FLYNN DRIVE AND MATHER DRIVE INDUSTRIAL DEVELOPMENT, NEERABUP

Environmental Review

Prepared for
City of Wanneroo

May 2014

DOCUMENT TRACKING

Item	Detail
Project Name	Flynn Drive and Mather Drive Industrial Development, Neerabup
Project Number	11PERPLA-0041
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Status	Final
Version Number	1
Last saved on	13 May 2014
Cover photo	Bushland on-site, taken by J. Collins (August 2012)

This report should be cited as 'Eco Logical Australia 2013. *Flynn Drive and Mather Drive Industrial Development, Neerabup – Environmental Review*. Prepared for the City of Wanneroo.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Michael Penson.

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Abbreviations

Abbreviation	Description
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CoW	City of Wanneroo
DAA	Department of Aboriginal Affairs
DEP	Department of Environmental Protection
DoE	Department of the Environment (Commonwealth)
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DPS	District Planning Scheme
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FCT	Floristic Community Type
ha	hectares
mAHD	Metres Australian Height Datum
mbgl	Metres below ground level
MRS	Metropolitan Region Scheme
NIA	Neerabup Industrial Area
OEPA	Office of the Environmental Protection Authority
PEC	Priority Ecological Community
SCP	Swan Coastal Plain
SRE	Short Range Endemic
TEC	Threatened Ecological Community
WA	Western Australia
WC Act	*Wildlife Conservation Act 1950*

Executive summary

This Environmental Review document is supporting documentation for assessment of the proposal by the City of Wanneroo for development of Flynn and Mather Drives, Neerabup under the *Environmental Protection Act 1986*.

The City of Wanneroo is pursuing resource extraction and industrial land development (the proposal) at Lot 9000 Flynn Drive, Lots 41 and 9003 Mather Drive and Part Lot 600 Wattle Avenue (referred to as Flynn and Mather Drives) in Neerabup, Western Australia (WA) (the site). The site covers approximately 210 hectares (ha) of land and is located in the suburb of Neerabup within the City of Wanneroo, approximately 30 km north of the Perth Central Business District and 4 km north-east of Joondalup. The site is also referred to as the Meridian Business Park and is located within the larger Neerabup Industrial Area (NIA).

Development of the site will be staged, generally involving clearing of vegetation and topsoil, followed by extraction of raw material (limestone and sand) and subsequent earthworks to achieve the finished levels as determined by the NIA Agreed Structure Plan 17.

The majority of the site is vegetated, with the underlying geology comprising Tamala Limestone and sand derived from Tamala Limestone, and is situated on the Spearwood Dune System. The depth to groundwater at the site ranges from approximately 17 metres below ground level (mbgl) to about 50 mbgl. The site contains potential habitat for several threatened species including the State and Federally listed Endangered Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*).

Several flora and fauna surveys have been undertaken over the site. A total of nine vegetation types have been described as occurring within the site, consisting of predominantly open woodland over degraded pasture, Jarrah and Banksia woodland over mixed low shrubland and a small amount of Tuart woodland. The remnant vegetation of the site is in 'Good – Excellent' condition. The Floristic Community Type (FCT) SCP 28 - Spearwood *Banksia attenuata* or *B. attentuata* – Eucalyptus woodlands and the Threatened Ecological Community (TEC) SCP 20a '*Banksia attenuata* woodland over species rich dense shrublands' both occur within the site. A portion of Bush Forever Site 295 occurs in the south-eastern corner of the site.

No Threatened (Schedule 1) flora species listed under the *Wildlife Conservation Act 1950* (WC Act) or Priority flora or fungi species listed by the Department of Parks and Wildlife have been recorded from the site. No other conservation significant flora are considered likely to occur.

The key fauna habitat present within the site is *Eucalyptus* sp. Woodland overstorey with a *Banksia* sp. low woodland understorey, and the majority of vertebrate fauna species recorded at the site are bird species. A total of three conservation significant terrestrial vertebrate fauna species have been recorded at the site; *Calyptorhynchus latirostris* (Carnaby's Black-Cockatoo), *Merops ornatus* (Rainbow Bee-eater) and *Macropus irma* (Western Brush Wallaby) and another is considered likely to occur; *Morelia spilota* subsp. *imbricata* (Carpet Python).

A total of six conservation significant invertebrate fauna species were identified as having potential to occur, however none are considered likely to occur. It is considered unlikely that the site would support a subterranean aquatic invertebrate fauna community and therefore impacts to stygofauna are unlikely.

No Aboriginal sites or other heritage places are known to occur within the site.

Key environmental impacts anticipated to result from implementation of the proposal include impacts to vegetation, flora and fauna. Other potential impacts associated with the development (e.g. changes to site water balance, noise, dust) will be managed in accordance with an environmental management framework that includes a Construction Environmental Management Plan and Water Management Plan.

Clearing requirements for the proposal will result in the clearing of approximately 140 ha of vegetation including areas that are in Degraded condition. The TEC and portion of Bush Forever Site 295 occurring within the site will not be disturbed and will be retained for the purpose of conservation. A buffer of at least 50 m (in some cases more than 200 m) will be applied around the conservation area which will be protected and managed in accordance with a Conservation Area Management Plan.

Of the conservation significant fauna species recorded or considered likely to occur at the site, the species most likely to be impacted by the proposal is Carnaby's Black-Cockatoo, which is known to utilise the site extensively for foraging. The site contains approximately 162 ha of high value and 18.7 ha of moderate value foraging habitat, of which approximately 112 ha and 18.7 ha is proposed to be cleared respectively. The moderate – high value foraging habitat proposed to be cleared represents approximately 0.27 % of the habitat available for this species within 20 km of Yanchep National Park. Approximately 50 ha of high value foraging habitat will be retained on-site within the conservation area to be managed in accordance with a Conservation Area Management Plan.

A total of 694 trees were identified as potential breeding trees within the site, including 539 Jarrah, 127 Marri, and 28 Tuart trees. Approximately 120 of these trees have hollows possibly suitable for Carnaby's Black-Cockatoo nesting, however no breeding activity has been recorded, and no known roosts occur within the site. A total of 119 potential breeding trees will be retained within the site [some with hollows, and some without hollows, based on criteria described by Cale (2003) as cited in ELA (2013) and criteria described in SEWPaC (2012 respectively)].

The City of Wanneroo will implement a range of other avoidance, mitigation and management measures to appropriately manage the industrial development and any potential environmental impacts. The following key documents will be prepared (if not already) and will guide implementation of the project:

- Construction Environmental Management Plan addressing:
    - Biodiversity
        - The entire footprint will not be cleared as a single exercise but cleared progressively over a number of years in accordance with the requirements for extraction of the limestone resource and demand for industrial land
        - An inspection of stages for suitable rehabilitation material (e.g. vegetation mulch and topsoil), prior to the commencement of clearing
        - Prior to vegetation clearing there will be a program of seed collection for revegetation purposes
        - Assessment of trees within the areas to be cleared for suitable Carnaby's Black-Cockatoo hollows that could potentially be relocated to adjacent habitat
        - The boundaries of vegetation to be cleared will be demarcated prior to clearing commencing for that stage
        - Hygiene management (i.e. dieback and weeds)
        - Fauna relocation program undertaken prior to clearing commencing in an area
        - Clearing occurring from a disturbed edge, where possible
    - Surface water (including erosion) and groundwater

  - Fuel and hazardous chemical handling and storage
  - Noise
  - Dust
  - Overall implementation including inductions, complaints/incident reporting and review requirements
- Water Management Plan in accordance with the *Better Urban Water Management* guidelines outlining:
  - Potable and non-potable water supplies
  - Overarching management principles
  - Details of the measures to be undertaken to manage stormwater and groundwater quality and quantity in the development (including limiting dewatering, if required)
  - Utilisation of best management practices to treat stormwater prior to infiltration or discharge in line with the Stormwater Management Manual (DoW 2004-2007)
- Conservation Area Management Plan for on-site conservation area addressing:
  - Fencing and access management
  - Signage
  - Fire management
  - Weed control
  - Future monitoring, particularly with regard to use of the site by Carnaby's Black-Cockatoo
- Meridian Park Landscape Master Plan Guidelines (Blackwell and Associates 2009)
  - Outlines streetscaping requirements, which is likely to include use of native species.

1 Introduction

The City of Wanneroo (CoW) is pursuing resource extraction and industrial land development (the proposal) at Lot 9000 Flynn Drive, Lots 41 and 9003 Mather Drive and Part Lot 600 Wattle Avenue (hereafter referred to as Flynn and Mather Drives) in Neerabup, Western Australia (WA) (the site) (**Figure 1**). The site is also referred to as the Meridian Business Park and is located within the larger Neerabup Industrial Area (NIA) (**Figure 2**).

Following advice from the Environmental Protection Authority (EPA) to the then State Planning Commission (now the Western Australian Planning Commission), the site, as part of the NIA, was zoned 'Industrial' in 1994 under the Metropolitan Region Scheme (MRS) by way of MRS Major Amendment no 948/33 for the North West Corridor (East Wanneroo).

Given the significance of particular environmental features of land within the NIA, the EPA indicated key issues that it recommended be addressed to ensure unacceptable environmental impacts are avoided. Subject to two separate Structure Plan proposals which were developed and approved in 2005, the site was subsequently zoned industrial and business under the CoW District Planning Scheme.

The development of the site will involve vegetation clearing and resource extraction followed by the creation of industrial lots, construction of roads and drainage infrastructure, and installation of services.

1.1 Brief site description

The site covers approximately 210 hectares (ha) of land and is located in the suburb of Neerabup within the City of Wanneroo, approximately 30 km north of the Perth Central Business District and 4 km north-east of Joondalup. The site consists of a northern portion and a southern portion (**Figure 2**). The northern portion is bounded by the Barbagallo Raceway to the north, native vegetation or rural landholdings to the east, industrial development to the south and native vegetation or quarry operations to the west. The southern portion is bounded by native vegetation to the north, native vegetation or rural landholdings to the east, Flynn Drive to the south and Mather Drive to the west. Surrounding land uses include industrial, rural and parks and recreation.

The western portion of the site is designated as a Priority Resource Location for limestone / limesand under the Basic Raw Materials Statement of Planning Policy 2.4 (Western Australian Planning Commission 2000). The intent of this policy is to ensure consideration of the availability of raw materials in the Perth metropolitan area for construction purposes, and to minimise the costs of land development and contribute to the availability of affordable housing.

The site consists of open woodland over degraded pasture, Jarrah and Banksia woodland over mixed low shrubland and a small amount of Tuart woodland. Some cleared land and disturbance from tracks is present in the north-west portion of the site. The site contains potential habitat for several threatened species including the State and Federally listed Endangered Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*).

