the proponent
- where possible, be outcome based rather than prescriptive (i.e. the will provide context around what is to be achieved rather than detail the specific requirements of how to achieve it)
- the outcome must be clearly stated and should be measurable, specific and achievable so that compliance with the condition can be measured by the proponent.

However, in circumstances where there is a degree of uncertainty, and it is difficult to predict environmental outcomes, prescriptive conditions may be necessary. The outcome-based conditions must also include an action plan that will be followed if the outcome is not met.

Where, possible, and to reduce duplication, a condition will not be suggested if the environmental impact can, or is adequately addressed by other environmental control instruments (Table 49), the EMP (Appendix 1) or the MCP (Appendix 2). Any breach of these instruments will require a response involving investigation of potential impacts and implementation of mitigation and management measures and stakeholder consultation, as required.

14. Offsets

14.1 Purpose and scope of this section

This offsets assessment, while forming part of the PER, is also designed to be read as a stand-alone document. This section summarises impact assessment and mitigation measures relevant to the assessment of offsets (additional detail is available within the remainder of the PER and associated appendices). The purpose of the offsets assessment is to identify the offsets requirements and describe environmental effects of the Proposal after the application of the offset package.

The offsets assessment has been structured to:

1. Identify guidance on the requirements and application of offsets (Section 14.2).
2. Summarise the residual impact (after the application of the on-site mitigation hierarchy presented in *Position Statement No. 9* (EPA 2006) of the Proposal; mitigation measures to avoid, minimise, rectify and reduce impacts) (Section 14.3).
3. Describe the elements of the offset package (Section 14.4).
4. Assess the impact after the application of offsets (Section 14.5.2).

14.2 Offsets policy

Offsets are actions to address significant residual environmental impacts of a development or activity. Where a significant residual environmental impact has been identified, both the WA Government and the Australian Government have policies regarding offsets that aim to achieve a net environmental benefit, or at a minimum maintain environmental values (DSEWPaC 2012, Government of Western Australia 2011, EPA 2008, EPA 2012b). Offsets comprise offsite actions that are taken in addition to any on-site management or rehabilitation. There are two categories of environmental offsets, recognised by both the WA Government and the Australian Government:

1. **Direct offsets** are those actions designed to provide for restoration or on-ground improvement, rehabilitation and conservation of habitat and extend beyond the project area.
2. **Indirect offsets** or 'other compensatory measures' are actions aimed at benefiting the affected environmental asset through improving scientific knowledge or community awareness and may include research, management planning or education that leads to the improved understanding of management of the environmental value.

Offsets are only considered after the avoidance and mitigation options have been undertaken. Offsets are used to compensate for residual environmental impacts and to achieve long term outcomes, building on existing conservation programs (Government of Western Australia 2011).

Australian Government policy specifies direct offsets should make up at least 90% of the required offset package (DSEWPaC 2012). However, deviation from this 90% will be considered where it can be demonstrated that there will likely be a greater benefit to the protected matter through increasing the proportion of indirect offsets or where scientific uncertainty is so high that it is not possible to determine a direct offset likely to benefit the protected matter.

As far as possible, the WA Government and the Australian Government will endeavour to ensure that there is minimal duplication in requirements for environmental offsets (Government of Western Australia 2011). The WA Environmental Offsets Policy provides the following principles for the use of environmental offsets:

1. Environmental offsets will only be considered after avoidance and mitigation options have been pursued.
2. Environmental offsets are not appropriate for all projects.
3. Environmental offsets will be cost effective, as well as relevant and proportional to the significance of the environmental value being impacted.
4. Environmental offsets will be based on sound environmental information and knowledge.
5. Environmental offsets will be applied within a framework of adaptive management.
6. Environmental offsets will be focussed on longer term strategic outcomes.

1.1.1 Offset guidance

The following WA Government documents relevant to environmental offsets include:

- *Guidance Statement No. 19: Environmental offsets – biodiversity* (EPA 2008)
- *Position Statement No. 9 Environmental Offsets* (EPA 2006)
- *WA Environmental Offsets Policy September 2011* (Government of Western Australia 2011)
- *Environment Protection Bulletin No. 1 Environmental Offsets* (EPA 2008).

The EPA has also prepared a draft *Environmental Assessment Guideline for Environmental Offsets* (EPA 2012b) to provide guidance on determining the circumstances under which offsets may be required, and how to develop an appropriate offset package.

The key Australian Government document on environmental offsets is:

- *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC 2012).

14.3 Assessment of offset requirements

The offsets assessment has been structured in accordance with the Environmental Offsets reporting form specified in *Guidance Statement No. 19: Environmental offsets – biodiversity* (EPA 2008):

- type of environmental asset (Section 14.3.1)
- potential significant impacts (Section 14.3.2)
- mitigation measures (Section 14.3.3)
- residual impacts (Section 14.3.4)
- proposed offsets package (Section 14.4).

While this structure has been presented in terms of WA EPA requirements, Section 14.3.1 outlines the relevant Australian Government Matters of National Environmental Significance (MNES) and Section 14.3.4 concludes on the likely residual impact to MNES.

14.3.1 Proposal summary

The Proposal is to extend the life of the existing NBG, located near Boddington, Western Australia. The mine is located within the Darling Botanical District of the South-western Botanical Province and is largely characterised by open forests of *Eucalyptus marginata* (Jarrah). The mine is primarily located on freehold land owned by NBGPL with a portion located in State Forest (to the west of the mine). State Forest is managed for recreation and nature conservation, to protect water catchments, and to provide for sustainable resource use (e.g. timber production, wildflower picking). Much of the land to the south of the mine has been cleared for agriculture and is used for grazing and cropping (freehold farmers). A mixture of Pine and Eucalypt plantation and private forest occurs to the north and east.

NBG first commenced operations in 1987, entering care and maintenance in 2001. Commercial production was again realised in 2009, with the commencement of the basement ore-mining phase, with an anticipated 15–20 year mine life. With the identification of additional resources, the Life of Mine Extension Project (the Proposal) has the potential to extend mine life until 2041.

The Proposal focuses on continuing to target low-grade hard rock ores lying beneath pits mined during previous operations. The Proposal includes additional Waste Rock Dumps (WRD), a new Residue Disposal Area (RDA) and minor modification to the existing RDA, widening and deepening pits, additional stockpiles (for bauxite, topsoil and gravel), new water storage dams and ancillary infrastructure (including roads, powerlines and pipelines).

To enable development of these elements, the Proposal will involve diversion of a 2 km section of Gringer Creek while the expansion of the WRD to the west will intersect a 2 km section of the Bibbulmun Track. The track will be required to be diverted around the mining operations and NBGPL is in discussions with the DPaW regarding this diversion. In total, the Proposal is expected to require clearing of approximately 1755 ha of native vegetation over the next 15–20 years. The clearing will occur in two stages (as shown in Table 50):

- initial clearing of 965 ha of native vegetation (commencing in 2015) for mine pit and waste dump expansion, and supporting infrastructure
- clearing of 790 ha of native vegetation (not expected to commence to 2022) for the new RDA.

Table 50 Indicative disturbance area and timing

Project component	Native vegetation (ha)	Hotham Farm: cleared or degraded (ha)	Plantation (ha)	Total (ha)
Initial clearing				
Pit expansion	22	0	0	22
WRD expansion	561	23	0	583
Stockpiles	99	7	0	106
Existing RDA	12	0	0	12
Drainage and other earthworks	271	29	0	300
Water supply storage dams	0	220	0	220
Totals:	**965**	**280**	**0**	**1245**
Clearing for New RDA				
New RDA	790	0	860	1650
Totals:	**1755**	**280**	**860**	**2895**

The native vegetation clearing for the Proposal is complex due to land tenure and ownership, with existing third party interests to be considered. There is one State Agreement Act for bauxite mining that covers part of the native vegetation clearing area and one adjacent to the Development Area. As described in Section 1.4.1, a portion of this Proposal is located within the existing approved area for disturbance of another project. A section of the Development Envelope is also within the State Forest.

Existing third party disturbance approval

As described in Section 1.4.1, a significant portion of the Development Envelope is within the BHP Billiton/Worsley Alumina mining envelopes as detailed in Figure 2 of Statement 719 issued under the WA Government EP Act. Approximately 845 ha of the total clearing of 1755 ha is within the BHP Billiton/Worsley Alumina mining envelopes as shown in Figure 44. The BHP Billiton/Worsley Alumina Project has also been approved under the Australian Government EPBC Act (2004/1566). Under these approvals, disturbance within mining envelopes has been approved and offsets requirements for residual impacts have been established. The area subject to this third party approval coincides with the RDA and a small portion of land in the southeast corner of the proposed WRD expansion.

Mining in these areas is likely to occur in the near future. Where NBGPL disturbs ground where there is a bauxite resource, prior to it being mined for bauxite, NBGPL is required to stockpile and store the bauxite resource for processing by a bauxite miner.

Area within State Forest

As described in Section 3.4.1 up to 624 ha of the waste rock dump and pit expansion will be within the Dwellingup State Forest. A component of the offset package is the change of ownership of privately held land by NBGPL for State Forest, such that there will be no net loss of State Forest (Section 14.4.2). As there will be no net loss of State Forest there is no impact to State Forest. The area to be exchanged will be of equal or greater quality and this is to be discussed and agreed upon with the DPaW. NBGPL will cover administrative costs incurred by DPaW as a result of the above land exchange.

Clearing of timber plantations

As described in Section 9.4, two sites were assessed in detail (four other options were dismissed early) as potential options for the location of the second RDA, that were able to store sufficient capacity for an extended mine life. These were the Saddleback plantation land (preferred option included in this Proposal) and another site, owned by NBGPL that entirely comprised of native jarrah forest. Based on topography, the second option would have been a larger facility potentially being up to 2000 ha in size. Section 9.4.1 details that the extent to which clearing of native vegetation has been minimised, due to predominantly locating the RDA within existing pine and eucalypt plantations (which were purchased by NBGPL in 2011). As stated in Section 9.4.1, approximately 860 ha of the proposed RDA footprint of 1650 ha is within existing timber plantations. Within this 860 ha, 454 ha of this land is fallow (where plantations have been harvested previously and not re-planted), 276 ha is currently pine and 130 ha is eucalypt plantation. Under the current harvesting plan, the fallow land will not be re-planted and the 406 ha of plantation land within the proposed RDA footprint will be harvested and thus fallow by the time of the RDA development in 2022. Harvesting operations for this area are planned to be complete by 2018.

The reason the majority of the plantation area is fallow is that the current business plan for the timber operations does not involve re-planting either the Pine or Eucalypt trees. This means that the trees within the RDA will not be re-planted. As the clearing without re-planting of these trees is considered to be the 'do nothing case', (i.e. regardless of whether this Proposal goes ahead or not) this not considered to be a change of land-use. Therefore, this clearing is not considered to be an impact and as such no offsets are proposed.

Matters of National Environmental Significance

The Proposal has the potential to significantly affect the following MNES protected under Part 3 of the EPBC Act:

- listed Threatened species and communities (sections 18 and 18A of the EPBC Act).

Of the 13 EPBC Act listed species identified as potentially occurring in the area, six have been recorded within the Development Envelope:

- Woylie/Brush-tailed Bettong (Endangered)
- Chuditch (Vulnerable)
- Carnaby's Black-Cockatoo (Endangered)
- Forest Red-tailed Black-Cockatoo (Vulnerable)
- Baudin's Black-Cockatoo (Vulnerable).

