ENVIRONMENTAL PRE-REFERRAL DOCUMENT

Mining Leases M70/1088 and M70/1142
Jandakot Road, Banjup

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Mining Leases M70/1088 and M70/1142 Jandakot Road, Banjup

Prepared by:

RPS

38 Station Street, SUBIACO WA 6008

PO Box 465, SUBIACO WA 6904

T: 618 9211 1111

F: 618 9211 1122

E: environment@rpsgroup.com.au

W: rpsgroup.com.au

Prepared for:

ROCLA QUARRY PRODUCTS

130 Fauntleroy Avenue

REDCLIFFE WA 6104

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EXECUTIVE SUMMARY

Sand Extraction Proposal

Rocla Quarry Products (Rocla) is seeking approval to extract sand within Lot 467 Jandakot Road and extend an internal road through to Lot 140 Armadale Road, Banjup Figure 1). Mining leases M70/1088 and M70/1142 are located within Lot 467 and total 10.1 hectares (ha) and 28.3 ha in area (Figure 2). The Department of Mines and Petroleum (DMP) in August 2010 granted endorsement for tenements M70/1142 and M70/1088 to Rocla. The sand excavation project would initially occur with Lot 467 and involve excavating approximately in two stages over an anticipated mine life of three years.

Sand extraction has been undertaken at Rocla's adjacent mining tenement M70/357 (Lot 140 Armadale Road) since early 2000. It is proposed to create an internal access road linking mining tenement M70/1142 and M70/1088 within Lot 467 to Rocla's existing site M70/357 within Lot 140 Armadale Road.

The extracted sand will be primarily utilised by concrete plants in Perth's southern and south-eastern corridors. Historically, Rocla's and Readymix's sand extraction operations in the Jandakot region supplied the concrete plants in Canningvale, Kwinana, Armadale and Rockingham areas. However, these historically locally available sand resources are now exhausted. As a result, Rocla transports concrete sand from its Gaskell Avenue operations, located in the northern suburb of Ellenbrook 55 kilometres (km) north of Jandakot, to the southern concrete plants.

This outcome has resulted in an additional 1.76 million truck kilometres being travelled at the cost of an estimated 2,640 additional greenhouse gases being omitted. The additional greenhouse gas emissions are non-compliant with Rocla's and the state / Commonwealth's policies and objectives for minimising these emissions.

Perth's southern corridors have undergone significant expansion over the past decade, substantially driven by urban growth. The resultant outcome is a demand for concrete products (therefore concrete sand) that exceeds the regional supply, a situation which is forecast to continue. The Western Australian Planning Commission's (WAPC) Directions 2031 (WAPC, 2010) growth estimates for the south-east subregion states it will need to accommodate an additional 35,000 dwellings. Further, it is estimated that by 2031 the population of the south-west subregion will have grown by 34 per cent to 278,000.

Rocla has historically extracted priority sand resource from nearby Lot 136 Armadale Road which was leased from the then Department of Housing and Works. Sand extraction within this lease was forced to stop (without consultation or consent from Rocla) when the Department of Housing and Works offered the site to Main Roads WA as an offset to its clearing of native vegetation (including rare orchids) as part of the Roe Highway Stage 7 works. This offset of Lot 136 Armadale Road was approved by the Minister for the Environment.

Purpose of the Environmental Pre-referral Report

This document outlines the key environmental issues identified and scopes the assessment methodology.

The purpose of this document is to:

- Provide a statement of environmental effects in accordance with State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region.
- Identify the relevant environmental issues and factors raised by the sand extraction proposal.
- Identify the potential environmental impacts.
- Outline preliminary environmental management strategies that are recommended to minimise potential adverse impacts from sand extraction.

Site Context

Lot 467 Jandakot Road is located approximately 14 km to the south-east of the Perth Central Business District in the suburb of Banjup which is located within the City of Cockburn. The Jandakot Airport is situated approximately 1.5 km to the north of the lot with larger rural style lifestyle blocks, situated to the north-west and north-east, in between Lot 467 and the Airport. The areas to the south consist of mixed rural pursuits with forested tracts of bushland remaining on private lands.

Policy Context

Bush Forever and State Planning Policy 2.8

Lot 467 is within an identified Bush Forever Site (Bush Forever Site No. 390). Acknowledging the project site's importance as an identified 'Priority Resource Location' in Statement of Planning Policy 2.4, the Bush Forever Policy site recommendation is for a "Negotiated Planning Solution" (NPS).

Appendix 1 of State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region (WAPC 2010) outlines the impact assessment process. The statement of environmental effects shall include, but is not limited to, the following information requirements:

- Provide evidence and demonstrate that a proposal or decision is consistent with this policy, in particular the planning assessment criteria.
- Describe and provide a rationale and planning context for the proposal.

- Describe the impacted area's bushland values and environmental attributes (to be consistent with the information sets in Bush Forever and with reference to the site descriptions and Environmental Protection Authority Guidance Statements 51 and 56 (EPA 2003b and 2003c).

- Demonstrate that all reasonable steps have been taken to avoid or minimise any likely adverse impacts consistent with the requirements of this policy, including a review of reasonable alternatives and details of any bushland-sensitive design measures to be adopted.
- Provide an evaluation of and justification for any likely adverse impacts.

- Provide an environmental and/or bushland management plan, where appropriate, and details of proposed conservation management measures to be adopted; or, where agreed, the environmental and/or bushland management plan or related measures may be a requirement through the statutory planning process.

- Provide details of proposed long-term protection, management, offset measures and implementation commitments to be adopted.

State Planning Policy 2.4 – Basic Raw Material

The Jandakot area has been identified as a significant sand resource location that requires appropriate protection for numerous years. The mining leases M70/1088 and M70/1142 (which are located within the Jandakot area) are identified as a 'Priority Sand Resource Location' in WAPC's State Planning Policy (SPP) 2.4 "Basic Raw Material".

These identified 'Priority Sand Resource Location' are known areas of high quality sand suitable for use in the construction industry and to accommodate Perth's planned growth. Therefore the sand resource locations were identified for this purpose and should be held available for current and future extraction in accordance with SPP 2.4.

Both the 2.4 – Basic Raw Material and State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Region, which are assumed to hold equal policy weighting, provide for negotiated outcomes in areas where potential conflicts occur.

Previous Environmental Investigations and Assessment

The following environmental investigations have been undertaken on Lot 467, which were completed in order to advance the environmental approvals for mining leases M70/1088 and M70/1142:

- Fauna Survey (M.J Bamford 1996)

- Declared Rare Flora Survey (BBG 2002)

- Notice of Intent – Proposed Sand Excavation Mining Lease M70/1088 and M70/1142 (RPS 2005).

The Environmental protection Authority (EPA) considered the Notice of Intent Report did not adequately address the EPA's objectives for protection of biodiversity, particularly the protection of remnant vegetation within a Bush Forever site. The proposal was subsequently withdrawn from the EPA assessment at this time; however Rocla advised they would undertake further vegetation survey work.

In advancing the environmental approval Rocla commissioned the following additional studies:

- An additional Priority Flora search in spring 2006. No Declared Rare Flora, particularly *Caladenia huegelii* which are known to occur in the Jandakot region were found on the site.
- Level 2 Flora and Vegetation Survey and report (RPS 2010).

These subsequent investigations are intended to form part of a revised environmental approvals application.

Key Project Characteristics

Key project characteristics of the sand extraction within Lot 467 project site are summarised in Table 1.

Table 1: Lot 467 Sand Extraction Proposal – Key Characteristics

Aspect	Proposal Characteristic
Site Location	
Lot 467 Jandakot Road, Banjup	40.29 ha
Mining tenements areas ▪ M70/1088 ▪ M70/1142	 ▪ 10.1 ha ▪ 28.3 ha
Excavation	
Total Area of Sand Excavation Area	10.5 ha (less existing cleared area - 0.7 ha)
Total Estimated Amount of Sand Resource	600,000 tonnes
Life of the Project	Approximately 3 years
Dewatering Requirements	Nil
Finished levels	RL 30 m AHD
Native Vegetation to be Cleared	9.8 ha (10.5 ha less existing cleared area of 0.7 ha – Area A)
Remnant vegetation remaining with Lot 467 (outside of the sand extraction area)	Approximately 23 ha
Processing	
Sand	Dry screening of sand only
Water requirements	Nil
Infrastructure	
Fuel Storage	Nil

Aspect	Proposal Characteristic
Transport	
Internal Access Road Total Area ▪ Access road from Lot 467 to Lot 140 ▪ Access road through Lot 140 (existing cleared area)	**1.11 ha** 0.16 ha (0.10 ha will require clearing) 0.95 ha
Truck Movements	Variable but approximately 3–5 per hour
External Site Access	Existing route along Armadale Road.
Restoration Areas	
Rehabilitation Area A	0.7 ha
Rehabilitation Area B	7.05 ha
Additional Rehabilitation Area outside of the mining tenement	0.33 ha
Sub-total	**8.1 ha**
Rehabilitation of the Sand Excavation Area	9.8 ha
Total Area for Restoration	**17.9 ha**

Environment Setting

The project would be undertaken over two stages within the mining tenement. Lot 467 is within an identified Bush Forever Site (Bush Forever Site No. 390).

A summary of the key elements of the existing environment is provided below.

Soil

The sand unit at the project site include Bassendean Sands (S_8) and Bassendean Sand over Guildford Formation (S_{10}). The proposed sand extraction area is within the Bassendean Sand soil complex.

Groundwater

The site is located within a Priority 1 Source Protection Area of the Jandakot Underground Water Pollution Control Area. The estimated Average annual maximum groundwater level beneath the project site is approximately 28 metres (m) Australian Height Datum (AHD).

Wetlands

Two wetlands are located within the lease areas. The wetland to the west of lease M70/1088 is listed as a Resource Enhancement (RE) management category. The wetland to the east of M70/1142 is classified as a Conservation Category Wetland (CCW).

The western RE wetland extends over a mapped area of 45.2 ha, of which 6.4 ha is within the lease area. The eastern CCW is 6.7 ha in size and is located wholly within Lot 467 and lease M70/1142.

Neither wetland is identified under the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.

No sand excavation / mining is proposed in either of the wetlands.

Vegetation

Lot 467 is within Bush Forever Site No. 390. The vegetation was generally described for Site No. 390 as upland Banksia woodland with significant areas of wetland and associated vegetation, predominantly in the western and eastern boundaries. Much of the vegetation at the site was considered to be in "Good or better" condition, with the remainder of the site (approximately one third) considered as being in "degraded" condition.

The proposed sand extraction area occurs within two major vegetation complex units. These are:

- Southern River Complex: Open woodland of *Corymbia calophylla – Eucalyptus marginata* and *Banksia* spp with fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla*

- Bassendean Complex - Central and South: Woodland of *Eucalyptus marginata – Casuarina fraseriana – Banksia* Spp.

The majority of the vegetation at the site is mapped as part of the Southern River Complex, with the vegetation in the south-western corner mapped as part of the Bassendean Complex – Central and South.

Summary of Potential Environmental Impacts

The key potential environmental impacts of the proposal (requiring a fuller assessment than other applicable factors) are listed below according to the following headings, estuarine environment and terrestrial environment:

- flora and vegetation
- fauna
- water drainage and management
- acid sulfate soils
- revegetation.

Scope of Works

A summary of the key investigations and / or scope of works which has been or will be undertaken as part of the environmental impact assessment of the sand extraction proposal are provided below:

- Level 2 Vegetation and Flora Survey
- Desktop fauna study.

Environmental Management Strategies

The focus of the environmental management strategy is to demonstrate a net environmental benefit through the implementation of following core initiatives:

1. Retention.
2. Rehabilitation.

Retention

The sand extraction works will include buffers to the wetlands which maximise the value of the sand resource but also maintains their environmental values. Approximately 23 ha of remnant bushland will be retained within Lot 467.

Banksia Woodland Restoration

The Banksia woodland restoration will be undertaken by Rocla and Kings Park Botanical Gardens and Park Authority (BGPA) to an agreed success criteria targets. Rocla has committed to the restoration of the Banksia Woodland and monitoring of the retained conservation areas. Following completion of the sand extraction and Banksia restoration work the site will remain as a Bush Forever reserve vested for conservation purposes to the WAPC.

In partnership with BGPA, Rocla has invested over $5.6 million in research and rehabilitation techniques focused on Banksia Woodland. The research and rehabilitation works undertaken to date have provided beneficial scientific and on-ground outcomes, however, the information and knowledge gained has the potential for much broader application and environmental benefit.

Rocla are proposing to commit to a significant long-term investment in conservation and rehabilitation as part of current and future operations on the Swan Coastal Plain. Accordingly, Rocla would put together a package of conservation activities and rehabilitation approaches that will benefit the restoration of Banksia Woodland (and therefore black cockatoo habitat). Key aspects of the package are:

- a “no net loss” long term through complete rehabilitation and restoration of all sand extraction areas (or equivalent area) to a high species diversity and vegetation cover (as per scientifically derived success criteria)

- securing of restored areas or equivalent in perpetuity for conservation purposes
- should the success rates for rehabilitation not be achieved Rocla will compensate for any net loss through off site conservation offsets
- Rocla will continue to invest in a range of collaborative research projects that will further improve Banksia habitat restoration and success. This includes the continued funding of BGPA and ARC industry partnership grant. Current value of approximately $1.23 million.

Rocla will restore the Banksia Woodland on the sand excavation area, approximately 9.8 ha. Sand excavation / mining was previously undertaken with a portion of Lot 467 in the 1980s, but has been left un-rehabilitated by the previous operators. Rocla will restore on the 8.1 ha of historically mined and abandoned excavation areas within Lot 467.

The total restoration work area is 17.9 ha, therefore an additional forty per cent of additional area will be restored resulting in a net increase of Banksia vegetation within Lot 467.

Rocla Environmental Offsets

Rocla's environmental offset principles comprise "Direct Offsets" and "Contributing Offsets".

Direct Offsets directly counterbalancing the reduction of native vegetation include:

- Rocla's commitment to a 1:1 Banksia restoration to independently benchmarked completion standards audited at years 1 and 5
- a financial bank guarantee in the event Rocla does not meet the agreed benchmarked outcomes
- rehabilitation of an additional 8.1 ha of the former quarry site (resulting in an additional 40% of area being revegetated when compared to the proposed sand excavation area). The total proposed rehabilitation is 17.9 ha.

Contributing Offsets to complement and enhance the direct offsets include:

- BGPA funding of $20,000 per year until the resource is exhausted.

Key Benefits:

- The environmental offsets will provide a net gain in Banksia woodland vegetation and improve the condition of the natural environment, and Carnaby's Cockatoo habitat reinstatement.
- The environmental offsets will be clearly defined, documented and audited by an independent third party.

- The environmental offsets will ensure both a short and long-term benefit.
- BGPA will be involved in the design, assessment and monitoring of the environmental offsets.

Summary of Commitments

Clearing and Hydrology

- Clearing will be undertaken in accordance with an approved Mine Plan.
- Excavation will not impact any wetland.
- The buffer to the wetland boundary will be clearly marked and fenced to prevent access.
- A monitoring bore will be installed at the site, adjacent to the CCW to monitor groundwater levels throughout the duration of the proposed sand extraction.
- Groundwater abstraction will not be undertaken at the project site.
- The finished batters will be used to integrate the mined surface with the surrounding natural topography of the site.

Restoration

- Progressive restoration will be undertaken by BGPA following sand extraction.
- Rehabilitation of an additional 8.1 ha of the former quarry site, resulting in an additional 40% of area being restored when compared to the currently cleared area and the sand excavation area.
- Weed management will be undertaken in the restoration areas.
- Completion criteria for the Banksia woodland restoration will be to the satisfaction of the Bush Forever office and the Department of Parks and Wildlife (DPaW).

General

- Fuels and chemicals will not stored on site.
- Management measures will be undertaken to prevent and / or minimise dust and noise. This will be detailed in the Mine Plan.

Conclusion

The operation of State Planning Policy 2.4 – Basic Raw Material and the offsets proposed by Rocla are such that impacts can be satisfactorily managed, but with a positive offset ratio consistent with the EPA Position Statement where restoration criteria are not met.

Rocla is seeking **temporary use of the land**, in order to extract a resource of benefit to the community, and post-completion of the proposed sand extraction activities will revegetate the mining tenements with a net result being that a larger area of land will be revegetated than the area from which the sand resource will be removed.

There are additional sustainability benefits from the project being:

- **a reduction in greenhouse gas emissions through reduced cartage**
- **a net increase in vegetation coverage upon the mining tenements**
- **utilisation of an important sand resource.**

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1.0 INTRODUCTION

Rocla Quarry Products (Rocla) is seeking approval to extract sand within Lot 467 Jandakot Road and extend an internal road through to Lot 140 Armadale Road, Banjup Figure 1). Mining leases M70/1088 and M70/1142 are located within Lot 467 and total 10.1 hectares (ha) and 28.3 ha in area (Figure 2). The Department of Mines and Petroleum (DMP) in August 2010 granted endorsement for tenements M70/1142 and M70/1088 to Rocla. The sand excavation project would initially occur with Lot 467 and involve excavating approximately in two stages over an anticipated mine life of three years.

Sand extraction has been undertaken at Rocla's adjacent mining tenement M70/357 (Lot 140 Armadale Road) since early 2000. It is proposed to create an internal access road linking mining tenement M70/1142 and M70/1088 within Lot 467 to Rocla's existing site M70/357 within Lot 140 Armadale Road.

The DMP tenement endorsement is subject to specific conditions including environmental requirements in particular regards to mining in proximity to wetlands, removal of vegetation, permission from the Department of Water (DoW) to operate within a priority water resource area and the submission of a plan of the proposed operations and measures to safeguard the environment prior to the commencement of works.

1.1 Sand Extraction in the Jandakot Region

Sand is used for the construction industry as both concrete sands and fill sand. Whilst sand is very common, much of the sand on the Swan Coastal Plain is less suitable for concrete production, because of its non-ideal grain size and degree of rounding. In addition the majority of the Swan Coastal Plain has now been sterilised for urban development, rural living subdivisions and the various Conservation Estates. This has led to a situation where there are few sand resources suitable for concrete production within the Perth Metropolitan Region.

It is important to note that sand is only extracted for the community. If the community did not need the sand there would be no extraction. Almost all sand is used on public works projects and for structural works, such as footings, structural walls in subdivisions and for building materials.

The sand proposed to be extracted from Lot 467 Jandakot Road, Banjup will be primarily utilised by concrete plants in Perth's southern and south-eastern growth corridors. Historically, Rocla's and Readymix's sand extraction operations in the Jandakot region supplied the concrete plants in the Canningvale, Kwinana, Armadale and Rockingham areas. However, these historically locally available sand resources are now exhausted. As a result, Rocla transports concrete sand from its Gaskell Avenue

operations, located in the northern suburb of Ellenbrook 55 km north of Jandakot, to the southern concrete plants. This outcome has resulted in an additional 1.76 million truck kilometres being travelled at the cost of an estimated 2,640 additional greenhouse gases being omitted.

Perth's southern corridors have undergone significant expansion over the past decade, substantially driven by urban growth. The resultant outcome is a demand for concrete products (therefore concrete sand) that exceeds the regional supply, a situation which is forecast to continue. The Western Australian Planning Commission's (WAPC) Directions 2031 (WAPC 2010) growth estimates for the south-east subregion states it will need to accommodate an additional 35,000 dwellings. Further, it is estimated that by 2031 the population of the south-west subregion will have grown by 34% to 278,000.

The Jandakot area has been identified as a significant sand resource location that requires appropriate protection for numerous years. The mining leases M70/1088 and M70/1142 (which are located with the Jandakot area) are identified as a "Priority Sand Resource Location" in WAPC's State Planning Policy (SPP) 2.4 "Basic Raw Material".

These identified "Priority Sand Resource Location" are known areas of high quality sand suitable for use in the construction industry and to accommodate Perth's planned growth. Therefore the sand resource locations were identified for this purpose and should be held available for current and future extraction in accordance with SPP 2.4.

Rocla was previously extracting sand from the adjacent Lot 136 Armadale Road which was leased from the then Department of Housing and Works. Sand extraction within this lease was forced to stop (without consultation or consent from Rocla) when the Department of Housing and Works offer the site to Main Roads WA as an offset to its clearing of native vegetation (including rare orchids) as part of the Row Highway Stage 7 works. This offset of Lot 136 Armadale Road was approved by the Minister for the Environment.

1.2 Sand Extraction Proposal

This proposal is to enable Rocla to extract sand from Lot 467 which is a listed "Priority Sand Resource Location" under SPP 2.4.

The objectives of SPP 2.4 policy are to:

- Identify the location and extent of known basic raw material resources.
- Protect 'Priority Resource' locations, key extraction areas and extraction areas from being developed for incompatible land uses which could limit future exploitation.

- Ensure that the use and development of land for the extraction of basic raw materials does not adversely affect the environment or amenity in the locality of the operation during or after extraction.

- Provide a consistent planning approval process for extractive industry proposals including the early consideration of sequential land uses (WAPC 2000).

Lot 467 is vested in the Western Australian Police Department (WAPD). Rocla has been granted approval by WAPD to extract sand within the mining tenement M70/1142 and M70/1088. The holders of the mining tenement M70/1088 have assigned Power of Attorney to Rocla.

This proposal aims to enable Rocla to meet their continued production requirements whilst strategically facilitating the staged use of sand resources for concrete production in the Jandakot area to supply Perth's southern and south-eastern growth corridors in order to satisfy long term community demand.

1.3 Proposal Overview

The sand extraction proposal within Lot 467 consists of two stages. Excavation is proposed to commence in Stage 1 and continue into Stage 2. Rocla will clear approximately 9.8 ha of native vegetation on a staged basis for the following reasons:

- there are obvious environmental benefits arising from progressive clearing including maximum time retention of habitat for regionally significant fauna that exist in the area, most notably the Carnaby's Cockatoo

- the proposed regeneration project will result in staged replacement of habitat that can be aligned to the progressive clearing

- progressive clearing will allow for the orderly and manageable salvage of topsoil, mulch, plant material and seed collection to align with the regeneration project

- to negate the requirement of watering of and fire risks associated with large mulch stockpiles.

Rocla will initially will harvest native Banksia spp and Mari seeds (and use topsoil if available) and focus the first phase of rehabilitation on previously mined areas, commencing within Area B. Area B is a 7.05 ha cleared open area. Rocla proposes to commence the rehabilitation of this area in advance of the proposed clearing and sand extraction. This outcome will assist both in restoring native vegetation to a cleared area (a net environmental benefit) but also with dust control. Rocla has also proposed to undertake an additional 0.33 ha rehabilitation outside of the mining tenement.

At the completion of each stage Kings Park Botanical Gardens and Parks Authority (BGPA) would commence the restoration of Banksia Woodland.

The sand extraction project time frame is three years. The Banksia Woodland restoration work would continue five years post-sand extraction work.

Sand extraction has been undertaken at Rocla's adjacent mining tenement M70/357 (Lot 4 Armadale Road) since early 2000. It is proposed to create an access road linking mining tenement M70/1142 and M70/1088 within Lot 467 to Rocla's existing site M70/357 – Armadale Road Operations.

Lot 467 would be used for sand extraction only. Sand is to be screened on site using a mobile screening plant. Trucks will be loaded with the screened sand for transport to the southern area concrete plants. No additional processing is proposed. No additional processing or operations is proposed.
Approved infrastructure currently in use at Rocla's existing Lot 4 Armadale Road operation would be utilised to minimise sand extraction footprint within Lot 467.

The summary of the key project characteristics are detailed in Table 1 in the Executive Summary.

1.4 Background and Previous Environmental Assessments

Lot 467 was previously mined for sand by another operator in the 1980s. The previous operator did not undertake any rehabilitation of their sand extraction area. This has resulted in a legacy of a two cleared sites (north and south of Lot 467) totalling 8 ha (Figure 2).

A Notice of Intent was prepared for Lot 467 Jandakot Road (M70/1088 and M70/1142) in 2005, and submitted to the then Department of Industry and Resources. The sand extraction proposal was innovative and included the mining of the cleared and approximately 9.8 ha of vegetated areas to the water table and rehabilitating the site as wetlands. The Notice of Intent report was forwarded by the Department of Industry and Resources to the EPA for comment.

The EPA advised based upon its initial review to set a level of assessment, it would recommend the level be set at "Proposal Unlikely to be Environmentally Acceptable". This was primarily due to the Lot 467 inclusion in Bush Forever (Bush Forever site 390). Based on this advice from the EPA, Rocla withdrew the referral at this time and advised they would undertake further vegetation survey work.

1.5 Project Need and Justification

The mining tenements M70/1142 and M70/1088 are located within an identified "Priority Sand Resource Location" under SPP 2.4.

Historically locally available sand resources are now exhausted. Perth's southern and south-eastern corridors are undergoing significant growth. This has resulted in a significant increase in the demand for concrete sand.

1.6 Purpose of this Document

This document outlines the key environmental issues identified and scopes the assessment methodology.

The purpose of this document is to:

- Provide a statement of environmental effects in accordance with State Planning Policy 2.8 - Bushland Policy for the Perth Metropolitan Region.
- Identify the relevant environmental issues and factors raised by the sand extraction proposal.
- Identify the potential environmental impacts.
- Outline preliminary environmental management strategies that are recommended to minimise potential adverse impacts.

1.7 Identification of the Proponent

Rocla have mined high grade sand resources from Western Australia since the early 1980s and has built up a significant enterprise providing a range of sand products to the construction industry.

Rocla is an industry leader in basic raw materials extraction and in Western Australia is particularly well known for their sand operations within the Gnangara Pine Plantation at Gaskell Road. In that operation Rocla works closely with the Forests Products Commission and the DPaW to ensure that the pine resource is utilised and that the land is returned to local native vegetation in line with Government Policy for the Gnangara Groundwater Mound. An essential part of the soil restoration and rehabilitation to native vegetation is working with Kings Park to achieve best industry outcomes.

The establishment of this sand mine site in Banjup will create a southern Perth operation, in particular servicing the urban and industrial areas of the Canning Vale, Kwinana, Armadale and Byford and will facilitate the long-term supply of high quality sand for Perth's continued expansion of its southern and south-eastern corridors and related construction industries.

The key Rocla contact is detailed below:

Contact Person:	Vern Newton
Position:	Resource and Development Manager
Phone:	(08) 9475 2500
Fax:	(08) 9477 2633

2.0 ENVIRONMENTAL ASSESSMENT PROCESS

2.1 Western Australia

2.1.1 Western Australian Legislation

The *Environmental Protection Act 1986* (EP Act) specifies some of the procedures for assessment, including responsibilities and functions of the Minister and appeal processes. It also provides for the preparation of environmental protection policies, which are legally binding and may be directly relevant to the assessment of the proposed project. The EP Act is the most important legal document for environmental assessment in Western Australia and prevails over other legislation. During the assessment process, the proponent and stakeholders must comply with the EP Act.

The EP Act establishes the EPA and lists its functions. One such function is to conduct environmental impact assessments. Under Part IV of the EP Act, the EPA is required to decide whether to assess the proposed project, which has been referred to the EPA under s38 of the Act. The EP Act regulates:

- pollution and environmental harm offences
- clearing of native vegetation
- prescribed premises
- works approvals and licences
- assessment of flora, fauna, wetlands, Aboriginal heritage and other environmental factors.