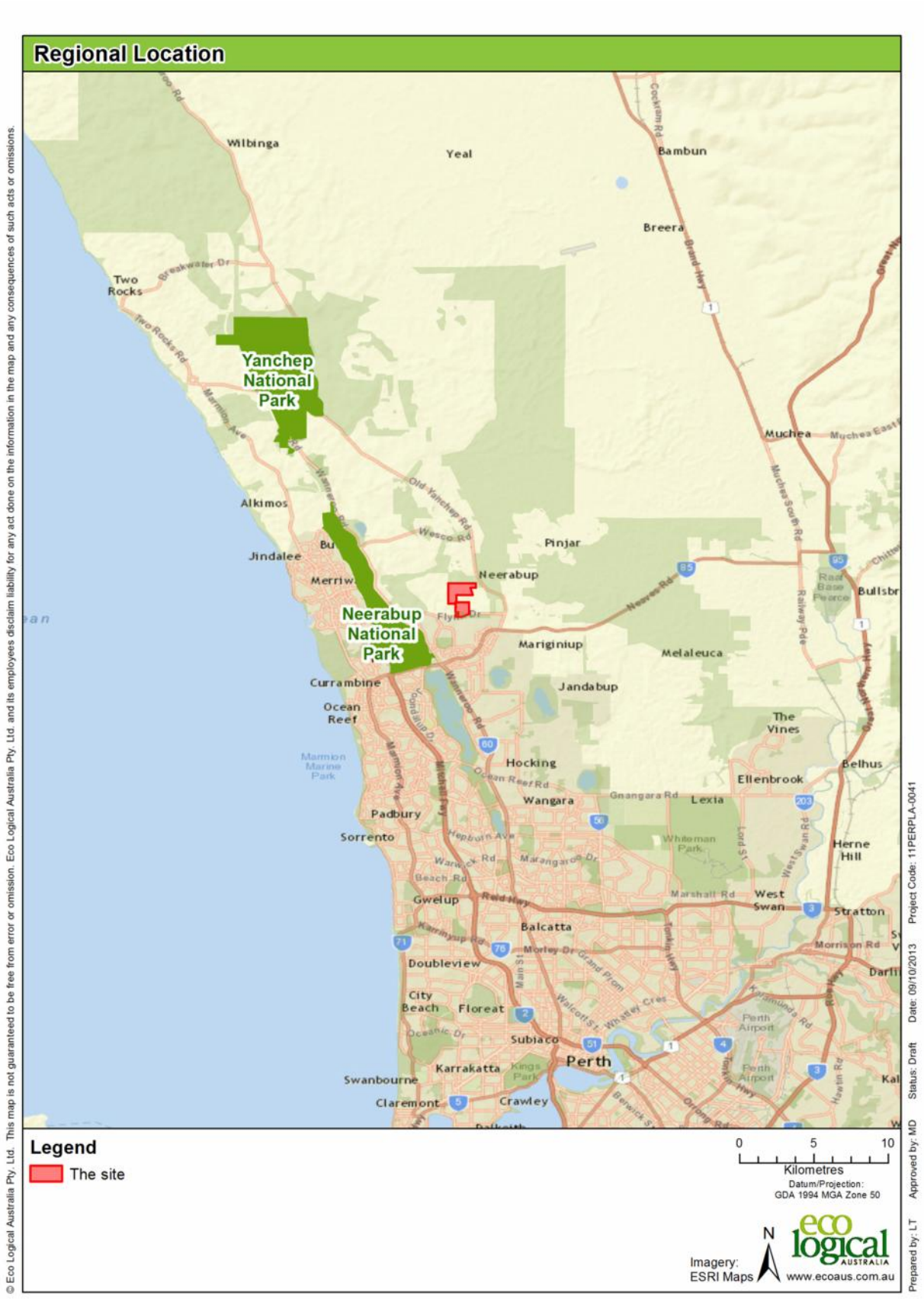

Figure 1: Regional location

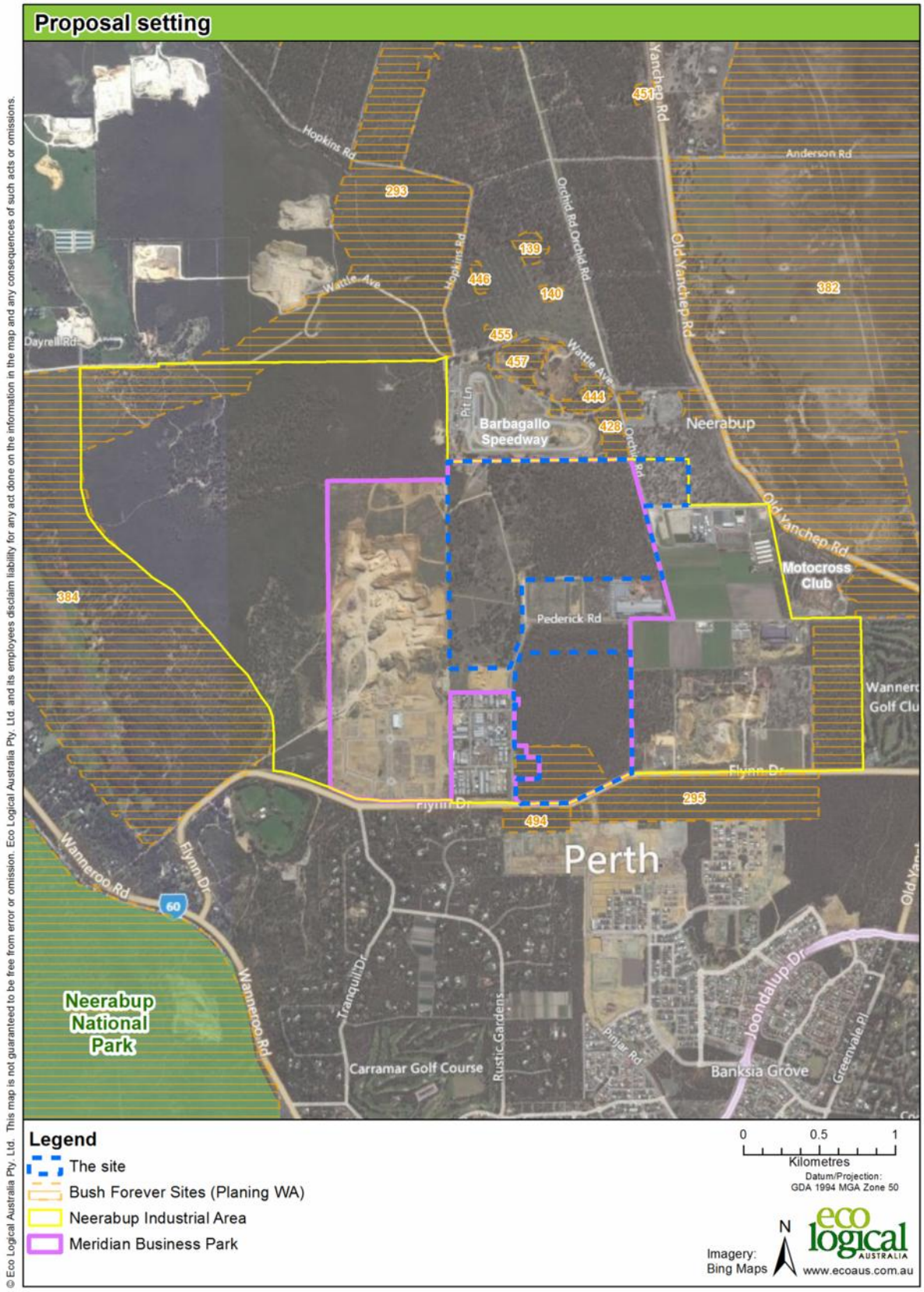

Figure 2: Proposal setting

1.2 Planning/Approvals history

Since 1995, the site has been the subject of two separate Structure Plan proposals and a Structure Plan review (CoW 2005). The NIA Agreed Structure Plan (as Amended) (**Appendix A**) was adopted in January 2005, under the provisions of Part 9 of CoW District Planning Scheme No. 2 (DPS 2). This Structure Plan has not been assessed formally by the EPA, but the (then) Department of Environmental Protection (DEP) did provide a submission during the public advertisement period. Liaison with the Office of the Environmental Protection Authority (OEPA) regarding the adjacent Lot 701 Flynn Drive indicates that DSP 2 was not assessed by the EPA and that proposals within the Structure Plan area can therefore be considered as not referred and not assessed; potentially allowing for formal assessment of a subdivision proposal under Section 38 of the *Environmental Protection Act 1986* (EP Act).

A referral to the Australian Government under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) by LandCorp on behalf of the CoW occurred in 2007 (EPBC Reference: 2007/3479), with the proposal considered to be a controlled action requiring assessment. The nominated proponent for the referral was transferred from LandCorp to CoW on 25 October 2012. The (now) Department of the Environment (DoE) sought additional information on the proposal, with this provided to DoE in November 2013.

1.3 Proposal context

Maximising the development potential of the NIA as a strategic employment node is essential for the provision of future jobs within the City of Wanneroo and to ensure that employment self-sufficiency targets can be realised. Achieving a 60% employment self-sufficiency target for the North West Corridor will be critical to ensure that transport systems in the northern area of Perth do not fail. The context for the development of the NIA and its relationship to the forecast growth in the CoW includes:

- The CoW is expected to grow to a population of over 300,000 by 2031 from its current population of 156,000 (2011);
- The resident workforce is projected to almost double from about 72,000 (as at 2011) to 136,000 by 2031;
- The City needs 82,000 jobs located within its boundary at 2031 to achieve 60% employment self-sufficiency;
- At 2011 (ABS Census) there were 32,000 jobs located in the CoW and with a resident workforce of 73,000, the employment self-sufficiency was 44%; and
- An additional 50,000 jobs will be required over the 20 year period 2011 to 2031 to achieve 60% employment self-sufficiency.

There are currently only two significant industrial areas within the CoW, namely Wangara/Landsdale and Neerabup. The Wangara estate is close to capacity and is experiencing some transition away from general industrial uses to more service / commercial oriented uses. This is resulting in a shortage of ready to occupy general industrial land in the North West Corridor (S. Marmion, CoW, pers. comm., November 2013; provided all of the above information).

1.4 Significance of the NIA

The NIA has a gross area of just over 1,000 hectares however there are many constraints to development as outlined in the Perth and Peel Industrial Land Needs Study (Department of Planning and Infrastructure / Landcorp, 2008). Therefore, maximising the usage of the developable areas within the NIA is of high importance.

Developing industrial estates requires a complex range of tasks from inception to zoning and first land use implementation. This process can take 10 years or longer, depending on the nature of service requirements and specific industry needs. The NIA was first identified for strategic industrial use 26 years ago by the Industrial Lands Development Agency (ILDA) in 1987 and by 2008 had only developed to a stage of employing approximately 550 people.

While there are areas within the CoW identified to be investigated for future industrial uses in the Economic and Employment Lands Strategy (EELS, WAPC April 2012), the long lead time, uncertainty of delivery and significant costs of planning and servicing, means that the CoW must ensure existing zoned industrial areas, such as the NIA, are used to their maximum potential. The EELS indicates a shortfall of 438 ha of industrial land by 2031 in the North West Corridor . The most recent EELS report card shows that the relatively small Wangara extension is well advanced with zoning now in place, but the Pinjar South site and other potential sites are yet to be investigated.

The CoW landholdings in Neerabup present an opportunity to provide affordable well located industrial land for the purposes of employment creation in the CoW. This proposal is a direct action by the CoW to assist in achieving a higher level of employment self-sufficiency in the region.

2 Proposal description

2.1 Overview

The CoW is planning to subdivide Flynn and Mather Drives into a number of different sized industrial lots as demand requires, with 27 different land parcels identified in the concept layout plan (**Figure 3**). The land parcels range in size from 1.95 ha to 12.96 ha and will allow for the subdivision to be integrated with potential future and existing industrial developments in the NIA. Development of the site will be staged, generally involving clearing of vegetation and topsoil, followed by extraction of raw material (limestone and sand) and subsequent earthworks to achieve the finished levels as determined by the NIA Agreed Structure Plan 17 (**Appendix A, Figure 4**). This will be followed by the creation of lots, construction of roads and drainage infrastructure and installation of services. The Priority Resource Extraction Area for limestone / limesand as defined in Western Australian Planning Commission (2000) is shown in **Figure 5**.

The southern portion of the site intersects 20.13 ha of Bush Forever Site 295, all of which will be retained for the purpose of conservation. A further 15.21 ha of remnant vegetation to the north-east of Bush Forever Site 295 is Floristic Community Type (FCT) SCP 20a (*Banksia attenuata* woodland over species rich dense shrublands), which is considered to be a Threatened Ecological Community (TEC; RPS 2006). This area will also be retained as part of the concept layout plan for conservation purposes. A total of approximately 24 % of the total area of the site will be retained for conservation, representing approximately 50 ha of Carnaby's Black-Cockatoo foraging habitat. A management plan will be prepared to ensure the ongoing long-term protection of the retained vegetation, including Bush Forever Site 295.

2.2 Pre-clearing

In order to avoid over-clearing of vegetation, the boundaries of the site and the retained vegetation will be surveyed and clearly marked prior to the commencement of clearing. In line with the staged approach to development at the site, each stage of clearing will also be individually surveyed and clearly marked to identify clearing limits. An induction will be provided to all personnel that will be on-site, which outlines the environmental values of the site and re-iterates the importance of remaining within defined clearing areas.

An inspection of the site for the supply of suitable rehabilitation material will also be undertaken prior to the commencement of clearing. Where considered suitable and available, seeds and other materials including; habitat logs, mulched vegetation and topsoil (specifically topsoil that is from vegetation mapped as being in Very Good or better condition and dieback free) will be collected and stored for later use in landscaping and/or rehabilitation of areas external to the site. Seed collection and storage will be influenced by the staging of limestone and sand extraction, however, is likely to be undertaken in the summer seed collection period (generally from October – February).