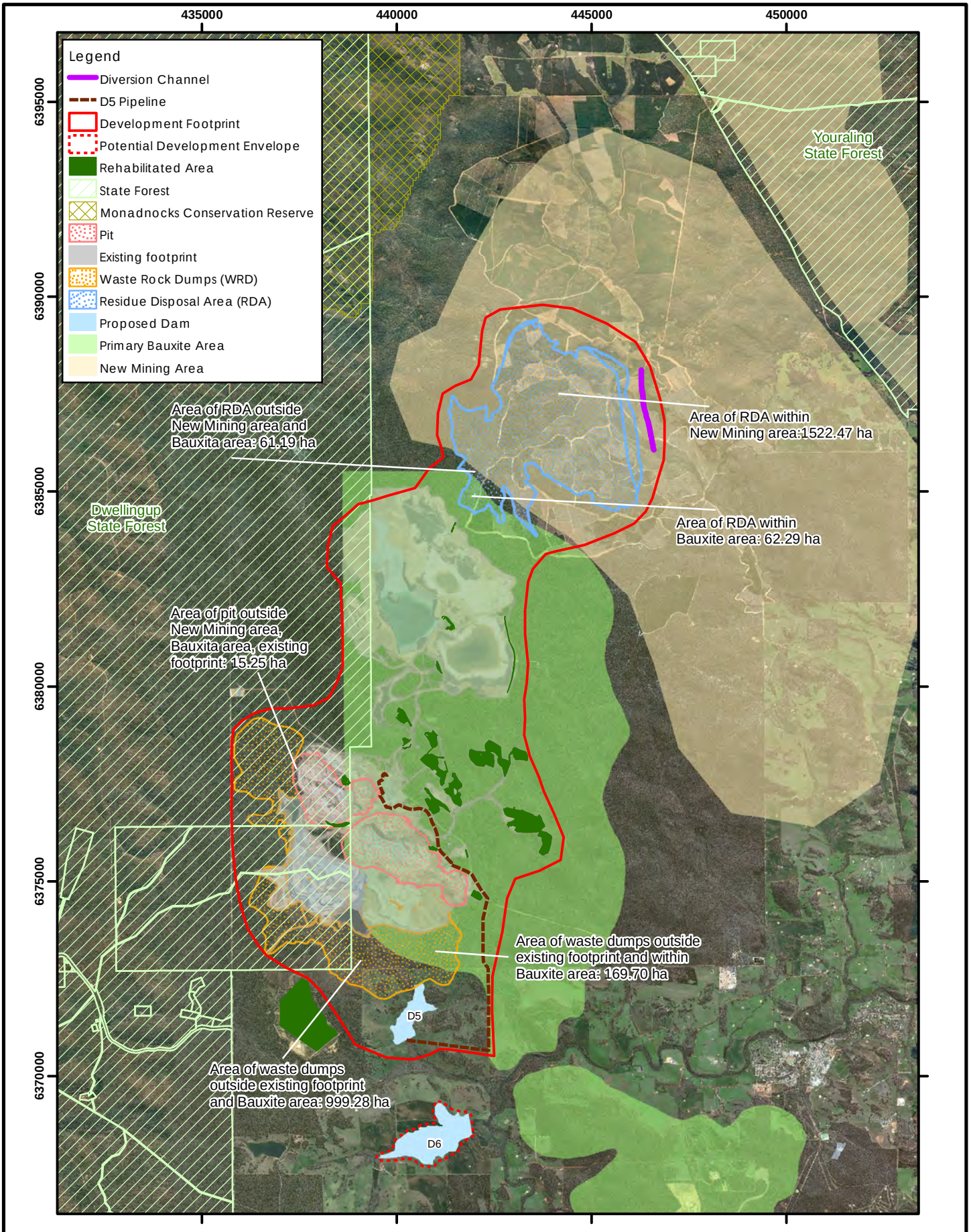

Figure 44 Disturbance within the BHP Billiton/Worsley Alumina mining envelopes 232

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Scale
0 1 2 3 4 5
Kilometers

1:130,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: State forest: DEC 2012. New mining area & bauxite areas: Client 2003.
All other data: Client 2012.
Note that positional errors may occur in some areas

Path: Q:\GIS\Consult\2011\BGM\BGM11099\ArcMap_Documents\R007\RevH\BGM11099_01_R007_RevH_F044.mxd

14.3.2 Potential significant impacts

The potential impacts of the Proposal considered in this PER (prior to the implementation of mitigation measures) are:

- impacts to groundwater-dependent ecosystems (including the Hotham River), as a result of groundwater drawdown and groundwater abstraction
- adverse effects to groundwater quality as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies
- impacts to surface water flows as a result of placement and design of new infrastructure, including alterations of existing drainage patterns of Gringer Creek and tributaries of the Hotham River
- adverse effects to surface water quality as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies
- clearing of up to 1755 ha of native vegetation over 15–20 years
- mining activities (such as vehicle movement and site disturbance) exacerbating the spread of weeds and pathogens (including dieback) within and outside the project area
- clearing of vegetation resulting in loss or fragmentation of fauna habitat, and death or injury of fauna during clearing and construction.

14.3.3 Mitigation measures

In accordance with the hierarchy of on-site mitigation measures presented in *Position Statement No. 9* (EPA 2006), the Proposal includes mitigation measures to avoid, minimise, rectify and reduce impacts prior to the application of environmental offsets. The mitigation measures for each potential impact are described in Table 51.

14.3.4 Summary of residual impacts

Remaining residual impact

WA and Australian Government offset policies identify that offsets can only be considered after avoidance and mitigation measures have been applied. Table 51 summarises the mitigation measures for each of the key environmental factors; for more detail refer to the mitigation section of each key factor.

The significant residual environmental impacts of the Proposal, after consideration of other mitigation measures to be applied, are expected to be:

- clearing of up to 1755 ha of native vegetation
- clearing of up to 1755 ha of foraging and breeding habitat for Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoo and foraging habitat for Baudin's Black-Cockatoo
- some fragmentation of local habitat for Woylies and Chuditch.

After the application of mitigation measures, other impacts of the Proposal are not expected to be significant. However, the offset package is expected to provide benefits to other environmental values affected by the Proposal.

Table 51 Summary of mitigation measures and residual impacts

Environmental Factor	Potential impact	Mitigation measures			Residual impact
		Avoid	Minimise	Rectify / reduce	
Groundwater	Impacts to groundwater-dependent ecosystems (including the Hotham River), as a result of **groundwater drawdown and groundwater abstraction**	Dewatering of the open pits cannot be avoided during the operational phase of the project. Dewatering is required to enable safe access to the ore and cannot be avoided. Evidence suggests that local swamp areas appear to be created from perched groundwater in the shallow seasonal system and are not connected to the bedrock aquifer (which is undergoing dewatering) (Schlumberger 2013).	To minimise the volume of water required to be pumped from Hotham River water reuse is maximised through the processing plant. Abstraction of surface water from the Hotham River is undertaken in a sustainable manner in accordance with DoW license conditions.	Investigations into the relationship between the Hotham River and the basement aquifer systems to determine if the summer baseflows of the Hotham could be impacted by the increased zone of depressurisation. If impacts to streamflow of the Hotham River likely appear to be due to drawdown, actions are proposed through the application of the Adaptive Groundwater Management Plan (AGMP). One potential option currently being considered under the AGMP includes the streamflow augmentation to maintain the low summer baseflows of the Hotham River below the potential impact point.	Negligible impact to groundwater-dependent ecosystems is expected after the application of mitigation measures.
	Adverse effects to groundwater quality as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies	Adverse effects to groundwater quality will be avoided through the application of established design and procedures described in Section 13.	Continuing to implement the containment and recovery plan for the residue disposal operations in relation to cyanide (as described in Section 13). Continued compliance with, and certification to, the International Cyanide Management Code. Contain and clean any spillages or leakages immediately in accordance with licence conditions. Continued compliance with AS 1940 with regards to storage of chemicals and hydrocarbons.	Relevant information (including handling and spill clean-up) provided through induction process for all personnel prior to commencing work on site. Preventing the migration of diffuse seepage to the South Dandalup catchment by engineering design and backup by monitoring/pumping bores to maintain groundwater levels on the perimeter of RDAs. Design/ construct hazardous materials storage to prevent potential runoff and stormwater ingress. Continued monitoring to ensure objectives and targets are met, as described in EMP.	No significant residual impact from adversely affected groundwater quality is expected after the application of mitigation measures.
Surface water	Impacts to surface water flows as a result of **placement and design of new infrastructure**, including alterations of existing drainage patterns of Gringer Creek and tributaries of the Hotham River	Although infrastructure placement avoids discrete features where possible (e.g. creeklines), it is not feasible to avoid impacting all surface flows. Placement of the new RDA has avoided the damming of Gringer Creek. A 2 km section of Gringer Creek will be diverted around the RDA to maintain flows downstream of the facility.	WRD and RDA structures will be designed and operated so that potentially mine impacted water does not enter the environment.		No significant residual impact to groundwater-dependent ecosystems is expected after the application of mitigation measures.

Environmental Factor	Potential impact	Mitigation measures			Residual impact
		Avoid	Minimise	Rectify / reduce	
	Adverse effects to surface water quality as a result of seepage or runoff from WRDs and RDAs, including potential impacts to drinking water supplies	Adverse effects to surface water quality will be avoided through the application of established design and procedures described in Section 13.		Where required, post-closure runoff and seepage from RDAs and WRDs will initially be treated to remove cyanide and low pH water. These treatments will be discontinued when acceptable standards of water quality are met.	No significant residual impact from adversely affected surface water quality is expected after the application of mitigation measures.
Flora and vegetation	**Clearing** of up to approximately 1755 ha of native vegetation over 15–20 years	To avoid clearing of native vegetation the RDA has been preferentially located within an existing timber plantation, resulting in a net disturbance of 790 ha of native vegetation for the new RDA. Assessment of the only other feasible option for a second RDA revealed this option required disturbance of approximately 2000 ha of native vegetation. Therefore, the chosen RDA location avoids disturbance of over 1200 ha of native vegetation.	Clearing of native vegetation has been minimised by expanding the WRD in a southerly direction to the existing cleared area of Hotham Farm. The alternative option considered involved expansion of the WRD in an easterly direction onto privately owned native vegetation, which would have resulted in much greater native vegetation clearing.	Progressive restoration will be conducted throughout the mine life. The closure plan currently predicts 133 ha of the F1/F3 embankment walls will be available for progressive restoration between now and 2025 and approximately 340 ha of the WRD slopes will be available for restoration between 2024 and 2041. The WRD and RDA areas will be fully revegetated following the completion of mining and processing activities respectively.	Clearing of up to 1755 ha of native vegetation.

Environmental Factor	Potential impact	Mitigation measures			Residual impact
		Avoid	Minimise	Rectify / reduce	
	Mining activities (such as vehicle movement and site disturbance) associated with the Proposal may result in the **spread of weeds and pathogens (including dieback)** within and outside the project area	Vehicle movements are restricted to approved access roads and tracks. Access to forested areas will be closed during periods of wet weather.	The impact of vehicle movements on the spread of weeds and plant pathogens will be minimised through the application of procedures described in Section 13. Access to areas deemed to be Mine Infected Areas require entry and exit protocols. Material stockpiled from Mine Infected Areas will be inventoried, mapped and set aside for specific use back in Mine Infected Areas. Access to forest areas is managed through a site permit system and is reportable to the DPaW. Pre-clearing forest disease surveys will be completed to determine if forest disease is present and if additional management protocols are required to limit spread of disease. Where forest disease is identified in an area to be cleared, management boundaries will be determined and control protocols communicated. Implementing control protocols such as management of drains, topsoil and gravel stockpiling and vehicle washdown.	Three-yearly rolling forest disease surveys are completed on site.	No significant residual impact from vehicle movements is expected after the application of mitigation measures.