2.2 Commonwealth Legislation

2.2.1 *Environment Protection and Biodiversity Conservation Act 1999*

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

2.3 Other Regulatory Requirements

Regulatory requirements relevant or potentially relevant to the proposed project are presented in Table 2.

Table 2: Applicable Legislation

Legislation	Requirements
Commonwealth	
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	Protects significant Aboriginal areas and objects considered to hold particular significance in accordance with Aboriginal tradition.
Environment Protection and Biodiversity Conservation Act 1999	Enables legislation for protection of migratory species under international agreements and other matters of national environmental significance.
National Greenhouse and Energy Reporting Act 2007	Mandatory reporting and dissemination of information about greenhouse gas emissions and energy use.
Native Title Act 1993	Recognises and protects native title and provides for land use agreements.
State	
Aboriginal Heritage Act 1972	Provides a mechanism for recognising Aboriginal Heritage and considering the impacts of developments on Aboriginal Heritage values. Requires submission of a request for Section 18 consent to disturb registered sites that cannot be avoided.
Land Administration Act 1997	Governs the administration of state land in Western Australia.
Rights in Water and Irrigation Act 1914	Provides for planning and allocation of water in Western Australia.
Wildlife Conservation Act 1950	Provides for the conservation and legal protection of threatened flora and fauna, especially rare species.
Heritage of Western Australia Act 1990	Provides for the conservation of places of significance to the cultural heritage of the state.
Metropolitan Water Authority Act 1982	Regulates drainage, water supply and sewerage.
Water and Rivers Commission Act 1995	Provides for the conservation, protection and management of state water resources.
Planning and Development Act 2005	Provides for the preparation and amendment of local and regional planning schemes, interim development orders and state planning policies.

The EPA and other decision making authorities issue guidance and policy statements that are also relevant to the environmental factors associated with this project and will be considered within the context of the proposed project. These are provided in Table 3.

Table 3: Relevant Policy and Guidance Policies

Policies
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992
Bush Forever and Statement of Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region (draft) (WAPC 2004a).
Environmental Protection (Swan Coastal Lakes) Policy, 1992
Guidance Statement
Guidance Statement 6: Rehabilitation of terrestrial ecosystems (EPA 2006)
Guidance Statement 12: Minimising greenhouse gas emissions
Guidance Statement 19: Environmental Offsets
Guidance Statement 51: Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia
Guidance Statement 54a: Sampling methods and survey considerations for subterranean fauna in Western Australia
Guidance Statement 56: Terrestrial fauna surveys for environmental impact assessment in Western Australia
Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes, May 2009
Draft Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes, January 2009
National Environment Protection Measure standards for ambient air quality
Carbon Pollution Reduction Scheme, Commonwealth Department of Climate Change

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3.0 SAND EXTRACTION PROPOSAL

The site contains deposits of Bassendean Sand which is suitable for use as construction and fill sand. Extraction of sand at this site will facilitate the continued supply of specialised sand for concrete products and engineering fill for projects in the Perth's southern and south-eastern corridors. It is estimated that there is approximately 600,000 tonnes of sand available for excavation within the 10.5 ha excavation area which will support mining for an estimated three years.

Land based sand extraction involves a sequence of operations as follows:

1. Vegetation clearing.
2. Topsoil removal.
3. Extraction operations.
4. Distribution.
5. Rehabilitation.

3.1 Project Description

3.1.1 Pre-excavation Works

Native vegetation clearing and topsoil removal will be conducted in stages as the excavation progresses. It is estimated under Stage 1 that 6 ha over 12 months will be cleared with 3 to 4 ha cleared annually thereafter under Stage 2.

All clearing will be conducted using a tracavator. The topsoil removed from cleared areas will be retained for use in the rehabilitation program. The topsoil will be stockpiled in an appropriate area on site or directly transferred to the completed excavation stage for rehabilitation works. The first section of topsoil will be recovered allowing for the best seed retention at a later date. This technique will utilise the best available research into *Banksia* re-establishment that Rocla has been conducting in partnership with the (Kings Park) BGPA since 1994.

3.1.2 Excavation Method

Sand will be mined from the excavation area in a staged program. The excavation process will be undertaken on a staged basis with rehabilitation commencing post-completion of each stage which reduces the exposed areas and minimises any areas where water may potentially pond. The extraction pit will be designed to maintain a buffer of greater than 2 m between the maximum depth of extraction and the maximum height of the water table. The open extent will be restricted to the staged area anticipated to be mined over the next twelve months, which is estimated to be approximately 6 ha. Following extraction in one stage, the next mined stage will be cleared and the previous cell rehabilitated back to *Banksia spp – Eucalyptus marginata*

woodlands. At this rate, it is estimated that the site will support mining for an estimated three years.

The sequence in the extraction of sand from the site is outlined below:

1. Excavation will commence on the south-eastern edge of the ridge and move westwards on a staged basis.

2. Prior to excavation, vegetation will be cleared, topsoil will be removed using a landplane and stored for use in rehabilitation, or directly transferred to a rehabilitation site.

3. Overburden will be removed and stored for future land rehabilitation through backfill and placement.

4. The sand resource is typically screened using a portable screening plant to remove any organic material and stockpiled prior to tipping directly into road trucks for transportation to stockpile areas.

5. Reforming of the land is normally carried out using a bulldozer.

6. Topsoil will be replaced between 50 mm and 100 mm using a land plane.

7. On completion, the land surface will be graded to ensure the final slopes will not exceed 1 in 3 horizontal to vertical.

8. Rehabilitation will progressively follow excavation wherever possible.

3.1.3 Finished Levels

Excavation proposes to lower natural surface topography following the east–west ridgeline by between 20 m to 2 m to a finished floor level of approximately 30 m Australian Height Datum (AHD). The floor level is above the 2 m separation required between the finished levels and the average annual maximum water table (AAMGL). To achieve the proposed excavation levels each stage will require a sufficiently large footprint to enable internal roads at suitable grades to ensure an efficient and safe excavation operation.

In accordance with the *Mines Safety and Inspection Act 1994* the final profile of the batters / faces used to integrate mined surfaces with the natural remaining topography of the site, equates to the final batters being 1 in 3 vertical to horizontal or less.

Working batters on the mine face will be left in a slumped condition at the end of each day and over weekends for safety.

3.1.4 Hours of Operation

Hours of operation will be from 7.00 am to 5.00 pm Monday to Saturday inclusive.

The flexibility of a six day week operation is necessary to maintain efficiency because not all parts of the site can be excavated at all times of the year. Although the sand will be transported throughout the year, excavation will be discontinuous and dependent upon the demand for this particular sand type, and to avoid very wet conditions. It is more efficient to excavate sand material to produce on-site stockpiles from which sand can be transported in the intervening times as this maximises the use of mobile plant equipment.

3.2 Infrastructure and Access

3.2.1 Haulage

An internal access road will be created to link Rocla's existing within Lot 140 Armadale Road with the adjacent Lot 467 sand extraction area. The road will be completely with Rocla's mining lease areas. The access road will not be located within any wetland areas.

Figure 2 illustrates the proposed location of the internal access road. Between Lot 467 and Lot 140 the access road has been deliberately sited, where practical, along an existing cleared track to minimise impact on the vegetation. The proposed access road between Lots 467 and 140 is 0.16 ha in total with 0.10 ha native vegetation to be cleared.

The internal access road through Lot 140 to Armadale Road is through historically cleared areas.

The number of trucks entering the site will vary throughout the year depending upon the demand for the sand resource. However, it is anticipated that between two to four trucks per hour will access the site per day. Truck payload size will vary depending whether they are semitrailers or rigid wheeler trucks. Trucks will only be entering and exiting the site between the hours of 7.00 am and 5.00 pm.

The main haulage route is anticipated to be along Armadale Road which is listed as a heavy vehicle route, with a maximum load of 87.5 tonnes and a maximum length of vehicle of 27.5 m.

3.2.2 Site Infrastructure

Sand extracted from Lot 467 mining lease M70/1088 and M70/1142 will be screened on site prior to sale. No additional processing is undertaken on site.

Site infrastructure will not be located with Lot 467. The extraction operations will make use of the existing adjacent facilities at Rocla's Armadale Road sand operations within the neighbouring Lot 140. The site infrastructure at Rocla's Armadale Road operations include:

- transportable site office
- weighbridge
- vehicle/equipment compound
- toilet
- refuelling facility (5000 litre (maximum) self bunded diesel above ground tank).

3.3 Safety

3.3.1 Operations

All excavation, mining practices and operations procedures will comply with the following legislation:

- *Mines Safety and Inspection Act 1994*
- Mines Safety and Inspections Regulations 1995
- *Occupational Health and Safety Act 1984*
- Occupational Health and Safety Regulations 1996
- Shire of Serpentine–Jarrahdale Extractive Industry Local Law 1999.

Rocla has developed procedures and work practices to manage safety, environmental impact, site management and rehabilitation. All personnel are trained to industry standards. All personnel are provided with site induction, safety and environmental awareness training. All workers are required to wear full-time protective safety and high visibility work gear when on site.

3.3.2 Signage

Rocla will place a sign not less than 1.8 m high and not less than 1 m wide which states "Danger Excavations Keep Out".

The signs will also indicate operation hours and contact details of the site manager.

4.0 ENVIRONMENTAL SETTING

Investigations have been conducted to identify the local and regional environmental features and values of the project site.

This section presents the existing conditions of the physical, biophysical and social environments, as well as cultural heritage values represented within the project area.

The main features within the project area include:

- wetlands
- groundwater
- vegetation
- fauna
- Aboriginal heritage.

4.1 Study Area

4.1.1 Climate

The Jandakot area experiences a Mediterranean climate, which predominates in the south-west of Western Australia, and is characterised by cool wet winters and hot dry summers. Average maximum and minimum temperatures in the summer season (October– March) range from 22 °C to 31 °C and 9 °C to 18 °C respectively. In the winter months, maximum and minimum temperatures range from 18 °C to 25 °C and 7 °C to 12 °C respectively (BOM 2010).

4.1.2 Topography

The site has a central ridge line located in the middle of Lot 467 and runs north-east with a maximum elevation of approximately 38 m AHD. The land falls in the west and east direction towards the wetlands (abutting the eastern and western boundary) to a height of approximately 30 m AHD (Figure 4).

4.1.3 Geology and Soils

The Jandakot area is underlain by Bassendean Sands derived from the Bassendean Dune System. Bassendean dunes are characterised as pale grey, white, medium grained, moderately sorted quartz sand with little or no calcium carbonate content. Bassendean dunes (located in the eastern portion of the project area) tend to be acidic, highly leached and nutrient poor (Bolland 1999).

4.1.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) is a collective term used to describe naturally occurring soils and sediments containing iron sulfides. These soils typically form in wet and oxygen limited horizons such as those found around wetlands. When ASS are exposed to air, the iron sulphides may react with oxygen and water to produce a variety of iron compounds and sulphuric acid. Initially a chemical reaction, the process is accelerated by soil bacteria. The resulting acid can cause environmental damage on its own, but can also leach substances (i.e. heavy metals) from the soil, which may in turn be released into surrounding water environments.

The Lot 467 sand excavation area is mapped as a 'moderate to low' risk classifications for potential ASS occurring (Figure 5). The proposed excavation area is set within soils of predominantly aeolian origins. The presence of ASS materials is expected to be limited to the low-lying alluvial wetland area excluded from the extraction area.

As the soil extraction operations are not proposed to breach a 2 m vertical buffer between excavations and the water table, and no dewatering is proposed, the oxidative effects of groundwater level modification can be discounted, and the risk of acid generation would hence be considered low, as all soils above the water table would potentially already have been exposed to oxidative effects.

It is important to note that these wetland feature will have a buffer from soil extraction operations, wetlands which maximise the value of the sand resource but also maintains their environmental values.

4.1.5 Groundwater

The estimated average annual maximum groundwater level beneath the site is 28 m ADH. Based upon the regional groundwater contour data, the groundwater flow is south-east from the site. The 2007 Perth Groundwater Atlas indicates that groundwater beneath the site migrates in a south to south-east direction (DoW 2009).

Lot 467 is located within the Priority 1 Jandakot Underground Water Pollution Control Area (UWPCA). Sand extraction within the UWPCA must be in accordance with Statewide Policy No 1 – Policy and Guidelines and Silica Mining in Public Water Source Areas (WRC 1999).

4.1.5.1 Groundwater Separation

The maximum depth of soil extraction activities will not exceed a minimum 2 m vertical buffer distance from the water table, which is consistent with Rocla's adjacent mining tenement M70/357 within Lot 140 Armadale Road. The basis of the 2 m separation distance is premised upon the separation distance that was applied to Rocla's Gaskell Avenue Operations in Lexia. Rolca's Gaskell Avenue Operations were the subject of a Public Environmental Review (PER). As a result of the PER the Minister for Environment issued a statement stating that the proposal may be implemented (pursuant to the

provisions of the *Environmental Protection Act 1986*) subject to conditions. The issue of water management were carefully considered during the assessment of the proposal as the project area was located above an important groundwater resource.

Condition 1 from the Ministerial Statement indicates that the proposal must fulfil the commitment given for environmental management. The environmental management commitments relating to the management of groundwater were as follows:

- Detailed "Working Arrangements" will be prepared in conjunction with CALM which will define management techniques to be adhered to during the mining operation. These will include rehabilitation of excavated pits. Plans for rehabilitation trials are already in progress and there is on-going discussion with CALM personnel.

- In general terms the objectives of the rehabilitation program will be

  – stabilisation of the surface sand against erosion

  – minimisation of disturbance to the hydrological balance within the proposed lease area and adjacent land

  – establishment of a diverse, effective and permanent vegetation cover capable of plant succession and regeneration to suit the present priority land use of water production.

- Conduct routine monitoring of groundwater levels and report results to the Water Authority of Western Australia on a regular basis

Water Quality Protection Note "Extractive Industries within Public Drinking Water Source Areas" (WRC 2000) states that in Priority 1 source protection areas:

> …the Commission requires a minimum of 3 metres of undisturbed soil / rock profile as a buffer between the base level of the excavated area and the maximum anticipated water table. In special circumstances, this buffer may be reduced to a minimum of 2 metres, if the operator can demonstrate effective risk management measures and acceptable rehabilitation to a final 3 metre buffer.

Rocla has extensive experience mining in Priority Groundwater Protection Areas with major sand extraction sites located in Gnangara (Priority 1 Source Protection Area) and Banjup (Priority 2 Source Protection Area).

The DEC annually audits operations at the Gnangara site and no groundwater related issues have been identified. Rocla will take all precautions necessary to ensure groundwater is not adversely impacted by extraction operations.

Rocla are committed to the following:

- survey control of quarry floor to ensure accurate recording of separation distance
- monthly monitoring of the groundwater via piezometer
- staged rehabilitation program.

These key commitments are characteristic of the DEC reporting requirements for Rocla's sand extraction operations within Priority Water Source Protection Areas. Additionally it is important to note that any refuelling will occur off site, at the existing facility, on the adjacent Rocla mining tenement M70/357.

4.1.5.2 Surface Drainage

Drainage on the site is towards the wetlands in the east and west of the site. Water run-off from incident rainfall percolates through the highly permeable sandy soils within the site. No direct drainage to the southern wetlands will occur by way of a defined channel.

4.1.6 Wetlands

A search of DEC's Geomorphic Wetlands Database (Landgate 2009) indicates that the majority of the site is not classified as a wetland. However, two wetlands are mapped by the DEC within Lot 467 (Figure 5). The wetland on the eastern edge of lease M70/1088 is listed as a Resource Enhancement (RE) management category. The wetland on the eastern side of M70/1142 is classified as a Conservation Category Wetland (CCW). The wetland categories and their respective management objectives are presented in Table 4.

Table 4: DEC Wetland Management Categories

Management Category	General Description	Management Objectives	No. of Wetlands for this Site
Conservation	Wetlands support a high level of ecological attributes and functions.	Highest priority wetlands. Objective is preservation of wetland attributes and functions through various mechanisms including: ▪ reservation in national parks, crown reserves and state-owned land ▪ protection under Environmental Protection Policies ▪ wetland covenanting by landowners. These are the most valuable wetlands and WRC will oppose any activity that may lead to further loss or degradation. No development.	1
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. Ultimate objective is for management, restoration and protection towards improving their conservation value. These wetlands have the potential to be restored to conservation category. This can be achieved by restoring wetland structure, function and biodiversity. Protection is recommended through a number of mechanisms.	1

Management Category	General Description	Management Objectives	No. of Wetlands for this Site
Multiple Use	Wetlands with few important ecological attributes and functions remaining.	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through land care. Should be considered in strategic planning (e.g. drainage, town/land use planning).	0

Source: adapted from Water and Rivers Commission, 2001

It is acknowledged in the Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005) that separation distances for both RE and CCW wetlands and management measures are recommended on the basis of potential threats in order to mitigate likely impacts of the surrounding land use. Separation measures are required to mitigate only those threats that are present.

A buffer from both the RE and the CC wetlands which maximise the value of the sand resource but also maintains their environmental values will be implemented.

4.1.7 Vegetation and Flora

A Level 2 Flora and Vegetation Survey was undertaken in spring 2010 to identify the type and condition of the vegetation present in the project area (Appendix 2).

4.1.7.1 Objectives

The specific objectives of the 2010 spring flora and vegetation survey were to:

- Identify all vascular plant species present within the survey area.
- Review the conservation status of the vascular plant species by reference to current literature and current listings by the Department of Environment and Conservation (2006a and 2006b) and the Department of the Environment and Heritage website under the EPBC Act 1999.
- Compare the plant communities at each site with those defined by Gibson et al. (1994) to aid in assessing their local and regional significance.
- Produce a report summarising the findings.

4.1.7.2 Methods

The proposed mining area was surveyed for rare and priority flora in October 2010. Additional searching for rare orchid species was undertaken by Arthur Weston in 2006.

No rare flora e.g. orchids were identified by either investigation.

All plant specimens collected during the field survey were handled and identified in accordance with the requirements of the Western Australian Herbarium. Where necessary, specimens were compared with pressed specimens housed at the Western Australian Herbarium, and plant taxonomists with specialist skills were consulted. Nomenclature of recorded species follows that recommended by the Western Australian Herbarium and Department of Parks and Wildlife (2006b and 2006c).

4.1.7.3 Heddle Mapping

The majority of the proposed sand extraction area within Lot 467 is located in the Southern River Vegetation Complex with areas in close proximity to the wetland located within the Bassendean – Central and South vegetation complex. The Southern River Vegetation and Bassendean – Central and South Complexes as defined by Heddle are outlined below:

- an open woodland of Marri-Jarrah-Banksia on the elevated areas and a fringing woodland of *E. rudis-M. rhaphiophylla* along the streams' (Heddle et al. 1980)

- woodland of Jarrah-Sheoak-Banksia on the sand dunes to a low woodland of *Melaleuca* spp. and sedgelands on the low-lying depressions and swamps (Heddle et al. 1980).

Two areas (Areas A and B in Figure 2) within Lot 467 was historically cleared of vegetation in the 1980s to facilitate sand extraction. Post sand extraction these areas were left in an un-rehabilitated (cleared) state by the previous owner. The extent of the cleared (former mine) areas A and B is approximately 8.1 ha.

4.1.7.4 Threatened and Priority Flora

Threatened Flora (TF) are flora that have been adequately surveyed and are considered to be in danger of extinction, rare or otherwise in need of special protection within Western Australia. TF are protected under the *Wildlife Conservation Act 1950* (as amended).

Additionally in Western Australia there are four categories of Priority Flora, which are not specifically covered under current legislation, but their conservation status warrants some protection. Three categories of Priority Flora are allocated to species that are poorly known (Priority 1 to 3). These require more information to be assessed for inclusion as TF. The categories are arranged to give an indication of the priority for undertaking further surveys based on the number of known sites, and the degree of threat to those populations. A fourth category of "Priority" (Priority 4) is included for those species that have been adequately surveyed and are considered to be rare but not currently threatened.

No Threatened or Priority Flora species were identified as occurring within the sand extraction or surrounding area.

4.1.7.5 Regional Significance and Species of Interest

The EPA (2004) in Guidance Statement 51 stated that species, subspecies, varieties, hybrids and ecotypes may be significant other than as Threatened or Priority Flora, for a variety of reasons, including:

- "a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species
- relic status
- anomalous features that indicate a potential new discovery
- being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- the presence of restricted subspecies, varieties, or naturally occurring hybrids
- local endemism / a restricted distribution
- being poorly reserved".

Two plant species considered to have regional significance, *Hensmania turbinata* and *Pultenaea ochreata*, were identified as occurring within the survey area by the Level 2 Flora and Vegetation survey undertaken in spring 2010.

Two taxa, *Leucopogon* sp. Murdoch (M. Hislop 1037) and *Hibbertia huegelii sens. lat.* recorded in the spring 2010 survey can be considered to be "Species of Interest". Further information regarding these two species is contained in Appendix 2.

4.1.7.6 Threatened and Priority Ecological Communities

Communities are described as "Threatened Ecological Communities" (TECs) if they have been defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee and found to be Presumed Totally Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). For definitions of TEC categories and criteria refer to English and Blyth (1997) and DEC (2006c). Selected plant communities have also been listed as "Threatened Ecological Communities" under the EPBC Act. The TECs at the national level are defined on the Environment Australia website (www.deh.gov.au).

Possible TECs that do not meet survey criteria or that are not adequately defined are added to Department of Environment and Conservation's Priority Ecological Community List under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation

status, so that consideration can be given to their declaration as TECs. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened (P1, 2 or 3), or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5.

No Threatened or Priority Ecological Communities were identified as occurring within the survey area by the Level 2 Flora and Vegetation Survey undertaken in spring 2010. One identified vegetation unit, *Banksia ilicifolia* woodlands, was shown to have some affinity with Floristic Community Type No. 22, which is a Priority 2 Ecological Community.

4.1.7.7 Bush Forever

Bush Forever is a 10 year strategic plan which formally commence in 2000 to protect approximately 51,200 ha of regionally significant bushland within around 290 Bush Forever sites, representing, where achievable, a target of at least 10 per cent of each of the original 26 vegetation complexes of the Swan Coastal Plain portion of the Perth Metropolitan Region (WAPC 2000).

The proposed sand extraction area is within Bush Forever Site No. 390, as shown in Figure 3.

4.1.8 Terrestrial Fauna

4.1.8.1 Previous Biological Studies

As a result of recent development in the areas surrounding Jandakot Airport, several surveys have been undertaken in the vicinity of the current project area. The most recent of these are:

- Fiona Stanley Hospital Fauna Assessment (GHD 2006)
- Roe Highway Stage 7 Extension Review of Fauna Investigations (Bamford 2003b)
- Champion Lakes Master Plan Fauna (Bamford 2003a)
- Fauna Survey of Jandakot Airport (Bamford 2002)
- Vertebrate Fauna of Ken Hurst Park (Dell & Cooper 1992).

4.1.8.2 Expected Fauna

Species are protected formally and informally by various legislative and non-legislative measures, which are as follows:

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Wildlife Conservation Act 1950*
- *Environmental Protection Act 1986*
- DEC Priority lists

- informal recognition of locally significant populations.

Commonwealth - Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect matters of national environmental significance.

Under the EPBC Act, lists threatened species and Threatened Ecological Communities in certain categories determined by criteria set out in the Act (www.environment.gov.au/epbc/index.html).

The Act provides for substantial penalties for any unauthorised actions likely to adversely affect matters of national environmental significance. It also provides for a national environmental assessment and approvals process for proposed actions likely to affect the prescribed matters of national environmental significance. If a proposed action is approved subject to certain conditions, the proponent of the action does not contravene the Act if the action is carried out in accordance with the conditions imposed.

State

Taxa under the provisions of the *Wildlife Conservation Act 1950* (WC Act) as protected and are classified as Schedule 1–Schedule 4 according to their need for protection The Act makes it an offence to "take" threatened species without an appropriate license. There are financial penalties for contravening the Act.

Fauna Priority Lists

The DEC produces a list of 'Priority' species that have not been assigned statutory protection under the WC Act. Priority Fauna are under consideration as 'scheduled' fauna, but are in urgent need for further survey or require regular monitoring, and although not currently threatened may become so in the future.

4.1.8.3 Potentially Occurring Fauna

Species of conservation importance that potentially occur in the project area is discussed in the following section.

Mammals

1. The Chuditch (Western Quoll) (*Dasyurus geoffroii*) is listed as Vulnerable under the EPBC Act and as a Schedule 1 species under the WC Act. This species once occurred over 70% of Australia, but it has been reduced to a patchy distribution throughout the Jarrah and mixed forests of the south-west of Western Australia (DEC 2008a). The Chuditch is found in a wide range of habitats, including woodlands, dry sclerophyll forests and riparian vegetation that contain hollow bearing trees and logs. Numbers have decreased because of habitat alteration,

removal of suitable den logs and dens, and competition for food and predation by foxes and cats (DEC 2008a). Considering the current distribution of the species, the urban nature of the site, and the presence of foxes and cats on the site, it is unlikely this species occurs within Lot 467.

2. The Wambenger (Southern Brush-tailed Phascogale) (*Phascogale tapoatafa*) is listed as Schedule 1 under the WC Act. The distribution of this species is believed to have been reduced to approximately 50% of its former range (DEC 2008a).This subspecies has been observed in dry sclerophyll forests and open woodlands containing hollow-bearing trees but a sparse ground cover. Habitat destruction, the loss of hollow-bearing trees and predation by feral animals are thought to be the major threats to surviving populations (DEC 2008a). None have previously been found in the area, and none are known from within approximately 10 km of the site from WA Museum records. Therefore it is unlikely that the Wambenger occurs at the site.

3. The Quokka (*Setonix brachyurus*) is listed as Vulnerable on the EPBC Act and as Schedule 1 by the DEC. It is found in the south-west regions of WA, mostly in densely vegetated swamps, tea tree thickets on sandy soils along creek lines and dense heath on slopes. Quokka numbers have declined because of predation by foxes and the clearing and burning of swamp habitats. This species is very rare on the mainland. It was not observed during the nocturnal or diurnal surveys or trapped during the survey, and has not been previously recorded on the Jandakot region. It is therefore highly unlikely to occur at Lot 467.

4. The Greater Long-eared Bat (*Nyctophilus timoriensis*) is listed as a Priority 4 species by the DEC. This species is considered widespread across southern Australia, but it is uncommon and localised. The Greater Long-eared Bat inhabits areas of tall forest in the south-west, roosting in tree hollows and under loose bark (Strahan 1995).

Birds

1. Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), preferred habitat is woodlands and scrubs of semiarid interior of Western Australia, in non-breeding season wandering in flocks to coastal areas, especially pine plantations (Johnstone & Storr 1998). Food includes seeds of Banksia species, Dryandra species, Hakea species, Eucalyptus species, Grevillea species and Pinus species; also fruiting almonds (Johnstone & Storr 1998).Occurs in south-west north to lower Murchison and east to Nabawa, Wilroy, Waddi Forest, Manmanning, Durokoppin, Lake Cronin and just east of Condingup. Endemic to Western Australia (Johnstone & Storr 1998). Considering the habitat present on the site, this species potentially occurs there.