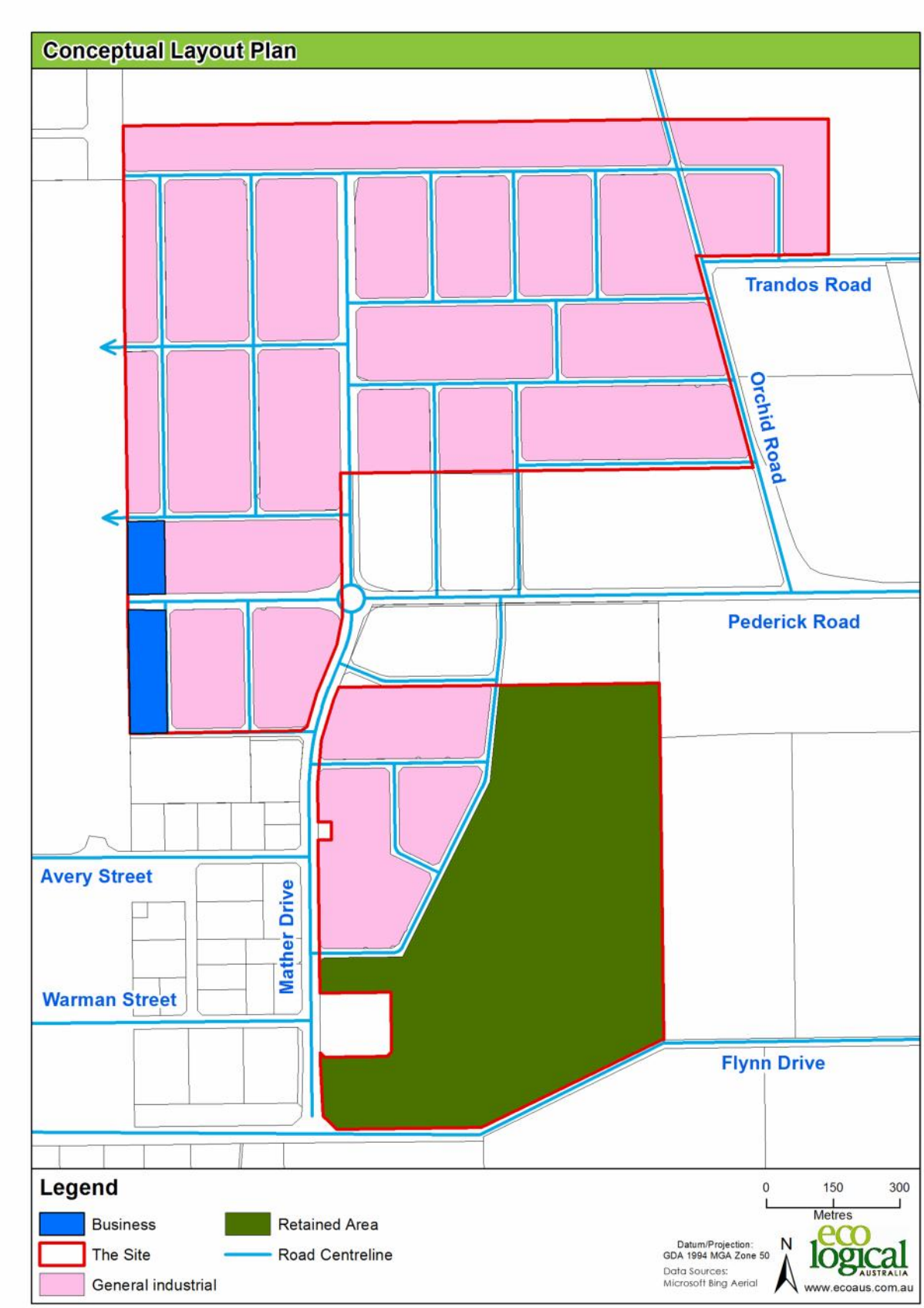

Figure 3: Conceptual layout plan

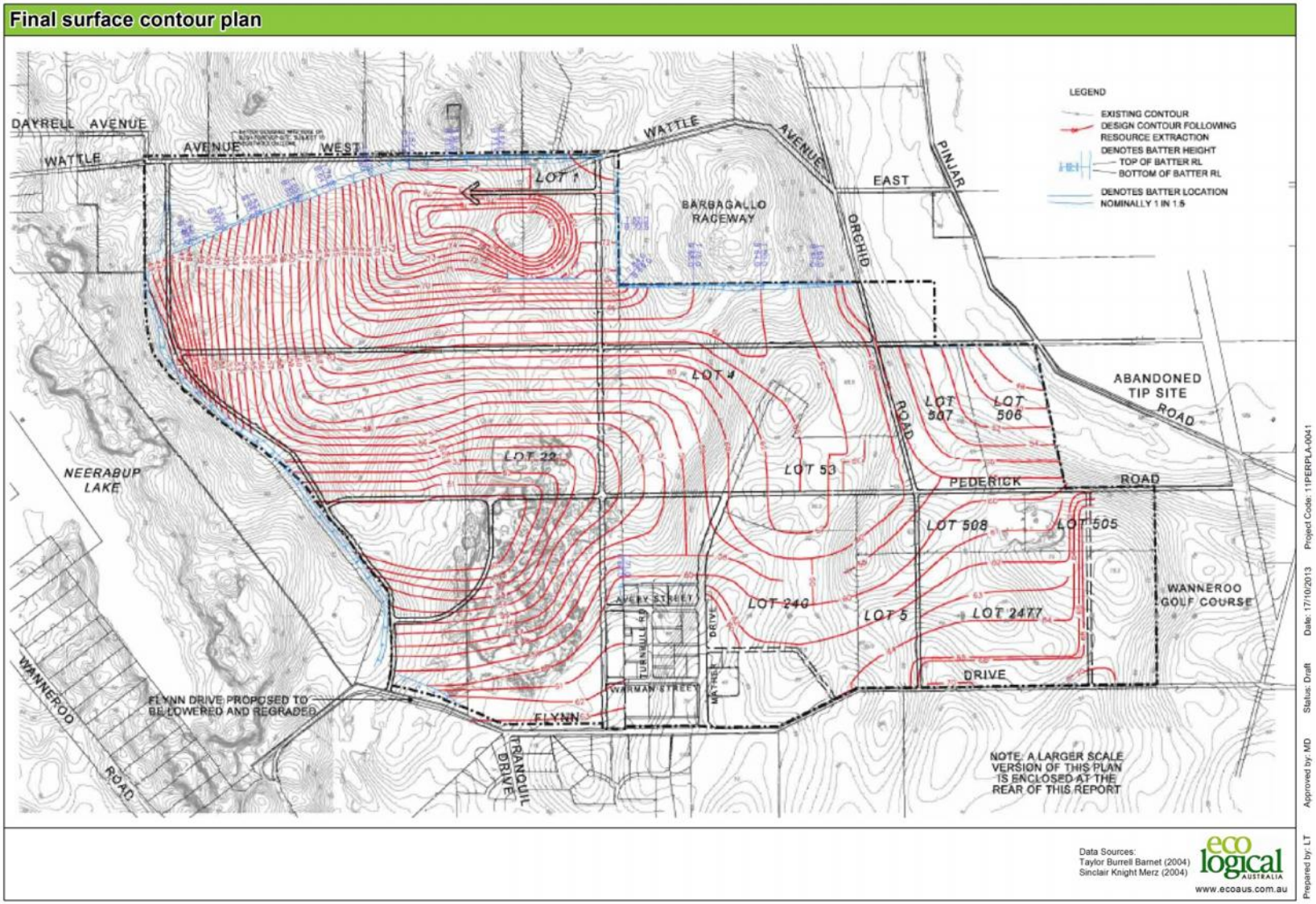

Figure 4: NIA final surface contour plan

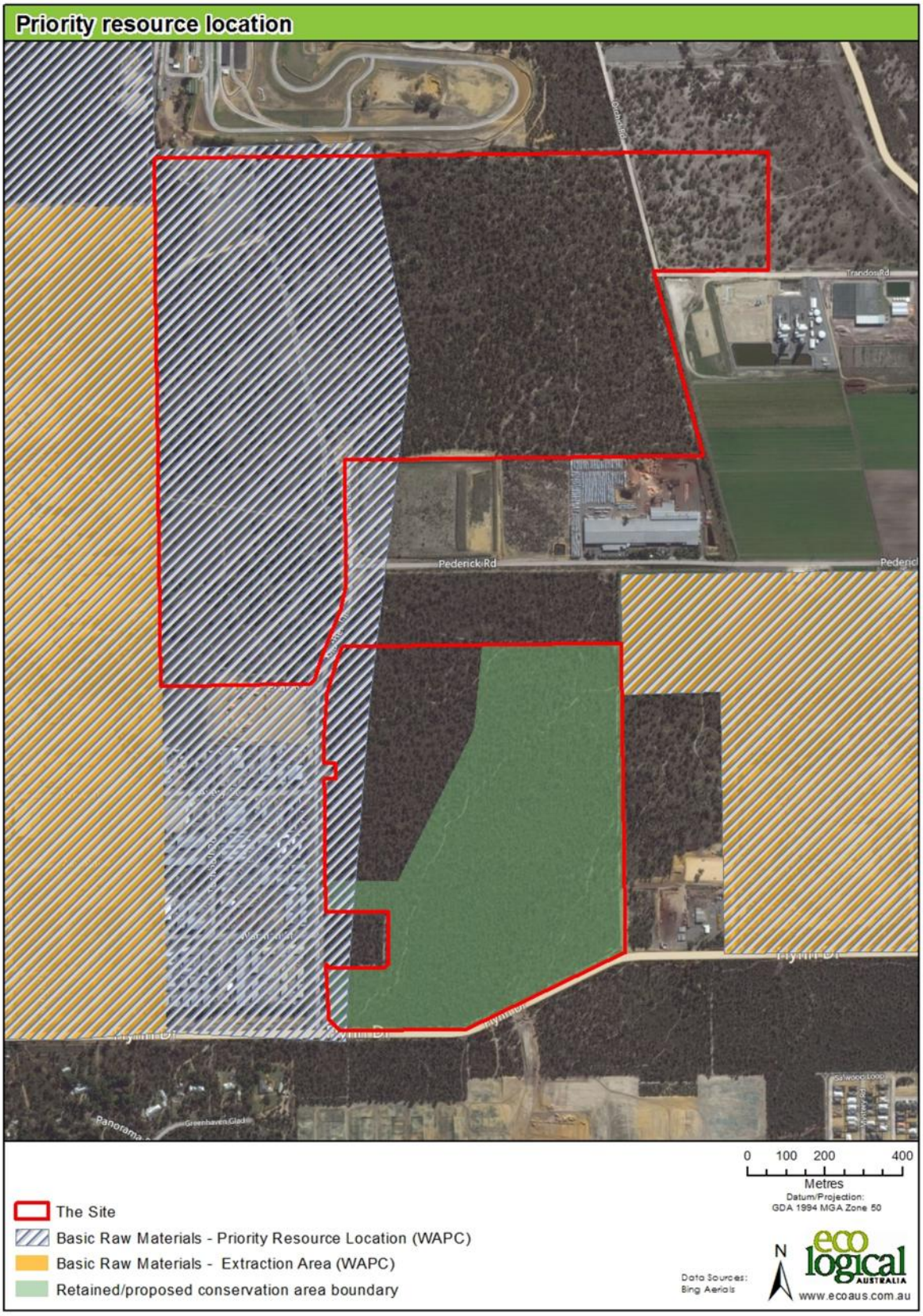

Figure 5: Priority resource location

2.3 Clearing and topsoil stripping

Clearing of the site will occur in phases in line with the staged approach to development. Clearing will also be dependent on the raw materials extraction that is likely to occur over the next 20 – 30 years. This timing and staged nature of the approach to clearing will facilitate the natural relocation of fauna to other suitable habitats in the area. All clearing will follow consistent, well defined processes and the following management measures will be implemented during all stages of clearing at the site:

- Vegetation clearing will occur from a disturbed edge, where possible, to encourage any remaining fauna to naturally migrate to retained vegetated areas
- Identification and relocation of hollows suitable for use by Carnaby's Black-Cockatoo for breeding [Cale (2003) as cited in ELA (2013) defined hollows suitable for nesting Carnaby's Black-Cockatoo to average 6.3 m above ground, and be approximately 110 cm deep, ranging from 25-250 cm]
- Cleared vegetation will be mulched for use on-site (landscaping) or in off-site rehabilitation
- A fauna handler will be available during all on-site clearing activities
- Where possible, topsoil will be directly relocated to off-site rehabilitation areas. Alternatively, topsoil will be stored until a rehabilitation use is identified (topsoil storage periods will be minimised as far as practicable)
- Where additional mulch and topsoil is identified that cannot be utilised for rehabilitation (including unsuitable material), this material will be disposed of to an appropriate facility.

2.4 Raw materials extraction and earthworks

It is anticipated that the resource extraction will occur progressively over the next 20 – 30 years. The extraction operations will be carried out by a suitably qualified earthworks and quarrying contractor, subsequent to a request for tender process.

Following raw material extraction at each stage, earthworks will be undertaken. This will involve reconfiguration of the residual soil to create the desired landforms, satisfying the final surface contours as defined in the NIA Agreed Structure Plan 17 (**Appendix A**). Earthworks will also be required to allow construction of infrastructure and services, including roads with batters to be constructed along the edges of the retained vegetation.

2.5 Development objectives

Under the NIA Agreed Structure Plan 17, the site is proposed for 'General Industrial' and 'Business' use. 'General Industrial' use is intended to provide for industrial development which the Council considers would be obtrusive in, or detrimental to, the amenity of the Service Industrial Zone.

The objectives of the General Industrial Zone are to:

- accommodate a wide range of industrial activities, including those generally involving production, processing, storage, wholesaling or distribution processes; and
- minimise adverse visual and environmental effects of industrial uses on surrounding areas.

Areas proposed for 'Business' use are intended to accommodate wholesaling, retail warehouses, showrooms and trade and professional services and small scale complementary and incidental retailing uses, as well as providing for retail and commercial businesses which require large areas such as bulky goods and category/theme based retail outlets that provide for the needs of the community but which, due to their nature, are generally not appropriate to, or cannot be accommodated in, a commercial area.

The objectives of the Business Zone are to:

- provide for retail and commercial businesses which require large areas such as bulky goods and category/theme based retail outlets as well as complementary business services; and
- ensure that development within this zone creates an attractive façade to the street for the visual amenity of surrounding areas."

2.6 Construction of industrial lots

Development of the industrial lots at the site will involve installation of infrastructure and services including power, water, telecommunications, roads and drainage systems. CoW will implement streetscaping for roads/road reserves, which is likely to comprise of native plant species (where possible, using seed collected from the site) and mulch from the site. Any remaining mulch will be made available for landscaping by future lot owners.

Future lot owners will be responsible for constructing buildings on the available lots. Design guidelines will be prepared to outline the minimum requirements for individual lot development; this will include stormwater management and landscaping standards. The CoW is required to approve any building applications by future land owners. The types of businesses that are likely to establish at the site are expected to have minimal visual and environmental impact on surrounding areas and include; warehouses, showrooms, equipment hire yards, mechanical workshops and distribution centres.