Environmental Factor	Potential impact	Mitigation measures			Residual impact
		Avoid	Minimise	Rectify / reduce	
Fauna and habitat	**Clearing of vegetation** would result in loss or fragmentation of fauna habitat	The RDA has been preferentially located within an existing timber plantation to avoid clearing of native vegetation. Assessment of the only other economically feasible option for a second RDA revealed this option required disturbance of approximately 2000 ha of native vegetation. Therefore, the chosen RDA location avoids disturbance of over 1200 ha of land.	Clearing of native vegetation has been minimised by extending the WRD in a southerly direction onto the existing cleared area of Hotham Farm. Black-cockatoo habitat surveys prior to clearing areas for evidence of breeding. Where removal of foraging or habitat trees for black cockatoo species is unavoidable, the mitigation measures, described in Section 13, will be applied to prevent the clearing directly affecting any individuals.	The impact to fragmentation of fauna habitat (particularly Woylies) will be reduced by maintaining connectivity between the eastern and western vegetated areas of the mine site by implementing fauna access and egress structures across roads and pipelines, and/or undertaking periodic trapping and relocation of fauna. Installing and maintaining drinking points near known black cockatoo breeding and feeding areas. Hollow-producing tree species are used in restoration seed mixes and Gastrolobium to provide habitat for Woylies. Progressive restoration of WRD and RDA areas during mining operations. Continue to investigate the use of artificial nest boxes.	Clearing of up to 1755 ha of foraging and potential breeding habitat for black cockatoo species. Some fragmentation of habitat for Woylies and Chuditch.
	Death or injury of fauna during clearing and construction	Vehicle movements associated with clearing and construction cannot be avoided. Black-cockatoo habitat surveys prior to clearing areas for presence of breeding pairs. Clearing to be avoided if breeding pairs are located until fledglings have left the nest.	Providing information to employees and contractors through the induction program on fauna management requirements. Conduct fauna trapping and relocation before clearing areas. Conduct spot checks of vehicles on site. Speed limits signposted on all access roads and tracks within the mining operation.		No significant residual impact from vehicle movements is expected after the application of mitigation measures.

Residual impacts to Matters of National Environmental Significance

Section 11 identified that the Proposal had the potential for the three residual impacts identified above to affect the six species listed under the EPBC Act as MNES relevant to the Proposal. The residual impact to the following MNES were considered against relevant significant impact criteria in Table 40 to Table 45:

- Woylie/Brush-tailed Bettong
- Chuditch
- Forest Red-tailed Black-Cockatoo
- Baudin's Black-Cockatoo
- Carnaby's Black-Cockatoo.

A summary of the residual impacts to MNES is considered in Table 52.

Table 52 Residual impact to MNES

Species	Discussion	Residual impact
Woylie/Brush-tailed Bettong	Clearing will result in a reduction of the extent of potential habitat within the local area (within the area subject to detailed Level 2 vegetation survey, more than 20 000 ha) by a maximum of 5.2%. The DEC has confirmed that the vegetation east of the mining operation was used as a translocation site for Woylie in the mid 1990s as part of Operation Foxglove. The presence of suitable habitat in the area and the continued fox baiting activities associated with Western Shield (since the mid 1990s) have probably contributed significantly to the persistence of this species in the area. The species was first recorded in the area in the 2011/2012 surveys around the operational mining site. Three individuals were recorded (one female with pouch young) to the east of the mining operation. None of the areas where Woylie were located will be impacted by the Proposal. The Proposal could also result in potential fragmentation of habitat for the local population as the WRD extends further south on to Hotham Farm. However, connectivity will be maintained with the west through the centre of the operations via the existing corridor and north of the existing RDA. The habitats to be cleared are not considered locally or regionally limited with the affected vegetation complexes extending further into State Forest to the west. Based on the extent of available habitat the vegetation clearing is not expected to be critical to the survival of the Woylie in the local area. Any impacts are anticipated to be localised and short term.	Some reduction in habitat locally and potential fragmentation impacts with the expansion of the WRD south. Potential residual impacts for this species are discussed further in the offset strategy.
Chuditch	Clearing will result in a reduction of potential habitat extent within the local area (within the area subject to detailed Level 2 vegetation survey, more than 20 000 ha) by a maximum of 7.8% for suitable habitat and 3.2% of potential habitat. The Proposal will also result in some minor habitat fragmentation for this species. Due to the location of extensive areas of suitable habitat nearby these changes are unlikely to significantly affect the distribution of the species. Clearing may result in some habitat loss/fragmentation for this species; however, the species is unlikely to be significantly affected due to the location of extensive areas of suitable habitat nearby. Chuditch have been recorded in the vicinity of existing operations and in the majority of sampling locations. Based on the extent of available habitat the vegetation clearing is not expected to be critical to the survival of the Chuditch in the local area. The population of the Chuditch has been difficult to estimate, as they are largely solitary animals, known to travel long distances and have relatively large home ranges (DEC 2012b). Chuditch are known to utilise a wide variety of habitats and although regularly trapped in the jarrah forest (e.g. as part of Western Shield monitoring), trap success is typically low due to the sparse distribution of the species and seasonal changes (DSEWPaC 2013). Chuditch are well represented on conservation estates with the largest populations monitored under the Western Shield program in nature reserves. Fox control baiting has occurred in the recent past (2010/11) by the DEC on the private and State Forest areas surrounding the mining operations. This may be a contributing factor to the trapping success seen in the 2011/12 surveys. Trapping success for this species has changed considerably over time in the Boddington area, (e.g. in 1984 only two individuals were trapped in comparison to 37 in the 2001/02 surveys [around the operational mine area]). In 2011/12, eight were trapped around the mine operations area and 11-in-the native vegetation around the timber plantation land. This is consistent with survey results from nearby bauxite mining sites where no Chuditch were trapped in the 1980s and early 1990s; however, 19 were trapped in 1996/97 and only two in the surveys completed in 2009–11 (Ninox 2012a). The habitat corridor between the mining operations and the current RDA will not be altered by this proposal and will continue to allow movement of Chuditch between the State Forest to the west and the private forest to the east.	The proposed clearing will reduce the availability of habitat for the species in the local area surrounding the mine. Impacts are anticipated to be short term and localised. The residual impacts for this species are discussed further in the offset strategy.

Species	Discussion	Residual impact
Forest Red-tailed Black-Cockatoo	The Boddington area lies within the known range for the Forest Red-tailed Black-Cockatoo (DSEWPAC 2012b). The Proposal will result in a reduction in the habitat extent for this species within the local area (within the area subject to detailed Level 2 vegetation survey, more than 20 000 ha) by approximately 7.8% for foraging habitat and 2.2% for potential breeding habitat. The species is known to forage and breed in the area. Within the local area the resident population is likely to be less than 50 individuals given the Forest Red-tailed Black-Cockatoo flock sizes observed at NBG (flock size: mean = 7.4; range = 1–45 with 92% of groups containing less than 20 individuals: Lee et al. 2012a). Flock size was used as a measure of local abundance for this species in a study conducted from December 2007 to mid-2010 (Finn 2011). Group size was consistent across all seasons for this species indicating that these groups are year round residents. The larger flock sizes were attributed to temporary aggregations at drinking points, usually during dusk. The total local Forest Red-tailed Black-Cockatoo population associated with the forested land to the east of the operation and adjacent areas is unlikely to exceed 150–250 birds, based on sightings and group sizes (Finn 2011). Native forest and woodland areas appear to be the main habitats for this species in the NBG area although paddocks also appeared to be important for feeding and water resources (i.e. paddock dams) (Lee et al.. 2012a). Availability of permanent water resources (particularly during dry periods) appears to be very important to this species. There did not appear to be consistent roost sites for this species in the continuous forest; however, remnant vegetation patches in paddocks appeared to provide overnight roosting opportunities. Group sizes did not appear to differ with seasons; however, abundance of FRTBC did change from year to year with higher numbers in 2007 and 2008 than subsequent years. This species is believed to be present in the NBG area all year round with local population shifts occurring in response to availability of food and water resources. Feeding on Marri and Jarrah was dominant for this species in the NBG region. Systematic sampling of vegetation within the southern half of the Development Envelope and an area immediately to the east of the Development Envelope (referred to as the eastern acquired lands) identified 55 potential hollow-bearing trees within 21 plots out of the 425 plots in native vegetation surveyed (Finn 2011). Of the potential hollows identified, 29 were outside the Development Envelope, 23 were inside the Development Envelope but unlikely to be affected and three were likely to be affected by the Proposal. Based on the extent of available nesting hollows within the local area (and in the jarrah forest [Abbott 1998]), nesting hollows is unlikely to be a limiting factor for this species in the northern jarrah forest. Contiguous remnant vegetation is available in adjoining State Forest and conservation estate; given this and the mobility of cockatoo populations, the Proposal area is unlikely to constitute a significant corridor or refuge habitat (H Finn [Murdoch University] 2013, pers. comm. 23 January). Based on the extent of available habitat in the area and the small size of the population using it, the reduction in extent of available habitat is unlikely to significantly affect the species. However, this impact will require the application of offsets to achieve a net environmental benefit to the species.	Loss of approximately 7.8% local foraging habitat and 2.2% local potential breeding habitat.
Baudin's Black-Cockatoo	The Boddington area lies within the known foraging areas for Baudin's Black-Cockatoo and is not within the identified breeding range of the species (DSEWPAC 2012b). The Proposal will result in a minor reduction in the extent of habitat for this species within the local area (within the area subject to detailed Level 2 vegetation survey, more than 20 000 ha) by approximately 12.4% for foraging habitat. Within the local area the population is likely to be small in size (flock size: mean = 14.5; range = 2–107 with 78% of groups containing less than 20 individuals: Lee et al. 2012a) and primarily use the Development Envelope as a short-term feeding habitat during the non-breeding season. Flock size was used as a measure of local abundance for this species in a study conducted from December 2007 to mid-2010 (Finn 2011). Moderate group sizes were observed from autumn to spring (although none were observed in October and November) and very small flocks were observed in summer (breeding season). These observations are consistent with other studies undertaken for this species in the jarrah–marri forest. Although the location is more than 50 km from the 'predicted breeding locations' of the species (DSEWPaC 2013), there may be evidence of the breeding range shifting (Lee et al. 2012a). The species does not maintain consistent roost sites in the NBG area and the lack of this consistency may be attributed to the homogeneity of forest stands and availability of water sources in the NBG area (Lee et al. 2012b). Contiguous remnant vegetation is available in adjoining State Forest and conservation estate; given this and the mobility of cockatoo populations, the Proposal area is unlikely to constitute a significant corridor or refuge habitat (H Finn [Murdoch University] 2013, pers. comm. 23 January). Based on the extent of available habitat in the area and the small size of the population using it, the reduction in extent of available habitat is unlikely to significantly affect the species. However, this impact will require the application of offsets to achieve a net environmental benefit to the species.	Loss of approximately 12.4% local foraging habitat. Although there is no evidence that the area is used for breeding, the occurrence of the species in the area over summer indicates there is a small possibility that it may provide potential future breeding habitat.