2. Baudin's Cockatoo (*Calyptorhynchus baudinii*), is listed as Vulnerable by the EPBC Act, as Schedule 1 by the WC Act, and is also considered locally significant. This species is distributed through the south-western humid and subhumid zones, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and across to Albany (Johnstone & Storr 1998). Baudin's Cockatoo rarely occurs in Perth, or anywhere along the coast south to approximately Mandurah. It usually occurs in small flocks of up to 30, occasionally up to 50, or rarely in aggregations of up to 1200 (Johnstone & Kirkby 2008). This species forages primarily in eucalypt forest, where it feeds primarily on Marri (*Corymbia calophylla*) seeds, flowers, nectar and buds (Johnstone & Kirkby 2008). It also feeds on a wide range of seeds of Eucalyptus, Banksia, Hakea and Dryandra, as well as fruiting apples and pears and persimmons, as well as Pines, and beetle larvae from under the bark of trees (Johnstone & Kirkby 2008, Johnstone & Storr 1998). Considering the habitat present on the site, this species potentially occurs there.

3. The Rainbow Bee-eater (*Merops ornatus*) is a migratory species listed under the EPBC Act, which migrates to south-western Australia to breed in spring and summer. The Rainbow Bee-eater is a common and widespread species in Western Australia. It occurs throughout Western Australia except the drier interior of the State and the far south-west (Johnstone & Storr 1998). It occurs in lightly-wooded often sandy country, preferring areas near water. The Rainbow Bee-eater feeds on airborne insects, and nests throughout its range in Western Australia in burrows excavated in sandy ground or banks, often at the margins of roads and tracks (Johnstone & Storr 1998). The Rainbow Bee-eater is common in Perth in summer. It is likely this species forages at the site, and possibly breeds there.

4.1.9 Aboriginal Heritage

An Aboriginal Sites database search was made of the Department of Indigenous Affairs' (DIA) Aboriginal Heritage Inquiry System on 1 February 2011 for mining tenements M70/1088 and M70/1142. No records of Registered Aboriginal Sites were recorded in either Tenement. One record of an "Other Heritage Place" was recorded as occurring within the boundaries of both the mining tenements (Site – 3301 Banjup: Calsil.) Information relating to this site and the Aboriginal Heritage Inquiry System search has been included in Appendix 3.

Only a small area of the proposed mining footprint is within the boundary of a "Heritage Place" the adjacent mining tenement is located predominately with the boundary. Rocla will confirm with the DIA if there is an area of concern with regard this specific site and if rehabilitation of the previously mined area can occur.

4.1.10 Non-Aboriginal Heritage

A database search was made of the Heritage Council of Western Australia's Places database. No places were recorded as occurring on Lot 467 Jandakot Road, Banjup.

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5.0 POTENTIAL IMPACTS AND MANAGEMENT MEASURES

5.1 Key Issues, Objectives and Principles

The EP Act requires the EPA to determine the environmental factors, objectives and principles relevant to the proposed project. The critical or key factors affected by the proposed project are identified in order to ensure the proponent complies with the following principles, as described by EPA:

- precautionary principle
- principle of intergenerational equity
- principle of conservation of biological diversity and ecological integrity
- principles relating to improved valuation, pricing and incentive mechanisms
- principle of waste minimisation (EPA 2009b).

Rocla will apply the principles set forth in the Principles of Environmental Protection (EPA 2002b) and the proposed project will be implemented within a sustainable framework.

Key factors for the proposed project are vegetation, wetlands, groundwater, fauna, aboriginal heritage, noise and visual amenity.

The key issues, factors and objectives are presented in Table 5.

Table 5: Key Issues, Factors and Objectives

Issue	Factor	Objective
Ecological Systems and Biodiversity	Vegetation	To maintain abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.
	Fauna	To maintain abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.
	Soils and Water	To maintain the integrity, ecological functions and environmental values.
Amenity	Dust	To protect the amenity of nearby residents and visitors to the recreation reserve from dust impacts resulting from activities associated with the proposal by ensuring the dust levels meet statutory requirements and acceptable standards.
	Noise	To protect the amenity of nearby residents and visitors to the recreation reserve from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

Issue	Factor	Objective
	Visual Amenity	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape.
Heritage	Aboriginal	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

This section details the potential environmental impacts and how these will be managed. Each environmental topic is addressed in the same format using a series of sub-headings as follows.

Background: the environmental topic is placed in context for Lots 467 and 140 Jandakot Road, Banjup.

Legislation, Policy and Guidelines: outlines the relevant government policy or guidelines applied to noise, dust and visual amenity.

Potential Impacts: describes the identified potential dust, noise and visual environmental impact that might arise from the proposed sand mining.

Management Response: proposed management responses are detailed.

5.2 Vegetation Clearing

5.2.1 Background

A total of 9.8 ha of remnant vegetation is proposed to be cleared.

Both the spring flora and vegetation surveys identified that the condition of the remnant vegetation across the proposed sand extraction area varies depending on disturbance and weeds. All three lots support portions of predominantly *Banksia* (*Banksia attenuata* and *Banksia menziesii* woodland) vegetation in Good or better condition.

5.2.2 Legislation, Policy and Guidelines

Relevant legislation, policy and guidelines for vegetation and flora include:

- Guidance Statement for Rehabilitation of Terrestrial Ecosystems Final Guidance Statement No. 6 (EPA 2006)
- Level of Assessment for Proposals Affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region Final Guidance Statement No 10 (EPA 2006)

- Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia Final Guidance Statement No. 49 (EPA 2006).

5.2.3 Potential Impacts

The important factors associated with the clearing of native vegetation include:

- loss of biodiversity (species and species assemblage)
- sedimentation and increased turbidity of local wetlands
- soil erosion
- reduced habitat for native fauna
- encourage the spread of weeds
- impacts on lifestyle opportunities.

5.2.4 Management Response

Rocla has committed to the following measures to protect and restore key native vegetation and flora:

- staged clearing of the site, through the stage mining process to allow for fauna movement away from proposed mining operations and clearing

- maintaining an approximate 23 ha vegetated buffer outside of the sand extraction area. The excavation area will be clearly defined through a site survey and marked out on the ground at each stage

- provision of a buffer from the sand extraction area to the RE and CC wetlands which maximise the value of the sand resource but also maintains the environmental values of the wetlands.

- staged rehabilitation in collaboration with BGPA to utilise over eighteen years of research into *Banksia* Woodland restoration. Rocla proposes the staged rehabilitation of the sand extraction area 9.8 ha but also the 8.1 ha of historically cleared areas. The total native vegetation rehabilitation area is 17.9 ha. This represents a 40% net increase in black cockatoo foraging habitat

- stockpiling or direct transfer of topsoil for use in regeneration of *Banksia* woodlands

- provision of the site to be used in future *Banksia* Woodlands rehabilitation research trials by BGPA

- dieback prevention measures in accordance with Dieback Working Group best practice guidelines

- weed control measures during and post-sand mining.

5.3 Dieback and Weed Management

5.3.1 Background

The proposal creates a potential risk for the introduction or spread of weeds and / or dieback (*Phytophthora cinnamomi*).

5.3.1.1 Weeds

- A weed survey was undertaken as part of the Level 2 vegetation and flora survey in spring 2008 (RPS 2008).
- There was one weed species found within the study area that is listed as a Declared Plant for the whole of the state; *Zantedeschia aethiopica* (Arum Lilly).

5.3.1.2 Dieback

Dieback is a plant disease caused by the introduced soil-borne pathogen *Phytophthora*, which is a water mould spread by the movement of soil. There are several species of *Phytophthora* present in native vegetation but by far the most widespread and destructive is *Phytophthora cinnamomi* (CALM 2003).

Evidence of dieback (*Phytophthora cinnamomi*) was not witnessed during the Level 2 flora and vegetation survey or by BGPA site review of the *Banksia* Woodlands.

5.3.2 Legislation, Policy and Guidelines

Relevant legislation, policy and guidelines include:

- *Agriculture and Related Resources Protection Act 1976* – declared weed control
- best practice guidelines for management of *Phytophthora* have been published by the Dieback Working Group.

5.3.3 Potential Impacts

Potential impacts as a result of sand mining include:

- spread of dieback due to sand mining activities which contributes to the reduction of flora and vegetation biodiversity and fauna habitats
- the spread and / or introduction of weeds during or post-sand mining which contributes to the loss of biodiversity.

5.3.4 Proposed Management

The proposed management of weeds and dieback *(Phytophthora cinnamomi)* is detailed below:

- Prevention
  - Undertake a baseline weed status survey prior to excavation works.
  - Implement a weed control program which includes spraying during the spring flowering season and ongoing monitoring.
  - If required, intra-project hygiene boundaries will be established to prevent the spread of weeds and dieback within the project area. These boundaries will be clearly demarcated on site and equipped with clean down facilities.
  - Sand excavation equipment will be cleaned to remove soil, vegetation, rock and debris prior to arrival at site.
- Mobilisation Hygiene Certificate
  - Internal approval for earth moving equipment to mobilise to site will be dependent on completion of hygiene requirements, i.e. dieback-free.
  - Any equipment or vehicle considered to have been working in a weed or dieback risk area will be cleaned down before remobilising.
  - Key Rocla and site personnel (e.g. site manager) will be made aware of dieback issues, identification of weed species / reporting of infestations and hygiene procedures. These key personnel will be responsible for the implementation of the weed control program and dieback management.
- Weed Control
  - A weed control program will be implemented for project areas where introduced species are present. Where required, infestations will be controlled by spot spraying or manual removal.
- Monitoring
  - Weed infestation status inspections will be conducted by the Site Manager as part of regular site inspections.
  - A targeted weed survey will be conducted at the completion of each sand extraction stage area (prior to rehabilitation works commencing) and repeated again within twelve months.

- Contingencies

  – Any new weed populations that arise in the project area as a result of the construction works will be removed.

  – Incidents relating to a failure in hygiene processes will be reported investigated and rectified to prevent recurrence.

5.3.5 Fauna

5.3.5.1 Background

Table 6 below details the potential occurrence of each protected matters species based on habitat requirements, habitat suitability on site, and general feeding / breeding requirements of the species.

Table 6: EPBC Act Protected Matters

Species	Description	Likelihood of Occurrence	Likelihood Justification
Birds			
Calyptorhynchus banksii naso (Forest Red-tailed Black-Cockatoo)	Preferred habitat is Eucalypt forests. Feeds on seeding *Corymbia calophylla* (Marri), *Eucalyptus marginata* (Jarrah), *Eucalyptus todtiana* (Blackbutt), *Eucalyptus diversicolor* (Karri), *Allocasuarina fraseriana* (Sheoak) and *Persoonia micranthera* (Snottygobble) (Johnstone & Storr, 1998). This subspecies occurs in the humid and subhumid south west, mainly in hilly interior, north to Gingin (formerly to Dandaragan) and east to Mt Helena (formerly to Toodyay), Christmas Tree Well, North Bannister (formerly to Wandering), Mt Saddleback (formerly to Kojonup), Rocky Gully and the upper King River. It is endemic to Western Australia (Johnstone & Storr, 1998).	Unlikely	The vegetation present at the site is generally not suitable for this species. The vegetation unit AfBaBm has some *Eucalyptus marginata* present. However, this vegetation unit only comprises a small portion of the SE corner of the site.
Calyptorhynchus baudinii (Baudin's Black-Cockatoo, Long-billed Black-Cockatoo)	Preferred habitat is southern eucalypt forests. Feeds on seeds of *Corymbia calophylla* (Marri), *Banksia*, *Hakea* and fruiting apples and pears, also strips bark from dead trees in search of insects, mainly beetle and borer larvae (Johnstone & Storr, 1998). Occurs in south-western humid and subhumid zones, north to Gidgegannup east to Mt Helena, Wandering, Quindanning, the Perup River, Lake Muir and King River, and west to eastern strip of Swan Coastal Plain including West Midland, Byford, North Dandalup, Yarloop, Wokalup and Bunbury also the Stirling and Porongurup Ranges. It is endemic to Western Australia. (Johnstone & Storr, 1998).	Possible	*Banksia* is a known foraging species. The vegetation unit BaBm has some Banksia species (*Banksia attenuata and Banksia menziesii*) present.

Species	Description	Likelihood of Occurrence	Likelihood Justification
Calyptorhynchus latirostris (Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo)	Preferred habitat is woodlands and scrubs of semiarid interior of Western Australia, in non-breeding season wandering in flocks to coastal areas, especially pine plantations (Johnstone & Storr 1998). Food includes seeds of Banksia species, Dryandra species, Hakea species, Eucalyptus species, Grevillea species and Pinus species; also fruiting almonds (Johnstone & Storr, 1998). Occurs in south-west north to lower Murchison and east to Nabawa, Wilroy, Waddi Forest, Manmanning, Durokoppin, Lake Cronin and just east of Condingup. Endemic to Western Australia (Johnstone & Storr, 1998).	Possible	*Banksia* is a known foraging species.
Rainbow Bee-eater (*Merops ornatus*)	Migratory species listed under the EPBC Act, It occurs in lightly-wooded often sandy country, preferring areas near water. The Rainbow Bee-eater feeds on airborne insects, and nests throughout its range in Western Australia in burrows excavated in sandy ground or banks, often at the margins of roads and tracks (Johnstone & Storr, 1998). The Rainbow Bee-eater is common in Perth in summer.	Possible	
Mammals			
Dasyurus geoffroii (Chudtich, Western Quoll)	Chuditch are known to have occupied a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts. The Chuditch now has a patchy distribution through the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west Western Australia (DEWHA, 2011a).	Unlikely	The site is predominantly Banksia woodland, with few Eucalypts species on site. Habitat is therefore not suitable.
Phascogale calura (Red-Tailed Phascogale)	The Red Tailed Phascogale inhabits Wandoo and Sheoak woodlands. They show a preference for habitat that has not been burnt for a substantial amount of time with continuous canopy as well as tree hollows (DEWHA, 2011b).	Unlikely	The site is predominantly Banksia woodland, with no Wandoo and few Sheoak species on site. Habitat is therefore not suitable.
Setonix brachyurus (Quokka)	Occurs on islands offshore from southern Western Australia. Some small populations are found on the mainland in dense vegetated swamps and tea tree thickets (DEWHA, 2009c). Feeds mainly on a variety of grasses.	Unlikely	No *Lepidosperma spp.* (Tea Tree) species are found within the site. Habitat is therefore not suitable.
Flora			
Darwinia sp Muchea (Muchea Bell)	Muchea Bell is known to occur in three populations north of Perth in swampy, seasonally wet habitat (DEWHA, 2009b).	Unlikely	Not located in known habitat range.

Species	Description	Likelihood of Occurrence	Likelihood Justification
Drakaea elastica (Glossy-leaved Hammer Orchid, Praying Virgin)	Known to occur in the Stirling Ranges (near Albany) and northeast of Boyup Brook (Phillimore and Brown, 2001).	Unlikely	Not located in known habitat range.
*Hemigenia ramosissima (*Branched Hemigenia)	Slender shrub that occurs on grey, loamy clay in open mallee shrubland composed of *Eucalyptus spathulata* (Swamp Mallet) over heath of *Melaleuca uncinata* (Broombush) and *M. acuminata* (Phillimore and Brown, 2003)	Unlikely	The site contains no clay soils, and no open mallee shrubland.
*Lasiopetalum sp serpentine (*Wing fruited Lasiopetalum)	It grows in deep sandy soil in mixed Jarrah (*Eucalyptus marginata*) and Banksia (*Banksia attenuata*) woodland (Hoffman and Brown, 1998).	Unlikely	Preferred habitat on site, but not located during Level 2 flora survey.
Lepidosperma rostratum (Beaked Lepidosperma)	Associated with Marsh Banksia (*Banksia telmatiaea*) and Hairy Clawflower (*Calothamnus hirsutus*) and grows in wet swamp conditions (Brown et al. 1998). Known from four populations east of Perth.	Unlikely	Both species associations where not found during the Level 2 flora survey, additionally, the proposed clearing site is not permanently damp or wet.

5.3.6 Legislation, Policy and Guidelines

Relevant legislation, policy and guidelines to fauna and fauna management include:

- Protection of Specially Protected Fauna is managed by the DEC under the *Wildlife Conservation Act 1950*.

- Proposes impacts on species / communities listed as nationally threatened under the Commonwealth's EPBC Act 1999 are subject to the Commonwealth Department of the Sustainability, Environment, Water, Population and Communities (DSEWPC) environmental assessment process.

5.3.7 Potential Impacts

The important factors associated with the clearing of native vegetation include:

- loss of biodiversity (species and species assemblage)
- reduced habitat for native fauna
- encourage the spread of weeds
- impacts on lifestyle opportunities.

5.3.8 Management Response

The sand mining proposal will be referred to the DSEWPC for determination on whether there was a potential for significant impact on a Matter of National Environmental Significance.

Rocla have committed to the staged rehabilitation (to *Banksia spp – Eucalyptus marginata* woodland) in collaboration with the BPGA of the site post-extraction works.

Based on the proposal, Rocla will implement the following general measures to avoid or reduce impacts to the black cockatoos:

- The sand extraction proposal is a temporary land use. Rocla proposes the staged rehabilitation of the sand extraction area 9.8 ha but also the 8.1 ha of historically cleared areas. The total native vegetation rehabilitation area is 17.9 ha. This represents a 40 % net increase in black cockatoo foraging habitat

- maintaining an approximately 23 ha vegetated buffer outside of the sand extraction area. The excavation area will be clearly defined through a site survey and marked out on the ground at each stage.

- provision of the site to be used in future Banksia Woodland rehabilitation research trials by BGPA.

- avoid damage to any habitat outside of the prescribed clearing area

- staged clearing of the site, through the stage mining process to allow for fauna movement away from proposed mining operations and clearing

- provision of a buffer from the sand extraction area to the RE and CC wetlands which maximise the value of the sand resource but also maintains the environmental values of the wetlands.

5.4 Surface and Groundwater Protection

5.4.1 Background

Due to the high porosity of the sandy soils and being sandy at the site, run-off from the excavation areas is not anticipated and infiltration will remain the predominant drainage process. As the base of the excavation will be 2 m above the maximum water table, no dewatering will be required.

Water infiltrating within the quarry will be direct rainfall run-off and is not expected to contain any potential contaminants. There is no vehicle refuelling to be conducted at the site.

5.4.2 Legislation, Policy and Guidelines

- The *Environmental Protection Act 1986* is a legislative tool for achieving environmental resource protection and implementing the National Water Quality Management Strategy and State Water Quality Management Strategy in Western Australia.

- The DoW implements its water allocation decisions and regulates the use of water through the powers assigned to it under the *Rights in Water and Irrigation Act 1914*.

5.4.3 Potential Impacts

Potential impacts upon surface and groundwater as a result of sand mining include:

- removal of the native vegetation in the proposed sand mining area can potentially increase the amount of groundwater recharge in these areas, resulting in rising groundwater levels which in turn can cause waterlogging or increase discharge of groundwater into the RE and CCW.

- erosion and sedimentation of waterways are strongly linked with the loss of fringing vegetation, catchment clearing and flood plain degradation. Erosion and sedimentation are caused by changes in flow regimes and channel accommodation changes.

- the contamination of surface / groundwater resources from "point sources" such as fuel spills.

5.4.4 Proposed Management

As a precaution, infrastructure e.g. the refuelling station will be located at Rocla's existing Armadale Road operation which is a 500 m separation distance away from the wetlands and the proposed excavation area. Given the separation distances, and that the risk of contaminant generation is low, water quality impacts on the wetlands and are not anticipated.

While water quality impacts are not anticipated, Rocla proposes that the following management measures be undertaken:

5.4.4.1 Surface Water

- provision of a buffer from the sand extraction area to the RE and CC wetlands which maximise the value of the sand resource but also maintains the environmental values of the wetlands.

- Maintain the final land surface with a separation distance of 2 m to the highest known groundwater level.

- Stage clearing of the site in accordance therefore minimising the exposed areas at any one time.
- Commence rehabilitation works at the completion of each mining stage in collaboration with BGPA.
- Maintain all plant equipment in good condition.
- Maintain all haul road and hardstand surfaces in good condition and with suitable grades.

5.4.4.2 Groundwater

Rocla will monitor groundwater levels at the site for the duration of the clearing program. Due to the nature of the soils at the site, run-off from the excavation areas is not anticipated rather, infiltration will remain the predominant drainage process.

As the base of the excavation will be at a minimum 2 m above the maximum water table, no dewatering will be required.

5.5 Dust Management

5.5.1 Background

Dust can be generated when the wind velocity and frequency is sufficiently strong enough to lift sand particles from the ground surface. The susceptibility of the soil particles to lift is a function of how exposed the ground surface is which includes whether there is any ground cover, level of compaction and the moisture content of the soil. Dust is measured as Total Suspended Particles (TSP) which refers to particles that can remain suspended in the atmosphere but not necessarily inhaled.

The potential for dust generation may occur during topsoil stripping, sand extraction, stockpiling and sand transport.

5.5.2 Potential Impacts

Dust resulting from operations has the potential to affect:

- human health and amenity
- natural environment
- social pursuits.

The potential for dust generation may occur during topsoil stripping, sand extraction, stockpiling and sand transport. Dust can originate from a number of operations and may impact on the on-site workers or travel off site.

5.5.3 Policies and Guidelines

The proposed measures to control dust during the proposed excavation works and has been undertaken in consideration the following applicable guidelines for air quality:

- National Environmental Protection (Ambient Air Quality) Measures (NEPM, 2003)
- EPA Guidance Statement 18 – Prevention of air quality impacts from land development sites (March 2000).

5.5.4 Proposed Management

There are a number of management actions that can be taken to minimise dust generation or travel and these will be used whenever possible. Key dust management measures are detailed below:

5.5.4.1 Dust from Traffic on Unsealed Roads

- Minimise the width and length of internal roads.
- Restrict vehicle movements to defined roads and operational areas.
- Avoiding disturbance of non-operational areas of the site.
- Use of water as appropriate to wet down roads and trafficked areas.
- Use of dust suppressants where appropriate (either mixed with water to enhance dust suppression and vegetation cover, or applied periodically to specific areas).
- Limit the speed of vehicles on the site.
- Maintain haul road surface in a good condition and with suitable grades.
- Enforce all vehicles leaving the site are required to have covered loads.

5.5.4.2 Dust from Operational and Non-operational Areas of the Site

- Extract topsoil extracted in months and conditions which minimise the potential for dust generation.
- Use of water carts to dampen dust prone areas.
- Commence the *Banksia* spp and *Eucalyptus marginata* woodland re-vegetation in the 7.05 ha historically cleared area (Area B) prior to sand extraction.

- Application of surface treatments (e.g. mulch) to stabilise any bare areas which might be prone to wind erosion.
- Minimise the area disturbed or open at any one time, as far as practicable.
- Define "no go" buffer areas of the site to avoid any unnecessary disturbance of stabilised surfaces or vehicle traffic.
- Cease operational activities until conditions improve and compliance can be achieved.
- Push overburden dumps into positions where they can form screening barriers (i.e. bunds) and at specific locations screening trees will be planted.
- Use screening fencing along Lot 6, 300 and 301 boundary if required.

5.6 Noise Management

5.6.1 Background

Noise can originate from a number of operations and impact on external sensitive premises. Noise impacts are addressed by reducing the noise generated from the sand excavation and processing operations.

5.6.2 Potential Impacts

Excessive exposure to noise can negatively impact upon people's health, amenity and the natural environment, in particular native fauna.

5.6.3 Legislation, Policies and Guidelines

Off site noise is governed by the Environmental Protection (Noise) Regulations 1997, and the EPA Guidance for the Assessment of Environmental Factors provides guidelines on noise from developments and other activities.

5.6.4 Proposed Management

There are a number of further management actions that will be undertaken to minimise noise generation. The general management actions are summarised below:

- Comply with the Environmental Protection (Noise) Regulations 1997.

- Retain and establish vegetation between the mine site and the adjacent land holdings to provide a physical separation barrier between mine site activities and adjacent noise sensitive premises.
- Maintain noise suppression devices in good condition on all operational machinery.
- Shut down equipment when not in use.
- Operate machinery within the designated hours of operation, 7.00 am to 5.00 pm, Monday to Saturday. Some operation may occur on a Sunday if required by project demand.
- Schedule activities to minimise the likelihood of noise nuisance.
- Use the dedicated transport route.
- Record and follow up any complaints received regarding noise disturbance immediately to minimise the cause, to the greatest possible extent.

5.7 Visual Amenity

5.7.1 Background

Visual impacts can occur in a number of circumstances typically if a proposed operation is located too close to neighbours and by insufficient visual protection.

5.7.2 Possible Impacts

Lack of visual harmony between the sand mining area and the surrounding rural and regional open space landscape.

5.7.3 Legislation, Policy and Guidelines

Under the *Environmental Protection Act 1986* the definition of environment includes the community's aesthetic surroundings to the extent that those surroundings are affected by the physical or biological environment. The definition of environmental value includes aesthetic enjoyment of the environment.

5.7.4 Proposed Management

There are a number of management actions that will be employed to minimise the visual impacts. The general management actions are summarised below and these will be used wherever possible.

- Retain and establish vegetation between the mine site and the adjacent land holdings to provide a physical separation barrier between mine site activities and adjacent premises.

- Overburden dumps will be positioned where they will form screening barriers (i.e. bunds).

- Stage workings and progressive rehabilitation to provide visual protection of later excavations.

- Minimise the amount of open ground at any one time.

5.8 Social Environment

5.8.1 Aboriginal Heritage

5.8.1.1 Background

Aboriginal Heritage may be relevant when it is directly linked to the physical or biological attributes of the natural environment and where those attributes maybe threatened as a result of development. Other Heritage Place Site 3301, Banjup: Calsil. has been identified as occurring on part of Lot 467 Jandakot Road, Banjup.

5.8.1.2 Possible Impacts

It may be possible that during the excavation activities occurring on Lot 467 Jandakot Road, Banjup that artefact or other items of cultural Aboriginal significance may be unearthed.

5.8.1.3 Legislation, Policy and Guidelines

Aboriginal Heritage is governed by the *Aboriginal Heritage Act 1972*.

The EPA (2004d) Assessment of Aboriginal Heritage Guidance Statement No. 41 provides advice when considering Aboriginal Heritage as a relevant environmental factor when assessing development applications.

5.8.1.4 Proposed Management

There are a number of management actions that can be taken to minimise impact to the identified Aboriginal heritage site and these will be used whenever practicable. Key Aboriginal heritage site management measures are detailed below:

- Should an evidence of Aboriginal significance be uncovered over the natural life of the quarry, development will be stopped pending an assessment by a recognised consultant.

5.9 Summary of Possible Impacts and Proposed Management Strategies

Issue	EPA Objective	Possible Impacts	Further Investigations	Proposed Management
Vegetation Clearing	To maintain abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Loss of Biodiversity (species and species assemblage); Sedimentation and increased turbidity of local wetlands; Soil erosion; Reduced habitat for native fauna; Encourage the spread of weeds; Impacts on lifestyle opportunities	▪ Spatial mapping of *Banksia* to inform Black Cockatoo habitat.	▪ Staged clearing of the site to allow for fauna movement away from proposed mining operations and clearing; ▪ Avoid disturbance of native vegetation outside of the sand extraction area; ▪ Provision of a buffer from the sand extraction area to the RE and CC wetlands which maximise the value of the sand resource but also maintains the environmental values of the wetlands; ▪ Stockpiling of topsoil; ▪ Staged rehabilitation in collaboration with BGPA to utilise over eighteen years of research into Banksia Woodland restoration. Rocla proposes the staged rehabilitation of the sand extraction area 9.8 ha but also the 8.1 ha of historically cleared areas. The total native vegetation rehabilitation area is 17.9 ha. This represents a 40% net increase in black cockatoo foraging habitat ▪ Provision of site to used in future trails by BGPA; ▪ Dieback prevention measures; and ▪ Weed control during and post-sand mining.
Dieback and Weed Management	To maintain abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Spread of dieback; Spread and / or introduction of weeds	▪ Weed surveys to be conducted at the completion of each sand extraction stage area, ▪ Baseline study and investigation of potential impacts of project on Phytophthora dieback.	▪ Undertake prevention activities; ▪ Require Mobilisation Hygiene Certification; ▪ Undertake Weed Control; ▪ Undertake regular Monitoring; and ▪ Implement Contingency actions.