3 Environmental setting

3.1 Climate

The climate of the Perth metropolitan region is described as Mediterranean, experiencing hot, dry summers and mild, wet winters. The highest rainfall occurs between the months of June to August. The closest official Bureau of Meteorology (BoM) weather recording station is at the Royal Australian Air Force (RAAF) Base Pearce (Station No. 009053), where climate data has been collected since 1937 (BoM 2013). Key climatic indicators from this location are summarised below and shown on **Figure 6**:

- Mean daily maximum temperature: 33.5°C (January) – 17.5°C (July)
- Mean daily minimum temperature: 17.8°C (July) – 8.1°C (July)
- Mean annual rainfall: 679.9 mm
- Mean annual rain days (≥1 mm): 56 days

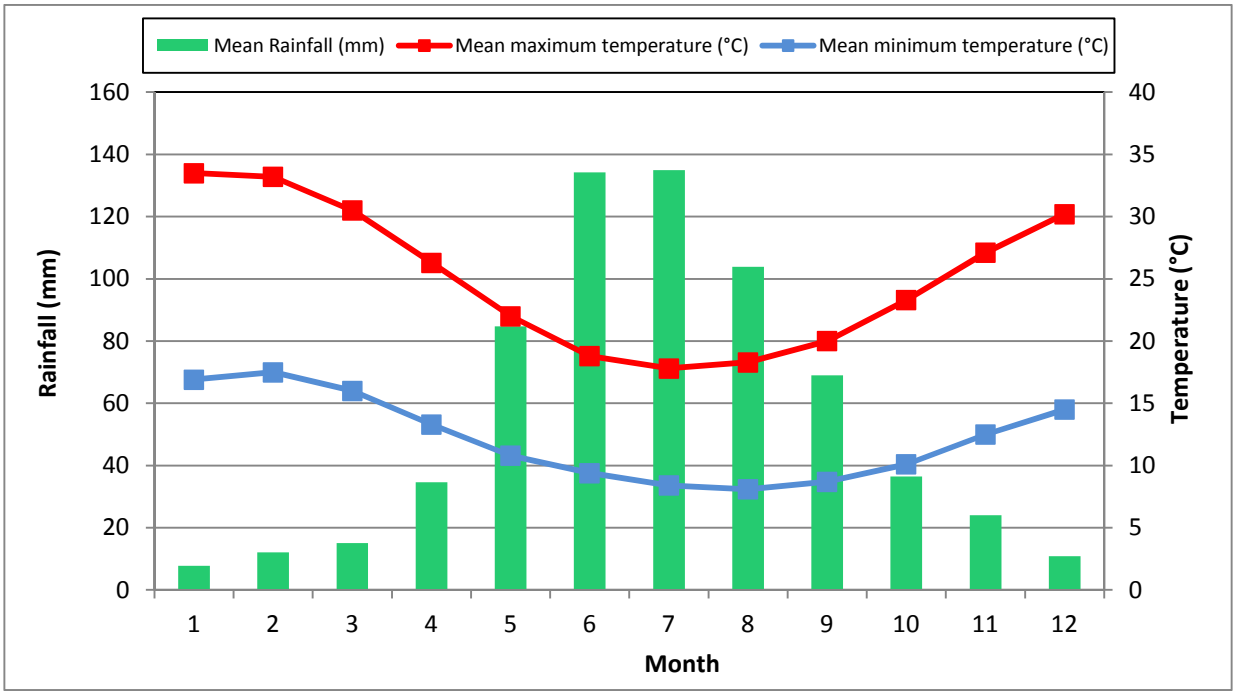

Figure 6: Key climatic indicators for RAAF Base Pearce (BoM Station No. 009053)

3.2 Geology and soils

The geological setting of a portion of the site was described by ATA (2006). Mapping by Gozzard (1982) indicates that the surficial geology of the site comprises Unit LS_1, which is Tamala Limestone, and Unit S_7, sand derived from Tamala Limestone. Tamala limestone is described as light yellowish-brown, fine to coarse grained, sub-angular to well-rounded quartz with shell debris and trace feldspar (Gozzard 1982 as cited in ATA 2006). Sand derived from Tamala limestone is similar but with negligible carbonate (shell) content.

Limestone is mapped as being relatively extensive between the site and Lake Neerabup to the west, however the site contains the easternmost mapped area of Tamala Limestone. The mapped limestone

exposure trends north-north-east in the vicinity of the site and is surrounded by sand derived from Tamala Limestone to the north and east (ATA 2006).

The geomorphology of the Swan Coastal Plain (SCP) is dominated by a series of sedimentary sand dune systems, the youngest being the Quindalup dunes located on the coast, the intermediate being the Spearwood dune system characterised by the limestone ridges and the oldest being the Bassendean dune system extending 16 km inland to the beginning of the Darling Scarp (McArthur & Bettenay 1960).

The Spearwood dune system consists of a limestone ridge that runs parallel to the coastline from north to south, with shallow brown / bright yellow sands covering the ridge. A number of different soils are associated with the Spearwood dune system including the Cottesloe, Karrakatta and Herdsman associations (Department of Agriculture and Food 2007). The following phases of the Spearwood soil system occur within the site (Department of Agriculture and Food 2007):

- Karrakatta Sand Yellow Phase (Ky) – undulating dunes on aeolian sand over limestone in the Swan Coastal Plain between Wanneroo and Lancelin. Yellow deep sands and brown deep sands.
- Karrakatta Shallow Soils Phase (Kls) – rocky low hills and ridges on limestone in the Swan Coastal Plain between Wanneroo and Lancelin. Bare rock, yellow/brown shallow sands and stony soils
- Spearwood (Kg) – please see attached image for description details.

3.3 Hydrogeology and wetlands

The site is situated over the Gnangara Mound which lies beneath the Swan Coastal Plain north of Perth. The mound is a representation of superficial or unconfined (shallow) groundwater and is 70 m above sea level at its highest point. Covering an area of approximately 2,200 km^2, the mound extends from the Swan River in the south; the Indian Ocean to the west; the Moore River and Gingin Brook in the north and to Ellen Brook in the east (Department of Water 2013a).

Lake Pinjar, a conservation category wetland, is the closest wetland to the site, located approximately 1 km north-east of the site. Lake Neerabup is the second nearest wetland to the site, located approximately 4 km to the west, and is categorised as a resource enhancement wetland.

The groundwater at the site flows in a westerly direction, towards Lake Neerabup and ultimately towards the coast. The Department of Water (DoW) Perth Groundwater Atlas indicates that groundwater depth under the site ranges from between approximately 38 metres Australian Height Datum (mAHD) on the eastern boundary to 31 mAHD on the western boundary. The depth to groundwater at the site ranges from approximately 17 metres below ground level (mbgl) to about 50 mbgl (DoW 2013b).

Any surface water runoff is expected to be retained within the site. A drainage basin occurs along the northern boundary of Bush Forever Site No. 295, immediately to the west of the TEC. The composition of the Tamala limestone and soils present at the site (see Section 3.2) are likely to allow for easy rainfall penetration, minimising surface water flows.

Minimal information is available regarding groundwater quality in the area (though there is some data regarding total dissolved solids) with one bore located to the south of the site along Flynn Drive, and others in neighbouring lots. The DoW Perth Groundwater Atlas indicates the site would be suitable for

garden bores, however, it is not known if this also applies to industrial lots. The site is not located within a Public Drinking Water Supply Area.

The DoW has considered the proposal and a summary of its conclusions in relation to potential impacts to hydrogeology and surface water is provided below (J. Mackintosh, DoW, pers. comm., October 2012).

> As the site is not located within a Public Drinking Water Supply Area, immediately adjacent to a significant wetland and groundwater levels are significantly deep, pre-development or post-development groundwater levels and water quality monitoring are not considered necessary as part of the proposal.

The CoW will prepare a water management plan consistent with the Better Urban Water Management Requirements prior to development to address the management of surface water at the site.

3.4 Vegetation

The following flora and vegetation surveys have previously been undertaken on land considered part of the site:

- Level 2 Vegetation and Flora Survey - RPS Bowman Bishaw Gorham (2006)
- Level 2 Flora and Vegetation Survey of the NIA (ATA 2007)
- Ground truthing of environmental values for Lot 4 Flynn Drive[1] – Eco Logical Australia (ELA2012a) (**Appendix B**)
- Targeted flora assessment of Lot 4 Flynn Drive (ELA 2013) (**Appendix C**).

The vegetation of the site is located within the Drummond Botanical District of the Swan Coastal Plain Subregion (Beard 1990). Regional vegetation complexes occurring in the area include the Cottesloe Complex – Central and South and the Karrakatta Complex – Central and South (both of which are associated with the Spearwood dune system) and the Herdsman Complex which is associated with wetlands (Heddle et al 1980). The typical sequences of vegetation comprises mainly Banksia low woodland on leached sands with Melaleuca swamps where ill-drained; and woodland of Tuart (*Eucalyptus gomphocephala*), Jarrah (*E. marginata*) and Marri (*Corymbia calophylla*) on less leached soils (Beard 1990, ATA 2007).

The Karrakatta Complex – Central and South is considered to be regionally significant (ATA 2007). EPA Guidance Statement No. 10 (EPA 2006) indicates that the Karrakatta Complex – Central and South is below the 10 % threshold recommended for Constrained Areas. The Karrakatta Complex – Central and South was assessed by Bush Forever as having 6,275 ha (or 18 %) of its pre-European extent remaining, with implementation of Bush Forever proposing retention of 8% of its pre-European extent within the Swan Coastal Plain (SCP) portion of the Perth Metropolitan Region (Government of Western Australia 2000). This is similarly below the 10 % threshold recommended by Bush Forever for retention of vegetation complexes within secure tenure. The Local Biodiversity Program (LBP 2013) identified that 11,905 ha (or 23.91 %) of the original extent of the Karrakatta Complex – Central and

[1] The site was known as 'Lot 4 Flynn Drive' at the time the additional ecological studies were undertaken. The site has since been renamed as 'Lot 9000 Flynn Drive, Lots 41 and 9003 Mather Drive and Part Lot 600 Wattle Avenue', and is also referred to as Flynn and Mather Drives.

South remains on the entire SCP south of Moore River with 7.26 % currently in tenure with formal protection (LBP 2013).

A total of eleven discrete vegetation types were identified as occurring within the site by ATA (2007). These were further refined to nine vegetation types by ELA (2012a, 2013) and are described in **Table 1** and shown on **Figure 7**.

Table 1: Vegetation types recorded within the site (ATA 2007 and ELA 2012a)

Vegetation Code	Description
CcBgBa	Open Woodland of *Corymbia calophylla*, *Banksia grandis* and *Banksia attenuata* over Low Open Shrubland of *Hibbertia hypericoides* over a Grassland of introduced species *Ehrharta calycina* on grey sands
Cleared	Cleared
EgOW	*Eucalyptus gomphocephala* Open Woodland over *Jacksonia furcellata* and *Acacia saligna* Tall Closed Scrub over *Macrozamia riedlei* and *Xanthorrhoea preissii* Open Shrubland
EmBAf	Open Forest of *Eucalyptus marginata* and *Allocasuarina fraseriana* over Woodland of *Banksia attenuata* and *Banksia menziesii* over Shrubland of *Xanthorroea preisii* over Low Open Shrubland of *Hibbertia hypericoides* with occasional *Hypocalymma robustum* and *Bossiaea eriocarpa* over Open Herbland including *Mesomelaena pseudostygia*, *Desmocladus flexuosus* and *Lyginia barbata* on grey loamy sands and sandy midslopes on midslope and upper slopes
EmBaBmA	Open Woodland to Low Woodland of *Eucalyptus marginata*, *Banksia attenuata*, *Banksia menziesii* and *Allocasuarina fraseriana* over Low Open Shrubland of *Xanthorrhoea preissii*, *Stirlingia latifolia* and *Hibbertia hypericoides* over Open Sedgeland of *Mesomelaena pseudostygia* on grey sandy flats
EmLw	*Eucalyptus marginata* Low Woodland with scattered *Banksia attenuata*, *Banksia menziesii* and *Allocasuarina fraseriana* over *Xanthorrhoea preissii* Low to Low Open Shrubland
ErAfMpOW	*Eucalyptus rudis*, *Allocasuarina fraseriana* and *Melaleuca preissiana* Open Woodland with scattered *Banksia ilicifolia* and *Nuytsia floribunda* over *Jacksonia furcellata* Tall Open Shrubland over an Open Grassland of *Ehrharta calycina*
EtNfLOW	*Eucalyptus todtiana* and *Nuytsia floribunda* Low Open Woodland over *Hibbertia hypericoides*, *Eremaea pauciflora* and *Xanthorrhoea preissii* Low Open Shrubland over Open Grassland of *Ehrharta calycina*
CcEmOF	*Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* open forest over *Hibbertia hypericoides* and *Hakea prostrata* low shrubland to open shrubland over **Ehrharta calycina*, **Ehrharta longiflora* and **Bromus diandrus* Open Grassland

3.4.1 Floristic Community Types

One Priority Ecological Community (PEC) was inferred from two vegetation types (SCP 24 – northern Spearwood shrublands and woodlands; Priority 3) during the ATA (2007) sur**v**ey, however, these vegetation types were later deemed to be not analogous to the PEC by ELA (2013). Flora and vegetation survey of the site conducted by ATA (2007) and additional survey and data analysis by ELA (2013) found floristic community type (FCT) SCP 28 - Spearwood *Banksia attenuata* or *B. attentuata* – Eucalyptus woodlands (Gibson et al. 1994) to be present within the site (excluding the portion contained

within the TEC, see Section 3.4.2). Refer to ELA (2013) for a detailed description of the FCT analysis conducted for the site.

3.4.2 Threatened Ecological Communities

The TEC SCP 20a '*Banksia attenuata* woodland over species rich dense shrublands' was mapped by RPS (2006) as EmBaBmAf in the south-east of the site and was confirmed by the Department of Environment and Conservation (DEC) [(now Department of Parks and Wildlife (DPaW)] (Threatened and Priority ecological communities database search) and by the ELA ground truthing survey in 2012 (ELA 2012a).

3.4.3 Vegetation condition

The vegetation condition of the site was mapped by both RPS (2006) and ATA (2007) and updated by ELA (2012a) and ranges from Completely Degraded to Excellent (**Figure 8**). The vegetation in Excellent condition occurs in the southern portion of the site, including Bush Forever Site 295 and the TEC. The Degraded areas are mainly associated with the zones of cleared land in the north-west of the site where large portions are significantly weed infested or degraded, and commonly contain rubbish.

3.4.4 Bush Forever Site 295

The selection criteria for this site consisted of representation of ecological communities, Rarity, General criteria for the protection of wetland, streamline and estuarine fringing and coastal vegetation. This site contains >75 % vegetation in Excellent – Very Good condition and has linkages to adjacent bushland to the north (Site 382, across Old Yanchep Rd) and is part of a regionally significant bushland / wetland linkage (Government of Western Australia 2000).