Species	Discussion	Residual impact
Carnaby's Black-Cockatoo	The Boddington area lies within the breeding range for Carnaby's Black-Cockatoo (DSEWPaC 2012b). The Proposal will result in a minor reduction in the habitat extent for this species within the local area (within the area subject to detailed Level 2 vegetation survey, more than 20 000 ha) by approximately 7.3% for foraging habitat and 7.5% for breeding habitat. Based on observed nesting rates and observations of breeding/nesting behaviour (e.g. single birds flying to/from a water site) the local population is likely to contain between 20–50 breeding pairs, with the breeding number varying from year to year (Finn 2011). Flock size was used as a measure of local abundance for this species in a study conducted from December 2007 to mid-2010 (Finn 2011). The resident population using the Development Envelope is likely to number less than 50 individuals given the flock sizes observed at NBG (flock size: mean = 10.1; range = 1–90 with 85% of groups containing less than 20 individuals, Lee et al. 2012a). Migratory flocks also use the Development Envelope as a short-term feeding habitat during the non-breeding season. Findings on group sizes for Carnaby's Cockatoos in this study are consistent with the smaller group sizes observed for this species within forest habitats, when compared with the larger group sizes reported for the Swan Coastal Plain. Of the three black cockatoo species, Carnaby's used the broadest range of food plants in the NBG area with no food plant accounting for more than 20% of feeding observations (Lee et al. 2012b). This species was also observed to use the broadest range of habitats. Systematic sampling of vegetation within the southern half of the Development Envelope and an area immediately to the east of the Development Envelope (referred to as the eastern acquired lands) identified 55 potential hollow-bearing trees within 21 plots out of the 425 plots in native vegetation that were surveyed (Finn 2011). Of the potential hollows identified, 29 were outside the Development Envelope, 23 were inside the Development Envelope but unlikely to be affected and three were likely to be affected by the Proposal. Further nesting hollows are likely to be present in habitat not surveyed as part of the systematic sampling. Contiguous remnant vegetation is available in adjoining State Forest and conservation estate; given this and the mobility of cockatoo populations, the Proposal area is unlikely to constitute a significant corridor or refuge habitat (H Finn [Murdoch University] 2013, pers. comm. 23 January). Based on the extent of available habitat in the area and the small size of the population using it, the reduction in extent of available habitat is unlikely to significantly affect the species. However, this impact will require the application of offsets to achieve a net environmental benefit to the species.	Loss of approximately 7.3% local foraging habitat and 7.5% local potential breeding habitat.

14.4 Offset package

The proposed offset package includes both direct and indirect offsets, as described below. The offset package focuses on the residual impacts identified in Section 14.3.4.

This offset strategy is being developed in consultation with DPaW and DSEWPaC based on the principles set out in *Guidance Statement No. 19: Environmental offsets – biodiversity* (EPA 2008) and *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC2012a). The strategy is staged, meaning that aspects of the strategy will be triggered throughout the mine life as development and therefore disturbance is planned.

The offset package components are separated between the WRD and other infrastructure (initial clearing), and RDA development (deferred clearing). The offset package comprises the following components:

1. Direct offsets: WRD and Other Infrastructure (offsetting initial clearing of 965 ha of native vegetation):
   (a) Offset component 1: Protection of approximately 2000 ha of adjacent vegetation with a conservation covenant over private land that NBGPL has acquired (subject to agreement by third parties) and provision of ongoing active management of this area. Implementation of the conservation covenant will commence immediately following approval of the Proposal by both the State and Australian Government. The current preferred location of the covenant is likely to be east of the existing mining operations.
   (b) In the event that the placement of 2000 ha of NBG land under covenant is not possible due to third party agreement, NBGPL commits to engage with State and Australian Government as required to secure an alternative area of land of equivalent size and value, under covenant.
   (c) Offset component 2: Restoration of up to 300 ha of cleared farming land in adjacent areas on private land that NBGPL has acquired and provision of ongoing management of this area. The focus of the restoration will be the establishment of black cockatoo foraging habitat (Eucalypts and proteaceous shrubs) plus Marri and Wandoo for hollow creation in the long-term. Restoration will include species preferred by Woylie (e.g. *Gastrolobium* spp.) and take into account the needs of Chuditch (e.g. use of hollow logs for refuge). The extent and timing of offset component 2 will be driven by project scheduling. This offset will be implemented after project scheduling has indicated the extent of clearing required exceeds that covered by offset component 1. Based on the calculation that offset component 1 compensates for a clearing of 665 ha; offset component 2 will only be implemented if project planning retains a requirement for clearing more than this. This measure is considered to be beneficial as it establishes a mechanism to encourage redesign of the project to reduce the extent of clearing.
2. Direct offsets: RDA (offsetting deferred clearing of 790 ha of native vegetation):
   (a) Offset component 3: Restoration of approximately 1050 ha of land previously used for timber plantation to promote fauna linkage between the Monadnocks Conservation Reserve and native vegetation to the east. Planning for this offset component will commence two years before the construction of the RDA (currently planned for 2022), with restoration works to commence the same year as the commencement of construction. The quantum of rehabilitated land will be directly proportional to the level of disturbance required for the RDA (i.e. if the final RDA design is smaller than the current plan as a result of new technologies or improved design) the amount of restoration required will also be reduced. The focus for the restoration will be the same as for that proposed in offset component 2.
3. Indirect offsets (1755 ha):
   (a) Offset component 4: Funding for black cockatoo research and/or conservation project/s and further investigation and survey regarding local Woylie population
   (b) Offset component 5: Land ownership exchange to ensure no net loss of State Forest.

The area of land owned by NBGPL currently under consideration for the conservation covenant is also located within an existing State Agreement for bauxite mining. Commercial discussions are currently underway with the relevant party to gain agreement to the creation of a covenant on this land. Although this outcome is considered to be likely, a contingency measure proposed by NBGPL is either the purchase of land or entering into land management agreements with landowners whereby landowners are compensated for implementing conservation practices on their land without jeopardising their livelihoods.

14.4.1 Calculation of habitat quality

Key inputs into the offset calculator include the quality of the habitat to be lost and the improved quality (through restoration and improved management) and/or improved protection of the land used for the offsets. For these calculations, 90% confidence in restoration of land is assumed. The 90% confidence is based on the existing demonstrated experience of NBGPL in on-site rehabilitation, which has been demonstrated to return foraging habitat for black cockatoos within 6-8 years (Lee et al. 2012b).

In the event that an alternative parcel of land is sought for this covenant, the land proposed for offsetting will be assessed with the DSEWPaC calculator to ensure it provides the offset required.

The quality value of habitat to be cleared has been determined using the DSEWPaC document *How to use the offsets assessment guide* (DSEWPaC 2012c), which requires three elements of habitat quality to be assessed and their relative importance for each MNES to be determined.

For black cockatoo species the weight for each of these three elements was developed by NBGPL in consultation with Dr Hugh Finn (Murdoch University) and Dr Mike Bamford (Bamford Consulting Ecologists). The basis for the quality values used in the offset calculations is outlined in Table 53. The rationale is based on the highly mobile nature of black cockatoos, which means that large areas of suitable habitat are required for their long-term protection and recovery and habitat loss is a key threatening process (DEC 2012a, DEC 2007) for these species. On this basis, the site condition, essentially habitat suitability was weighted higher (60%) than site context and species stocking rate. Site context was given a low weighting (20%) as black cockatoos are highly mobile and therefore the location of the site in relation to other suitable habitat is less important than for ground-dwelling species or birds with smaller ranges. Species stocking rate was also given a low rating (20%); despite good information existing in the Boddington area regarding cockatoo sightings, population estimates (based on flock size observations from December 2007 to July 2010) of such mobile species are inherently difficult and numbers vary both seasonally and year to year. Therefore, given the three species are known to utilise the area, the suitability of the habitat was considered more important than the exact numbers of birds that had been counted.

For Woylies and Chuditch, the scoring system has been modified to reflect the different requirements of this species (i.e. they are less mobile than birds) (Table 54). In the scoring system site condition was weighted at 40%, site context 30% and species stocking rate 30%. This weighting system recognises that the higher importance for land-based mammals of context and stocking rates relative to that of mobile black cockatoos.

Table 53 Assessment of quality values for the impact area used in the offset calculator for black cockatoos

Weigh	Quality component	Carnaby's	Baudin's	Forest Red-tail	Justification and references if available
60%	**Site Condition**				
	Foraging habitat quality - suitability and diversity of foraging species	8	8	8	The vegetation proposed to be cleared is predominantly jarrah-marri forest and is known to be utilised by all three species for foraging (Lee et al. 2012a). The area has been subject to historical logging activities and contains no values that are considered unique or restricted within the region.
	Breeding habitat quality	7	3	7	Carnaby's Black-Cockatoos are known to nest within the Development Envelope and breeding pairs have been observed in close proximity to the Development Envelope (Lee el al. 2012a). Carnaby's numbers peaked in spring and summer indicating that most Carnaby's use the Development Envelope on a short-term/migratory basis and are not resident year round (Lee et al. 2012a). Baudin's Black-Cockatoos generally breed in the lower southwest of Western Australia (DEC 2007) rather than the northern jarrah forest of the Development Envelope. However, recent studies have recorded Baudin's breeding at a site 140 km northwest of Boddington and this raises the possibility that breeding by this species may occur at NBG now or in the future (Lee et al. 2012a). Forest Red Tailed Black-Cockatoos are known to nest within the Proposal area and are resident year-round at NBG with numbers staying relatively consistent throughout the year (Lee et al. 2012a). This is consistent with other studies that found adult birds moved up to 19 km and juvenile birds moved on average less than 3 km from their natal tree (Johnstone et al. In prep). A 17 year study of the breeding biology of the Forest Red-tailed Black-Cockatoo throughout its range in southwest Western Australia, observed 128 nesting sites. Of these, 10 were in living or dead Jarrah with 107 in living or dead Marri. The remainder were in Wandoo, Blackbutt, Bullich or unknown dead trees (Johnstone et al in prep.) Availability of nesting hollows is not a limiting factor for black cockatoos in the northern jarrah forest. In a study of vegetation surrounding the mine by Murdoch University, approximate estimates of potential large hollow densities in the forest immediately east of the Development Envelope were 38 hollows per km^2 for Jarrah, 27 hollows per km^2 for Marri and 18 hollows per km^2 for Wandoo (Finn 2011). These densities are most likely highly conservative and should be viewed in light of the fact that black cockatoos appear to rarely nest in Jarrah trees within the jarrah-marri forest with a strong preference for Wandoo and Marri (also supported by Johnstone et al. in prep.). In addition, nest-site suitability is almost certainly linked with other factors such as food availability and permanent water sources (Finn 2011) and potentially where there is the ability to nest close to other members of the same flock (Johnstone et al. in prep.). Assessment of felled trees where potential hollows had been observed from ground-based surveys, found that only 31.5% of those observed in Jarrah were sufficiently large for nesting compared to 55.6% for Marri and 66.7% for Wandoo (Finn 2011).
	Proximity to permanent water	9	9	9	Access to permanent water resources within 6 km of nesting and foraging habitat appears to be a prime factor in selection of nest sites for black cockatoos. NBG has various permanent water sites established around the operation as well as the D1 and D4 dams (note: D4 will be replaced by D5). There are also several dams on Hotham Farm where birds are known to drink. Hence, vegetation within this radius appears to be preferable for foraging and breeding habitat.
	Site condition	8.0	6.7	8.0	
20%	**Site context**				
	Importance of the site for species connectivity and extent	6	6	6	NBG lies well within the current species range of all three black cockatoos and therefore occupancy at the site does not influence species extent. NBG is within the northern jarrah forest, which comprises the largest contiguous tract of native vegetation in southwest WA and is adjacent to the Dwellingup State Forest which represents 180 000 ha of jarrah forest. Therefore, NBG does not represent a corridor or refuge site that is necessary to ensure species connectivity (H Finn [Murdoch University] 2013, pers. comm. 23 January). The mobility of these taxa also indicates that the scale of the disturbance will cause local-scale changes only with birds dispersing into adjoining native forest.