Issue	EPA Objective	Possible Impacts	Further Investigations	Proposed Management
Fauna	To maintain abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Loss of Biodiversity (species and species assemblage); Reduced habitat for native fauna; Encourage the spread of weeds; Impacts on lifestyle opportunities	▪ Assessment of potential impacts of the project on fauna. ▪ Determination of measures to avoid, minimise or mitigate impacts on fauna.	▪ Staged clearing of the site to allow for fauna movement away from proposed mining operations and clearing. ▪ Avoid disturbance of native vegetation outside of the sand extraction area. ▪ Provision of a buffer from the sand extraction area to the RE and CC wetlands which maximise the value of the sand resource but also maintains the environmental values of the wetlands. ▪ Stockpiling of topsoil. ▪ Staged rehabilitation in collaboration with BGPA to utilise over eighteen years of research into Banksia Woodland restoration. Rocla proposes the staged rehabilitation of the sand extraction area 9.8 ha but also the 8.1 ha of historically cleared areas. The total native vegetation rehabilitation area is 17.9 ha. This represents a 40% net increase in black cockatoo foraging habitat. ▪ Provision of site to used in future trails by BGPA.
Surface and Ground Water Protection	To maintain the integrity, ecological functions and environmental values	Increased ground water recharge leading to water logging or increased discharge into wetlands; Erosion and sedimentation associated with loss of riparian vegetation; Contamination water resources from point sources	▪ Ongoing survey control of quarry floor to ensure accurate recording of separation distance. ▪ Ongoing ground water monitoring.	▪ Provision of a buffer from the sand extraction area to the RE and CC wetlands which maximise the value of the sand resource but also maintains the environmental values of the wetlands ▪ Maintain finished level with a separation distance of 2 m to the highest known groundwater level; Staged clearing of the site ▪ Commence rehabilitation works at the completion of each mining stage ▪ Maintain all plant in good condition; Maintain all road and hardstand surfaces in good condition ▪ Monitoring of groundwater levels at the site for the duration of the clearing program.

Issue	EPA Objective	Possible Impacts	Further Investigations	Proposed Management
Dust	To protect the amenity of nearby residents and visitors to the recreation reserve from dust impacts resulting from activities associated with the proposal by ensuring the dust levels meet statutory requirements and acceptable standards.	Human health and amenity; Natural environment; Social pursuits	None Required	▪ Implement identified best practice protocols to reduce dust from traffic on unsealed roads and from operational and non-operational areas of the site; and ▪ Commence the Banksia spp and *Eucalyptus marginata* woodland re-vegetation in the 7.05 ha historically cleared area (Area B) prior to sand extraction.
Noise	To protect the amenity of nearby residents and visitors to the recreation reserve from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	Human health and amenity; Natural environment; Social pursuits	Monitoring of existing noise.	▪ Comply with the Environmental Protection (Noise) Regulations 1997 ▪ Retain and establish vegetation between the mine site and the adjacent land holdings to provide a physical separation barrier ▪ Maintain noise suppression devices in good condition on all operational machinery ▪ Shut down equipment when not in use ▪ Operate machinery within the designated hours of operation ▪ Schedule activities to minimise the likelihood of noise nuisance ▪ Use the dedicated transport route ▪ Record and follow up any complaints received regarding noise disturbance immediately to minimise the cause.
Visual Amenity	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape.	Loss of visual amenity and natural environment.	None Required	▪ Retain and establish vegetation between the sand extraction area and the adjacent land holdings to provide a physical separation barrier ▪ Position overburden dumps to form screening barriers, if required ▪ Stage workings and progressive rehabilitation to provide visual protection of later excavations ▪ Minimise the amount of open ground at any one time.

Issue	EPA Objective	Possible Impacts	Further Investigations	Proposed Management
Aboriginal	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	Loss of Cultural Heritage.	▪ Identification of interested Aboriginal Stakeholders. ▪ Consultation with relevant Aboriginal Stakeholders. ▪ Commissioning of a cultural heritage survey adherent to requirements of Section 18 of *Aboriginal Heritage Act 1972*.	▪ Stop quarrying activities should any Aboriginal artefacts be uncovered; ▪ Submit a Section 18 application under the *Aboriginal Heritage Act 1972*.

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6.0 REHABILITATION AND DECOMMISSIONING

Rocla have committed to, the staged rehabilitation (to *Banksia* spp and *Eucalyptus marginata* woodland) in collaboration with the BGPA to maximise the regeneration of natural bushland.

6.1 Rehabilitation

Rehabilitation will commence with the establishment of topographic contours. The final contours are anticipated to be visually compatible with other parts of the local landscape. A commitment will be made to ensure that the final slopes are similar to those in the local area on the slopes and that the excavation will be left in a safe manner in conformity with the *Mines Safety and Inspection Act 1994*.

The proposed excavation has been designed to comply with the objectives of the zoning and to return the landform to its current existing pre-excavation form and rehabilitate the disturb land with native vegetation.

The main objective for the rehabilitation of the site is to restore native *Banksia* woodland to the site. The methodology adopted for the rehabilitation is based on fifteen years of experience at other Rocla sand extraction sites and rehabilitation as well as research conducted into the ecology of native *Banksia* woodland areas. The rehabilitation completion criteria are as follows:

- a landform compatible with the surrounding contours
- a self sustaining cover of native vegetation
- weed species at levels not likely to threaten the native species.

In 1995, Rocla approached the BGPA with the aim of returning post-sand extraction mine sites back into former *Banksia* woodland. Rocla sought the assistance of the Science Directorate at BGPA to undertake research into the ecology and restoration of *Banksia* woodland and have now subsequently built a long-term scientific relationship. This research resulted in Rocla and BGPA being awarded the Golden Gecko environmental award by the Department of Mines and Petroleum in 2008, the most prestigious environmental award in the state.

As a result of this partnership Rocla have successfully restored over eight former sand extraction sites back to *Banksia* woodland on the Swan Coastal Plain.

The objectives of the Lots 467 and 140 Jandakot Road, Banjup site rehabilitation program are to:

- Undertake progressive rehabilitation to minimise the open excavation area at any one time.

- Stabilise the surface sands against erosion.
- Establish a southern and north-west ecological corridor.

The proposed rehabilitation program will consist of application of topsoil and overburden to a depth of approximately 10 cm to the rehabilitation areas and seeding with native species. Topsoil is proposed to be directly transferred from the cleared areas to the rehabilitation sites with clearing and rehabilitation preparation occurring simultaneously on an annual basis, after the first year. Topsoil will also be managed and protected to maximise regeneration.

Clearing and commencement of rehabilitation is proposed to occur in autumn each year. It is anticipated that approximately 4 to 6 ha will be mined per year, therefore rehabilitation is proposed to commence in Year Two and continue at a rate of approximately 3 ha per year until excavation is complete and the quarry fully rehabilitated.

Brushing with larger logs (remaining following regrowth clearing) will occur on the perimeter of rehabilitation sites to decrease the potential for erosion and vehicle movement.

6.1.1 Rehabilitation Stages

The stages involved in the site rehabilitation program are summarised as follows:

- Rocla will initially will harvest native Banksia spp and Mari seeds (and use topsoil if available) and focus the first phase of rehabilitation on previously mined areas, commencing within Area B. Area B is a 7.05 ha cleared open area. Rocla proposes to commence the rehabilitation of this area in advance of the proposed clearing and sand extraction. This outcome will assist both in restoring native vegetation to a cleared area but also with dust control.

- Rocla has also proposed to undertake an additional 0.33 ha rehabilitation outside of the mining tenement adjacent to Area B (Figure 2).

- Rocla will undertake the *Banksia* spp and *Eucalyptus marginata* woodland rehabilitation for the sand extraction area concurrently with clearing works which are proposed to occur in autumn each year.

- The proposed rehabilitation program will consist of application of topsoil to a depth of approximately ten centimetres to the rehabilitation areas and seeding. Where possible topsoil and overburden will be directly transferred from an area being cleared to an area to be rehabilitated. Where this is not possible, the topsoil and overburden will be stored in low piles for future use in rehabilitation.

- The levelled topsoil will be cross-ripped to a depth of 50 to 80 cm with wing shaped tynes. This is intended to eliminate the compaction created in the soil profile during the excavation process.

- A supplementary seed mix containing species which do not regenerate readily from the replaced topsoil will be distributed over the rehabilitation area by hand.

- Slopes are shaped and battered with retained topsoil. These will then be spread with vegetative debris, which acts as a barrier to wind erosion and maximises microhabitats.

- Assessment of the success of the rehabilitation works will be undertaken annually with additional supplementary seeding, planting or re-broadcasting of seed applied in the subsequent winter if considered necessary by the BGPA and Rocla.

- Brushing with larger logs (remaining following regrowth clearing) will occur on the perimeter of rehabilitation sites to decrease the potential for erosion and vehicle movement.

Rocla will undertake, manage and fund the rehabilitation program until the completion criteria outlined below are met. Table 7 presents a provisional schedule of all programmed monitoring activities.

Table 7: Monitoring Schedule

Issue	Parameter	Frequency	Time Frame	Responsibility
Rehabilitation	Finalise topography levels.	Once	Prior to site works.	Rocla.
	Finalise native species list for re-vegetation.	Once	Prior to the commencement of rehabilitation works	Rocla (in collaboration with BGPA).
	Undertake topsoil replacement.	Once a year for life of mine	Every year for the duration of mining.	Rocla.
	Undertake supplementary seed planting.	Once a year	Post-application of topsoil	BGPA.
	Undertake planting (if required).	Once a year	Post-application of topsoil	BGPA.
	Weed Control. Weeds sprayed with an appropriate herbicide or weeded by hand in accordance with the DoW's Herbicide use in Wetlands (WRC 2001).	As required	Two years from initial planting.	Rocla and Rocla.
	Establish two quadrats (2 m x 2 m) plots.	Once	When first year of rehabilitation has been completed.	Rocla.

Issue	Parameter	Frequency	Time Frame	Responsibility
	Survey quadrats.	Annually (spring)	Five years.	Rocla.
	Assess the success of the re-establishment of vegetation planted.	Annually	Five years.	Rocla.

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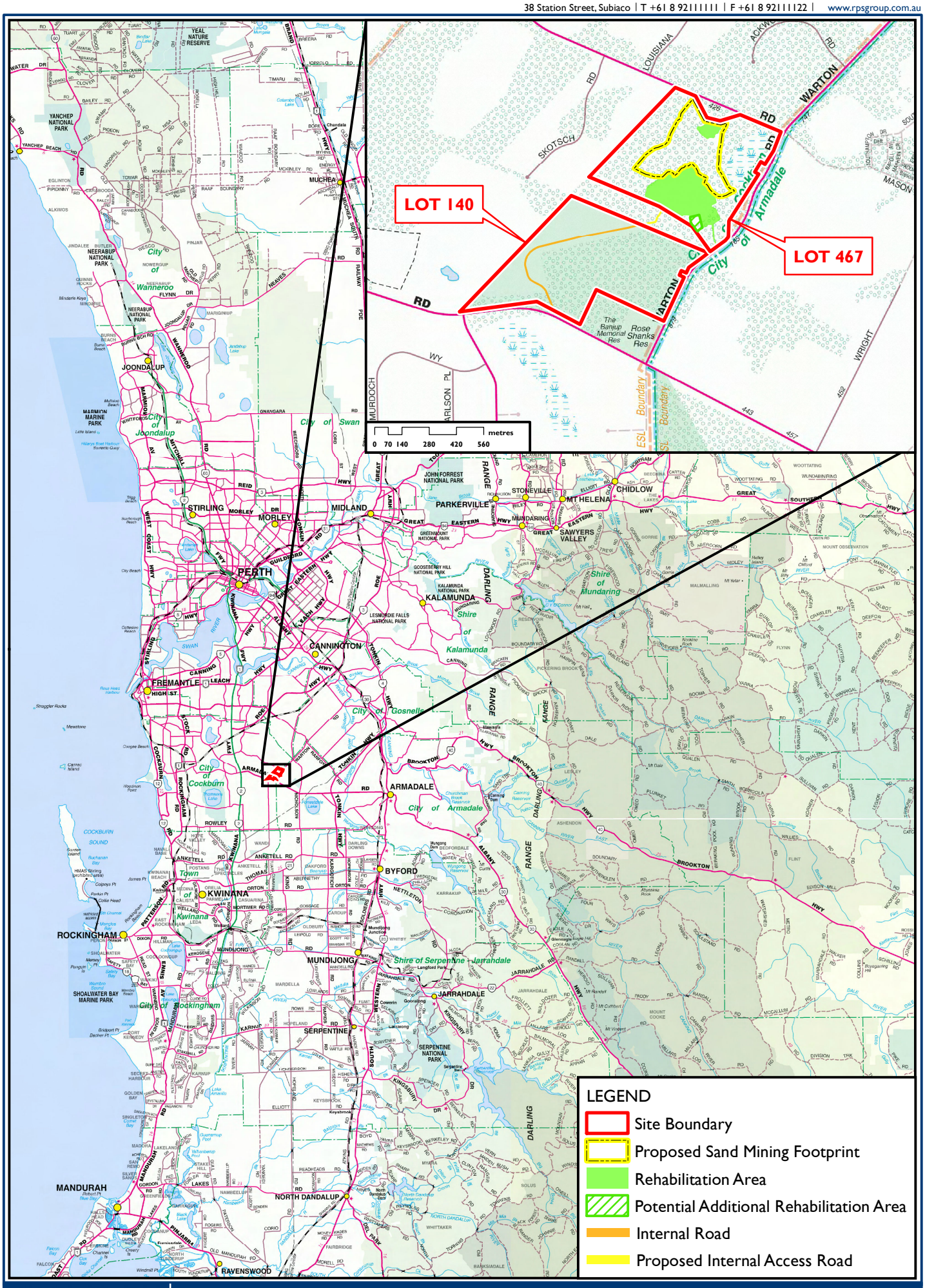
FIGURES

38 Station Street, Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au



RPS

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Date: 23.09.13
Scale: Map - 1:500000 @ A4 Inset 1:25000 @ A4
Version: A
Drafted by: HT
Source: Landgate, 2008

Figure 1

Site Location

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LEGEND

- Site Boundary
- Mining Tenement
- Proposed Sand Mining Footprint (10.5ha)
- Rehabilitation Area
- Potential Additional Rehabilitation Area
- Internal Road (through existing cleared areas)
- Proposed Internal Access Road

EXISTING ROCLA MINING AREA

EXISTING SITE INFRASTRUCTURE & REFUELING STATION

PROPOSED MINING AND REHABILITATION AREAS	Area (ha)
Proposed Sand Extraction Area (will be rehabilitated)	9.8 ha
Proposed Rehabilitation Area A	0.7 ha
Proposed Rehabilitation Area B	7.05 ha
Potential Additional Rehabilitation Area	0.33 ha
Proposed Rehabilitation Area Total	**17.9 ha**
PROPOSED INTERNAL ACCESS ROAD	
Internal Road (through existing cleared areas)	0.95 ha
Cleared Area Within the Proposed Access Track	0.06 ha
Vegetation to be Cleared Within the Proposed Access Track	0.10 ha
Proposed Access Track Area Total	**1.11 ha**

RPS

Job Number: L10590
Date: 23.09.13
Scale: 1:5000 @ A3
Revision: B
Drafted by: MA
Source: Orthophoto (2013), Cadastre (2011) - Landgate Mining Tenement - Landgate, 2010

0 25 50 100 150 200 metres

Figure 2

Mining Leases M70/1088 and M70/1142

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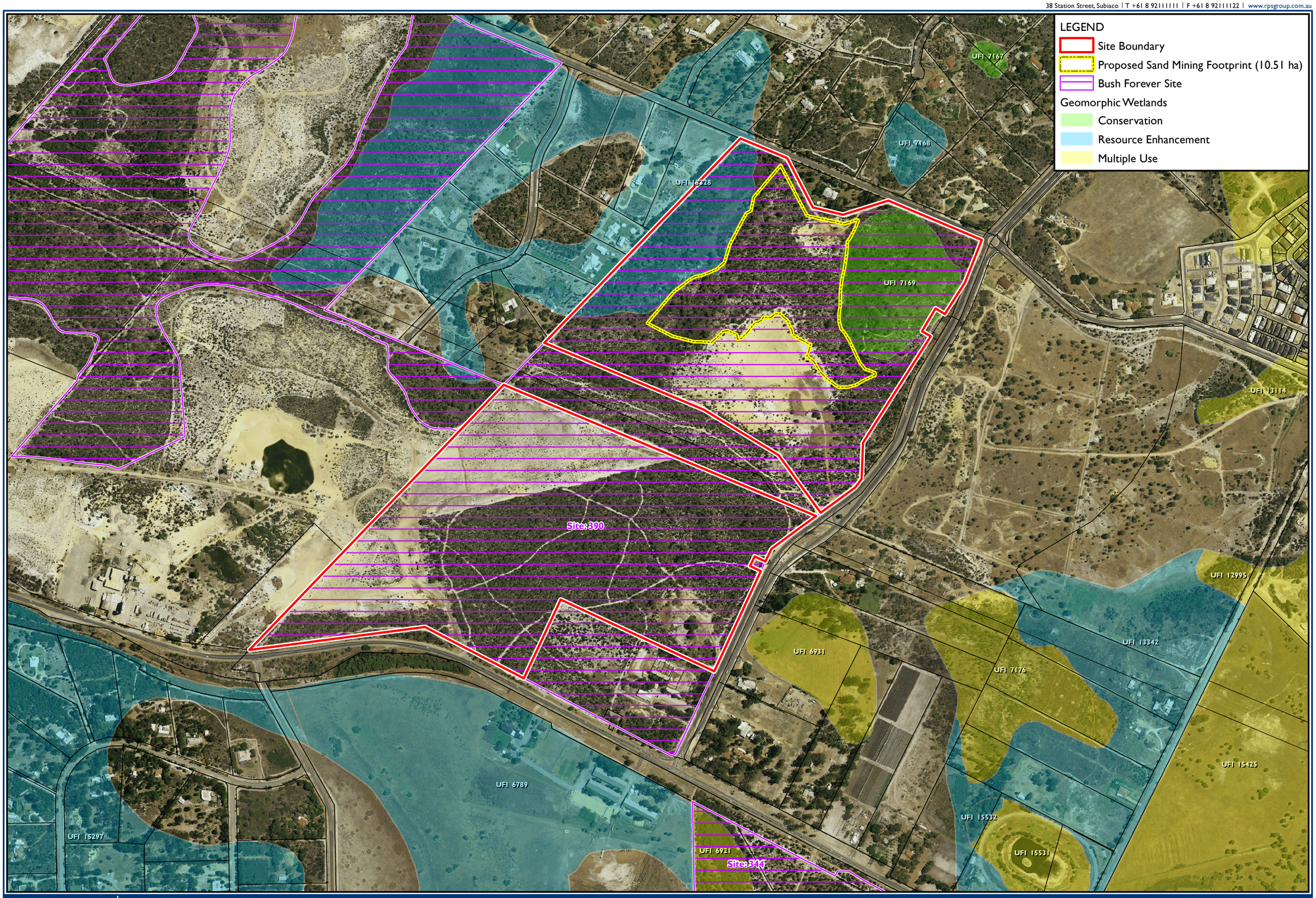

Job Number: L10590
Date: 23.09.13
Scale: 1:7500 @ A3
Revision: B
Drafted by: MA
Source: Cadastre (2011) & Orthophoto (2013) - Landgate Wetlands - DEC, 2013 Bush Forever - DPI, 2009

0 37.5 75 150 225 300 metres

Figure 3

Bush Forever and Geomorphic Wetlands Within the Mining Leases

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LEGEND
- Site Boundary
- Proposed Sand Mining Footprint
- Mining Tenement
- Cadastre
- Contour (mAHD)

IANDAKOT RD
MASON RD
SKOTTSCH RD
M 70/1088
M 70/1142
WARTON RD
RUDDELOW RD
ARMADALE RD

RPS

Job Number: L10590
Date: 26.08.11
Scale: 1:5000 @ A3
Revision: A
Drafted by: SC
Source: Orthophoto & Cadastre - Landgate, 2011 Mining Tenement - Landgate, 2010 Contours - Landgate & ION Services

0 25 50 100 150 200 metres

Figure 4

Topography

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LEGEND

- Site Boundary
- Proposed Sand Mining Footprint
- Mining Tenement
- Cadastre

Acid Sulfate Soil Risk Mapping

- High to moderate risk
- Moderate to low risk

JANDAKOT RD
LOUISIANA GLEN
ACKWORTH RD
WARTON RD
SKOTSCH RD
M 70/1088
M 70/1142
SOUTHAMPTON DR
DELFT L
DELFT L
NAPOLI AV
PADUA RD
BRESCIA L
MASON RD
MURDOCH WY
LIDDELOW RD
CARLSON PL
ARMADALE RD
WRIGHT RD

Job Number: L10590
Date: 26.08.11
Scale: 1:7500 @ A3
Revision: A
Drafted by: HT & SC
Source: Orthophoto, Cadastre - Landgate, 2011 Mining Tenement - Landgate, 2010. Acid Sulphate Soil Mapping - DEC 2010.

0 37.5 75 150 225 300 metres

RPS

Figure 5

Acid Sulfate Soil Risk Mapping

RPS

APPENDIX I

Tenement Endorsements

Government of Western Australia
Department of Mines and Petroleum

eMITS MAINTENANCE

Tenement Endorsement and Conditions Extract

Tenement: M 70/1088
Show History: Yes
Working versions only: No

#	ENDORSEMENTS	Status	Start Date	End Date
1	The Lessee's attention is drawn to the provisions of the: • Aboriginal Heritage Act 1972 and any Regulations thereunder; • Water and Rivers Commission Act 1995 and any Regulations thereunder; • Identification of environmental sensitive wetlands listed within the RAMSAR Convention 1971, ANCA's Directory of important wetlands, the National Estates Register and the Environmental Protection Policies 1999; • Country Areas Water Supply Act 1947 and any Regulations thereunder; and • Metropolitan Water Supply Sewerage and Drainage Act 1909 and any Regulations thereunder.	Active	24/08/2010	
2	The Lessee's attention is drawn to the Environmental Protection Act 1986 and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, which provides for the protection of all native vegetation from damage unless prior permission is obtained.	Active	24/08/2010	
3	In respect to the area designated as FNA 2874, in TENGRAPH pursuant to Clause 9(20)(c) of the Alumina Refinery Agreement Act 1961, the grant of this Lease does not include the right to mine bauxite.	Active	24/08/2010	

#	CONDITIONS	Status	Start Date	End Date
1	Survey.	Active	24/08/2010	
2	All surface holes drilled for the purpose of exploration are to be capped, filled or otherwise made safe immediately after completion.	Active	24/08/2010	
3	All disturbances to the surface of the land made as a result of exploration, including costeans, drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, Department of Mines and Petroleum (DMP). Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, DMP.	Active	24/08/2010	
4	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.	Active	24/08/2010	
5	Unless the written approval of the Environmental Officer, DMP is first obtained, the use of drilling rigs, scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.	Active	24/08/2010	
6	The lessee submitting a plan of proposed operations and measures to safeguard the environment to the Director, Environment, DMP for his assessment and written approval prior to commencing any developmental or productive mining or construction activity.	Active	24/08/2010	
7	Written notification, where practicable, of the time frame, type and extent of proposed ground disturbing activities being forwarded to the Department of Water Perth seven days prior to commencement of those activities.	Active	24/08/2010	
8	Any significant waterway (flowing or not), wetland or its fringing vegetation that may exist on site not being disturbed or removed without prior written approval from the Department of Water.	Active	24/08/2010	
9	The rights of ingress to and egress from the Lease being at all reasonable times preserved to officers of the Department of Water for inspection and investigation purposes.	Active	24/08/2010	
10	The storage and disposal of hydrocarbons, chemicals and potentially hazardous substances being in accordance with the Department of Water's Guidelines and Water Quality Protection Notes .	Active	24/08/2010	
11	All Mining Act tenement activities prohibited within 200 metres of RAMSAR or ANCA listed wetlands unless written permission of Department of Environment and Conservation, in consultation with the Department of Water, is first obtained.	Active	24/08/2010	
12	All Mining Act tenement activities prohibited within 200 metres of "Conservation" and "Resource Enhancement" Category wetlands unless written permission of the Department of Water is first obtained.	Active	24/08/2010	
13	All proposed exploration activities within Public Drinking Water Source Areas complying with the Department of Water's Water Quality Protection Note Land Use Compatibility in Public Drinking Water Source Areas.	Active	24/08/2010	
14	All Mining Act tenement activities within Public Drinking Water Source Areas being prohibited unless the prior written approval has been obtained from the Department of Water.	Active	24/08/2010	
15	All Mining Act tenement activities are prohibited within 2 kilometres of the maximum storage level of a reservoir including the reservoir itself, unless the prior written approval of the Department of Water is first obtained.	Active	24/08/2010	
16	Storage and use of hydrocarbons and potentially hazardous substances requiring the prior written approval or appropriate permits from the Department of Water.	Active	24/08/2010	
17	All hydrocarbon or other pollutant spillage being reported to the Department of Water. Remediation being carried out to the satisfaction of the Department of Water.	Active	24/08/2010	

#	CONDITIONS	Status	Start Date	End Date
18	• All Mining Act tenement activities are prohibited within a 300-metre radius of any observation well in a Public Drinking Water Source Priority P1, P2 & P3 Areas unless the written approval of the Department of Water is first obtained.	Active	24/08/2010	
19	All Mining Act tenement activities are prohibited within a 500-metre radius in a P1 area or a 300-metre radius in a P2 or P3 area of any Public Drinking Water Source production well or dam, unless the written approval of the Department of Water is first obtained.	Active	24/08/2010	
	Consent to mine on Police Reserve No. 33500 granted.	Active	24/08/2010	

-- End of Report --

Government of Western Australia
Department of Mines and Petroleum

RECEIVED 30 AUG 2010
eMITS MAINTENANCE

Tenement Endorsement and Conditions Extract

Tenement: M 70/1142
Show History: Yes
Working versions only: No

#	ENDORSEMENTS	Status	Start Date	End Date
1	The Lessee's attention is drawn to the provisions of the: • Aboriginal Heritage Act 1972 and any Regulations thereunder; • Water and Rivers Commission Act 1995 and any Regulations thereunder; • Identification of environmental sensitive wetlands listed within the RAMSAR Convention 1971, ANCA's Directory of important wetlands, the National Estates Register and the Environmental Protection Policies 1999; • Country Areas Water Supply Act 1947 and any Regulations thereunder; and • Metropolitan Water Supply Sewerage and Drainage Act 1909 and any Regulations thereunder.	Active	24/08/2010	
2	The Lessee's attention is drawn to the Environmental Protection Act 1986 and the Environmental Protection (Clearing of Native Vegetation) Regulations 2004, which provides for the protection of all native vegetation from damage unless prior permission is obtained.	Active	24/08/2010	
3	In respect to the area designated as FNA 2874, in TENGRAPH pursuant to Clause 9(20)(c) of the Alumina Refinery Agreement Act 1961, the grant of this Lease does not include the right to mine bauxite.	Active	24/08/2010	
4	The grant of this Lease does not include land the subject of Section 19/152 which was declared exempt from occupation as a mining tenement on 25 September 2000 and published in the Government Gazette dated 6 October 2000 and Club and Club Premises (Pistol Club) Reserve 8129.	Active	24/08/2010	