3.5 Flora

The families with the greatest representation by terrestrial vascular flora taxa recorded within the site were the Proteaceae (Banksia), the Myrtaceae (Eucalyptus) and the Papilionaceae (Pea) families. Non-vascular flora were not specifically sampled but were noted in a variety of habitats; these flora included liverworts on soil crusts, lichens on rocks and soil crusts, and fungi on dead wood.

No Threatened (Schedule 1) flora species listed under the *Wildlife Conservation Act 1950* (WC Act) or Priority flora or fungi species listed by the DPaW have been recorded from the site.

Although a total of 34 conservation significant vascular flora species were identified from database searches as possibly occurring (**Appendix D**), none are considered likely to occur based on the presence of suitable habitat and species distribution patterns. One species recorded at the site, *Conostylis aculeata* subsp. *cygnorum*, is listed in Bush Forever as significant flora of the Perth metropolitan region due to being endemic to the Swan Coastal Plain (Government of Western Australia 2000).

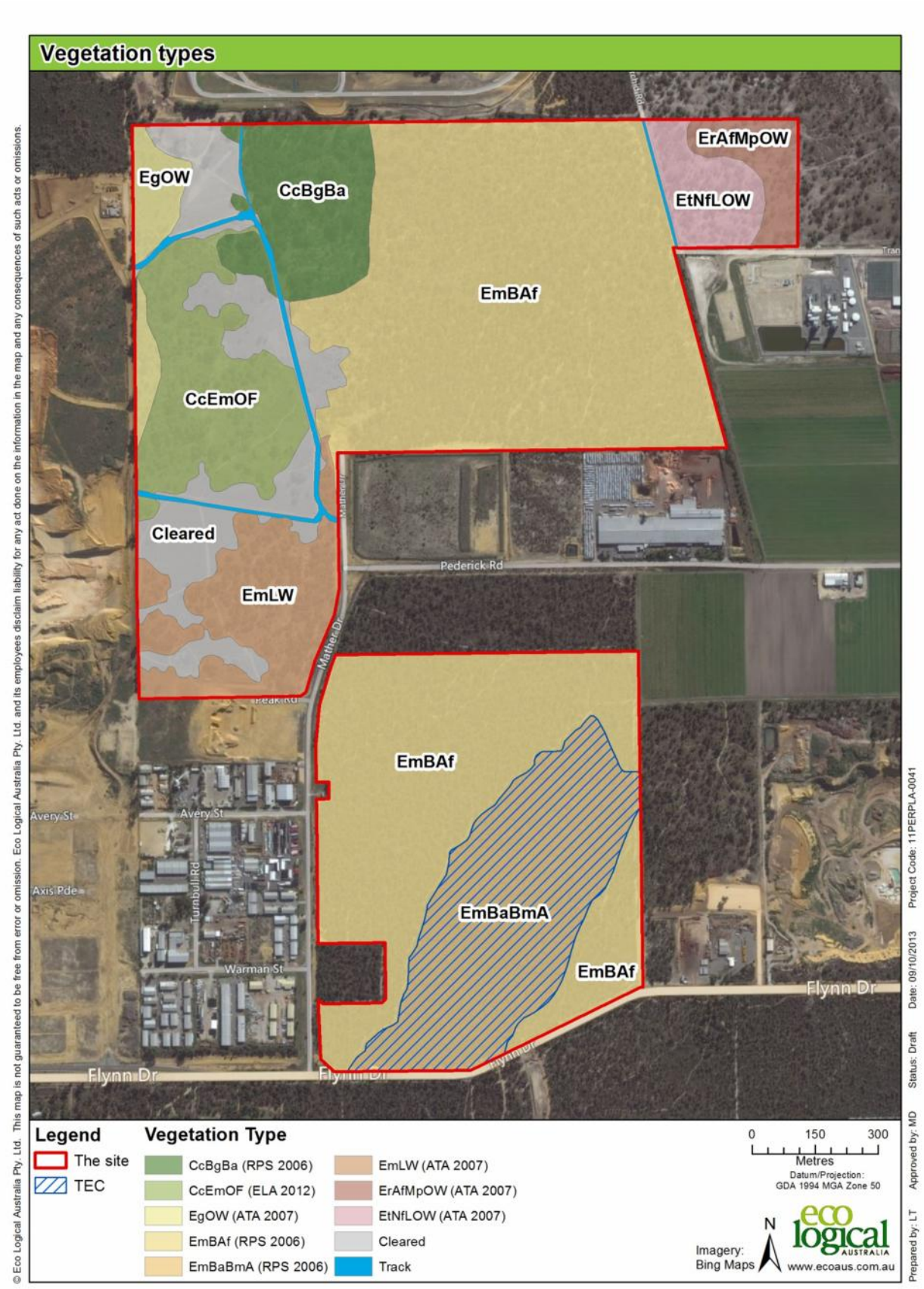

Figure 7: Vegetation types

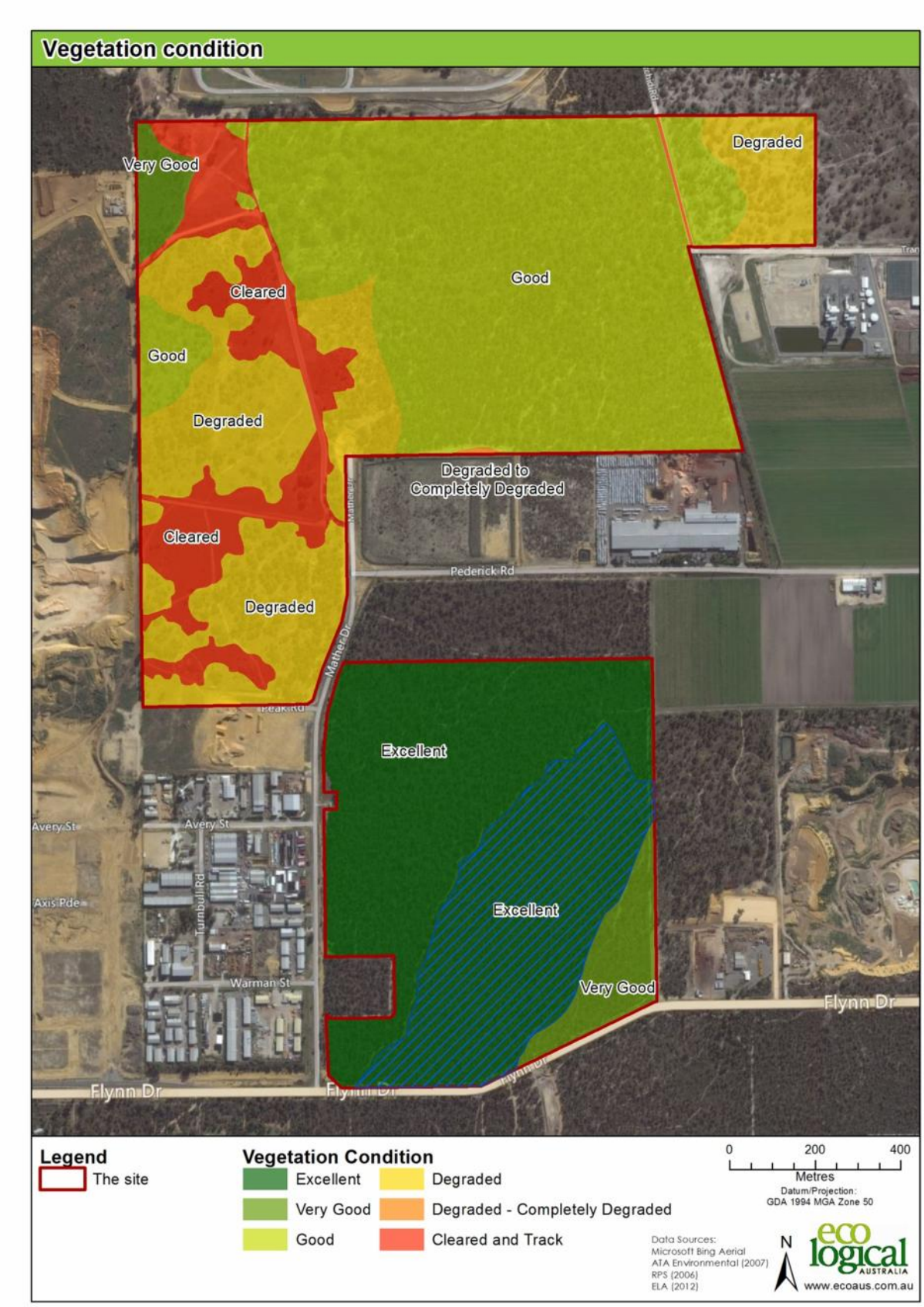

Figure 8: Vegetation condition

3.6 Vertebrate fauna

3.6.1 Terrestrial fauna and habitats

The following fauna surveys have previously been undertaken on land considered part of the site:

- Level 2 Vertebrate Fauna Survey of the NIA as part of ATA (2007)
- Ground truthing of environmental values for Lot 4 Flynn Drive – ELA (2012a)
- Targeted Fauna Assessment of Lot 4 Flynn Drive as part of ELA (2013).

In recent years, considerable fauna survey effort has been undertaken on the northern Swan Coastal Plain in vegetation supported by Quindalup and Spearwood dunes (ATA 2007). ATA (1996) described two major faunal habitats in the local area: limestone heath and Banksia woodland, with smaller areas of Tuart woodland on the Spearwood dunes. The key fauna habitat present within the site is *Eucalyptus* sp. Woodland over-storey with a *Banksia* sp. low woodland understorey (ATA 2007).

The majority of vertebrate fauna species recorded at the site are bird species. Mammals, reptiles and amphibians have also been recorded during surveys of the site. Bird species that frequent the coast and Indian Ocean (approximately 8 km to the west) are likely to fly over the site, however, some are unlikely to use the site for foraging or nesting due to the absence of suitable habitat (e.g. marine and freshwater birds, salt lake specialists, darters, gulls and terns, ibis and spoonbills) (ATA 2007).

A number of introduced and feral animals have been recorded from the site including mice (*Mus musculus*), cats (*Felis catus*) and foxes (*Vulpes vulpes*) (ATA 2007).

3.6.2 Conservation significant vertebrate fauna

A total of 38 conservation significant species were identified as potentially occurring within the search area (**Appendix D**) (excluding marine species as the proposal will not affect the marine environment), of which four are considered likely to occur, or have been recorded within the site (**Table 2**).

Table 2: Database search results for conservation significant fauna species that may occur at the site

Species	Conservation Status[1]	Likelihood of Occurrence
Calyptorhynchus latirostris (Carnaby's Black-Cockatoo)	S1 Endangered	Recorded on site – observed by ELA (2013) and ATA Environmental (2007).
Merops ornatus (Rainbow Bee-eater)	Migratory terrestrial bird (EPBC Act)	Recorded on site – observed by ATA Environmental (2007).
Macropus irma (Western Brush Wallaby)	P4	Recorded on site – scats recorded during targeted survey (R. Browne-Cooper, ELA, pers. comm, September 2013).
Morelia spilota subsp*. imbricata* (Carpet Python)	S4	Likely. ELA scientists found sloughed skin of the Carpet Python in survey of nearby Lot 701 Flynn Drive (ELA 2012b).

[1] State Conservation Status:

- S1 = Schedule 1 under WC Act – Rare and likely to become extinct
- S4 = Schedule 4 under WC Act – Other specially protected fauna
- P4 = Priority 4 – Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

Commonwealth Conservation Status (EPBC Act):

- Endangered = is facing a very high risk of extinction in the wild in the near future

The species listed in **Table 2** are discussed further below.

Rainbow Bee-eater

A total of 16 individual Rainbow Bee-eaters have been observed within the site (ATA 2007). Habitat for this species is present within the site in the form of Low Open Heath, Shrublands and Cleared areas (ATA 2007). No nesting sites have been recorded within the site. Although they have been recorded utilising the site, Rainbow Bee-eaters have a range of alternative foraging and nesting areas in the region.

Carnaby's Black-Cockatoo

As part of the Targeted Flora and Fauna Assessment conducted at the site by ELA (2013), an assessment to determine the presence and extent of habitat for Carnaby's Black-Cockatoo was undertaken. The results of this assessment are summarised below.

The site contains foraging habitat for Carnaby's Black-Cockatoo. Carnaby's Black-Cockatoos were observed, in large numbers (approximately 100 birds), foraging across the site during the ELA (2013) survey, mainly in the northern portion of the site. In addition, evidence of foraging activity was observed throughout the site by ELA ecologists.

Based on DoE's consideration that all trees with Diameter Breast Height greater than 50 cm have the potential to form hollows suitable for nesting within the short to medium term (SEWPaC 2012), 694 trees were identified as potential breeding trees, including 539 Jarrah, 127 Marri, and 28 Tuart trees (**Figure 9**). Of these, 120 trees, comprising 111 Jarrah, seven Marri, and two Tuart trees had hollows possibly suitable for Carnaby's Black-Cockatoo nesting, based on criteria defined by Cale (2003).

Based on the habitat assessment of the vegetation types present, the site contains approximately 162 ha of high value foraging habitat and 18.7 ha of moderate value foraging habitat. The presence of key plant species of value to Carnaby's Black-Cockatoo, such as Eucalyptus and Banksia species, provides foraging value.

The site also supports tree species known as roost species for Carnaby's Black-Cockatoo including Tuart and Flooded Gum, however, there are no known roosts within the site. There are approximately 16 known roost sites within a 6 km radius of the site, based on mapping by the Department of Planning (2011).

Western Brush Wallaby

Scats of this species were opportunistically recorded in the south-eastern corner of the site during the targeted fauna survey undertaken by ELA (R. Browne-Cooper, ELA, pers. comm, September 2013). Scats were also recorded from the nearby Lot 701 Flynn Drive during a Level 2 fauna survey of that location (ELA 2012b). The species is also known from other confirmed records in the Neerabup area according to database searches.