Weigh	Quality component	Carnaby's	Baudin's	Forest Red-tail	Justification and references if available
20%	**Species stocking rate**				
	Bird numbers recorded relative to numbers recorded at other sites throughout the species range	5	5	6	Flock sizes at NBG for all three black cockatoos are comparable to those reported in the eastern jarrah forest (Weerheim 2008). For Carnaby's Black-Cockatoo, flock sizes are generally smaller than those reported for the Swan Coastal Plain (Saunders 1980). The breeding density of Carnaby's Black-Cockatoos appears lower than at Wheatbelt sites, based on observations of 7 probable nests at NBG and surrounds based on research to date (2007–2010) (H. Finn. Murdoch University, unpublished data). Baudin's Black-Cockatoos are likely to be short-term occupants as they migrate through feeding areas in the northern jarrah forest during the non-breeding season. Whilst some birds are seen around NBG during the breeding season, no evidence of breeding pairs have been observed. Forest Red-tailed Black-Cockatoos were recorded year round and are likely to have a resident population. The breeding density of Forest Red-tailed Black-Cockatoos appears to be low, based on observations of two probable nests at NBG and surrounds (2007–2010) (H. Finn. Murdoch University, unpublished data). Breeding densities for Forest Red-tailed Black-Cockatoos are characteristically low in the area (Johnstone & Kirkby 1999).
	Overall quality	**7**	**6**	**7**	

Note: Quality scores are qualitative values from 1 to 10 (10 being the highest quality value) that have been based on the available literature and expert opinion.

Table 54 Assessment of quality values for the impact area used in the offset calculator for Woylie and Chuditch

Weigh	Quality component	Woylie	Chuditch	Justification and references if available
40%	**Site Condition**	8	9	Records of Woylies (including breeding individuals) occur in habitat on the eastern side of the current mining operations and none of these locations will be affected by the Proposal. However, suitable habitat is present within the areas proposed to be cleared. The 2011/12 surveys were the first time that Woylie had been recorded in this area. It is possible that these individuals are descendants from the translocated populations released into the area in the mid 1990s as part of Operation Foxglove. Fox control has been implemented in the area since the 1990s as part of Western Shield in the surrounding private and State Forest areas. In addition, based on the presence of vegetation such as *Gastrolobium* spp. in the wider area and thick understorey areas, the condition of the habitat to be cleared would appear to have potential to support the ecological requirements of the Woylie. However, the area to the west and south are known to be infected by *P. Cinnamomi* along drainage lines and access tracks (Glevan 2011). This could have the potential to disrupt the structure of natural habitats and impact important fungal communities that are an important food source (DEC 2012). Chuditch have been recorded in the vicinity of existing operations and in the majority of sampling locations. The population of the Chuditch has been difficult to estimate as they are largely solitary animals, known to travel long distances and have relatively large home ranges (DEC 2012b). Chuditch are known to utilise a wide variety of habitats and although regularly trapped in the jarrah forest (e.g. as part of Western Shield monitoring), trap success is typically low due to the sparse distribution of the species and seasonal changes (DSEWPaC 2013). Chuditch are well represented on conservation estates with the largest populations monitored under the Western Shield program in nature reserves. The area proposed to be cleared has the potential to support Chuditch in densities as seen elsewhere. Given historic survey records, the species appears to have responded well following the implementation of fox control under the Western Shield program in the mid 1990s, making this habitat valuable with a reduced predation risk. Weather conditions which in turn impact food availability for this species (DEC 2012) could also influence local population numbers with the 2001/02 surveys experiencing above average rainfall (47 records of Chuditch) and the 2011/12 surveys recording average to below average rainfall (19 records of Chuditch). However, the presence of *P. Cinnamomi* has potential to impact this habitat and infestations are known to the areas west and south of the operation along drainage lines and tracks.
30%	**Site context**	7	6	The habitats to be cleared are not considered locally or regionally limited with the affected vegetation complexes extending further into State Forest to the west. Connectivity will be maintained through the centre of the operations via the existing corridor and north of the existing RDA.

Weigh	Quality component	Woylie	Chuditch	Justification and references if available
30%	**Species stocking rate**	6	6	It has been confirmed with the DEC that the vegetation to the east of the mine site was used for translocation of Woylie in the mid 1990s as part of Operation Foxglove. It is unknown if the individuals present are descendants of this translocated population or the result of a natural population that has always been present. However, no Woylies have been recorded in surveys in the area prior to the 2011/12 surveys. The species is breeding in the area as a female with a pouch joey was recorded in Autumn 2011. This species may be persisting in this area due to the presence of suitable habitat and the control of foxes in the surrounding forest since the mid 1990s. In general, the species responds well in areas of fox control (DEC 2012; SPRAT 2012). In 2006, the species was known to occur in 21 locations (SPRAT 2012). Some of these are island communities or isolated reserves and many have large numbers with the overall distribution not severely fragmented (SPRAT 2012). However, there have been rapid declines in population numbers at a number of sites considered key to the survival of this species. It is unknown at this point if the species undergoes regular cyclic population fluctuations or if there are other factors currently impacting the species such as disease. Trapping success for Chuditch has changed considerably over time in the Boddington area (e.g. in 1984 only two individuals were trapped in comparison to 37 in the 2001/02 surveys [around the operational mine area]). In 2011/12 eight were trapped around the mine operations area and 11-in-the native vegetation around the timber plantation land. This is consistent with survey results from nearby bauxite mining sites where no Chuditch were trapped in the 1980s and early 1990s; however, 19 were trapped in 1996/97 and only two in the surveys completed in 2009–11 (Ninox 2012a). The population appears to have responded well following the implementation of fox control in the private and State Forest surrounding the operation since the mid 1990s and the results between the 2001/02 and 2011/12 surveys could be a result of different rainfall patterns, and hence food availability, in the years preceding these surveys. Although this species is regularly trapped in the jarrah forest, trapping success rates are usually low due to the solitary nature and larger home ranges of this species. Distribution has also been estimated based on road kill data (SPRAT 2012). The trapping success in the forest around NBG appears to be quite successful for this species, which indicates that the local population is quite established and reproducing. This is most likely highly influenced by the abundance of suitable habitat in the local area and the control of foxes over the region.
	Overall quality	**7**	**7**	

14.4.2 Direct offsets

Offset component 1: Protection of vegetation and fauna habitat locally

Table 55 provides the objectives and description of offset component 1 – the establishment of a conservation covenant on privately owned land, covering up to 2000 ha of private forest owned by NBGPL. This offset aims to compensate for the residual impact associated with the loss of vegetation and the loss of breeding and foraging habitat for black cockatoo species, Woylies and Chuditch. The covenant will be developed in accordance with the Nature Conservation Covenant Program (DEC 2010). While ownership of the land does not change, a covenant represents a legally binding agreement between NBGPL and the Director General of the DPaW to ensure protection of the land's natural values.

Table 55 Protection and improvement of remnant native vegetation habitat for black cockatoos, Woylie and Chuditch in surrounding land

Objective	Description
Protect habitat for black cockatoo species by removing or reducing threatening processes	Development of a Conservation Covenant over this land will: • protect habitat used for foraging by all three species of black cockatoo (Finn 2011) • protect habitat used for breeding by Carnaby's Black-Cockatoo and Forest Red-tailed Black-Cockatoo (likely to use the area throughout the year), and potentially Baudin's Black-Cockatoo which are most prevalent April to September (during the non-breeding season) • protect habitat in close proximity to permanent water sources, which is a limiting factor for black cockatoos, particularly for Forest Red-tail Black-Cockatoos in breeding areas • improve condition of the habitat through conservation management programs including feral animal species and weed control, monitoring of fauna species and management for forest hygiene.
Protect habitat for Woylie and Chuditch by removing or reducing threatening processes	Development of a Conservation Covenant over this land will: • protect suitable habitat for Woylie and Chuditch in the local area • improve the quality of the land through land management practices such as feral animal control, weed management and forest hygiene management.

Conservation of habitat is consistent with the definition of a direct offset in accordance with the WA Environmental Offsets Policy (EPA 2011) and the EPBC Environmental Offsets Policy (DSEWPaC 2012b). Protection of habitat is also consistent with the principles of the *Baudin's and Forest Red Tailed Black-Cockatoo Recovery Plan (2007–2016)* (DEC 2007), *Carnaby's Cockatoo* (Calyptorhynchus latirostris) *Recovery Plan* (DEC 2012a), *Chuditch* (Dasyurus geoffroii) *National Recovery Plan* (DEC 2012b) and the *National Recovery Plan for the Woylie* (Bettongia penicillata ogilbyi) (DEC 2012c).

The land proposed for the conservation covenant is currently subject to a State Agreement for bauxite mining, and is therefore at risk of future clearance as part of mining activities. The conservation covenant will prevent potential future bauxite mining activities in this area, as well as provide for active management of threats including forest pathogens (such as dieback, which alters structure and reduces diversity), feral animals (such as pigs, which have potential to spread dieback and impact vegetation condition) and weeds. A detailed program will be developed prior to the conservation covenant being established.

The habitat quality of offset component 1 was valued as equivalent to that of the area to be impacted, as described in Section 14.4.1. In fact, the habitat quality of the proposed conservation covenant is likely to be higher than the habitat of the impact area, based on detailed habitat assessments of the area in question. For example, the area to be impacted has several known infestations of *P. cinnamomi* (forest disease) whilst the covenant area has little evidence of dieback (or is deemed uninterpretable due to a lack of indicator species). Based on the risk of degradation through bauxite mining operations, the relative value of the habitat should the conservation covenant not proceed was set at five (Table 56). Although rehabilitation works would follow quickly after bauxite mining, increased disturbance in the area would increase the risk of spread of forest disease and weed infestations. The relative value of habitat should

the conservation covenant be implemented was set at one point above the current value (Table 56) to reflect the positive impacts of active management by NBGPL.

Table 56 Habitat values for land proposed for conservation covenant under different scenarios

Scenario	Carnaby's	Baudin's	Forest Red-tail	Woylie	Chuditch
Habitat value under current conditions	7	6	7	7	7
Habitat value with potential mining risk	5	5	5	5	5
Habitat value if conservation covenant proceeds	8	7	8	8	8

NBGPL is a signatory and financial contributor to the Gnaala Karla Booja (GKB) Employment and Economic Development Agreement, which also includes the GKB people, SWALSC, Australian Government and the Western Australian Government. This agreement is currently assessing a project to establish Aboriginal land management services in GKB Country. This project aims to assess the need, desire and capacity for establishing these services and then commencing with the development of such an Aboriginal land management service. The land management components of this proposed offset package could be integrated with this project.

Additionally, this offset will protect habitat for all impacted fauna species recorded in the area. Due to the ongoing negotiation of the proposed conservation covenant with third parties, finer detail on the exact attributes of the area in question cannot be supplied. However, specific detail, including the current preferred location of the proposed covenant and an analysis of the habitat values this covenant will protect will be supplied to regulators in a separate, commercial-in-confidence memo.

In the event that the placement of 2000 ha of NBGPL owned land under a conservation covenant is not possible, due to opposition by a third party, NBGPL will engage with the EPA, DPaW and DSEWPaC to identify and secure suitable alternative land, of equivalent size and value. The DSEWPaC offset calculator will be used to determine the optimum offset extent.