#	CONDITIONS	Status	Start Date	End Date
1	Survey.	Active	24/08/2010	
2	All surface holes drilled for the purpose of exploration are to be capped, filled or otherwise made safe immediately after completion.	Active	24/08/2010	
3	All disturbances to the surface of the land made as a result of exploration, including costeans, drill pads, grid lines and access tracks, being backfilled and rehabilitated to the satisfaction of the Environmental Officer, Department of Mines and Petroleum (DMP). Backfilling and rehabilitation being required no later than 6 months after excavation unless otherwise approved in writing by the Environmental Officer, DMP.	Active	24/08/2010	
4	All waste materials, rubbish, plastic sample bags, abandoned equipment and temporary buildings being removed from the mining tenement prior to or at the termination of exploration program.	Active	24/08/2010	
5	Unless the written approval of the Environmental Officer, DMP is first obtained, the use of drilling rigs, scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.	Active	24/08/2010	
6	The lessee submitting a plan of proposed operations and measures to safeguard the environment to the Director, Environment, DMP for his assessment and written approval prior to commencing any developmental or productive mining or construction activity.	Active	24/08/2010	
7	The prior written consent of the Minister responsible for the Mining Act 1978 being obtained before commencing any mining activities on Government Requirements Reserve 33589 and Government Requirements State Energy Commission Reserve 33590.	Active	24/08/2010	
8	No interference with the transmission line or the installations in connection therewith, and the rights of ingress to and egress from the facility being at all times preserved to the owners thereof.	Active	24/08/2010	
9	Written notification, where practicable, of the time frame, type and extent of proposed ground disturbing activities being forwarded to the Department of Water Perth seven days prior to commencement of those activities.	Active	24/08/2010	
10	Any significant waterway (flowing or not), wetland or its fringing vegetation that may exist on site not being disturbed or removed without prior written approval from the Department of Water.	Active	24/08/2010	
11	The rights of ingress to and egress from the Lease being at all reasonable times preserved to officers of the Department of Water for inspection and investigation purposes.	Active	24/08/2010	
12	The storage and disposal of hydrocarbons, chemicals and potentially hazardous substances being in accordance with the Department of Water's Guidelines and Water Quality Protection Notes .	Active	24/08/2010	
13	All Mining Act tenement activities prohibited within 200 metres of RAMSAR or ANCA listed wetlands unless written permission of Department of Environment and Conservation, in consultation with the Department of Water, is first obtained.	Active	24/08/2010	
14	All Mining Act tenement activities prohibited within 200 metres of "Conservation" and "Resource Enhancement" Category wetlands unless written permission of the Department of Water is first obtained.	Active	24/08/2010	
15	All proposed exploration activities within Public Drinking Water Source Areas complying with the Department of Water's Water Quality Protection Note Land Use Compatibility in Public Drinking Water Source Areas.	Active	24/08/2010	

#	CONDITIONS	Status	Start Date	End Date
16	All Mining Act tenement activities within Public Drinking Water Source Areas being prohibited unless the prior written approval has been obtained from the Department of Water.	Active	24/08/2010	
17	All Mining Act tenement activities are prohibited within 2 kilometres of the maximum storage level of a reservoir including the reservoir itself, unless the prior written approval of the Department of Water is first obtained.	Active	24/08/2010	
18	Storage and use of hydrocarbons and potentially hazardous substances requiring the prior written approval or appropriate permits from the Department of Water.	Active	24/08/2010	
19	All hydrocarbon or other pollutant spillage being reported to the Department of Water. Remediation being carried out to the satisfaction of the Department of Water.	Active	24/08/2010	
20	All Mining Act tenement activities are prohibited within a 300-metre radius of any observation well in a Public Drinking Water Source Priority P1, P2 & P3 Areas unless the written approval of the Department of Water is first obtained.	Active	24/08/2010	
21	All Mining Act tenement activities are prohibited within a 500-metre radius in a P1 area or a 300-metre radius in a P2 or P3 area of any Public Drinking Water Source production well or dam, unless the written approval of the Department of Water is first obtained.	Active	24/08/2010	
	Consent to mine on Police Reserve No. 33500 granted.	Active	24/08/2010	

-- End of Report --

RPS

APPENDIX 2

Level 2 Flora and Vegetation Survey

A

LEVEL 2

FLORA AND VEGETATION

SURVEY OF

PROPOSED SAND MINING AREA

AT

LOT 467, WARTON RD:

Prepared for

RPS Environmental

by

Brian Morgan

Consultant Plant Biologist

May 2011

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EXECUTIVE SUMMARY

Rocla Quarry Products is proposing to extract sand from parts of mining leases M70/1088 and M70/1142, which are located on Lot 467 Jandakot Rd, Banjup. The survey area covered the proposed excavation area and was about 11.3 hectares.

A Level 2 survey was conducted in accordance with the Environmental Protection Authority's Guidance statement *No 51* .

The Rocla Warton Rd survey area lies near the western edge of the Southern River unit of the Bassendean Dune landform system. The survey area was therefore located near the western boundary of the Southern River vegetation complex. In addition, the survey area bushland

- is part of a north-south linkage between Gibbs Rd and the Jandakot Airport/Canningvale bushlands;
- has a Resource Enhancement wetland abutted the western survey area boundary and a Conservation category wetland abutted the eastern survey area boundary; and
- is part of BushForever site 390 'Fraser Rd Bushland, Banjup', which is contiguous with a number of other BushForever sites.

One hundred and fifty five (155) native plants were recorded in the Rocla Warton Rd survey area. Thirty eight (38) non-native species were also recorded. The number of native species recorded was probably a moderate number for the area (eleven hectares). The species richness of quadrats was greatest in the Banksia woodland and low in the dampland sites.

No Declared Rare Flora or Priority flora species were recorded in the Rocla Warton Rd survey area. Two plant species recorded in the survey area, *Hensmania turbinata* and *Pultenaea ochreata*, were considered to have regional significance.

Six vegetation units were described in the remnant bushland in the Rocla Warton Rd survey area. *Banksia attenuata-Banksia menziesii* low woodlands covered the dune crest and slopes that occupied most of the survey area. *Eucalyptus todtiana* occurred in scattered patches across the dune, but occurred more consistently on the lower slopes with the Banksia woodland. Transitional dryland vegetation in the form of mixed woodlands with scattered *Melaleuca preissiana* trees occurred on the gentle slopes along

the base of the dune on the western edges and parts of the eastern edges of the survey area. Small areas of wetland vegetation that included *Melaleuca preissiana* low closed forest and *Pericalymma ellipticum* heaths and *Schoenus subfascicularis* sedgelands (seasonal damplands) occurred in the south-western, north-western and south-eastern corners of the survey area.

The vegetation in the survey area was mostly rated Very Good to Excellent, with the vegetation condition rated Excellent at a number of sample locations on the dunes and flats. The condition of the wetland vegetation was Very Good to Excellent. Completely Degraded areas in the northern and southern parts of the survey area were former sand mines. Weed cover was generally low throughout the remnant bushland and were only abundant in the Completely Degraded areas.

Banksia spp. deaths, including recent deaths, were noted on some parts of the dune slopes in the survey area. The deaths and decline of *Banksia* trees at this site probably indicate the presence of the Dieback fungus *Phytophthera cinnamomi*. However, other agents such as fire and drought (including falling water tables), as well as other pathogens, may also be responsible for Banksia tree deaths. A dieback survey by accredited 'dieback interpreters' would be required to confirm if Dieback is present and if so, over what area.

Lomandra maritima was not recorded in the Rocla Warton Rd survey area. However, *Lomandra hermaphrodita* plants were recorded at all three of the quadrats located on the dune slopes and are probably scattered on the dune slopes. *Lomandra hermaphrodita* and *L. maritima* are two known food plants of the Graceful Sun Moth (*Synemon gratiosa).*

Mr Ted Griffin concluded that the Rocal Warton Rd dataset was probably sufficiently compatible with the Swan Coastal Plain dataset to obtain reliable PATN floristic determinations. The dune Banksia woodland vegetation sites were all most similar to Floristic Community Type (FCT) 23a. The *Schoenus subfascicularis* sedgeland vegetation was consistently similar to FCT5 dampland sites. The *Adenanthos cygnorum-Hypocalymma angustifolium* shrubland site had mixed affinities, but had strong affinity to dampland FCT4 vegetation. The *Melaleuca preissiana* low open forest vegetation had some affinity with dampland vegetation FCT5. Both the *Melaleuca preissiana* low open forest and *Adenanthos cygnorum-Hypocalymma angustifolium* shrubland vegetation were deemed to be wetland vegetation because of the floristic affinities and because of the presence and cover of obligate wetland species.

No Threatened Ecological Communities or Priority Ecological Communities were found to be present in the vegetation units in the survey area, although vegetation unit 'AcHa' had some affinity with FCT22, a Priority Ecological Community (Priority 2). FCT's were inferred for two described vegetation units.

Using the criteria for determination of regional significance of natural areas set out in the EPA Guidance Statement No. 10, the Rocla Warton Rd survey area was assessed as regionally significant for flora and vegetation on the following grounds:

- Representation of ecological communities (less than 10% of Southern River Complex is protected); and
- Maintaining linkages (part of a 'regionally significant but not contiguous linkage of bushland/wetland area').

1.0 INTRODUCTION

1.1 Background

Rocla Quarry Products is proposing to extract sand from parts of mining leases M70/1088 and M70/1142, which are located in Lot 467 Jandakot Rd, Banjup.

RPS Environmental recommended that a Level 2 flora and vegetation survey of the area, including a targeted search for Declared Rare Flora (DRF), should be undertaken to meet part of the approvals requirements.

1.2 Purpose of the study

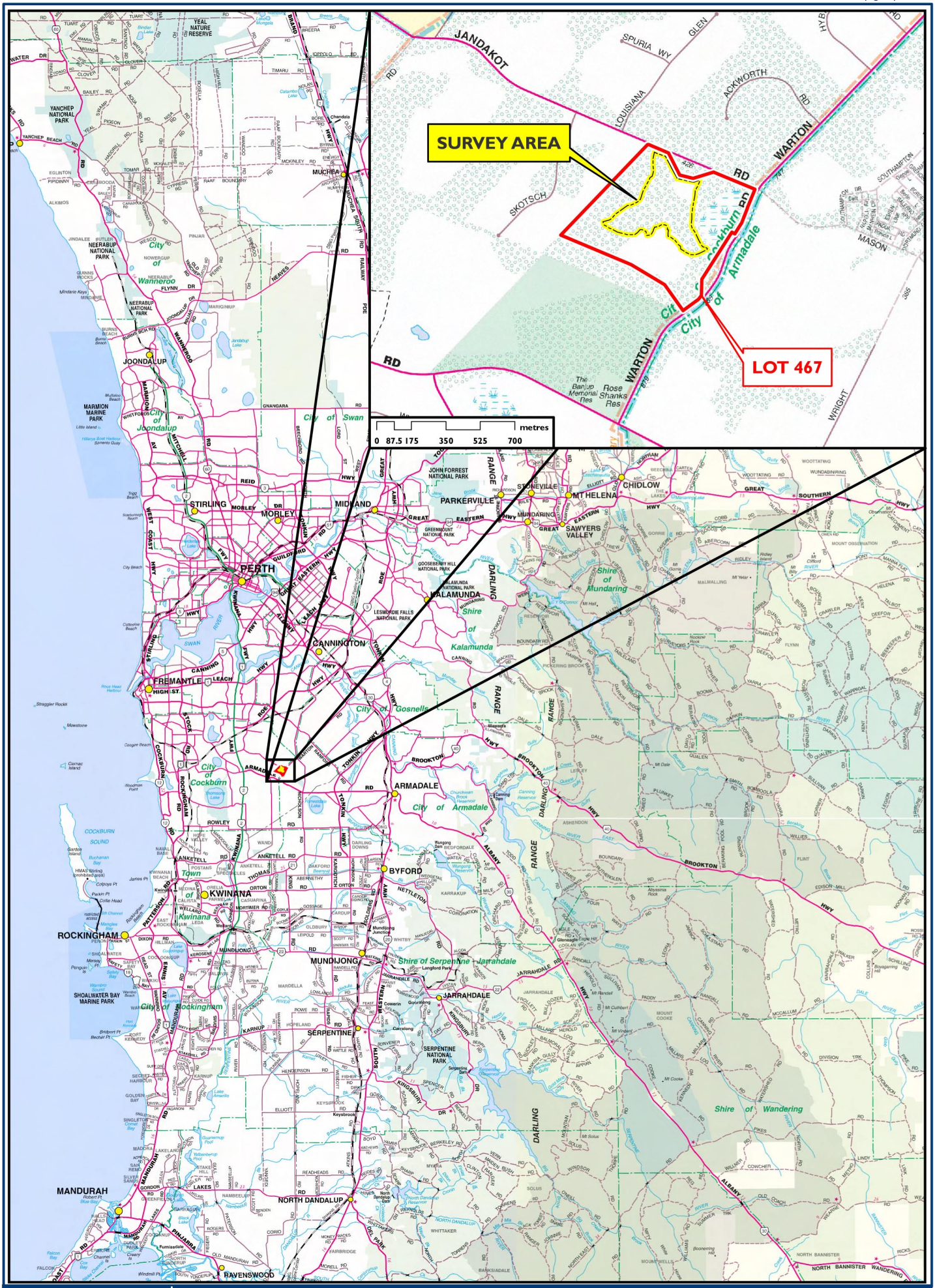
The purpose of the Level 2 flora and vegetation survey of Lot 467 Jandakot Rd was to:

- list the flora in the survey area, including any Significant flora;
- map the vegetation and the vegetation condition in the survey area, including a delineation of wetland vegetation boundaries;
- Record quadrats and analyse the quadrat data to determine the vegetation values in the survey area;
- conduct a targeted search for *Caladenia huegelii* and other DRF in the survey area;
- report on the survey results.

The Level 2 survey was conducted in accordance with the Environmental Protection Authority's (2004) *Guidance for the assessment of Environmental Factors – Terrestial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (No 51)*.

1.3 The survey area

The survey area covered the proposed excavation area in the Mining Lease areas M70/1088 and M70/1142 in Lot 467 Jandakot Rd, Banjup (here after referred to as 'Rocla Warton Rd' survey area; see Figure 1). The survey area mostly excluded the adjacent Conservation and Resource Enhancement Geomorphic wetland areas. The size of the survey area was approximately 11.3 hectares.



RPS

Job Number: L10478
Date: 20.05.11
Scale: Map - 1:500000 @ A4 Inset 1:25000 @ A4
Version: A
Drafted by: SC
Source: Landgate, 2008

0 2.5 5 10 15 20 km

Figure 1

Site Location

2.0 SITE DESCRIPTION AND BACKGROUND INFORMATION

2.1 Physical Environment

2.1.1 Climate

The Swan Coastal Plain, which includes the survey area, has a Mediterranean type climate with hot, dry summers and mild, wet winters.

2.1.2 Geomorphology of the survey area

The Swan Coastal Plain consists of a series of geomorphological elements which are sub-parallel to the present coastline (McArthur and Bettenay, 1960; Churchward and McArthur, 1980). Each of these geomorphic elements has distinctive geology, vegetation, topography and soils.

The Rocla Warton Rd survey area lies near the western edge of the Southern River unit (McArthur and Bettenay, 1960). The Southern River unit and the Bassendean unit are two of the three units within the Bassendean Dune system, the oldest and furthest inland of the three main aeolian dune systems on the Swan Coastal Plain. The three units of the Bassendean Dune system differ mainly in the nature of associated swamps, with the Bassendean unit having peaty podzols in the swamps and the Southern River unit having swamps which often have a clay base as a result of sand blowing over alluvial soils (Churchward and McArthur, 1980).

2.2 Flora and vegetation background

2.2.1 Vegetation

2.2.1.1 Regional vegetation

Beard (1980) defined boundaries for botanical provinces, districts and subdistricts for Western Australia on the basis of his vegetation mapping of the State. In this framework, the survey area lies in the Drummond Botanical Subdistrict (more or less equivalent to the Swan Coastal Plain and part of the Dandaragan Plateau) of the Darling Botanical District of the South Western Botanical Province of Western Australia.

Heddle *et al* (1980) mapped the vegetation of part of the Drummond Botanical Subdistrict at a very broad scale, describing a series of vegetation complexes. These are related groups of vegetation associations found on particular landform-soil units (geomorphic elements, see above). They mapped a total of 38 vegetation complexes on the Swan Coastal Plain. The Rocla Warton Rd survey area is located near the western boundary of the Southern River Complex (Figure 2). The Southern River Complex was described as consisting of ‘an open woodland of Marri-Jarrah-Banksia

on the elevated areas and a fringing woodland of *E. rudis-M. rhaphiophylla* along the streams' (Heddle *et al*., 1980). The vegetation of the 'Bassendean Complex-Central and South', the adjacent Complex to the west, was described as ranging from 'woodland of Jarrah-Sheoak-Banksia on the sand dunes to a low woodland of *Melaleuca* spp. and sedgelands on the low-lying depressions and swamps' (Heddle *et al*., 1980). It was also noted that 'it includes the transition area of Jarrah and Pricklybark (*Eucalyptus todtiana*) in the vicinity of Perth'.

More recently, an alternative analysis of the plant assemblages on the Swan Coastal Plain south of Gingin Brook was carried out using a floristic approach (Gibson *et al*., 1994) and was extended in 2000. This work identified 66 floristic community types in four floristic 'Super Groups' for the southern Swan Coastal Plain. These units are defined at a similar level of synthesis to that of Heddle *et al*. (Trudgen, 1999). The four 'super groups' of sites correlate closely with the major geomorphological elements on the Swan Coastal Plain (and also to rainfall), with the exception of one group which contained the seasonal wetlands, which includes sites across all geomorphological groups (Gibson *et al*., 1994). Floristic community types have not been mapped across the Swan Coastal Plain.

2.2.1.2 Rare vegetation: Threatened Ecological Communities (TEC's) and Priority Ecological Communities (PEC's)

The Department of Conservation and Land Management has developed a procedure for identifying 'Threatened Ecological Communities' (Department of Environmental Protection 2000b; English and Blythe 1997). Threatened Ecological Communities (TEC's) are assigned to one of four categories: 'Presumed Totally Destroyed'; 'Critically Endangered'; 'Endangered' or 'Vulnerable' (Department of Environmental Protection, 2000b).

On the Swan Coastal Plain, twenty five potential Threatened Ecological Communities, delineated by a number of floristic and other studies, have been assessed for threatened ecological community status. Of these, twenty four have been confirmed as 'threatened' (Department of Environmental Protection 2000b). Currently eighteen Floristic Community Types on the Swan Coastal Plain, as identified by Gibson *et al*. (1994), are recognized as Threatened Ecological Communities (Department of Environment and Conservation website, May 2011 (unpublished)).

Priority Ecological Communities (PECs) include 'possible threatened ecological communities that do not meet survey criteria or are not adequately defined' (DEC,

unpublished). These are added to the DEC's PEC's list under Priorities 1, 2 and 3. Priority 4 status is given to "Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. Conservation Dependent ecological communities are placed in Priority 5 (DEC, unpublished). The list of PECs (Department of Environment and Conservation website, May 2011 (unpublished)) includes some that are Floristic Community Types (FCT's) as identified by Gibson *et al*. (1994).

A search of the Department of Environment and Conservation's TEC and PEC database found that there were a number of TEC's and PEC's recorded within a 5 kilometre radius of the survey area (Figure 3):

- TEC SCP08 (Vulnerable): 'Herb rich shrublands in clay pans';
- TEC SCP10a (Endangered): 'Shrublands on dry clay flats';
- PEC SCP22 (Priority 2): '*Banksia ilicifolia* woodlands, southern Swan Coastal Plain (type 22)';
- PEC SCP21c (Priority 3): 'Low lying *Banksia attenuata* woodlands or shrublands (type 21c)'.

2.2.1.3 BushForever Sites

The Rocla Warton Rd survey area is part of BushForever site 390 'Fraser Rd Bushland, Banjup' (Department of Environmental Protection 2000a; Figure 4). It is contiguous with BushForever sites:

- BF site 388: Jandakot Airport, Jandakot;
- BF site 389: Acourt Rd Bushland, Banjup;
- BF site 472: Canning Vale Prison Bushland;
- BF site 253: Harrisdale swamp and Adjacent Bushland, Forrestdale/Wungong;

2.2.1.4 Vegetation linkages

Large consolidated areas are considered the best options for viable conservation of natural ecosystems and populations (Department of Environmental Protection, 2000b). In the Perth Metropolitan Region, there are few large areas available for conservation, with most areas being relatively small in size (less than 100 hectares)

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LEGEND
- Survey Area
- Lot 467

Vegetation Complex Boundary
- Bassendean Complex-Central And\South
- Southern River Complex

Bassendean Complex-Central And\South

Southern River Complex

CLIFTON RD
WATERFOOT LOOP
ROEBUCK AV
ALTHAM WY
BURNSIDE TCE
GUNDARING TURN
NINAN WY
DRISCOLL DR
ACOURT RD
WARTON RD
CHARIOT TURN
SADDLE L
BAYSTONE PDE
HYBRID CT
HEBE RD
COLUMBIA PWY
NICHOLSON RD
TURIN L
BROADWAY BVD
BARCLAY WY
TURTLEDOVE RD
RAVEN WY
GRENOBLE ST
BORDEAUX PDE
DELFT L
PADUA RD
MASON RD
WRIGHT RD
BATTERSEA RD
FRASER RD
BANKSIA CT
BERRIGAN DR
LAKES WY
DEAN RD
GLEN IRIS DR
VIRGILIA TCE
HARTWELL PDE
PAR CT
GLENDALE CR
BOEING WY
SOLOMON RD
FALCON PL
CESSNA DR
VERNA CT
IMLAH CT
PRINSEP RD
MURIEL CT
CUTLER RD
DOLLIER ST
CHIRLEY BR
SOLOMON RD
ABAAYA ST
BISCAYNE WY
FRASER RD
NORTH LAKE RD
KENTUCKY CT
BEELIAR DR
LINKAGE AV
KNOCK PL
AVIOR AV
POLETTI RD
SKOTSCH RD
LOUISIANA GLEN
ACKWORTH RD
HANDAKOT RD
WRIGHT RD
SHEPHERD CT
RANFORD RD
FURLEY RD
BALFOUR
EDENCOURT
CHIARA AV
INGOT L
BENALLA DR
SOHO L
MINGARA AV
STILLS AV
HARRISDALE DR
WHITEHORSE DR
DELMAR AV
PARDALOTE RD
KULSARDI WY
BARN L
GLOBAL AV
KUDOS CCT
REILLY RD
BALANNUP RD
SKEET RD
LYDON BVD
ALABASTER DR
HAWKESBURY RTT
TAPPER RD
SCIANO AV
PEARSON DR
KWINANA FWY
WATERS AV
LOMBE GDNS
MYALL PL
GUTTERIDGE RD
MURDOCH WY
CARLSON PL
STEINER AV
GILLEN WY
REEVES ENT
KEW WY
FOLLAND PDE
TAPPER RD
HARPER RD
HEBBLE LOOP
GRANT PL
KEANE RD
ANSTEY RD
ARNO L
BARTRAM RD
AVON CR
BEENYUP RD
CALDER WY
BENDEE DR
MYSTIC ELB
VIVAL L
PAPERBARK L
SANGUINE WY
UTOPIA L
DUNLAP AV
RUTHERFORD ENT
POSEY L
HYGEIA BEND
LYON RD
CHIVALRY WY
UNITY WY
WINDCHIMETCE
HARMONY AV
GOODWILL AV
MYRRH L
LAUDERDALE DR
MUIR CT
SCOFIELD PL
LIDDELOW RD
BORONIA RD
TAYLOR RD
ARMADALE RD
ALLEN RD
WELD ST
DUMSDAY DR
LOFTIES ST
DEW ST
FORREST RD
LEAKE ST
BROOME ST
LAKE RD
SWAMP RD
COMMERCIAL RD

Job Number: L10478
Date: 20.05.11
Scale: 1:25000 @ A3
Revision: 0
Drafted by: SC
Source: Cadastre & Orthophoto - Landgate 2010 Wetlands - DEC, 30.12.10 Vegetation - Heddle, 2002

0 187.5 375 750 1,125 1,500 metres

RPS

Figure 2

Swan Coastal Plain Vegetation Complex Map

and isolated from other conservation areas (Department of Environmental Protection, 2000b). Consequently, the consideration of proximity to other natural areas and connectivity with them is considered important by the DEC in assessing the significance of natural areas.

Linkages have been categorized by the DEC as follows (Department of Environmental Protection, 2000b):

- Regionally significant contiguous corridors of bushland/wetland areas;
- Regionally significant fragmented bushland/wetland areas;
- Regionally significant potential bushland/wetland areas.

A map of existing and potential bushland/wetland linkages in the Perth Metropolitan Area (Department of Environmental Protection, 2000b) shows that the Rocla survey area is part of a north-south linkage between Gibbs Rd and the Jandakot Airport/Canningvale bushlands. This linkage has been assigned the status 'Regionally Significant but not Contiguous Linkage of Bushland/Wetland Areas'.

2.2.2 Rare flora

Twenty three (23) DRF and Priority species were recorded on the DEC database as having been previously recorded in the locality of the Rocla Warton Rd survey area (within 5 kilometre radius of Rocla Warton Rd) (Figure 3; Table 1).

2.3 Wetlands

Western Australia's wetlands have been defined as 'areas of seasonally intermittently or permanently waterlogged soils or inundated land whether natural or otherwise, fresh or saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries (Wetland Advisory Committee 1977, quoted in Department of Environmental Protection, 2000b).

There are over 9600 wetlands covering over 25% of the Swan CoastalPlain land area (Balla, 1994). Semeniuk proposed a classification of wetlands for south-western Australia based on landform and water longevity (Hill *et. al*., 1996; Table 2).