Habitat for this species is present within the site, in particular the vegetation type and condition present within the area of TEC and Bush Forever Site 295 in the south-eastern corner. Similar habitat is present in the remainder of Bush Forever Site 295, to the south-east of the site and south of Flynn Drive. The species' presence within the site is likely to be transient in nature, given the scarcity and age of scats recorded (R. Browne-Cooper, ELA, pers. comm, September 2013).

Carpet Python

This species inhabits forest, heath, or wetland areas and shelter in hollow logs or in branches of large trees (ATA 2007). A sloughed skin of a Carpet Python was identified within Lot 701 to the west by ELA

personnel (ELA 2012d) and a live specimen was also previously recorded in a private property within Neerabup on Flynn Drive (Robert Browne-Cooper, ELA, pers. obs.). Habitat for this species occurs within the site in the form of Eucalyptus and Banksia woodlands which may contain hollow logs and large trees suitable for providing shelter.

3.7 Invertebrate fauna

The ATA (2007) report outlines that Short Range Endemic (SRE) invertebrate fauna were also targeted during the fauna survey, however, the results were not presented.

A total of six conservation significant invertebrate fauna species were identified as potentially occurring within the site (ELA 2012b) as listed in **Table 3**.

Table 3: Database search results for conservation significant invertebrate fauna species that may occur at the site

Species	Conservation Status[1]	Likelihood of Occurrence
Austrosaga spinifer (cricket)	P3	Possible. Historical records exist (early 1980s) of this species recorded in Neerabup National Park (DEC fauna database search). There is little information available on the ecology and preferred habitat of this species (Terry Houston pers. comm.), and there is no effective survey method available for detection to assess presence or absence.
Hylaeus globuliferus (bee)	P3	Possible. This species has previously been recorded from nearby Flynn Drive in Neerabup (DEC fauna database search). Suitable feeding habitat occurs.
Leioproctus douglasiellus (Short-tongued Bee)	S1 Endangered Critically Endangered (EPBC Act)	Unlikely. This species is known from three locations within the Perth metropolitan area around Cannington and Forrestdale, approximately 40 km south of the site (DEC 2009 as cited in Commonwealth Government 2013). Specimens of *L. douglasiellus* have been collected on two Priority flora species; *Goodenia filiformis* (Priority 3) and *Anthotium junciforme* (Priority 4) (DEC 2009 as cited in Commonwealth Government 2013), neither of which have been recorded from the site.
Idiosoma nigrum (Shield-backed Trapdoor Spider)	S1 Vulnerable (EPBC Act)	No. One isolated record has been made near Wanneroo but is expected to be an incorrect record. The nearest records are approximately 50 km away in the escarpment/hills.
Leioproctus contrarius (bee)	P3	Unlikely. Site lacks suitable habitat.
Westralunio carteri (freshwater bivalve)	P4	No. Site lacks suitable wetland habitat.

[1] State Conservation Status:

- S1 = Schedule 1 under WC Act – Rare and likely to become extinct
- P3 = Priority 3 – Poorly-known taxa: Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.
-

Commonwealth Conservation Status (EPBC Act):

- Critically Endangered = it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
- Vulnerable = the species is not critically endangered or endangered; and it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.

Stygofauna

Stygofauna are obligate groundwater dwellers that spend their entire life cycle below ground, occasionally occurring very close to surface waters as well as in deeper aquifers (EPA 2003). Stygofauna require favourable conditions to inhabit water-bearing permeable rock habitats such as large caves, mesocaverns in karst and basalts, and the interstitial spaces of alluvial aquifers.

Stygobiotic species with restricted ranges are known to occur at Yanchep, approximately 20 km north-west of the site (Bennelongia 1998). The cave system at Yanchep in which these species were found is a listed TEC with a total of 91 subterranean invertebrates previously recorded. Stygobiotic communities have also been recorded from the Leederville and Yarragadee aquifers, approximately 30 km south-east and 280 km north of the site.

Limestone is mapped as being relatively extensive between the site and Lake Neerabup to the west, however, the site contains the easternmost mapped area of Tamala Limestone. The mapped limestone exposure trends north-north-east in the vicinity of the site and is surrounded by sand derived from Tamala Limestone to the north and east (ATA 2006). The two specific geological units occurring within the site as mapped by Gozzard (1982); LS_1 and S_7 (described in Section 3.2), are not associated with karst formations. The geological unit LS_2 occurring approximately 2 km west of the site, is described as containing abundant karstic phenomena including caves, swallows and dolines (Gozzard 1982).

During the drilling conducted by ATA for the limestone assessment at the site in 2009, there was no obvious evidence of karst (dissolution) features in terms of cores showing cavities, or significant loss of drilling pressure due to intersection of significant caverns (ATA 2009).

ELA conducted a stygofauna survey of seven bores within and surrounding Lot 701, to the west of the site in 2011,including within the LS_2 geological unit (ELA 2012c). A total of five of the bores sampled are located <1 km from the site, the closest is located approximately 350 m south of the northern portion of the site. No stygofauna were recorded during the survey. It was concluded that there may be an insufficient connectivity between land surface and the water table below Lot 701 to sustain stygofauna communities, and if the degree of karstification below the water table at Lot 701 is low, and individual solute cavities are not well connected, then it is further unlikely that stygofauna will exist there (ELA 2012c). It was concluded that resource extraction and development of industrial lots on land within Lot 701 could proceed without posing a significant threat to stygofauna (ELA 2012c).

Based on the results of this nearby survey, and the mapped extent of limestone within the site it is considered unlikely that the site would support a subterranean aquatic invertebrate fauna community, and therefore impacts to stygofauna resulting from implementation of the proposal are considered unlikely.

3.8 Heritage

An archaeological and ethnographic survey was undertaken of the site (and surrounds) in May 2013 by R. & E. O'Connor Pty Ltd (R. & E. O'Connor). A search of the Register of Aboriginal Sites administered by the Department of Aboriginal Affairs (DAA) as part of this survey established that no Aboriginal sites or other heritage places have been previously recorded within the area of proposed development. The field component of the survey was carried out by representatives of the Whadjuk, Ballaruk and

Bibbulmun Aboriginal groups between 20 and 22 May 2013. No Aboriginal sites were newly recorded by these Aboriginal representatives.

A search of the WA Heritage Council database returned nil European heritage sites known for the site. The nearest known European heritage sites are located 2.5 km south-west and 3 km north-west of the site.

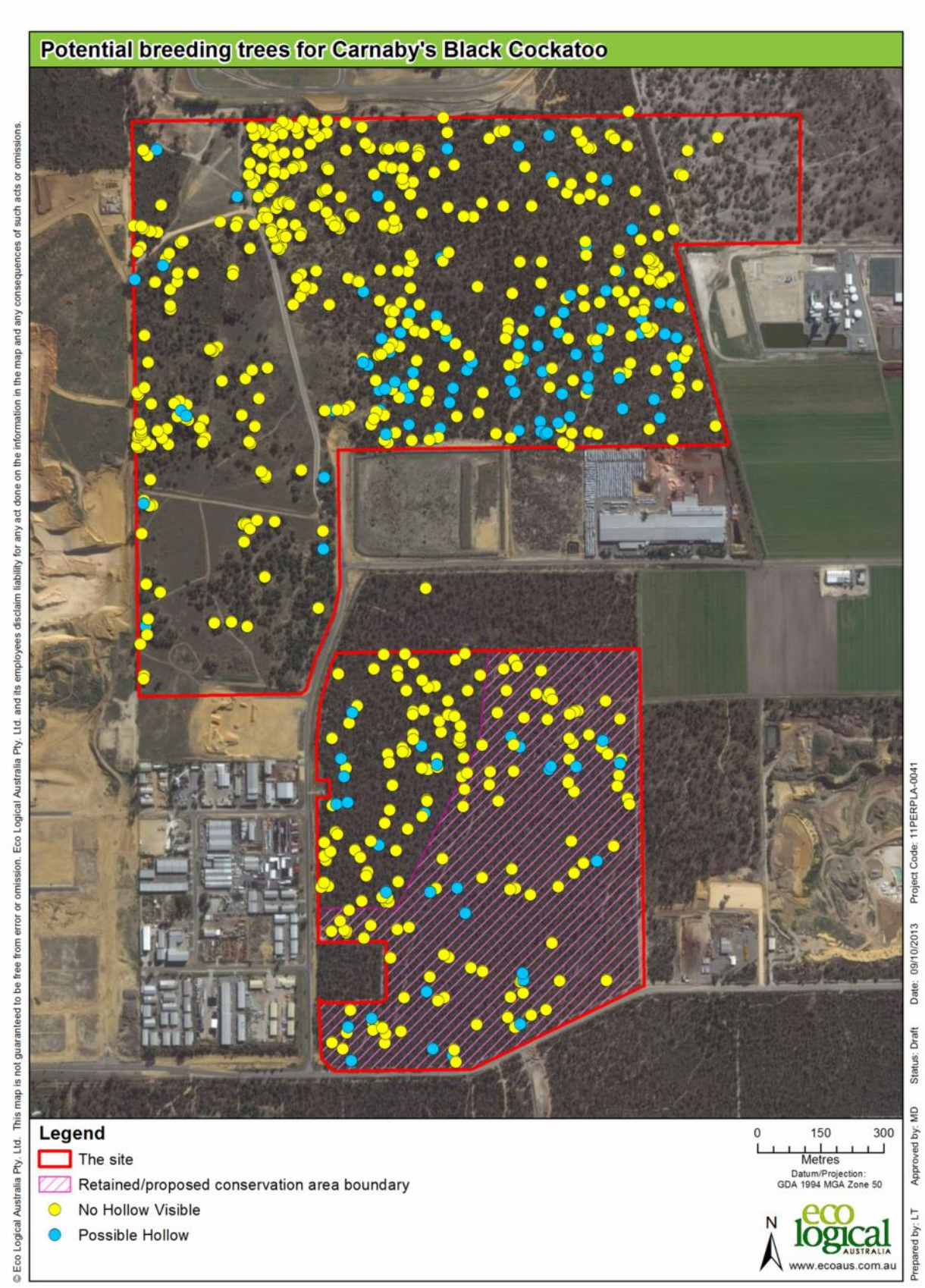

Figure 9: Potential breeding trees for Carnaby's Black-Cockatoo

4 Potential environmental impacts and management strategy

Key environmental impacts anticipated to result from implementation of the proposal include impacts to vegetation, flora and fauna. Potential impacts to these factors will be discussed in detail in the following sections. Other potential impacts associated with the development (e.g. changes to site water balance, noise, dust) will be managed in accordance with an environmental management framework that includes a Construction Environmental Management Plan and Water Management Plan.

4.1 Vegetation and flora

4.1.1 Key values

Vegetation

Eleven vegetation types were identified as occurring within the site by ATA (2007), which were refined to nine vegetation types by ELA (2012a, 2013). An FCT statistical analysis resulted in the majority of the vegetation on site being inferred to represent FCT SCP 28 – Spearwood *Banksia attenuata* or *B. attentuata* – Eucalyptus woodlands (Gibson et al. 1994).

The TEC SCP 20a '*Banksia attenuata* woodland over species rich dense shrublands' Floristic Community Type (Gibson et al. 1994) also occurs in the south-east of the site.

The vegetation condition of the site ranges from Completely Degraded to Excellent (**Figure 8**). The vegetation in Excellent condition occurs in the southern portion of the site, including Bush Forever Site 295 and the TEC. The Degraded areas are mainly associated with cleared land in the north-west of the site where large portions are significantly weed infested and commonly contain rubbish.

Flora

No Threatened or Priority flora or fungi species have been recorded from the site. *Conostylis aculeata* subsp. *cygnorum*, which is listed in Bush Forever as significant flora of the Perth metropolitan region due to being endemic to the Swan Coastal Plain (Government of Western Australia 2000), has been recorded at the site.

4.1.2 Assessment of potential impacts

Direct Impacts

Clearing requirements for the proposal will result in the clearing of approximately 140 ha of vegetation including areas that are in Degraded condition. No Threatened or Priority flora or fungi species have been recorded from the site.

Clearing of vegetation will directly reduce the extent of vegetation communities. Potential impacts to the vegetation types are summarised in **Table 4**.

Approximately 81.3 ha of the Karrakatta Complex – Central and South occurs within the site. Approximately 35.84 ha of this complex will be impacted by the proposal, which equates to <1 % of the original extent of this vegetation complex remaining on the broader SCP and of its original extent within the SCP portion of the Perth Metropolitan area. Whilst below the retention target of 10% for the complex within the Bush Forever study area, vegetation proposed for removal was not identified for

retention as part of the Bush Forever program. Of the 45.5 ha of this complex to be retained within the site, 32 ha occurs outside of Bush Forever Site 295.

The vegetation type EmBaBmA, which is representative of the restricted FCT SCP 20a (also listed as a TEC), has been completely avoided through the concept design for the site and will not be directly affected by the Proposal.

Table 4: Area and percentage impacts to vegetation types

Vegetation Type	Area (ha)		% Impact
	Flynn and Mather Drives	Industrial (impact area)	
CcBgBa	12.4	12.4	100
Cleared	18.7	18.7	100
EgOW	4.3	4.3	100
EmBaBmA*	27.2	0	0
EmBAf	106.6	83.5	78.3
EmLw	14.4	14.4	100
ErAfMpOW	4.3	4.3	100
EtNfLOW	5.6	5.6	100
CcEmOF	15.9	15.9	100

* This vegetation type represents the TEC within the site

The remnant vegetation of the site was generally assessed to be in 'Good – Excellent' condition. Approximately 30.7 % of 'Excellent', 31.8 % of 'Very Good' vegetation and 100 % of 'Good' vegetation will be impacted (**Table 5**).