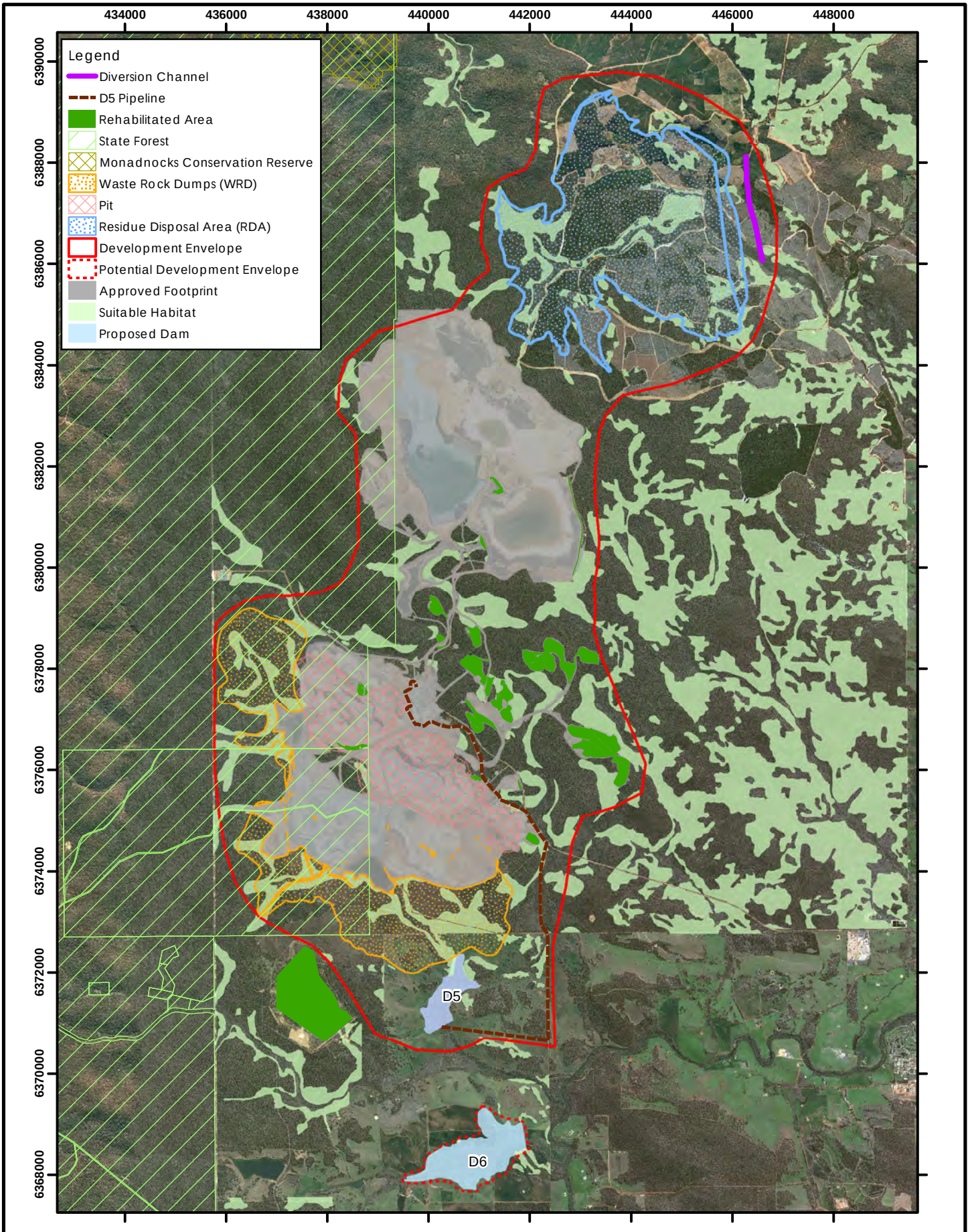

Figure 45 Distribution of habitat for Woylie/Brush-tailed Bettong

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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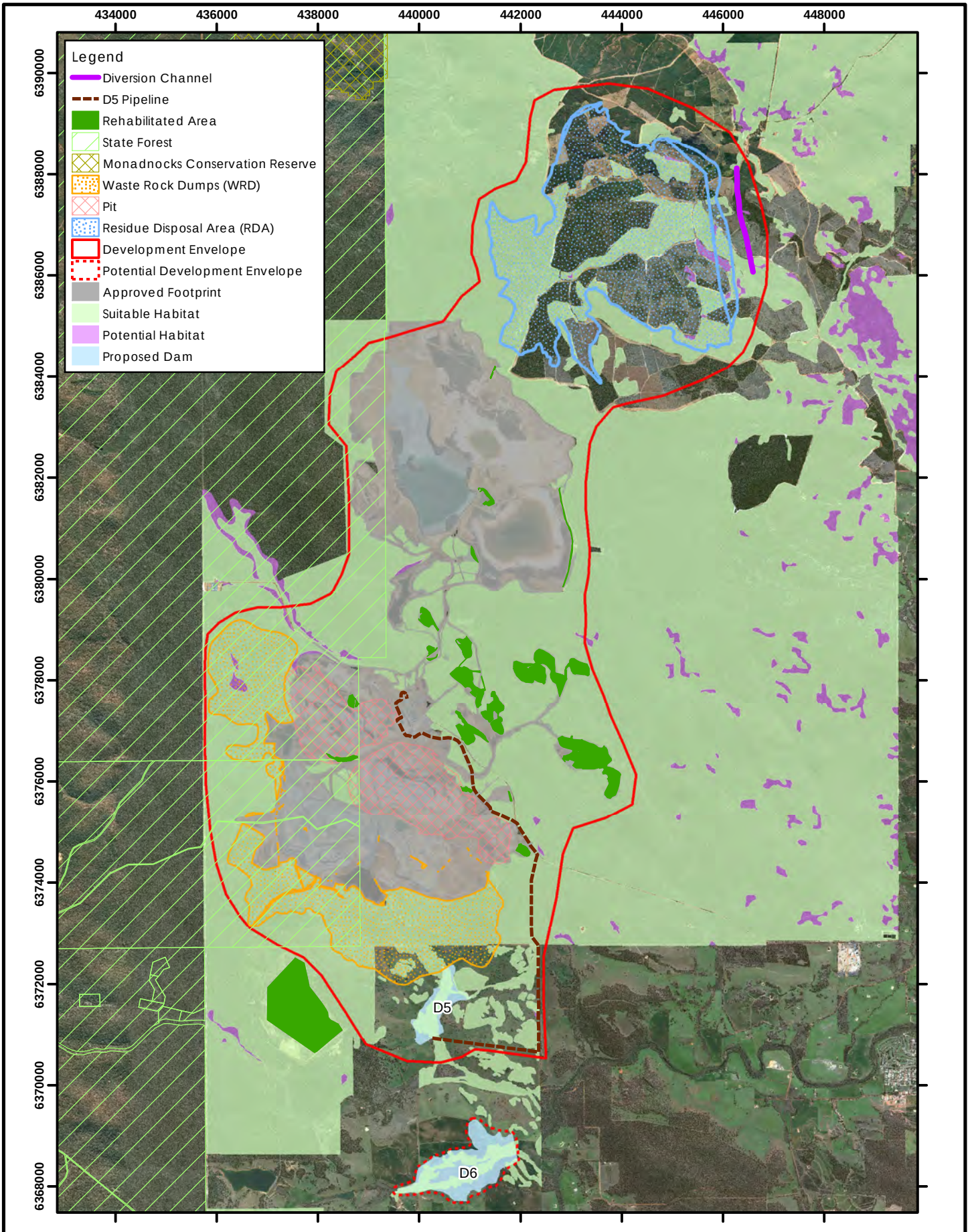

Figure 46 Distribution of habitat for Chuditch

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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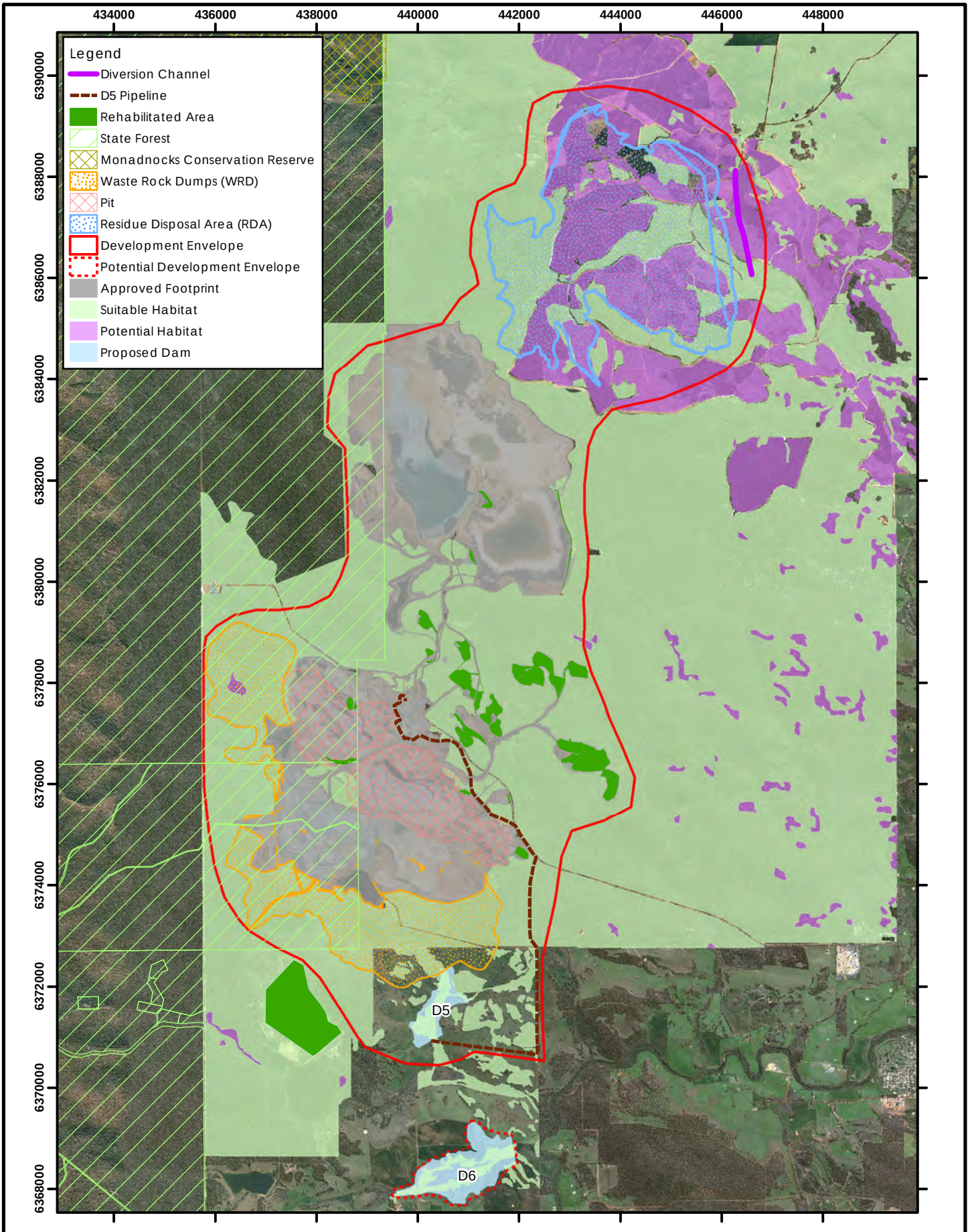