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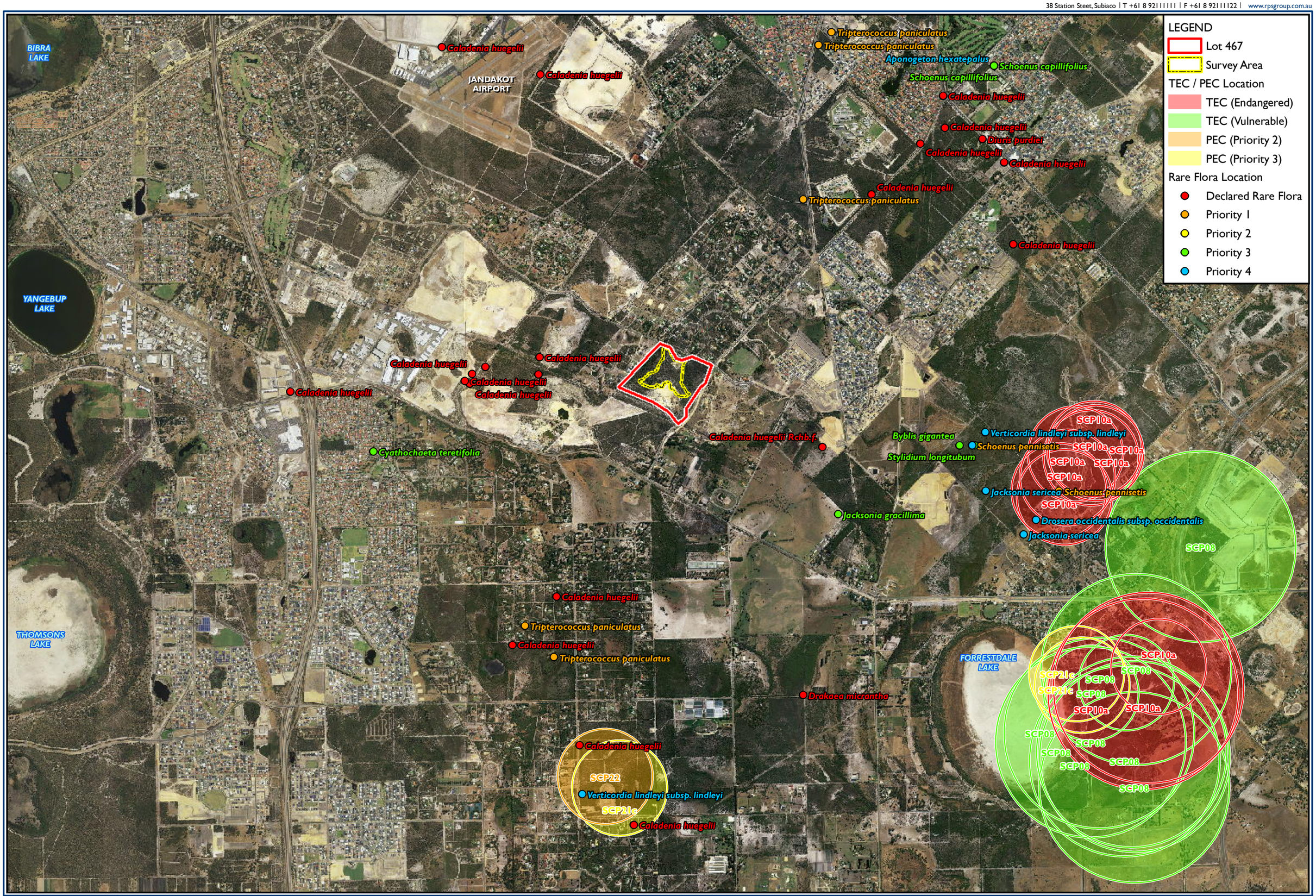

Job Number: L10478
Date: 20.05.11
Scale: 1:35000 @ A3
Revision: 0
Drafted by: SC
Source: Cadastre & Orthophoto - Landgate 2010 DRF TEC/PEC - DEC

0 0.25 0.5 1 1.5 2 km

Figure 3

Location of DEC Records of Rare Flora and TECs/PECs

Table 1. Declared Rare and Priority Flora previously recorded within a 5 kilometre radius of the Rocla Warton Rd survey area (from DEC DEFL and WAHERB database searches, October 2010).

Taxon	Status[a]	Likelihood of occurrence in the survey area	Comments
Caladenia huegelii	DRF	Moderate	Banksia woodland on dune slopes is suitable habitat and *C. huegelii* recorded in the locality.
Diuris purdiei	DRF	Low to moderate	Grows under *Pericalymma* and *Melaleuca* spp. trees in winter-wet swamps and drainage lines (Brown *et. al*., 2008). The species only flowers in trhe season after a summer flower. This habitat type was limited in the survey area.
Drakaea elastica	DRF	Low to moderate	Found in low-lying situations adjoining winter-wet swamps (DEC Florabase, May 2011). This habitat type was limited in the survey area.
Drakaea micrantha	DRF	Low	Perth at northern end of range. Not expected on dune slopes.
Lepidosperma rostratum	DRF[b]	Low to moderate	Known from four populations in the east of the metropolitan area of Perth. Grows in sandy soil among low heath in a winter-wet swamp. Limited suitable habitat in the survey area.
Acacia lasiocarpa var. *bracteolata* long peduncle variant (G.J. Keighery 5026)	P1[b]	Low	Grey or black sand over clay. Swampy areas, winter wet lowlands. Limited suitable habitat in the survey area.
Ptilotus sericostachyus subsp. *roseus*	P1[b]		
Schoenus pennisetis	P1	Low to moderate	Grey or peaty sand, sandy clay. Swamps, winter-wet depressions. Limited suitable habitat in the survey area.
Acacia benthamii	P2	Low	Typically found on limestone breakaways. No suitable habitat in the survey area.
Byblis gigantea	P3	Low	Found in sandy-peat swamps. Seasonally wet areas. Limited suitable habitat in the survey area.
Cyathochaeta teretifolia	P3	Low to moderate	Prefers grey sand, sandy clay. Swamps, creek edges. Limited suitable habitat in the survey area.
Jacksonia gracillima	P3	Low to moderate	Found in areas adjacent to seasonal damplands. Limited suitable habitat in the survey area.
Schoenus capillifolius	P3	Low	Found on brown mud. Claypans. No suitable habitat in survey area.

Table 1 (cont). Declared Rare and Priority Flora previously recorded within a 5 kilometre radius of the Rocla Warton Rd survey area (from DEC DEFL and WAHERB database searches, October 2010).

Taxon	Status[a]	Likelihood of occurrence in the survey area	Comments
Stylidium longitubum	P3	Low to moderate	Sandy clay, clay. Seasonal wetlands. Limited suitable habitat in the survey area.
Aponogeton hexatepalus	P4	Low	Freshwater: ponds, rivers, claypans. No seasonally/perennially inundated areas in survey area.
Dodonaea hackettiana	P4[b]	Low	Occurs on sand and outcroping limestone. No limestone outcropping in survey area.
Drosera occidentalis subsp. *occidentalis*	P4	Low to moderate	Occurs on sandy & clayey soils and around swamps & wet depressions. Limited suitable habitat in the survey area.
Grevillea thelemanniana	P4[b]	Low to moderate	Prefers areas of sand, sandy clay, with winter-wet low-lying flats.
Jacksonia sericea	P4	Low	Found on calcareous and sandy soils. Soil in survey area not calcareous.
Microtis quadrata	P4[b]	Low to moderate	Grows around coastal swamps (Brown *et al*., 2008)
Ornduffia submersa (formerly Villarsia submerse)	P4[b]	Low	Prefers freshwater pools, lakes, swamps, winter-wet depressions, claypans. Does not appear to be inundation in survey area. (Paczkowska and Chapman, 2000).
Tripterococcus paniculatus	P4	Low to moderate	Prefers grey, black or peaty sand and winter-wet flats.
Verticordia lindleyi subsp. *lindleyi*	P4	Low to moderate	Occurs on sand, sandy clay in winter-wet depressions. Limited suitable habitat in the survey area.

a. The rare flora status classification definitions are set out in Appendix 1.

b. Exact locations were not known for these taxa. Rather, they were caught by a search of Herbarium records by suburb name within 5 kilometres of the survey area (DP List).

Table 2. Wetland classification based on permancy of water and a global geomorphic classification system (reproduced from Department of Environmental Protection, 2000b; after Semeniuk in Hill *et al*., 1996).

Water Longevity	Landform				
	Basin	**Channel**	**Flat**	**Slope**	**Highland**
Permanent inundation	lake	river	-	-	-
Seasonal inundation	sumpland	creek	floodplain	-	-
Intermittent inundation	playa#	wadi#	barlkarra#	-	-
Seasonal Waterlogging	dampland	trough#	palusplain	paluslope	palusmont#

Not used on the Swan Coastal Plain in the Perth Metropolitan Region.

Management categories for wetlands in Western Australia have been described by the Water and Rivers Commission (Department of Environmental Protection, 2000b). They are:

- Conservation wetlands: 95-100% vegetated; management objective of preserving their natural attributes and functions.;
- Resource enhancement: 10-94% vegetated; management for restoration and enhancement of natural attributes and functions.;
- Multiple Use: 0-9% vegetated; management for their use and development in the context of water, town and environmental planning.

Geomorphic wetlands have been mapped for the Swan Coastal Plain. Geomorphic wetlands and their management categories in the Rocla Warton Rd locality are shown in Figure 4.

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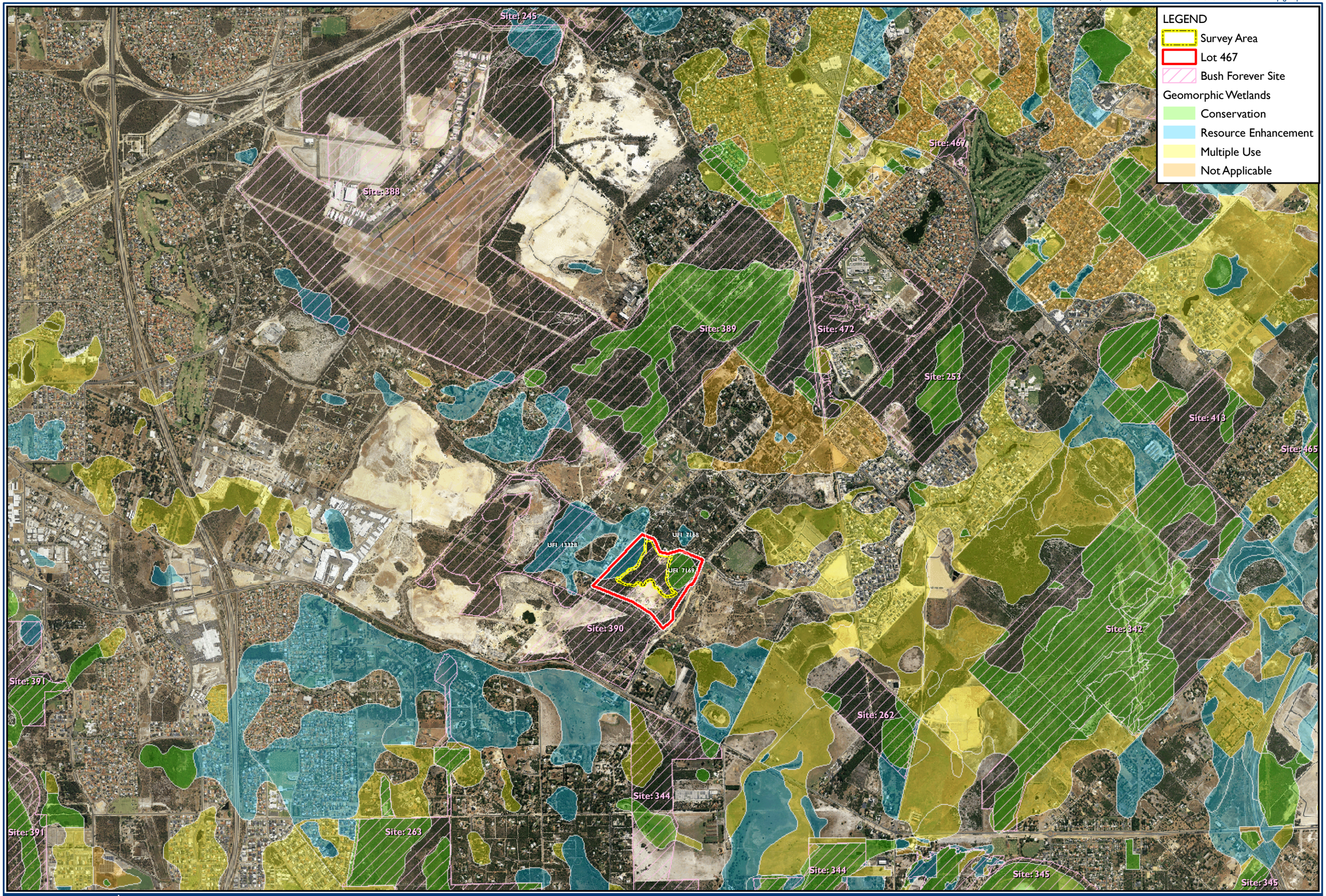

Job Number: L10478
Date: 20.05.11
Scale: 1:30000 @ A3
Revision: C
Drafted by: SC
Source: Cadastre & Orthophoto - Landgate 2010 Wetlands - DEC, 30.12.10 Bush Forever - DPI, 30.09.09

0 190 380 760 1,140 1,520 metres

Figure 4

Bush Forever and Geomorphic Wetlands Within Survey Locality

3.0 METHODS AND LIMITATIONS

3.1 Introduction to the field survey

The Rocla Warton Rd flora and vegetation fieldwork was conducted on the 6th and 7th of October 2010, with a site revisit to re-record quadrats and finalise other works on the 28th of October 2010.

3.2 Vegetation survey

3.2.1 Methods of the vegetation survey

Vegetation was described using quadrats, releves and mapping notes. Locations of sample sites were selected that were representative of observed variations in the vegetation and habitat. Suitable sites for the more detailed descriptions (quadrats) were limited to sites in Good or better condition, where a good suite of species representative of that vegetation type, were present.

Six (6) quadrats, WR1 to WR6, were recorded. Quadrats were 10 metres by 10 metres in size and were marked out with a field measuring tape between fence dropper stakes, which were driven into the ground at each corner. The 10 metre by 10 metre quadrat dimensions were used firstly because a 100m^2 sample area on the Swan Coastal Plain is considered to capture most species in a given plant community and secondly because that was the quadrat size used to collect data for the Gibson *et al*. (1994) Swan Coastal Plain study, with which the Rocla Warton Rd survey data set needed to be compatible.

Each quadrat was photographed. A description of the quadrat location, the habitat, surface soil texture and colour were recorded and the time since the site was last burnt was estimated. The vegetation structure was described using a modification of Specht's vegetation description table by Aplin (1979; Appendix 2). To obtain more representative data for the overstorey cover, the tree layer(s) cover was estimated over a larger area around the quadrats. The condition of vegetation in the quadrat was described using the Keighery classification outlined in Bush Forever (Department of Environmental Protection, 2000b; see Appendix 3). All plant species occurring in a quadrat were recorded, along with their height, percentage cover and specimen number if collected. Where a plant species was not well known, a specimen was collected and allocated a specimen number.

The specimens collected were pressed, dried and identified. The identifications were made by comparison to specimens in the reference and research collections of the

Western Australian Herbarium, by the use of keys in various papers and books and by relevant experts on various groups of flora that occur on the Swan Coastal Plain.

The Department of Environment and Conservation Declared Rare and Priority Flora List (Smith, 2010; definitions in Appendix 1) was consulted as required to confirm the status of plant species in the survey area.

The quadrats were revisited near the end of October to meet the Environmental Protection Authority's (2004) Guidance No 51 requirements. The two visits improved quadrat sampling by increasing the chances of recording, in at least one visit, early and later season flowering plants.

Two releves and three mapping notes were also recorded to describe the vegetation in the survey area. Releves are vegetation descriptions of an unbounded area around a point. Releve descriptions were similar to those for quadrats, but not all plant species were recorded, but rather some associated species were recorded. Mapping notes were an abbreviated form of releves descriptions.

3.2.2 Limitations of the vegetation survey

The cover estimate of each plant species recorded in the quadrats was based on estimating species projected canopy cover. The assumption was made that for most species, canopy cover and projected foliar cover are reasonably similar, or that the difference is less than the level of accuracy of the estimates.

There is a limit to the accuracy of the assignment of the different strata in the vegetation descriptions to structural units (for example, low open woodland, low woodland, low open forest, open shrubland, shrubland etc.). Referral of a stratum to a structural category depends on assessment of its cover. Such estimation is imprecise and it is not unusual for different observers to give quite different estimates of the cover of a species, or stratum in a stand. However, descriptive exercises such as that carried out for this report require only a moderate level of accuracy.

3.3 Flora survey

3.3.1 General flora survey methods

The flora in the study area was recorded while describing and sampling the vegetation (quadrats, releves and mapping notes), while walking between the vegetation recording sites, while mapping the vegetation units and when conducting rare flora searches.

Plant species were recorded elsewhere in the study area if they had not been recorded at a quadrat or releve sampling site or if they were of particular interest. Where a plant species was not well known, a specimen was collected and allocated a specimen number. GPS coordinates were recorded (using a Garmin 60CX hand held GPS unit) whenever it was considered there was a possibility that the plant species may be of special interest.

3.3.2 Rare flora searches

Grid searches for rare flora were conducted over the entire survey area on the 7th of October 2010. The main target was the giant spider orchid, *Caladenia huegelii* (Declared Rare Flora), because it had been recorded in the region and the Banksia woodland on dune slopes was considered to be suitable habitat for that taxon. Grid lines were spaced about 20 metres apart, with adjacent lines walked by one of three botanists. Despite a fairly early and dry Spring season, *Caladenia huegelii* plants were flowering at that time (Andrew Brown (DEC), *pers. comm*.). While searching for the *Caladenia huegelii*, other plants were also recorded if they were not well known, if there was some chance they may have been significant (DRF, Priority or Regionally Significant) or if they had not been recorded elsewhere in the survey area.

3.3.3 Limitations of the flora survey

The major limitation of the flora survey is that any such survey is a sampling procedure of a variable environment with plant populations of variable growth habit, life span and flowering season. Some species, including annuals, are only available for collection for part of the year. This means that to locate all species that grow in an area is a substantial task, the success of which is related to the time available and the size and diversity of habitat in the survey. Consequently, it is possible that there are species present in the survey area that were not recorded during this survey as they have only low abundance on the land, or were not flowering at the time of the survey. However, this limitation was minimised by surveying the site and then revisiting the quadrats during early and late Spring respectively, increasing the number of annual taxa that were in or near some stage of flowering at a survey time.

Given the limitations of the flora survey, it is likely that this survey recorded more than 85 to 90% of the vascular flora in the survey area. That is, while the flora survey was relatively thorough, it was possible that some species occurring in the survey area were not recorded.

3.4 Vegetation mapping

3.4.1 Methods for vegetation mapping

Vegetation units were recorded generally between plant community and plant association level. The vegetation unit boundaries were drawn on a computer generated aerial photograph while traversing the study area, using GPS coordinate readings to locate actual boundary positions. Orthocorrected aerial photography at 1:5000 was supplied by 360 Environmental PL.

The vegetation mapping unit descriptions were based on the quadrat, releve and mapping note descriptions. The vegetation descriptions recorded in the field were later synthesized into vegetation units, with some reference to the floristic similarity of quadrats determined by PATN analysis (see below).

3.4.2 Wetland vegetation mapping

The identification and delineation of a wetland is dependent on an areas hydrology, hydric soils and wetland vegetation (Hill *et al*., 1996). Obligate wetland species are considered reliable wetland indicators (Hill *et al*., 1996).

The vegetation units recorded at Rocla Warton Rd survey area were classified as wetland vegetation if a number of obligate wetland species were present in the units as dominants and if PATN analysis suggested an affinity with wetland Floristic Community Types (see below). Obligate wetland species were considered to be those that only occur in wetland sites and therefore appeared to require wetland conditions for growth. Table 3 shows a list of selected plant species that occur in the Perth Metropolitan area that were considered to be obligate wetland species after reference to the literature and from the experience of the author.

3.5 Floristic Community Types and PATN analysis of vegetation units

3.5.1 Introduction

The floristic analysis compared the similarity of species presence/absence data collected at the six (6) Rocla Warton Rd quadrats with the data for 509 sites recorded across the Swan Coastal Plain in a broad survey by Gibson *et al*. (1994).

3.5.2 Data storage and handling

The Rocla Warton Rd vegetation quadrat data was entered into a specially designed computer database developed by E. A. Griffin and M. Trudgen using Microsoft Access.

Table 3. List of a selection of plant species considered to be obligate wetland species in south-west Western Australia.

Wetland Species	Notes[a]
Astartea affinis	Found on seasonal wetlands, flats, creeklines, claypans.
Baumea juncea	Found in seasonally waterlogged or partially inundated areas which have fresh to brackish or seasonally saline water (Water and Rivers Commission, 1997).
Baumea vaginalis	In fresh and semi-saline waters at seasonally wet to permanently inundated sites such as swamp margins.
Baumea articulata	Can tolerate deep inundation for prolonged periods; normally fringes lakes, sumplands and watercourses.
Banksia littoralis (Swamp banksia)	Associated with winter-wet depressions. Frequently occurs in swampy areas, but is not tolerant of inundation and prefers areas subject to only short winter waterlogging or very shallow groundwater table (Water and Rivers Commission, 1997).
Cyathochaeta teretifolia	Usually found bordering swamps and along watercourse (Wheeler *et. al*., 2002).
Eucalyptus rudis subsp. *rudis* (Flooded gum)	Flooded gum is common fringing winter-wet depressions, lakes and watercourses on the SCP. It can tolerate prolonged periods of flooding and usually found in waterlogged areas (Water and Rivers Commission, 1997).
Euchilopsis linearis	Frequent in winter-wet depressions on Coastal Plain (Marchant *et al*.1987)
Lepidosperma longitudinale	Sandy and peaty soils in winter-wet depressions and along watercourses (Water and Rivers Commission, 1997).
Melaleuca lateritia	Fringes watercourses and in seasonally wet depressions (Water and Rivers Commission, 1997).
Melaleuca preissiana	In waterlogged soils fringing rivers and swamps. Less tolerant of prolonged inundation than *Melaleuca rhaphiophylla* (Water and Rivers Commission, 1997).
Melaleuca rhaphiophylla (Swamp paperbark)	Tolerates periodic inundation, but prefers waterlogged sites. Found near both fresh and saline water, but is less adapted for saline water conditions than Saltwater Paperbark (Water and Rivers Commission, 1997).
Melaleuca teretifolia	Associated with lakes or in winter-wet depressions on Coastal Plain; in sandy soils, sometimes with clay (Marchant *et al*., 1987).
Pericalymma ellipticum	occurs mainly in winter-wet depressions and along water courses (Marchant *et al*., 1987).
Pultenaea ochreata	Occurs on sandy soils of winter-wet depressions on the Swan Coastal Plain (Marchant *et al*., 1987).
Schoenus efoliatus	Occurs in swamps and winter-wet areas (Wheeler *et. al*., 2002).
Schoenus subfascicularis	Occurs in winter-wet depressions on Coastal Plain (Marchant *et al*., 1987).
Taxandria linearifolia (Swamp peppermint)	Fringes swamps and watercourses (Water and Rivers Commission, 1997).

a: Notes from DEC, 1997.

3.5.3 Data preparation and compatibility

To conduct the analysis on the Rocla Warton Rd quadrat data and the Gibson *et al*. (1994) dataset, it was first necessary to reconcile the names of the flora species. This step was necessary because of changes in the nomenclature over the last ten years and the potential for survey specific variations in the application of names. The reconciliation involved reducing some infra-specific names to the relevant species name, combining some taxa where confusion is known to have occurred in field observations and identifications and omitting some names (mostly where a taxon had only been identified to genus).

The Rocla Warton Rd data was compatible with the Gibson *et al*. (1994) data. Both datasets were based on data collected from quadrats of the same size (10 metres by 10 metres) and collected from two visits to each quadrat, at different times of season. Weed species were included in both the Gibson *et al*. (1994) and Rocla Warton Rd datasets.

3.5.4 PATN analysis

Mr Ted Griffin conducted the Rocla Warton Rd quadrat PATN analysis.

Following the reconciliation of species names between the Rocla Warton Rd survey and the Gibson *et al*. (1994) Swan Coastal Plain survey, the PATN analysis was conducted on the combined datasets. This analysis grouped the Rocla Warton Rd survey sites with the most floristically similar sites from the combined dataset. Each of the Rocla Warton Rd sites could then be allocated the Gibson *et al*. Floristic Community Type (FCT) of the most similar sites from the Gibson *et al*. dataset, with the degree of similarity indicated by 'dissimilarity coefficients'.

The methods of the PATN analysis are set out in more detail in a report prepared by Mr Ted Griffin that is included in full in Appendix 8.

3.5.5 Limitations of the floristic analysis

It has been found in other floristic analysis that the addition of new sites to the Gibson *et al*. (1994) data set to produce a combined classification, may disrupt the original classification of sites (Griffin and Trudgen, 2004). The more data that is added, the higher the level of disruption. If this occurs it can make it difficult to assign the new sites to the Gibson *et al*. Floristic Community Types (Griffin and Trudgen, 2004).

Another limitation in conducting a PATN floristic analysis using the above methods may arise depending on the degree of success in reconciling the two data sets. A further limitation may arise from any significant differences in data collection methods between the two surveys. However, this limitation was most likely inimportant in this PATN analysis, as the collection methods were similar between the two surveys (see above comments).

3.6 Identification of Threatened Ecological Communities (TEC's) and Priority Ecological Communities (PEC'S).

Once the Rocla Warton Rd quadrats were each assigned to a Floristic Community Type, a current table of Swan Coastal Plain TEC'c (DEC website, 2011) was consulted to determine if any of the Rocla Warton Rd vegetation sites (FCT's) were TEC's.

To determine if any of the Rocla Warton Rd FCT's were PEC's, a list of PEC's was consulted (DEC website, 2011).

3.7 Flora and vegetation and regional significance

Regional significance of the Rocla Warton Rd flora and vegetation was assessed against the criteria for the determination of regional significance of natural areas set out in Guidance Statement No. 10 (EPA, 2006).

4.0 FLORA OF THE SURVEY AREA

4.1. Flora list for the survey area

One hundred and fifty three (153) species of native flowering plants, one native fern and one native cycad (the Zamia Palm, *Macrozamia riedlei*) were recorded in the Rocla Warton Rd survey area. In addition, thirty eight (38) non-native species were recorded from the survey area. A list of species recorded in the Rocla Warton Rd survey area are shown in Appendix 4.

The flowering plant families that were well represented by native species in the survey area were the Myrtaceae (eucalypt family) with eighteen (18) native species, Fabaceae (pea and *Acacia* family) with fifteen (15) native species, Cyperaceae (sedge family) with eleven (11) native species, the Asteraceae (daisy family) with nine (9) native species, the Haemodoraceae family with nine (9) native species and the Proteaceae (Banksia family) with nine (9) native species.

The number of native species recorded in the Rocla Warton Rd survey area was probably a moderate number for the limited habitats in what was a small survey area (eleven hectares). The species richness (including weeds) of quadrats was greatest in the Banksia woodland and low in the dampland sites (Table 4). The higher number in dampland quadrat WR4 reflected its transitional nature, with many dryland species present.

Table 4. Number of species recorded in the Rocla Warton Rd survey quadrats.

Quadrat number	Number of species	Vegetation
WR1	68	Banksia woodland
WR2	55	Banksia woodland
WR3	46	Banksia woodland
WR4	50	*Melaleuca preissiana* woodland (dampland)
WR5	32	*Schoenus subfascicularis* sedgeland (dampland)
WR6	33	*Adenanthos cygnorum*, *Hypocalymma angustifolium* shrubland (dampland)

4.2 Significant flora and flora of interest in the survey area

4.2.1 Declared Rare Flora (DRF) recorded in the survey area

No Declared Rare Flora were recorded in the Rocla Warton Rd survey area.

4.2.2 Priority flora species recorded from the survey area

No Priority flora species were recorded in the survey area.