Approximately 26.2 % of the Industrial (Impact) area is 'Degraded' vegetation, and approximately 0.12 % is 'Degraded - Completely Degraded' (**Table 5**). These areas are degraded due to access, infrastructure, and road and track edges associated with disturbance within the neighbouring site.

Table 5: Area and percentage impacts to vegetation condition

Vegetation Condition	Area (ha)		% Impacted
	Flynn and Mather Drives	Industrial (impact area)	
Excellent	63.9	19.6	30.7
Very Good	9.1	2.9	31.8
Good	75.8	75.8	100
Degraded	41.7	41.7	100
Degraded-Completely Degraded	0.2	0.2	100
Cleared	18.7	18.7	100

The TEC occurring within the site will not be disturbed during the development of the proposal, and a buffer of at least 50 m (in some cases more than 200 m) will be applied around the TEC. The TEC will be protected and managed in accordance with a Conservation Area Management Plan. All of the 20.13 ha of Bush Forever Site 295 occurring within the site will be retained (contained in the same area as the TEC) for the purpose of conservation, and therefore will not be impacted directly by the proposal. The area of Bush Forever Site 295 occurring within the site will further be protected through the buffer to be applied to the TEC. The buffer will minimise any potential indirect impacts (increased human activity, dust generation etc.) and edge effects.

Indirect Impacts

Vegetation retained adjacent to the development area, including the TEC and associated buffer, has the potential to be affected by indirect impacts arising from changes in surface hydrology, increased human activity, dust generation, and other edge effects. The on-site conservation areas will be protected and managed in accordance with a Conservation Area Management Plan.

In addition, secondary impacts to vegetation health may result including:

- changes to surface hydrology
- increased human activity as a result of development may increase indirect impacts on vegetation through uncontrolled access and rubbish dumping
- vehicle movements and earthworks have the potential to introduce and spread weed species and dieback
- dust generation due to earthworks and vehicle movements has the potential to smother vegetation
- potential edge effects to surrounding vegetation from clearing and construction activities.

Increased human activity

The proposal will result in increased human activity in the area, and increased vehicle movements during construction and post-construction. These activities may result in uncontrolled and unmanaged access to areas of remnant vegetation which could lead to:

- introduction and / or spread of weeds
- illegal rubbish dumping

- direct disturbance of vegetation and flora (e.g. from trampling and erosion of existing sandy tracks).

Large portions of the site are significantly weed infested or degraded, with areas containing rubbish. Disturbance has also occurred within the site where vegetation has been completely cleared, and some small areas disturbed from development of, and access to, adjacent lots.

Managing access as part of the proposal will improve the protection of retained native vegetation through the provision of fencing, hard edges and an increased management presence in the area.

Increased human activity in the area is therefore considered manageable and is not expected to result in the impacts listed above.

Dust Generation

Earthworks during construction at the site will generate dust which may have direct physical effects on plants such as blockage and damage to stomata, shading, abrasion of leaf surface or cuticle and cumulative effects (e.g. drought stress on already stressed species). Dust may also result in adverse effects on the health of construction workers.

Development at the site will be undertaken in stages relevant to resource extraction and requirements for industrial land, which will limit exposed surfaces from which dust can be generated. Dust will be managed throughout the clearing and construction phase of development in accordance with the publication "A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities" (DEC 2011b) through the use of water trucks or other suitable dust suppression methods. Areas left exposed following development will be sealed (e.g. chemical dust suppressant) where appropriate, to reduce the risk of dust generation between clearing and industrial land development.

Potential edge effects

There is the potential for edge effects to occur to the vegetation surrounding the Industrial (Impact) area. These may include general construction activities during the construction phase of the proposal, recreational walking and littering, which could all result in degradation of vegetation surrounding the Industrial (Impact) area. These potential edge effects would only be minor and would be subject to proposed management strategies (e.g. inductions advising construction workings of value of adjoining areas and regular rubbish collections around the boundary of the site).

Management of operational environmental aspects (e.g. air quality emissions) is not part of the proposal, however, it is expected that these will be managed consistent with current guidelines, licensing and other legislative requirements.

4.1.3 Key management actions

There is currently a range of impact avoidance and minimisation measures for flora and vegetation to be implemented as part of the proposal, specifically:

- Complete avoidance and retention of the TEC, including buffer of at least 50 m (in some cases more than 200 m)
- Complete avoidance and retention of Bush Forever Site 295 that occurs within the site (noting that part of this area is currently already utilised for drainage purposes)
- Minimisation of clearing and retention of 45.46 ha of Karrakatta Complex – Central and South (100 % of occurrence within site that is in Very Good or Excellent condition).

The result of the above is an approximately 50 ha conservation area that will protect the above values, to be managed in accordance with a Conservation Area Management Plan.

Further minimisation, and also rectification mitigation measures, that will be implemented for flora and vegetation include:

- Preparing and implementing a Construction Environmental Management Plan (CEMP) that includes measures regarding
  - hygiene management (weeds and dieback)
  - dust
  - fire prevention
  - access control
- Preparing and implementing management plan/s that address hydrology in accordance with the *Better Urban Water Management* guidelines.

The clearing of native vegetation on the site was previously considered by the then DEC to be at variance to, or may have been at variance to, a number of the native vegetation clearing principles (**Table 6**). The implementation of a range of mitigation measures is considered to adequately address the potential variance.

Table 6: Clearing principles considered to be potentially or actually at variance by then DEC

Relevant Clearing Principles and Summary of DEC Comments	Proponent Response
Comprise a high level of biological diversity – given the number of flora and fauna species identified and the large areas of structurally intact native vegetation in very good condition.	No Priority flora or fungi species have been recorded at the site (ELA 2013). The vegetation in the southern portion of the site is generally in better condition than the northern section, being considered Very Good to Excellent. Approximately 50 ha (72 %) of this portion of the site will be retained as a conservation area. Part of this includes an area of regionally significant vegetation identified under Bush Forever as Site 295 (noting that part of this site is currently used for drainage purposes). The northern portion of the site only contains 2.9 ha considered to be in Very Good condition, with the remainder in Good (75.9 ha), Degraded – Completely Degraded (0.2 ha) or considered devoid of vegetation. Though the proposed development will result in approximately 140 ha of vegetation clearing, the retained conservation area will continue to provide habitat for a range of species as well as acting as a stepping stone between large bushland reserves to the east (Lake Pinjar) and west (Lake Neerabup and Neerabup National Park).
Comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia – nine fauna species of conservation significance could potentially	As outlined above, approximately 50 ha of the site will be retained and continue to provide high value foraging habitat for Carnaby's Black-Cockatoo (27.6 % of available moderate – high value foraging habitat in site). The onsite conservation area will maintain a stepping stone function between nearby large

Relevant Clearing Principles and Summary of DEC Comments	Proponent Response
occur, of particular note the proposed clearing contains a large area of Carnaby's Black-Cockatoo habitat including trees identified containing hollows possibly suitable for Carnaby's Black-Cockatoo.	reserves associated with Lake Pinjar, Neerabup National Park and the Pine plantations further to the north of the site. Additionally, a range of local and regional offsets are proposed to further protect and enhance Carnaby's Black-Cockatoo foraging habitat.
Includes, or is necessary for the continued existence of rare flora	No Threatened (Declared Rare Flora) species have been recorded at the site (ELA 2013).
Comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community – the southern quadrant of Lot 4 supports a TEC and a 50-100 m buffer around this TEC is recommended.	The identified TEC will be retained, with a minimum 50 m buffer within the onsite conservation area (buffer is over 200 m in some areas). The zoning will be changed to ensure protection for conservation purposes and a Conservation Area Management Plan will be prepared to manage the site in the future.
It is significant as a remnant of native vegetation in an area that has been extensively cleared – the vegetation applied to be cleared may be significant as a remnant of native vegetation, being representative of vegetation associations that have been extensively cleared (less than 30 % remaining of pre-European extent). Additionally, the likely occurrence of clearing more of these vegetation types in the vicinity was noted.	The site contains 81.3 ha of vegetation categorised as Karrakatta Complex – Central and South (6.3 ha of which is considered to be in Degraded condition), which has less than 10 % protected or proposed for protection in conservation areas within the Bush Forever study area. As part of the proposed development, 45.5 ha (60 %) of this complex will be retained in a conservation area (of which 13.5 ha was identified for retention within Bush Forever Site 295). This will retain the majority of the vegetation that is in Very Good or Excellent condition. Additionally, one of the proposed offset areas that will be protected and maintained into the future is categorised as representative of the Karrakatta Complex – Central and South.
Native vegetation growing in, or in association with, an environment associated with a watercourse or wetland	The nearest wetland to the site is Lake Pinjar, which is approximately 1 km north-east of the site. The native vegetation growing at the site is not considered to be associated with this nearest wetland.
Clearing of the vegetation is likely to cause appreciable land degradation – there is no known risk of ASS or potential ASS, however the sandy soils are considered potentially erodible and clearing the large area is likely to cause wind erosion and appreciable land degradation.	The site will ultimately be developed for industrial purposes, however, resource extraction activities will occur in the western part of the site initially. The site will therefore be developed in a staged manner, which will reduce the extent of erosion and land degradation. A CEMP will be prepared to manage potential impacts from dust and a Drainage, Nutrient and Water Management Plan (superseded by relevant document required by *Better Urban Water Management* guidelines) is required to be prepared to manage hydrology issues (which will likely also include erosion from surface water).
Clearing of the vegetation is likely to have an impact on the environmental values of any	The designated conservation area will increase in the general vicinity of the site as a result of the retention of the TEC and

Relevant Clearing Principles and Summary of DEC Comments	Proponent Response
adjacent or nearby conservation area – given the large area proposed to be cleared and the connectivity to nearby conservation areas (Bush Forever sites, System 6 Conservation Reserve) it is likely that the clearing will impact on the environmental values of these conservation areas. Additionally, the proposed clearing has the potential to indirectly impact the environmental values of the adjacent reserves through the spread or introduction of weeds and diseases (i.e. dieback).	associated buffer, as well as the portion of Bush Forever Site No. 295 that is located within the site (total area retained being approximately 50 ha). These areas are considered in the best condition (being Very Good to Excellent) and will be subject to management outlined in a Conservation Area Management Plan, to maintain them into the future. Retention of the TEC, buffer and Bush Forever site connects with vegetation south of Flynn Drive and maintains a stepping stone for connectivity between Lake Pinjar to the east and Neerabup Lake and the Neerabup National Park to the west. Additionally, landscaping of streetscapes within the development area will comprise native vegetation and further facilitate connectivity. A CEMP will be prepared to manage potential indirect impacts to the surrounding conservation areas, including hygiene measures.
Clearing of the vegetation is likely to cause deterioration in the quality of surface and underground water	Groundwater flows west from the site, with Lake Neerabup being the closest wetland located approximately 4 km to the west. The depth to groundwater across the site ranges from approximately 17-50 m. The site is not located in a Public Drinking Water Source area. The vegetation clearing is considered unlikely to cause deterioration in the quality of surface and underground water. Additionally, a Drainage, Nutrient and Water Management Plan (superseded by relevant document required by *Better Urban Water Management* guidelines) is required to be prepared to manage hydrology issues at the site.
Clearing of vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding	The clearing of vegetation is considered unlikely to cause or increase the incidence or intensity of flooding.

4.2 Vertebrate fauna

4.2.1 Key values

ATA (1996) described two major faunal habitats in the local area: limestone heath and Banksia woodland, with smaller areas of Tuart woodland on the Spearwood dunes. The key fauna habitat present within the site is *Eucalyptus* sp. Woodland overstorey with a *Banksia* sp. low woodland understorey (ATA 2007).

A total of four vertebrate fauna species of conservation significance have been recorded, or are considered likely to occur, within the site:

- Carnaby's Black-Cockatoo (WC: Act S1, EPBC Act: Endangered)
- Rainbow Bee-eater (EPBC Act: Migratory)

- Western Brush Wallaby (Priority 4)
- Carpet Python (WC Act: S4).

4.2.2 Assessment of potential impacts

Clearing of fauna habitat

To facilitate construction of associated elements of the Proposal, ground disturbance within the site, including the clearing of vegetation (approximately 140 ha), will be required. This will reduce the extent of local habitat for fauna.

Clearing will occur in a staged manner over a number of years, which will facilitate the natural relocation of fauna to other suitable habitats in the area. Prior to clearing commencing in an area, a fauna relocation program will be undertaken. Clearing will commence from disturbed edges, where possible, to encourage any remaining fauna to naturally migrate to retained vegetated areas. A fauna handler will also be available during on-site clearing activities.

Potential impacts to conservation significant fauna

Carnaby's Black-Cockatoo

The Carnaby's Black-Cockatoo is of high conservation significance, and is known to utilise the site extensively for foraging. Based on the habitat assessment of the vegetation types present, the site contains approximately 162 ha of high value foraging habitat and 18.7 ha of moderate value foraging habitat, of which approximately 112 ha and 18.7 ha is proposed to be cleared respectively (**Figure 3**). The moderate – high value foraging habitat proposed to be cleared for the development represents approximately 0.27 % of the habitat available within 20 km of Yanchep National Park. Approximately 50 ha of high value foraging habitat will be retained on-site within conservation areas.

Approximately 120 trees, comprising 111 Jarrah, seven Marri, and two Tuart trees with hollows possibly suitable for Carnaby's Black-Cockatoo nesting (Cale [2003] as cited in ELA [2013]) defined hollows suitable for nesting Carnaby's Black-Cockatoo to average 6.3 m above ground, and be approximately 110 cm deep, ranging from 25-250 cm), occur within the site (**Figure 9**) however, there are no records of breeding occurring on-site. It is noted that the site lies outside the known foraging range (within 6 – 12 km) of a recorded breeding site within Yanchep National Park. There are no known roosts within the site, however, there are approximately 16 known roost locations within a 6 km radius of the site, based on mapping by the Department of Planning (2011). There are no natural water sources on-site that are expected to support roosting.