Figure 47 Distribution of habitat for Forest Red-tailed Black-Cockatoo

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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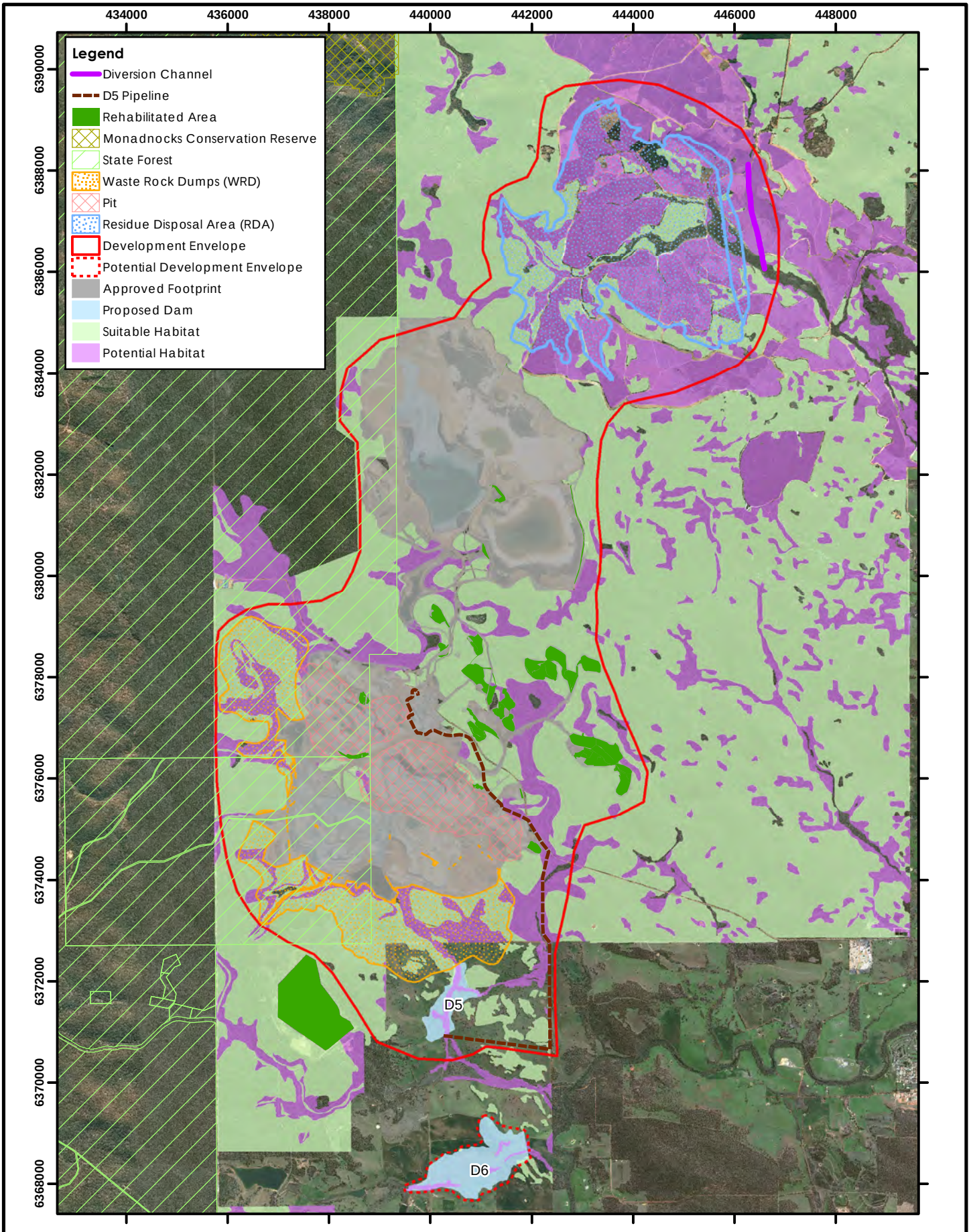

Figure 48 Distribution of habitat for Baudin's Black-Cockatoo

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Scale
0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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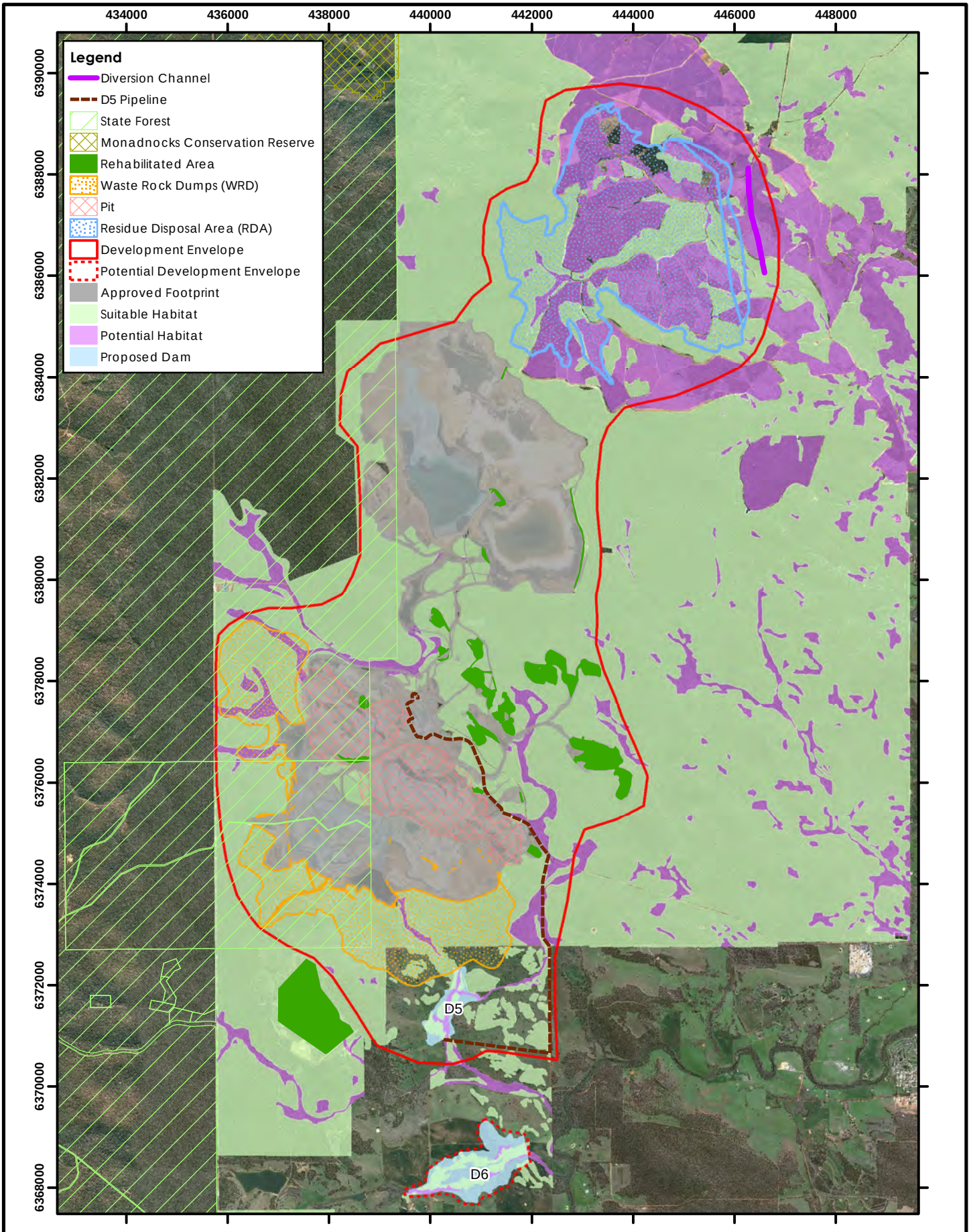

Figure 49 Distribution of habitat for Carnaby's Black-Cockatoo

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Scale

0 1 2 3 4
km

1:100,000
at A4

Coordinate System: GDA 1994 MGA Zone 50
Date: 7/08/2013
Author: jcrute

Source: Tenements: DMP10/2012. All other data: Client 2011-2012.
Note that positional errors may occur in some areas

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Offset component 2: Restoration of local pastoral land

Table 57 provides the objectives and description of offset component 2. This offset focuses on restoration of black cockatoo foraging habitat (*Eucalypts* and proteaceous shrubs) as well as Marri and Wandoo for hollow creation in the long-term. *Gastrolobium* spp. will also be planted due to the preference\ by Woylies and the area will be rehabilitated with Chuditch habitat preferences in mind (e.g. use of hollow logs for refuge).

This offset will rehabilitate up to 300 ha of pastoral land with foraging species for black cockatoo species and to provide suitable habitat to Woylie and Chuditch. The area is bordered on three sides by established jarrah forest (including State Forest) and has suitable water sources located within 6 km^2. The local population of all three black cockatoo species were recorded foraging in rehabilitated vegetation within six to eight years of it being planted and have been observed to forage more frequently in restored landscapes than in the native forest (Finn 2011). Research through Murdoch University has indicated that access to water sources is a limiting factor for black cockatoos in the northern jarrah forest and that there seems to be a preference for breeding sites that are within 6 km of a permanent water source (Finn 2011).

This offset will be complemented by ongoing active management (including feral animal, weed and forest disease management) to improve the quality of habitat and be subject to restoration targets. Details of the management program and restoration targets will be developed prior to restoration commencing.

Table 57 Restoration of pastoral land for the provision of black cockatoo foraging habitat and suitable Woylie and Chuditch habitat

Objective	Description
Increase available foraging habitat for black cockatoo species and provide additional habitat for Woylie and Chuditch	The restoration of land locally will: • provide up to 300 ha of foraging habitat in the southwestern corner of Hotham Farm, which is surrounded on three sides by native vegetation (including State Forest and is within 6 km of water sources) • provide the foraging resource within 6-8 years • use of horizontal tree hollows in the rehabilitation for use by Chuditch • use of species such as *Gastrolobium* spp. in the rehabilitation

The current habitat value of the land proposed for restoration is considered to be zero (Table 58), reflecting the lack of foraging, roosting or breeding habitat currently existing on the cleared pastoral land. However, following restoration using known cockatoo foraging species the comparative value of habitat in this area will rise to six for all three species of black cockatoos within a proposed timeframe of 10 years. There are several examples of rehabilitation providing foraging resources for black cockatoos within a timeframe of six to eight years (Finn 2011). This reflects the high quality of restored vegetation as a foraging resource (Finn 2011) and that this area is in close proximity to permanent water resources.

Table 58 Habitat values for land proposed for restoration under different scenarios

Scenario	Carnaby's	Baudin's	Forest Red-tail	Woylie	Chuditch
Habitat value under current conditions	0	0	0	0	0
Habitat value without restoration	0	0	0	0	0
Habitat value if restoration proceeds	6	6	6	4	5

Offset component 3: Restoration of timber plantation land

Table 59 provides the objectives and description of this direct offset. This offset focuses on the residual impacts associated with the loss of vegetation and loss of breeding and foraging habitat for black cockatoo species, Woylie and Chuditch.

Offset component 4 provides for the restoration of approximately 1050 ha of fallow land (previously used for timber plantation) to promote fauna linkage between the Monadnocks Conservation Reserve and native vegetation to the east. Rehabilitation of this area will use species used for foraging by black cockatoo and to provide suitable habitat to Woylie and Chuditch. As described in Section 10, the local population of all three black cockatoo species have been recorded foraging in rehabilitated vegetation within six to eight years of it being planted and have been observed to forage more frequently in restored landscapes than in the native forest due to the early availability of proteaceous shrubs (Finn 2011). Research through Murdoch University has indicated that access to water sources is a limiting factor for black cockatoos in the northern jarrah forest (Finn 2011).

Planning for this offset component will commence two years before the construction of the RDA (currently planned for 2022) with restoration works to commence the same year as the commencement of construction. The quantum of rehabilitated land will be directly proportional to the required footprint of the RDA (i.e. if the final RDA design is smaller than the current plan as a result of new technologies or improved design) the amount of restoration required will also be reduced.