4.2.3 Other species of regional significance recorded in the survey area

Two plant species considered to have regional significance in the Rocla Warton Rd survey area, *Hensmania turbinata* and *Pultenaea ochreata*, were recorded.

4.2.3.1 *Hensmania turbinata*

Hensmania turbinata is a perennial herb about 20cm high (Paczkowska and Chapman, 2000). It is considered regionally significant in the Perth Metropolitan area because that is about the southern most extent of its range (Department of Environmental Protection, 2000b).

Hensmania turbinata was recorded from one location in the survey area, although its exact location was not recorded.

4.2.3.2 *Pultenaea ochreata*

Pultenaea ochreata is an erect shrub that grows to between 30 cm and 2 metres tall, has a pea flower and has been recorded on sandy soils in winter wet depressions (Paczkowska and Chapman, 2000; Plate 1). The Perth Metropolitan area appears to be at the northern limit of *Pultenaea ochreata's* range and it would therefore be of regional significance in the Perth area.

Plate 1. *Pultenaea ochreata*. (Photograph reproduced from FloraBase, Dept of Environment and Conservation website).

Pultenaea ochreata was recorded at three locations in the south-east corner of the survey area, near (and including) quadrat WR6.

4.2.4 Other species of interest recorded in the survey area

Two taxa recorded in the survey area, *Leucopogon* sp. Murdoch (M. Hislop 1037) and *Hibbertia huegelii sens. lat*., were also of interest.

Leucopogon sp. Murdoch (M. Hislop 1037) is an erect open shrub growing to a height of 70 to 80 centrimetres (DEC FloraBase website, May 2011; Plate 2). It grows on sand soils on winter wet sites, plains and swamps. Its range includes the Swan Coastal Plain and Geraldton sand plains between Eneaba in the north and Bunbury in the south (Mike Hislop, Western Australian Herbarium, *pers. comm*.). However, it is scattered sparsely within its range and generally only occurs in small numbers (Mike Hislop, *pers. comm*.). In its general appearance, without close scrutiny, *Leucopogon* sp. Murdoch (M. Hislop 1037) may be mistaken for *L. propinquus*.

Leucopogon sp. Murdoch (M. Hislop 1037) was recorded and collected once in the south west corner of the survey area.

Plate 2. *Leucopogon* sp. Murdoch (M. Hislop 1037). (Photograph reproduced from Flora Base, Dept of Environment and Conservation website).

Hibbertia huegelii sens. lat. refers to one collection of *Hibbertia huegelii* from the survey area that differed from the more common form of *H. huegelii* by having a dense covering of long hairs on the outer calyx surface as well as on the lower parts of the leaves. *Hibbertia huegelii sens. lat*. keyed to *Hibbertia huegelii* and matched some variations of *Hibbertia huegelii* in the Western Australian Herbarium's main collection (Mike Hislop, *per. comm*.). It was collected on the lower dune slopes on the eastern side of the survey area.

5.0 VEGETATION OF THE SURVEY AREA

5.1 Vegetation description

5.1.1 Introduction to the vegetation descriptions

The vegetation units described are considered to be mostly described at the vegetation association level.

The vegetation unit codes that discriminate the mapped vegetation units are derived from the generic and species names of the more abundant genera or species in the different strata present in each unit (see Table 5). For example, the vegetation unit 'MpAa' has its code derived from two of the dominant species in that unit: 'Mp' (*Melaleuca preissiana*) and 'Aa' (*Astartea affinis*).

Table 5. Abbreviations for species names that were used in vegetation unit codes.

Code	Species name	Code	Species name
Aa	*Astartea afinis*	Ha	*Hypocalymma angustifolium*
Ac	*Adenanthos cygnorum*	Mp	*Melaleuca preissiana*
Ba	*Banksia attenuata*	Pe	*Pericalymma ellipticum*
Bm	*Banksia menziesii*	Ss	*Schoenus subfascicularis*

5.1.2 Vegetation of the Rocla Warton Rd survey area

5.1.2.1 Overview

Six vegetation units were described and mapped in the remnant bushland in the Rocla Warton Rd survey area (Figure 5). These have been arranged into three vegetation groupings according to habitat in which they occurred:

- *Banksia attenuata-Banksia menziesii* low woodlands on dune slopes;
- *Melaleuca preissiana* mixed woodlands on gentle slopes and flats around the base of the dune (transitional vegetation);
- *Pericalymma* heaths and sedgelands on flats (dampland/palusplain).

Banksia attenuata-Banksia menziesii low woodlands covered the dune crest and slopes that occupy most of the survey area (Figure 5). *Eucalyptus todtiana* occurred in scattered patches across the dune, but occurred more consistently on the lower slopes. Transitional dryland vegetation of mixed woodlands with *Melaleuca preissiana* scattered low trees occurred along the base of the dune on the western and parts of the eastern edges of the survey area. Transitional wetland vegetation included *Melaleuca preissiana* low open forests and shrublands of *Adenanthos cygnorum* and *Hypocalymma angustifolium* on the flats (included wetland and dryland species).

Small areas of *Pericalymma ellipticum* heath and *Schoenus subfascicularis* sedgelands (seasonal damplands) occurred in the south-western and north-western corners of the survey area.

5.1.2.2 Vegetation units

(i) *Banksia attenuata-Banksia menziesii* low woodlands on dune slopes

BaBm

Banksia attenuata, Banksia menziesii, (*Allocasuarina fraserina*) low woodland over *Allocasuarina humilis* shrubland over *Hibbertia hypericoides, Astroloma xerophyllum* low shrubland over *Desmocladus flexuosus, Amphipogon turbinatus* open sedgeland/grassland.

Habitat and soil: Mid to upper slopes of dune. Pale grey sand over yellow sand.

Notes: This vegetation was recorded at quadrats WR1, WR2 and WR3 (Plate 3) (details in Appendix 5). *Eucalyptus todtiana* occurred occasionally on the upper slopes and scattered on the lower slopes.

(ii) *Melaleuca preissiana* mixed woodlands on gentle slopes and flats around the base of the dune

MpAa

Melaleuca preissiana, (*Allocasuarina fraseriana*) low open forest over *Xanthorrhoea preissii, Astartea affinis* open shrubland over *Hypocalymma angustifolium* scattered low shrubs over *Dasypogon bromeliifolius* open herbland to herbland.

Habitat and soil: North facing, very gently sloping to flat seasonal dampland. Grey sand.

Notes: This vegetation was recorded at quadrat WR4 (Plate 4) (details in Appendix 5). It occurred in the south-west corner of the survey area and included dryland species (eg *Allocasuarina fraseriana*) as well as dampland species (eg *Melaleuca preissiana, Baumea juncea*). It was considered to be transitional dampland vegetation.

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VEGETATION UNITS

(i) *Banksia attenuata-Banksia menziesii* low woodlands on dune slopes

BaBm *Banksia attenuata*, *Banksia menziesii*, (*Allocasuarina fraserina*) low woodland over *Allocasuarina humilis* shrubland over *Hibbertia hypericoides*, *Astroloma xerophyllum* low shrubland over *Desmocladus flexuosus*, *Amphipogon turbinatus* open sedgeland/grassland.

(ii) *Melaleuca preissiana* mixed woodlands on gentle slopes and flats around the base of the dune

MpAa *Melaleuca preissiana*, (*Allocasuarina fraseriana*) low open forest over *Xanthorrhoea preissii*, *Astartea affinis* open shrubland over *Hypocalymma angustifolium* scattered low shrubs over *Dasypogon bromeliifolius* open herbland to herbland.

MpBmBa *Melaleuca preissiana*, *Banksia menziesii*, *Banksia attenuata*, (*Nuytsia floribunda*, *Eucalyptus todtiana*) low woodland over *Xanthorrhoea preissii*, *Adenanthos cygnorum* subsp. *cygnorum* shrubland over *Hibbertia subvaginata* low open shrubland with *Dasypogon bromeliifolius* herbland.

(iii) *Pericalymma* heaths and sedgelands on flats (dampland/palusplain).

Pe *Pericalymma ellipticum* closed heath over *Daviesia incrassata* subsp. *incrassata*, *Euchilopsis linearis* scattered low shrubs (*Hypocalymma angustifolium* low shrubland in parts) over *Lyginia imberbis*, *Hypolaena exsulca* very open sedgeland.

Ss *Acacia pulchella* var. *goadbyi* scattered shrubs over *Hypocalymma angustifolium*, *Pericalymma ellipticum* scattered low shrubs over *Schoenus subfasciculatis* closed sedgeland.

AcHa *Kunzea glabrescens* scattered tall shrubs over *Adenanthos cygnorum* shrubland over *Hypocalymma angustifolium* low open shrubland over *Hypolaena exsulca* very open sedgeland with *Dasypogon bromeliifolius*, *Phlebocarya ciliata* herbland.

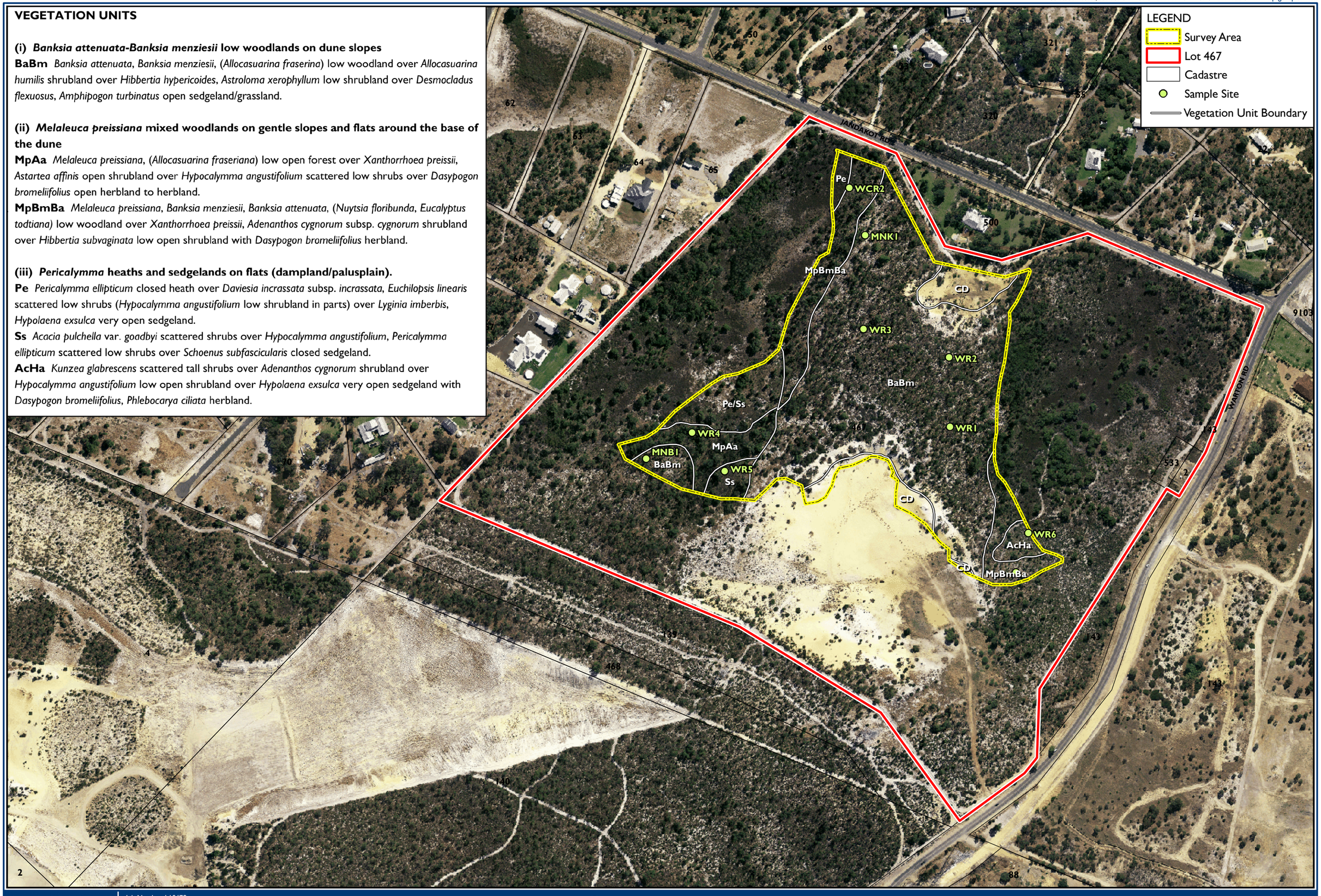

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Figure 5

Vegetation Units

Plate 3. ***Banksia attenuata-Banksia menziesii*** **low woodland unit 'BaBm' at quadrat WR3.**

Plate 4. Vegetation unit 'MpAa' at quadrat WR4.

MpBmBa

Melaleuca preissiana, *Banksia menziesii*, *Banksia attenuata*, (*Nuytsia floribunda, Eucalyptus todtiana)* low woodland over *Xanthorrhoea preissii*, *Adenanthos cygnorum* subsp. *cygnorum* shrubland over *Hibbertia subvaginata* low open shrubland with *Dasypogon bromeliifolius* herbland.

Habitat and soil: Flats adjacent to dune. Pale grey sand.

Notes: This vegetation was recorded at releve WCR1 (Plate 5) (details in Appendix 6). This transitional vegetation occurred between the *Banksia* low woodland on the dune slopes and the damplands/palusplain on the flats adjacent to the dune slopes. It included scattered *Melaleuca preissiana* amongst dryland tree and shrub species.

Plate 5. Vegetation unit 'MpBmBa' at releve site WCR1.

(iii) *Pericalymma* heaths and sedgelands on flats (dampland/palusplain).

Pe

Pericalymma ellipticum closed heath over *Daviesia incrassata* subsp. *incrassata*, *Euchilopsis linearis* scattered low shrubs (*Hypocalymma angustifolium* low shrubland in parts) over *Dasypogon bromeliifolius*, *Phlebocarya ciliata* open herbland (near edge of unit) and *Lyginia imberbis*, *Hypolaena exsulca* very open sedgeland.

Habitat and soil: Slight depression on flat (wetland). Sand.

Notes: This vegetation was recorded at releve WCR2 (Plate 6) (details in Appendix 6). It occurred in a small area in the north-west corner of the survey area. It occurred in a mosaic with sedgeland unit Ss in the south-western part of the survey area, where it was surrounded by transitional dampland vegetation that had an overstorey that included scattered *Melaleuca preissiana*, *Banksia littoralis* and *Banksia ilicifolia* and had patches of *Melaleuca teretifolia* open shrubland (see site description MNB2, Appendix 6)

Ss

Acacia pulchella var. *goadbyi* scattered shrubs over *Hypocalymma angustifolium*, *Pericalymma ellipticum* scattered low shrubs over *Schoenus subfascicularis* closed sedgeland.

Habitat and soil: Flat dampland. Grey sand.

Notes: This vegetation was recorded at quadrat WR5 (Plate 7) (details in Appendix 5). This vegetation occurred in a small area in the southwest corner of the survey area.

AcHa

Kunzea glabrescens scattered tall shrubs over *Adenanthos cygnorum* shrubland over *Hypocalymma angustifolium* low open shrubland over *Hypolaena exsulca* very open sedgeland with *Dasypogon bromeliifolius*, *Phlebocarya ciliata* herbland.

Habitat and soil: Flat at base of dune (wetland transition). Pale grey to white sand.

Notes: This vegetation was recorded at quadrat WR6 (Plate 8) (details in Appendix 5). It occurred in a small area in the south-east corner of the survey area.

Plate 6. ***Pericalymma ellipticum*** **heath vegetation, 'Pe', at releve site WCR2.**

Plate 7. ***Schoenus subfascicularis*** **sedgeland vegetation unit 'Ss' at quadrat WR5.**

Plate 8. Vegetation unit 'AcHa' at quadrat WR6.

5.2 Wetland vegetation

The vegetation units described in section 5.1 above are shown in Table 6, together with their wetland status. The location of the wetland vegetation and its boundaries can be seen in Figure 6.

The *Pericalymma ellipticum* heath ('Pe') and *Schoenus subfascicularis* sedgeland ('Ss') units were considered to be wetland vegetation (seasonal damplands). These wetlands units occurred on the eastern side of the survey area. Two transitional vegetation units on the flats at the baseof the dune ('MpAa' and 'AcHa'), were deemed to be transitional damplands. 'MpAa' was considered to be a transitional dampland because of its relationships with the wetland FCT5 evident in the PATN analysis dendrogram and because it included high cover of the wetland obligate *Melaleuca preissiana*. 'AcHa' was considered to be a transitional dampland because of its affinity to wetland FCT4, demonstrated in the PATN nearest neighbour analysis and because of the presence of some wetland obligate species. Conversely, the transitional vegetation unit 'MpBmBa', that occurred on the base of the dune slopes, had mostly dryland elements and was considered to be transitional dryland vegetation.

Table 6. Rocla Warton Rd vegetation units and their wetland status

Vegetation grouping	Vegetation unit	Wetland status	Comments
(i) *Banksia attenuata-Banksia menziesii* low woodlands on dune slopes	BaBm	Dryland	
(ii) *Melaleuca preissiana* mixed woodlands on gentle slopes and flats around the base of the dune (transitional vegetation)	MpAa	Transitional wetland (dampland)	Includes some obligate wetland species (*Melaleuca preissiana* (as a mixed low open forest), *Astartea affinis* and *Baumea juncea*) and came out close to FCT5 on the PATN dendrogram, although nearest neighbours found 'MpAa' most similar to dryland FCT's 23a and 28 (see Appendix 8).
" "	MpBmBa	Dryland (transitional)	Only scattered *Melaleuca preissiana* trees amongst predominantly dryland species.
" "	AcHa	Transitional wetland (dampland)	Includes some obligate wetland species, such as *Astartea affinis* and *Hypolaena exsulca* and is floristically similar to the dampland FCT4, as well as some dryland vegetation FCT's (see Appendix 8).
(iii) *Pericalymma* heaths and sedgelands on flats (dampland/palusplain).	Pe	Wetland (dampland)	Inferred as FCT5
" "	Ss	Wetland (dampland)	Affinity to wetland FCT5 demonstrated by PATN nearest neighbours analysis

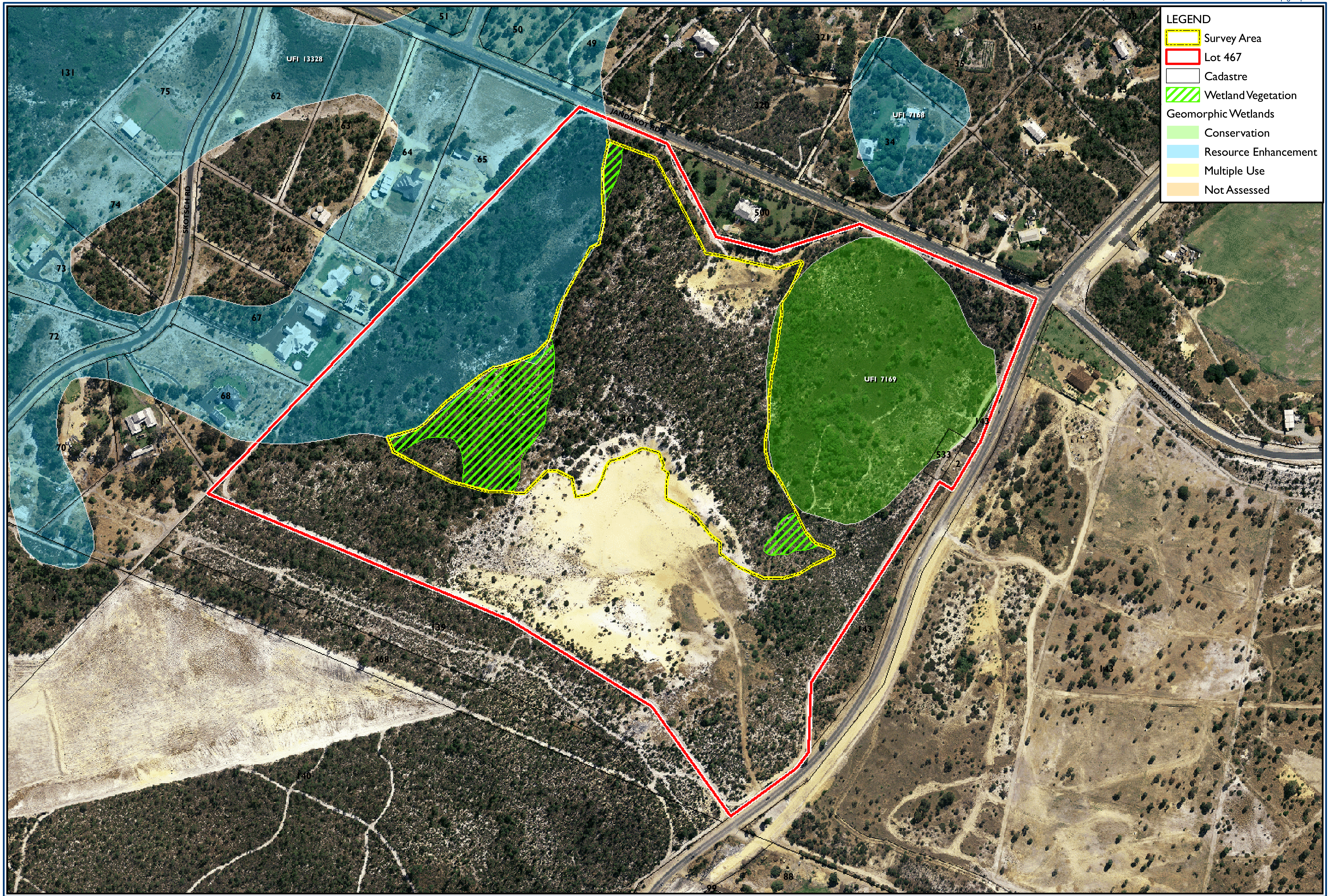

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Figure 6

Wetland Vegetation

5.3 Vegetation condition

The vegetation in the survey area was mostly rated Very Good to Excellent, with the vegetation condition rated Excellent at a number of sample locations on the dunes and flats (Figure 7). The condition of the wetland vegetation was considered to be Very Good to Excellent. Completely Degraded areas in the northern and southern parts of the survey area were past sand mine areas (Plate 9).

Thirty eight weeds were recorded in the survey area (Appendix 4). However, weed cover was generally low throughout the remnant bushland in the survey area and were only abundant in the Completely Degraded areas.

Banksia spp. deaths, including recent deaths, were noted on the dune slopes in the survey area (Plates 10, 11). Locations of some of the observed areas of Banksia deaths are provided in Appendix 7. The deaths and decline of *Banksia* trees at this site probably indicate the presence of the Dieback fungus *Phytophthera cinnamomi*. However, other agents such as fire and drought (including falling water tables), as well as other pathogens, may also be responsible for Banksia tree deaths. To determine if Dieback is present and over what area, a dieback survey by accredited 'dieback interpreters' would be required.

Plate 9. Completely Degraded old sand mine area at the northern end of the survey area.

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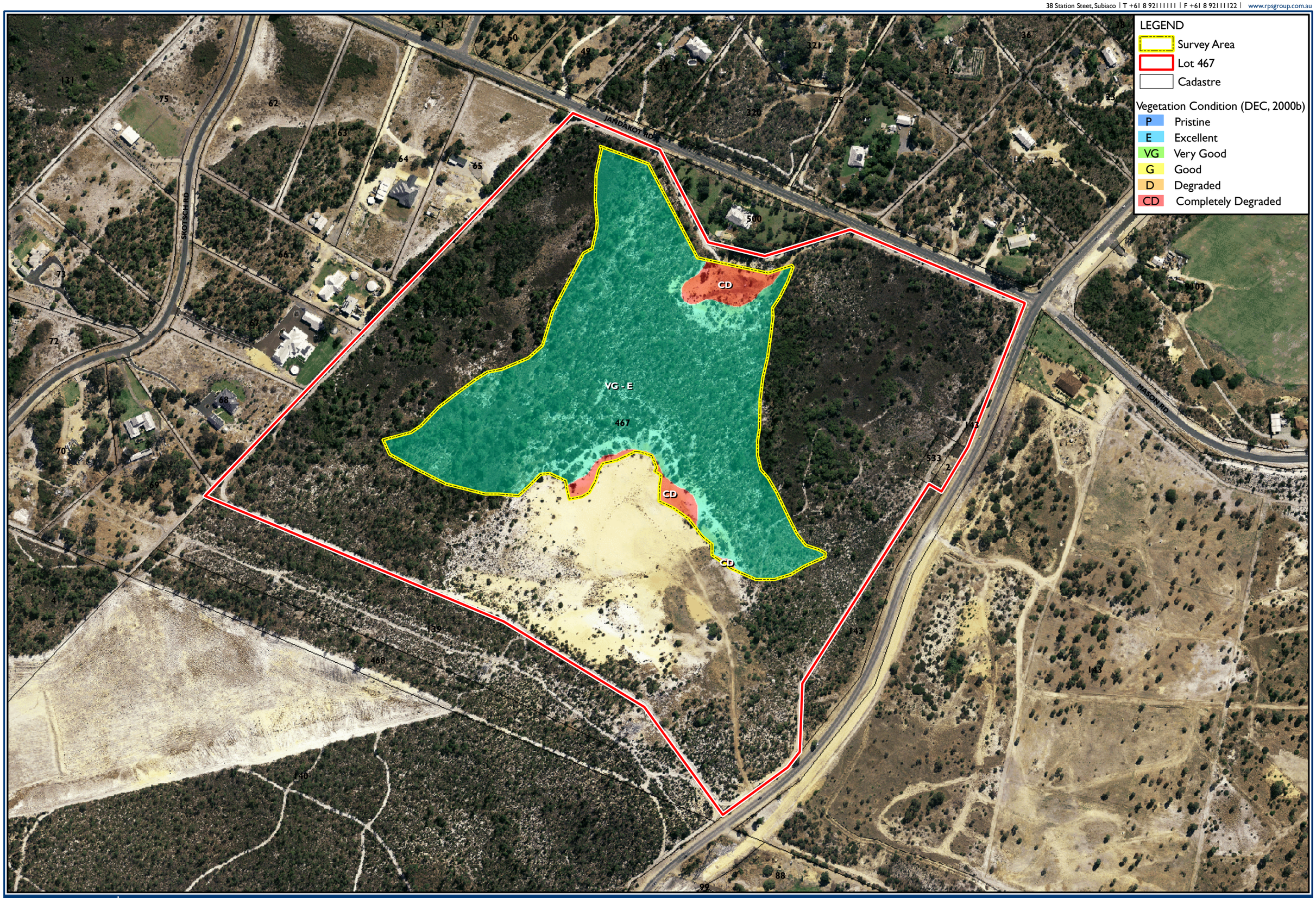

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Figure 7

Vegetation Condition

Plate 10. Banksia tree deaths in bushland just south of the old northern sand mine.

Plate 11. *Banksia attenuata* and *Banksia menziesii* deaths at the base of the dune on the east side of the survey area.