Rainbow Bee-eater

The Rainbow Bee-eater is present within the site, however, no nesting sites have been recorded. The Proposal is unlikely to impact ecologically significant proportions of the population of Rainbow Bee-eater. The Rainbow Bee-eater is distributed across much of mainland Australia and forages across a wide range of habitats (SEWPaC 2013). Given the wide geographic range of this species and the range of alternative foraging and nesting areas in the region, significant impacts on the survival of this species are considered unlikely to occur.

Western Brush Wallaby

Scats of this species were opportunistically recorded in the south-eastern corner of the site during the targeted fauna survey undertaken by ELA (Robert Browne-Cooper pers comm). The DPaW database search shows records of this species in the Neerabup area, and the species is also known to utilise habitat within the nearby Lot 701 Flynn Drive (ELA 2012b).

Habitat for this species is present within the site, in particular the vegetation type and condition present within the area of TEC and Bush Forever Site 295 in the south-eastern corner, all of which will be retained within the conservation area. The species' presence within the site is likely to be transient in nature, given the scarcity and age of scats recorded and the site is therefore unlikely to be of significance to this species.

The existing Flynn Drive to the south of the site divides the northern and southern portions of Bush Forever Site 295 and won't be altered as part of the Proposal. While installation of fencing is proposed for the conservation area, this is directed at access management so will consider fauna movement during design by maintaining points of access.

Southwest Carpet Python

A sloughed skin of a Carpet Python was identified within Lot 701 to the west by ELA personnel (ELA 2012d) and a live specimen was also previously recorded in a private property within Neerabup on Flynn Drive (Robert Browne-Cooper, ELA, pers. obs.). This species inhabits forest, heath, or wetland areas and shelters in hollow logs or in branches of large trees (ATA 2007). Habitat for this species occurs within the site in the form of Eucalyptus and Banksia woodlands which may contain hollow logs and large trees suitable for providing shelter. However, due to commitments to retain the area of TEC in the south-east of the site and connectivity with the remainder of Bush Forever Site 295, as well as a staged clearing for resource extraction, it is expected that if present, this species will not be significantly impacted by the Proposal.

Management of indirect impacts

Other threatening processes that may impact on the terrestrial fauna values of the site include habitat modification as a result of altered surface hydrology, erosion, and the introduction of weeds. These potential impacts have largely been discussed previously (under 'Vegetation and flora') and are considered to be manageable.

4.2.3 Key management actions

There is currently a range of avoidance measures for vertebrate fauna to be implemented as part of the proposal, specifically:

- Retention of 50 ha of habitat for all fauna species
- Retention of 50 ha of Carnaby's Black-Cockatoo high value foraging habitat and 119 potential breeding trees [some with hollows, and some without hollows, based on criteria described by Cale (2003) as cited in ELA (2013) and criteria described in SEWPaC (2012 respectively)].

The approximately 50 ha conservation area that will protect the above values, will be managed in accordance with a Conservation Area Management Plan.

Minimisation and rectification measures that will be implemented for fauna include:

- Landscaping streetscapes and Public Open Space with native flora species (creating foraging habitat and maintaining an ecological corridor through the development area)
- Preparing and implementing a CEMP that includes measures regarding hygiene management (weeds and dieback) and fauna management (e.g. inspection of tree hollows, nests and vegetated debris prior to clearing)
- Preparing and implementing management plan/s that address hydrology in accordance with the *Better Urban Water Management* guidelines.

The clearing of native vegetation on the site was previously considered by the then DEC to be at variance to, or may have been at variance to, a number of the native vegetation clearing principles (**Table 6**). The implementation of a range of mitigation measures is considered to adequately address these potential issues.

4.3 Environmental management framework

The City of Wanneroo will implement a range of avoidance, mitigation and management measures to appropriately manage the industrial development and any potential environmental impacts. The following key documents will be prepared (if not already) and will guide implementation of the project:

- Construction Environmental Management Plan addressing:
  - Biodiversity
    - The entire footprint will not be cleared as a single exercise but cleared progressively over a number of years in accordance with the requirements for extraction of the limestone resource and demand for industrial land
    - An inspection of stages for suitable rehabilitation material (e.g. vegetation mulch and topsoil), prior to the commencement of clearing
    - Prior to vegetation clearing there will be a program of seed collection for revegetation purposes
    - Assessment of trees within the areas to be cleared for suitable Carnaby's Black-Cockatoo hollows that could potentially be relocated to adjacent habitat
    - The boundaries of vegetation to be cleared will be demarcated prior to clearing commencing for that stage
    - Hygiene management (i.e. dieback and weeds)
    - Fauna relocation program undertaken prior to clearing commencing in an area
    - Clearing occurring from a disturbed edge, where possible
  - Surface water (including erosion) and groundwater
  - Fuel and hazardous chemical handling and storage
  - Noise
  - Dust
  - Overall implementation including inductions, complaints/incident reporting and review requirements
- Water Management Plan in accordance with the *Better Urban Water Management* guidelines outlining:
  - Potable and non-potable water supplies
  - Overarching management principles
  - Details of the measures to be undertaken to manage stormwater and groundwater quality and quantity in the development (including limiting dewatering, if required)
  - Utilisation of best management practices to treat stormwater prior to infiltration or discharge in line with the Stormwater Management Manual (DoW 2004-2007)
- Conservation Area Management Plan for on-site conservation area addressing:
  - Fencing and access management
  - Signage
  - Fire management
  - Weed control

  - Future monitoring, particularly with regard to use of the site by Carnaby's Black-Cockatoo
- Meridian Park Landscape Master Plan Guidelines (Blackwell and Associates 2009)
  - Outlines streetscaping requirements, which is likely to include use of native species.

A number of specific procedures may be created to meet the management action requirements within these documents (e.g. design guidelines for future individual lot development that outlines stormwater management and landscaping standards).

5 Conclusion

This Environmental Review document is supporting documentation for assessment of the City of Wanneroo proposal to develop Flynn and Mather Drives, Neerabup (for industrial purposes) under the *Environmental Protection Act 1986*.

This Environmental Review provides:

- A description of the key components of the industrial land development proposal
- A brief summary of the important physical, biological and social values of the existing environment
- A preliminary evaluation of potential impacts of the proposal to key environmental factors
- A preliminary discussion of strategies and measures to ensure environmental factors and values are protected and managed to an appropriate level.

Based on the preliminary environmental impact assessment presented in this Environmental Review, the environmental impacts of the proposal and anticipated environmental outcomes are summarised as follows:

- Vegetation and flora:
  - Clearing of approximately 140 ha of vegetation
  - Retention of a 50 ha area that includes a TEC, portion of Bush Forever Site No. 295 within the site, Karrakatta Complex – Central and South vegetation complex and surrounding vegetation in Very Good or Excellent condition
- Terrestrial fauna:
  - Removal of habitat which provides foraging or potential breeding habitat for conservation significant species including Carnaby's Black-Cockatoo (S1 under the WC Act and Endangered under the EPBC Act), Rainbow Bee-eater (Migratory under the EPBC Act), Western Brush Wallaby (P4) and Southwest Carpet Python (S4 under the WC Act)
  - Retention of 50 ha of fauna habitat, including foraging habitat for Carnaby's Black-Cockatoo.

The City of Wanneroo will implement a range of avoidance, mitigation and management measures to appropriately manage the industrial development and any potential environmental impacts. A number of key documents will be prepared (if not already) and will guide implementation of the project. This includes protection and management of an on-site conservation area and offsets associated with Carnaby's Black-Cockatoo foraging habitat.

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Appendix A: NIA Agreed Structure Plan No. 17

PREFERRED WATTLE AVENUE EAST WEST LINK TO BE FURTHER INVESTIGATED

LEGEND

- GENERAL INDUSTRIAL
- SERVICE INDUSTRIAL
- BUSINESS
- OPEN SPACE
- STRUCTURE PLAN BOUNDARY
- DISTRIBUTOR OR ARTERIAL ROADS
- MANDATORY ROAD INTERFACE TO TO OPEN SPACE
- POSSIBLE SEWER PUMP STATION SITE (NOTIONAL SIZE ONLY)

DAYRELL AVENUE
WATTLE AVENUE WEST
WATTLE AVENUE EAST
PINJAR ROAD
ORCHID ROAD
ABANDONED TIP SITE
PEDERICK ROAD
FLYNN DRIVE
AVERY STREET
TURNBULL RD
MATHER DRIVE
WARMAN STREET
TRANQUIL DRIVE
WANNEROO ROAD
NEERABUP LAKE
WANNEROO GOLF COURSE

LOT 1
LOT 4
LOT 22
LOT 53
LOT 240
LOT 5
LOT 2477
LOT 507
LOT 506
LOT 508
LOT 505

BUSHFOREVER SITE SUBJECT TO NEGOTIATION
BARBAGALLO RACEWAY
BUSHFOREVER SITE SUBJECT TO NEGOTIATION
BUSHFOREVER SITE SUBJECT TO NEGOTIATION

NEERABUP INDUSTRIAL AREA
ZONING AND LOCAL STRUCTURE PLAN

400m 200m 0m 200m 400m

NORTH

PLAN 1

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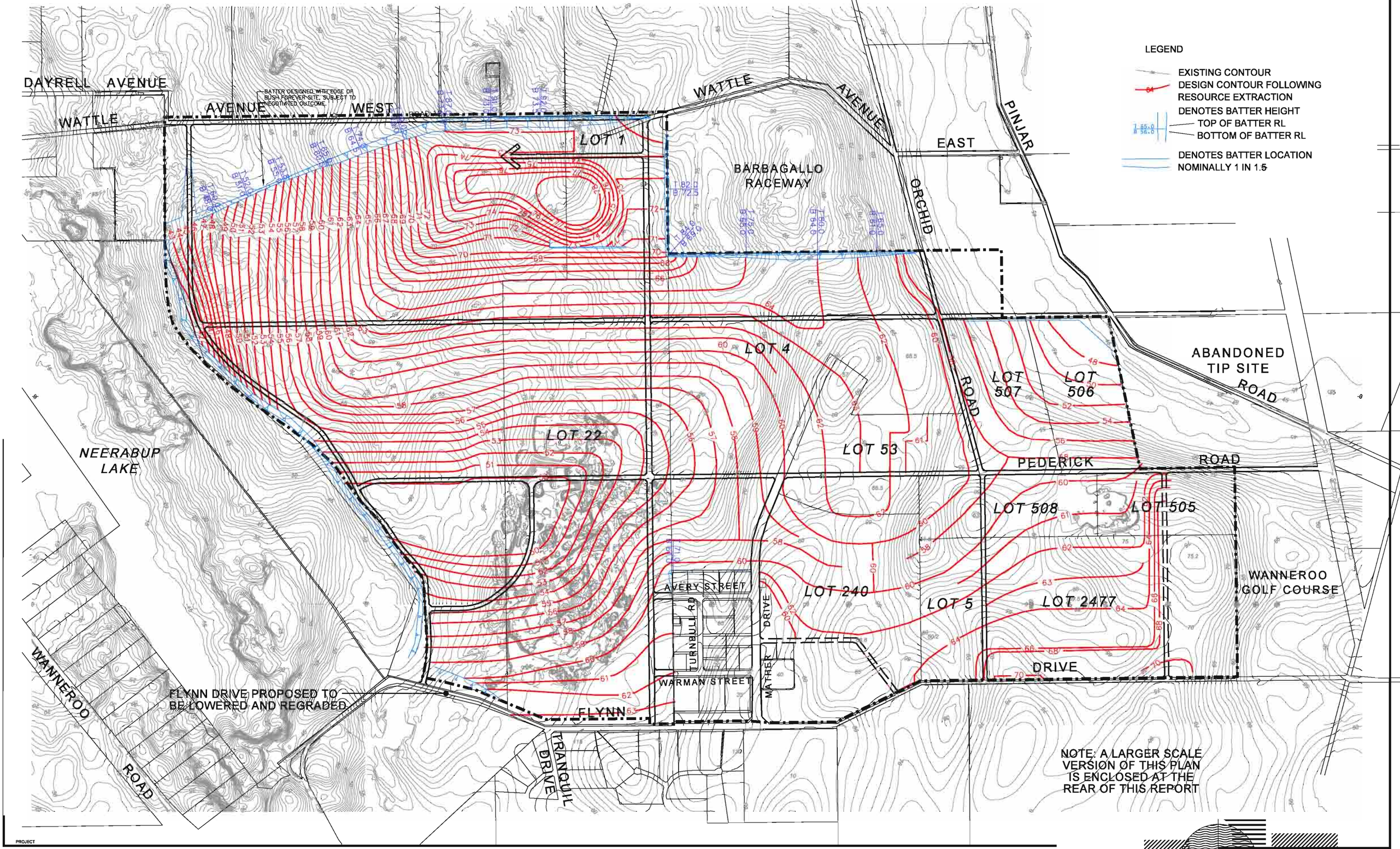

NEERABUP INDUSTRIAL AREA
FINAL SURFACE CONTOUR PLAN (SEPT 2004)

400m 200m 0m 200m 400m

NORTH

PLAN 2

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Appendix B: Ground truthing of environmental values for Lot 4 Flynn Drive (ELA 2012a)

(Contained on CD)

Appendix C: Targeted flora and fauna assessment of Lot 4 Flynn Drive (ELA 2013)

(Contained on CD)

Appendix D: Database search results

- NatureMap report
- Threatened and Priority flora database
- Threatened fauna database
- Threatened and Priority flora List
- WA Herbarium

(Contained on CD)

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