Table 59 Restoration of ex-timber plantation for the provision of habitat and linkages between remnant vegetation

Objective	Description
Increase available foraging habitat for black cockatoo species and provide additional habitat for Woylie and Chuditch	The restoration of land locally will: • provide an additional 1050 ha of foraging habitat in the northern area of Saddleback tree farm promoting linkage between Monadnocks Conservation Reserve and native vegetation to the east • provide a new foraging resource, to substantially improve foraging resources for black-cockatoos in the area. • provide additional habitat for Woylie and Chuditch

The current habitat value of the land proposed for restoration is considered to be 0 (Table 60), reflecting the lack of foraging, roosting or breeding habitat currently existing on the ex-timber plantation land. However, following restoration using known cockatoo foraging species the comparative value of habitat in this area will rise to 6 for all three species of black cockatoos. This reflects the high quality of restored vegetation as a foraging resource (Finn 2011) in close proximity to water resources, while acknowledging that the restored habitat will not provide additional breeding hollows for at least 100–200 years.

Table 60 Habitat values for land proposed for restoration under different scenarios

Scenario	Carnaby's	Baudin's	Forest Red-tail	Woylie	Chuditch
Habitat value under current conditions	0	0	0	0	0
Habitat value without restoration	0	0	0	0	0
Habitat value if restoration proceeds	6	6	6	6	6

14.4.3 Indirect offsets

Offset component 4: Funding for black cockatoo and Woylie research and/or conservation programs

Table 61 provides the objectives and description of this indirect offset. This offset focuses on improving the understanding of habitat use by the three black cockatoo species in the northern jarrah forest.

NBGPL has an existing relationship with Murdoch University and is currently providing funding towards a black cockatoo health and population demographics study. NBGPL has commenced discussions with Murdoch to identify opportunities to contribute to research that will improve the understanding of black-cockatoo ecology (with a focus on the northern jarrah forest) and to obtain essential habitat use information. The information obtained from this study is anticipated to lead to benefits for all three black cockatoo species by improving scientific understanding of habitat use by the three species of cockatoo, particularly in the jarrah forest, where this is currently poorly understood.

At present, NBG is interested in providing support for a five-year study that has been proposed and involves the first satellite/GPS tracking of all three black cockatoo species in the NBG area, with associated regional-level tracking to obtain essential habitat use information for all three species. The Murdoch study has in principle support from the DPaW and the chairs of both black cockatoo Recovery Teams are aware of this proposal.

NBGPL has also commenced discussions with Kaarakin Black Cockatoo Conservation Centre to investigate opportunities to invest in conservation programs for these species, such as rehabilitation programs for cockatoos.

Given the recent finding of Woylie in the area, and possibility that this population includes descendants from individuals translocated to the area in the mid 1990s, funding will also be invested in a targeted Woylie survey within NBG leases and surrounding lands. The survey will aim to determine the extent of the local Woylie population and to assess the success of the translocated population, in accordance with the National Recovery Plan for this species.

Although an indirect offset will be included in the final offset package, the funding of the package will be confirmed after negotiations with regulators.

Table 61 Provision of funds for research priorities

Objective	Description
Ongoing support of research and/or conservation programs	Currently the range of projects being investigated /discussed with black cockatoo specialists includes: • Murdoch University habitat ecology study • Black Cockatoo Conservation Centre rehabilitation program • work with DPaW for development of surveys of the local Woylie population. This may involve trialling different trapping methods such as camera traps to avoid stressing animals in cage traps.

Offset component 5: Land Exchange

NBGPL is proposing to enter into an agreement with DPaW to exchange ownership land within the State Forest that will be affected by the Proposal, with vegetated land located adjacent to the State Forest. This Proposal is anticipated to disturb up to approximately 624 ha of State Forest and this exchange will transfer an equivalent area to preserve the extent of State Forest. This is considered consistent with the principles discussed in the Draft Forest Management Plan 2014–2023 (CCWA 2012) to maintain the net area of native vegetation and to seek the replacement of native ecosystems permanently lost to development.

No third party approval is anticipated to be required for this land exchange offset, as this land is located on private NBGPL owned land and is not under State Agreement. NBGPL will cover administrative costs incurred by DPaW as a result of the above land exchange.

This exchange does not prevent the provision of offsets to compensate for the residual impacts, i.e. it is an administrative change to boundaries and does not affect the calculation of offsets in Section 14.3.

The provision of this component is not included in the calculation of residual impacts (Section 14.3).

14.5 Calculation of offset package

This offset package has been developed to provide benefits specifically for the loss of foraging and breeding habitat for black cockatoo species, Woylie and Chuditch.

The DSEWPaC offset calculator has been used to determine the quantum of offset required to achieve a positive conservation outcome for these species. The calculator allows assessment of a proposed direct offset against the total offset required for a given habitat loss. The outcomes of the offset calculations undertaken by NBGPL are shown in Table 62.

Table 62 Percentage of the offset requirement met by proposed direct offsets

Offset	Initial clearance of 972 ha for WRD, open pit expansion and infrastructure			Clearance of 790 ha for RDA
	Offset component 1: Protection and management of approximately 2000 ha of adjacent vegetation	Offset component 2: Restoration of approximately 300 ha of cleared pastoral land	Total	Offset component 4: Restoration of 1050 ha of ex-timber plantation land
Baudin's Black-Cockatoo	68%	27%	95%	117%
Carnaby's Black-Cockatoo	75%	21%	96%	91%
Forest Red-tailed Black-Cockatoo	82%	24%	106%	101%
Woylie	82%	24%	106%	101%
Chuditch	82%	24%	106%	101%

The proposed direct offsets meet the 90% direct offset requirement for the three MNES species with significant residual impacts. To achieve a full 100% offset package, NBGPL proposes to fund black cockatoo research and/or conservation programs in the region (indirect offset component 5) as an 'other compensatory measure'. Although some flexibility is required in the offset package, NBGPL will develop an offset package that meets the requirements of the DSEWPaC offset assessment guide and the 90% direct offset requirement.

14.5.1 Process for finalisation of the offset package

A more detailed offsets strategy will be provided to the Office of the EPA and consultation with DSEWPaC on the appropriateness of the package will continue after the feedback on the PER from the public response period. The finalised offset strategy will be provided to the EPA at the time of submission of the Summary and Response to Public Submissions on the PER.

14.5.2 Assessment of offset package

This offset package contains direct and indirect offsets to meet the requirements of both the WA and Australian governments. The direct offsets involve the protection of land to be managed for conservation and the provision of resources to improve the habitat quality in the area.

The offsets have been prepared for the loss of up to 1755 ha of foraging and breeding habitat for black cockatoos, Woylie and Chuditch due to clearing. To support the direct offsets, an indirect research offset has also been supplied.

The implementation of this offset package will result in the following outcomes:

- increase the area of black cockatoo (and other fauna) habitat protected and managed for conservation
- increase the area of foraging habitat available to black cockatoo species locally through restoration
- improve knowledge regarding habitat use by black cockatoos in the northeastern jarrah forest and their distribution and management
- improve knowledge regarding the extent of the local Woylie population and determine if this population is the result of translocation efforts in the mid 1990s. This also supports the National Recovery Plan for this species.

15. Acronyms and short titles

Table 63 Glossary of terms used in PER

Term	Definition
Acquired Land	Property east of the Development Envelope owned by NBGPL
Proposal	Life of Mine Extension Project
Original Proposal	Current approved operations at NBG
Development Envelope	Area encompassing the Proposal
Primary Bauxite Areas	Bauxite mining envelopes with previous approval under State Agreement
New Mining Area	Expanded bauxite mining areas under Statement 719
Noise Regulations	Environmental Protection (Noise) Regulations 1997
Worsley	BHP Billiton/Worsley Alumina

Table 64 Acronyms and abbreviations used in PER

Acronym/abbreviation	Description
ACN	Australian Company Number
AER	Annual Environmental Report
AGMP	Adaptive Groundwater Management Plan
AH Act	*Aboriginal Heritage Act 1972*
APAC	Newmont Asia Pacific
ANZECC	Australian and New Zealand Environment and Conservation Council
ARD	Acid Rock Drainage
ARI	Average Return Interval
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
BGM	Boddington Gold Mine
BGM EMLG	Boddington Gold Mine Environmental Management Liaison Group
CALM	Department of Conservation and Land Management
CALM Act	*Conservation and Land Management Act 1984*
CAMBA	China–Australia Migratory Bird Agreement
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMU	Closure Management Units
CPA	Community partnership agreement
D1 – D5	Water dams
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DMP	Department of Mines and Petroleum
DoE	Department of Environment (now DER and DPWC)
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EEO	Energy Efficiency Opportunities
EMLG	Environmental Management Liaison Group
EMP	Environmental Management Plan
EMS	Environmental Management System
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority

Acronym/abbreviation	Description
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPS	Environmental Protection Statement
EPT	Ephemeroptera Plecoptera Trichoptera
ESD	Environmental Scoping Document
EWR	Ecological Water Requirement
EWP	Environmental Water Provision
GDE	Groundwater-dependent ecosystem
GHG	Greenhouse gas
GKB	Gnaala Karla Booja People
HAI	Heritage Area of Influence
HAPA	Heritage Agreement Project Area
HGM	Hedges Gold Mine
IBRA	Interim Biogeographic Regionalisation for Australia
ICMC	International Cyanide Management Code
IWS	Impacted Water Storage
IMS	Integrated Management System
JAMBA	Japan–Australia Migratory Bird Agreement
LOM	Life of mine
MACC	Marginal abatement cost curve
Mining Act	*Mining Act 1978*
MCP	Mine Closure Plan
MNES	Matters of National Environmental Significance
NBG	Newmont Boddington Goldmine
NBGJV	Newmont Boddington Gold Joint Venture
NBGPL	Newmont Boddington Gold Pty Ltd
NCWP	Northern Clear Water Pond
NEPM	National Environmental Protection Measure
NEPC	National Environment Protection Council
NGERS	National Greenhouse and Energy Reporting Scheme
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NSW OEH	New South Wales Office of Environment and Heritage
NWQMS	National Water Quality Management Strategy
P1 – P5	Priority 1 – Priority 5
PAHA	Preservation of Aboriginal Heritage Agreement
PDWSA	Public Drinking Water Source Area
PEC	Priority Ecological Community
PER	Public Environmental Review
PM	Particulate matter
PRAC	Progressive Rehabilitation and Closure
RDA	Residue disposal area
RIWI Act	*Rights in Water and Irrigation Act 1914*
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
ROM	Run of mine
SGB	Saddleback Greenstone Belt
SIA	Social Impact Assessment

Acronym/abbreviation	Description
SRE	Short-range endemic species
SWALSC	South West Aboriginal Land and Sea Council
SWMP	Site Water Management Plan
TDS	Total dissolved solids
TEC	Threatened Ecological Community
TEOM	Tapered Element Oscillating Balance
TSP	Total Suspended Particulates
TWA	Time Weighted Average
VWP	Vibrating wire piezometer
WC Act	*Wildlife Conservation Act 1950*
WRC	Water and Rivers Commission (now DoW)
WRD	Waste rock dump
WRM	Wetland Research and Management
WSR	Water storage reservoir

Table 65 Units of measurement used in PER

Abbreviation	Unit of measurement
AHD	Australian Height Datum
$CO_{2\text{-}e}$	Carbon dioxide equivalent
ML/a	Megalitres per annum
mRL	Metres, reduced level
Mt	Million tonne
Mtpa	Million tonnes per annum
MWh/a	Megawatt hours per annum
t/a	Tonnes per annum
t/m^3	Tonnes per cubic metre

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List of Appendices

The following appendices are found on CD-ROM inside the back cover of this report

Appendix 1 Environmental Management Plan

- Strategen 2013, *Newmont Boddington Gold Life of Mine Extension Project Environmental Management Plan*, report prepared for Newmont Boddington Gold, August 2012.

Appendix 2 Mine Closure Plan

- Newmont Boddington Gold 2012, *Newmont Boddington Gold Closure Plan December 2012*, December 2012.

Appendix 3 Supporting documents

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