5.4 *Lomandra hermaphrodita* and *L. maritima* occurrence : host plants of the Graceful Sun Moth

The Graceful Sun Moth (*Synemon gratiosa*, Family Castniidae) is endemic to Western Australia, and is currently considered restricted to the Swan Coastal Plain between the Wanneroo area in northern Perth, south to Mandurah (approximately 60 km south of Perth). The Graceful Sun Moth is listed as under the *Environment Protection and Biodiversity Conservation Act 1999* and is also currently listed on Schedule 1 (fauna that is rare or is likely to become extinct) of the Western Australian *Wildlife Conservation Act 1950.*

The Graceful Sun Moth is thought to breed exclusively on *Lomandra* species, probably *L. hermaphrodita*. Two known food plants for the Graceful Sun Moth are *Lomandra hermaphrodita* and *L. maritima* (McNamara 2009, sited on Department of the Environment, Water, Heritage and the Arts website).

Lomandra maritima was not recorded in the Rocla Warton Rd survey area. However, *Lomandra hermaphrodita* plants were recorded at all three of the quadrats located on the dune slopes. While opportunisitic sightings of *Lomandra hermaphrodita* plants elsewhere in the site were not recorded during the survey, the fact that it occurred at all three sample points on the dune (less than 2% cover) suggests that it is probably scattered on the dune slopes in the survey area.

6.0 FLORISTIC COMMUNITY TYPES (FCT'S), THREATENED ECOLOGICAL COMMUNITIES (TEC'S) AND PRIORITY ECOLOGICAL COMMUNITIES (PEC'S)

This section outlines the results of the floristic analysis conducted by Mr Ted Griffin using the 2010 Rocla Warton Rd survey data and the Gibson *et al*. (1994) Swan Coastal Plain dataset. It is based on a detailed report prepared by Mr Ted Griffin, which is set out in full in Appendix 8.

6.1 Floristic analysis

6.1.1 Data Compatability

Mr Ted Griffin assessed that the Rocla Warton Rd survey sites appeared to have similar numbers of ephemeral species (such as Orchids) to those of the Gibson *et al*. (1994) sites. Further, he concluded that on the basis of richness and names that the datasets were probably sufficiently compatible to obtain reliable determinations (Appendix 8).

6.1.2 Determination of Floristic Community Types (FCT) by classification

The dendrogram results of the PATN analysis classification are shown in Appendix 8 and Table 7. This shows that the Rocla Warton Rd sites were divided between the dune sites that were most similar to FCT23a and sites on the flats that were similar to the wetland FCT's 4 and 5.

6.1.3 Determination of Floristic Community Types (FCT) using nearest neighbours method

Griffin found that the the nearest neighbour analysis also suggested that the Rocla Warton Rd dune slope sites belong to FCT23a, but suggested that two of the sites on the flats had affinities to both wetland and dryland FCT's (see Table 7; Appendix 8).

6.1.4 Combining the results: assignment of Floristic Community Types (FCT) to the Rocla Warton Rd quadrat sites

The overall result of the Rocla Warton Rd quadrat PATN analysis is shown in Table 7 below (reproduced from Griffin's report, see Appendix 8).

The dune Banksia woodland vegetation sites were all most similar to Floristic Community Type (FCT) 23a. The *Schoenus subfascicularis* sedgeland vegetation was consistently similar to FCT5 dampland sites. The *Adenanthos cygnorum-Hypocalymma angustifolium* shrubland site had mixed affinities, but had strong affinity to dampland FCT4 vegetation. The *Melaleuca preissiana* low open forest vegetation had some affinity with dampland vegetation FCT5. Both the

Melaleuca preissiana low open forest and *Adenanthos cygnorum-Hypocalymma angustifolium* shrubland vegetation were deemed to be wetland vegetation units because of their PATN floristic affinities and because of the presence and cover of obligate wetland species.

In interpreting the PATN analysis results, Griffin noted that "It is common for the classification '(dendrogram)' to indicate a simple result and the nearest neighbour analysis to be less conclusive. This is more a product of the classification process often suggesting an over simplified view than of inconsistency of the analyses" (see Appendix 8). Griffin (*pers. comm*.) has previously noted that the nearest neighbour analysis is more easily interpreted and reliable than the classification analysis and has given more weight to the nearest neighbour analysis assignment of vegetation sites to FCT's.

Table 7. Summary of Rocla Warton Rd PATN Analysis results. (Adapted from report by EA Griffin which is reproduced in full in Appendix 8).

Site	Dendrogram FCT	NNB FCT	Summary FCT
WR1	23a	23a	23a
WR 2	23a	23a	23a
WR 3	23a	23a	23a
WR 4	5	23a,28	23a/5
WR 5	5	5	5
WR 6	4	4,22,23a	4? (4/22)

6.2 Rocla Warton Rd vegetation units, their Floristic Community Types and assessment for Threatened Ecological Communities (TEC's) and Priority Ecological Communities (PEC's)

The vegetation units described and mapped in the Rocla Warton Rd survey area are listed in Table 8, together with the quadrats recorded in those units and the FCT's attributed by PATN analysis (and in some cases inferred) to those sites. FCT's were inferred to the vegetation units by comparison with other floristically similar Rocla Warton Rd vegetation units where quadrats had been recorded or by comparing species in site descriptions with species occurring in the Gibson *et al*. FCT's.

All of the FCT's with which Rocla Warton Rd vegetation units were found to have an affinity, are listed in Table 9, along with their descriptions, predominant landforms and status. Referrence to the current list of TEC's for Western Australia (DEC

website Aug 2010) showed that none of the FCT's occurring in the survey area were Threatened Ecological Community. One vegetation unit, 'AcHa', had some affinity with FCT22, which is a Priority 2 PEC (Tables 8 and 9).

Table 8. Summary of Rocla Warton Rd survey area vegetation units and FCT's.

Mapped Vegtn unit	Broad classification	Site	FCTz
AcHa	*Pericalymma* heaths and sedgelands on flats (dampland/palusplain).	WR6	4/22
BaBm	*Banksia attenuata-Banksia menziesii* low woodlands on dune slopes	WR1, WR2, WR3	23a
MpAa	*Melaleuca preissiana* mixed woodlands and mixed shrublands on gentle slopes and flats around the base of the dune (transitional vegetation)	WR4	23a/5
MpBmBa	*Melaleuca preissiana* mixed woodlands and mixed shrublands on gentle slopes and flats around the base of the dune (transitional vegetation)	WCR1, MNK1	$23a_z$
Pe	*Pericalymma* heaths and sedgelands on flats (dampland/palusplain).	WCR2, MNB2	5_z
Ss	*Pericalymma* heaths and sedgelands on flats (dampland/palusplain).	WR5	5

z FCTs inferred.

Table 9. Summary of Floristic Community Types occurring in the Rocla Warton Rd survey area.

FCT	Generalised description	Predominant landform	Status
FCT4	*Melaleuca preissiana* damplands	Bassendean	none
FCT5	Mixed shrub damplands	Bassendean/Pinjarra plain	none
FCT22	*Banksia ilicifolia* woodlands	Bassendean	PEC (Priority 2)
FCT23a	Central *Banksia attenuata-Banksia menziesii* woodlands	Bassendean	none

7.0 REGIONAL SIGNIFICANCE ASSESSMENT

Flora and vegetation values in the Rocla Warton Rd survey area were assessed for regional significance (Table 10) using the criteria for determination of regional significance of natural areas set out in the EPA Guidance Statement No. 10 (Environmental Protection Authority, 2006) and Bush Forever (Department of Environmental Protection, 2000a).

The Rocla Warton Rd survey area was assessed as regionally significant for flora and vegetation on the following grounds (see Table 10):

- Representation of ecological communities (less than 10% of Southern River Complex is protected (Department of Environmental Protection, 2000b)); and
- Maintaining linkages (part of a 'regionally significant but not contiguous linkage of bushland/wetland area') (Department of Environmental Protection, 2000b).

The vegetation in the Rocla Warton Rd survey area is Southern River Complex, of which 17% of its original extent in the Perth Metropolitan area remains, but about 6% of this original extent has some existing protection (Department of Environmental Protection, 2000a). The Department of Environment and Conservation has a modified objective for Constrained Areas being to seek to:

• retain at least 10% of the pre-clearing extent of the ecological community where >10% of the ecological community remains, or

• retain all remaining areas of each ecological community where <10% of this ecological community remains. (Environmental Protection Authority, 2006)

It was also noted that bushland in the survey area was part of an area of 'upland and wetland' ecological communities.

The Rocla Warton Rd survey area is part of a north-south orientated bushland corridor between Gibbs Rd and Jandakot Airport/Canningvale bushland that has been assigned the status of 'Regionally significant but not contiguous linkage of bushland/wetland areas' (Department of Environmental Protection, 2000b).

It is noted that the Rocla Warton Rd survey area includes a narrow strip along the edge of a Conservation Category Wetland along its eastern boundary (Figures 4 and 5). The vegetation in this part of Conservation Category Wetland has been checked and confirmed as dryland vegetation adjacent to wetland vegetation outside the survey area.

Table 10. Regional Significance Assessment: Rocla Warton Rd

Criterion	Comment
(i) Representation of ecological communities	
Vegetation complexes	BushForever (SCP part of PMA) (DEP, 2000a): Southern River Complex: 17%of original area remaining; 6% existing protection, 10% proposed BF protection. System6+part System 1 (EPA, 2006): Southern River Complex: 19.8% of pre-1750 extent; 1.5% in reserve
Floristic community types	Affinity to 4 FCTs
Size and shape	Fairly small area of remnant bushland within larger area of bushland.
Uplands and wetlands	Wetlands and adjacent upland vegetation is present in the survey area.
Vegetation condition	Remnants mostly in Very Good to Excellent condition. Dieback is most likely present in the survey area, but plant deaths do not appear to have been broad scale, with the exception of small areas of recent deaths that were observed.
Conclusion	• Southern River Complex have less than 10% of original extent in reserve = Regionally Significant.
(ii) Diversity	
Vegetation Complexes	One Complex (Southern River), although very close to the western edge of Bassendean Central and South Complex.
FCT's	Vegetation units mainly group with 4 FCT's.
Vegetation units	Six vegetation units (some wetland units only small area). One dryland unit, 1 dryland (transitional) unit, 1 wetland unit and 2 wetland (transitional) vegetation units and 2 wetland units.
Flora	155 native plant species recorded. Moderate number for size of area (11 hectares). Species richness: dampland quadrats had lower species richness (32 spp. incl. weeds); Banksia woodland had moderate to high species richness (46-68). Transitional dampland sites had higher species counts due to their transitional nature (dryland specie also found there.)
Conclusion	Moderate values for diversity
(iii) Rarity	
Flora	No DRF. No Priority species. Two other species of regional significance.
Vegetation :TEC's	No Tec's. One vegetation unit had mixed affinity that included a secondary affinity to PEC (FCT22). This vegetation units only covered a small area.
Conclusion:	Moderate values for rare vegetation.
(iv) Maintaining ecological processes	
Linkage	Rocla Warton Rd survey area lies in a north-south bushland corridor between Gibbs Rd and Jandakot airport/Canningvale bushlands that has been deemed 'Regionally significant but not contiguous linkage of bushland/wetland areas' (DEP, 2000b).
Size of areas in natural condition	Remnant area covers most of survey area, which is a little greater than 10 hectares in size.
Conclusion:	Regionally significant for maintaining linkages.
(v) Scientific or evolutionary importance	No known scientific or evolutionary importance.
(vi) General criteria for protection of wetland, streamline, estuarine	Wetland vegetation was recorded in the survey area (Very Good to Excellent condition), but is not classified as 'conservation category wetland' A small strip of a conservation wetland along the eastern boundary was inside the survey area. However, the actual vegetation inside the boundary was 'dryland vegetation'.
Conclusion:	
Summary:	Regionally significant for: • representation of ecological communities and • for maintaining linkages

8.0 ACKNOWLEDGEMENTS

Field work was coordinated by Carrie Gill (RPS). Quadrat recording and rare flora searching was undertaken by Carrie Gill, Kelli McCreery and Brian Morgan. Carrie Gill did the vegetation unit and vegetation condition mapping in the field.

Plant identifications were mostly undertaken by Brian Morgan and Chris Hancock, with some assistance from Cate Tauss. Mike Hislop (Western Australian Herbarium) undertook a few difficult identifications, Allen Lowrie identified some of the Drosera and Stylidium specimens and Russell Barrett identified the Lepidosperm's.

Mr Ted Griffin ran the PATN analysis and gave advice on the interpretation of the results. His report is included in full in Appendix 8.

Simon Croft (RPS) prepared the GIS mapping for the report.

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APPENDIX ONE. The Department of Environment and Conservation Declared Rare Flora and Priority Flora Categories (from Smith, 2010)

Declared Rare Flora - Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

Declared Rare Flora - Presumed Extinct Flora

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

Priority One - Poorly Known Taxa.

Taxa which are known from one or a few (generally < 5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority Two - 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 (ie. not currently endangered). Such taxa are under consideration for declaration as "rare flora", but are in urgent need of further survey.

Priority Three - Poorly Known Taxa.

Taxa which are known from several populations, and the taxa are not believed to under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally > 5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further study.

Priority Four - 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. These taxa require monitoring every 5-10 years.

APPENDIX TWO. Vegetation structural table of Trudgen based on Aplin's (1979) modification of Specht's classification

Life form and height of tallest stratum	Projective foliage cover of tallest stratum as %	Description
Trees over 30 metres	70 -100	High closed forest
	30 -70	High open forest
	10 - 30	high woodland
	2 -10	high open woodland
	under 2	Scattered tall trees
Trees 10 - 30 metres	70 -100	Closed forest
	30 -70	Open forest
	10 - 30	Woodland
	2 -10	Open woodland
	under 2	Scattered trees
Trees under 10 metres	70 -100	Low closed forest
	30 - 70	Low open forest
	10 - 30	Low woodland
	2 -10	Low open woodland
	under 2	Scattered low trees
Shrubs over 2 metres	70 - 100	Closed scrub
	30 - 70	Open scrub
	10 - 30	High shrubland
	2 -10	High open shrubland
	under 2	Scattered tall shrubs
Shrubs 1 - 2 metres	70 - 100	Closed heath
	30 - 70	Open heath
	10 - 30	Shrubland
	2 -10	Open shrubland
	under 2	Scattered shrubs
Shrubs under 1 metre	70 - 100	low closed heath
	30 - 70	low open heath
	10 - 30	low shrubland
	2 -10	Low open shrubland
	under 2	Low scattered shrubs
Herbs/Sedges/Grasses	70 - 100	Closed herb, sedge, grassland
	30 - 70	Herb, sedge, grassland
	10 - 30	Open herb, sedge, grassland
	2 -10	Very open herb, sedge, g'land
	under 2	Scattered herbs sedges, grasses

Grasslands then divided into:
Tussock grasslands (perennial tussock species, e.g. Eragrostis species);
Hummock grasslands (Triodia and Plectrachne species that form hummocks)
Curly spinifex grassland (Plectrachne pungens, which does not form hummocks) (follows J.S. Beard).
Annual tussock grassland (e.g. annual Sorghum species).

APPENDIX THREE. Vegetation condition scale and descriptions

(from Keighery 1994, reproduced in Department of Environmental Protection 2000b)

Pristine (1) : Pristine or nearly so, no obvious signs of disturbance

Excellent (2) : Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

Very Good (3) : Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Good (4) : Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (5) : Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (6) : The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX FOUR Flora list for the Rocla Warton Rd survey area

Notes:
1. Plant families are listed in alphabetical order within the main classification groups.
2. An asterisk (*) beside the taxon name indicates an introduced species not native to the survey area..
4. The 'status' column shows the conservation status of significant flora species on the list.
DRF = Declared Rare Flora; P1 to P4 = Priority 1 to Priority 4 (see definitions in Appendix 1); RS = other regionally significant flora

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
PTERIDOPHYTA (ferns and fern allies)		
CLASS LYCOPSIDA (fern allies)		
SELAGINELLACEAE		
Selaginella gracillima		
GYMNOSPERMAE		
CLASS CYCADOPSIDA (Cycads)		
ZAMIACEAE		
Macrozamia riedlei	Zamia	
ANGIOSPERMAE (flowering plants)		
AIZOACEAE		
*Carpobrotus edulis	pigface	
APIACEAE		
Trachymene pilosa		
Xanthosia huegelii		
ARACEAE		
*Zantedeschia aethiopica	Arum lily	
ASPARAGACEAE		
*Asparagus asparagoides	Bridle creeper	
Chamaescilla corymbosa		
Laxmannia ramosa subsp. ramosa		
Laxmannia squarrosa		
Thysanotus manglesianus/patersonii		
Thysanotus tenellus		
ASTERACEAE		
*Arctotheca calendula	Capeweed	
Brachyscome iberidifolia		
*Hedypnois rhagadioloides subsp. cretica		
Hyalosperma cotula		

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
ASTERACEAE (cont)		
*Hypochaeris glabra		
Lagenophora huegelii		
Podotheca angustifolia		
Podotheca chrysantha		
Podotheca gnaphalioides		
Quinetia urvillei		
Rhodanthe citrina		
Siloxerus humifusus		
*Sonchus oleraceus		
*Ursinia anthemoides		
BORAGINACEAE		
*Echium plantagineum		
CACTACEAE		
*Opuntia stricta	Prickly pear	
CAMPANULACEAE		
*Wahlenbergia capensis		
Wahlenbergia preissii		
CASUARINACEAE		
Allocasuarina fraseriana	Sheoak	
Allocasuarina humilis		
CENTROLEPIDACEAE		
Centrolepis drummondiana		
COLCHICACEAE		
Burchardia congesta		
Wurmbea sp.		
CRASSULACEAE		
Crassula colorata var. colorata		
CYPERACEAE		
Baumea juncea		
Baumea vaginalis		
*Isolepis marginata		
Lepidosperma longitudinale		
Lepidosperma scabrum (Inland form)		
Lepidosperma sp.	(formerly L. pubisquameum)	
Lepidosperma sp. Coastal Dunes	(formerly L. pubisquameum)	
Lepidosperma sp. K Boorabbin (K.L. Wilson 2579)	(formerly L. pubisquameum)	

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
CYPERACEAE (cont)		
Mesomelaena pseudostygia		
Schoenus clandestinus		
Schoenus curvifolius		
Schoenus subfascicularis		
DASYPOGONACEAE		
Calectasia narragara		
Dasypogon bromeliifolius		
Lomandra caespitosa		
Lomandra hermaphrodita		
Lomandra preissii		
Lomandra suaveolens		
DILLENIACEAE		
Hibbertia aurea		
Hibbertia huegelii		
Hibbertia huegelii sens. lat.		
Hibbertia hypericoides		
Hibbertia racemosa		
Hibbertia subvaginata		
Hibbertia vaginata		
DROSERACEAE		
Drosera erythrorhiza subsp. erythrorhiza		
Drosera glanduligera		
Drosera menziesii subsp. penicillaris		
Drosera paleacea		
Drosera pallida		
ERICACEAE		
Astroloma xerophyllum		
Conostephium pendulum		
Leucopogon conostephioides		
Leucopogon sp. Murdoch (M. Hislop 1037)		
EUPHORBIACEAE		
*Euphorbia peplus		
Monotaxis occidentalis		
Poranthera microphylla		

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
FABACEAE		
Acacia applanata		
Acacia huegelii		
*Acacia longifolia	Sydney Golden wattle	
Acacia pulchella var. goadbyi		
Acacia stenoptera		
Bossiaea eriocarpa		
Daviesia incrassata subsp. incrassata		
Daviesia triflora		
Euchilopsis linearis		
Gastrolobium capitatum		
Gompholobium tomentosum		
Hardenbergia comptoniana		
Hovea trisperma		
Jacksonia furcellata		
Kennedia prostrata		
Pultenaea ochreata		
*Trifolium arvense		
GERANIACEAE		
*Erodium botrys		
*Pelargonium capitatum		
GOODENIACEAE		
Dampiera linearis		
Lechenaultia floribunda		
Scaevola repens var. repens		
HAEMODORACEAE		
Anigozanthos humilis		
Anigozanthos manglesii subsp. manglesii	Red and Green kangaroo paw	
Conostylis aculeata subsp. aculeata		
Conostylis aculeata subsp. preissii		
Conostylis aurea		
Conostylis juncea		
Haemodorum spicatum		
Phlebocarya ciliata		
Phlebocarya filifolia		
HALORAGACEAE		
Gonocarpus pithyoides		

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
HEMEROCALLIDACEAE		
Arnocrinum preissii		
Dianella revoluta var. divaricata		
Hensmania turbinata		
Tricoryne elatior		
IRIDACEAE		
*Gladiolus caryophyllaceus		
Patersonia occidentalis var. angustifolia		
*Watsonia meriana var. bulbillifera		
LAMIACEAE		
Hemiandra pungens		
LAURACEAE		
Cassytha racemosa forma racemosa		
LOGANIACEAE		
Phyllangium divergens		
LORANTHACEAE		
Nuytsia floribunda	Christmas tree	
MOLLUGINACEAE		
Macarthuria australis		
MYRTACEAE		
Astartea affinis		
Calothamnus hirsutus		
Calytrix angulata		
Calytrix flavescens		
*Chamelaucium uncinatum	Geraldton wax	
Darwinia citriodora		
Eremaea pauciflora var. pauciflora		
Eucalyptus marginata subsp. marginata	Jarrah	
Eucalyptus rudis	Flooded gum	
Eucalyptus todtiana	Prickly bark	
Hypocalymma angustifolium		
Kunzea glabrescens		
Melaleuca preissiana	Moonah	
Melaleuca seriata		
Melaleuca teretifolia		
Melaleuca thymoides		
Pericalymma ellipticum		
Regelia inops		
Scholtzia involucrata		

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
ORCHIDACEAE		
Caladenia discoidea		
Caladenia flava subsp. flava	Cowslip orchid	
Eriochilus dilatatus subsp. multiflorus	White bunny orchid	
Pterostylis sanguinea	Dark banded greenhood orchid	
Pterostylis sp.		
Pyrorchis nigricans		
Thelymitra sp.		
OXALIDACEAE		
*Oxalis pes-caprae	Sour sob	
PAPAVERACEAE		
*Fumaria capreolata		
POACEAE		
*Aira caryophyllea		
Amphipogon turbinatus		
Aristida contorta		
Austrostipa elegantissima		
Austrodanthonia occidentalis		
Austrostipa flavescens		
Austrostipa camplachne		
*Avena barbata		
*Brachypodium distachyon		
*Briza maxima		
*Briza minor		
*Cynodon dactylon	couch	
*Ehrharta calycina	Perennial veldt grass	
*Ehrharta longiflora	Annual veldt grass	
*Eragrostis curvula	Love grass	
*Holcus lanatus		
*Lagurus ovatus		
Microlaena stipoides var. stipoides		
*Pentaschistis airoides subsp. airoides		
*Vulpia bromoides		
*Vulpia myuros forma myuros		
PORTULACACEAE		
Calandrinia corrigioloides		
PRIMULACEAE		
* Lysimachia arvensis	formerly Anagalis arvensis	

FAMILY/TAXA	COMMON NAMES	PRIORITY STATUS
PROTEACEAE		
Adenanthos cygnorum subsp. cygnorum		
Banksia attenuata		
Banksia ilicifolia		
Banksia littoralis	Swamp Banksia	
Banksia menziesii		
Persoonia saccata		
Petrophile linearis		
Stirlingia latifolia		
Synaphea spinulosa subsp. spinulosa		
RESTIONACEAE		
Desmocladus flexuosus		
Hypolaena exsulca		
Lyginia barbata		
Lyginia imberbis		
RUTACEAE		
Boronia crenulata		
Boronia dichotoma		
Boronia ramosa subsp. anethifolia		
Philotheca spicata		
SOLANACEAE		
*Solanum nigrum		
STYLIDIACEAE		
Stylidium brunonianum		
Stylidium repens var. repens		
Stylidium saxifragoides		
Stylidium schoenoides		
THYMELAEACEAE		
Pimelea imbricata		
XANTHORRHOEACEAE		
Xanthorrhoea preissii		

APPENDIX FIVE. Quadrat descriptions and species lists for the Rocla Warton Rd survey area

Warton Rd RPS **Site** WR1
Described CG **Date** 6/10/2010 **Type** Q 10x10
Season E **Uniformit**
Location
MGA Zone 50 396281 **mE** 6444986 **mN**
Habitat South-west facing, upper slope of dune.
Soil Pale grey sand over yellow sand.
Rock Type None
Vegetation Banksia attenuata, Banksia menziesii, (Allocasuarina fraserina) low woodland over Allocasuarina humilis shrubland over Hibbertia hypericoides, Astroloma xerophyllum low shrubland over Desmocladus flexuosus, Amphipogon turbinatus open sedgeland/grassland.
Veg Condition (BF). Excellent. Low to medium disturbance; recent Banksia deaths nearby.
Fire More than 5 years since fire.
Notes Bareground 20%. Litter 40%.
SPECIES LIST:

Quad	Name	Cove	C	Heigh	Specime	Notes
	Acacia applanata	+		35	WR1-33	Acacia ? wind/app
	Acacia stenoptera	+		45	WR1-21	Acacia ? stenop
	Aira caryophyllea	+		4	WR1-38	Aira
	Allocasuarina humilis	23		160		Allocasuarina humilis
	Amphipogon turbinatus	7		35	WR1-4	Amphipogon
	Anigozanthos humilis	+		10		Anigozanthos humilis
	Astroloma xerophyllum	+		30	WR1-1,1-41	Epacrid
	Austrodanthonia occidentalis	+		30	WR1-27,1-46	Austrodanth
	Austrostipa flavescens	+		20	WR1-10,44.51	Austrostipa flavescens
	Banksia attenuata	15		600cm		Banksia attenuata (2% dead)
	Banksia menziesii	6		500		Banksia menziessii
	Boronia ramosa subsp. anethifolia	+		25	WR1-47	Boronia
	Bossiaea eriocarpa	+		12	WR1-22	Bossiaea eriocarpa
	Briza maxima	+		40		Briza maxima
	Burchardia congesta	+		40		Burchardia congesta
	Caladenia flava subsp. flava	+		20	WR1-13	Caladenia flava
	Calandrinia corrigioloides				WR1-39	Calandrinia
	Calytrix flavescens	2		20		Calytrix flavescens
	Chamaescilla corymbosa	+		10		Chamaescilla
	Conostephium pendulum	+		20	WR1-35	Epacrid
	Conostylis aculeata subsp. aculeata	+		20	WR1-7	Conostylis aculeata
	Conostylis aurea	+		15	WR1-6	Conostylis
	Conostylis juncea	+		15	WR1-8	Conostylis g/y ???
	Dampiera linearis	+		15		Dampiera linearis
	Dasypogon bromeliifolius	+		15		Dasypogon brom
	Desmocladus flexuosus	3		15	WR1-3	Desmocladus
	Drosera pallida	+		10	WR1-9	Drosera ? macrantha
	Ehrharta calycina	+		50		Ehrharta calycina
	Eremaea pauciflora	2		70	WR1-2	Eremaea pauc
	Gastrolobium capitatum	+		30	WR1-32	Gastrolobium
	Gladiolus caryophyllaceus	+		90		Gladiolus caryoph
	Gompholobium tomentosum	+		60		Gompholobium toment
	Hibbertia huegelii	+		40	WR1-5	Hibbertia huegelii
	Hibbertia hypericoides	23		70		Hibbertia hyp
	Hibbertia racemosa	+		30	WR1-26	Hibbertia subvag
	Hyalosperma cotula	+		5	WR1-11	Hyalosperma cot
	Hypochaeris glabra	+		10		Hypochaeris glabra
	Laxmannia ramosa subsp. ramosa	+		15	WR1-28	Laxmannia
	Laxmannia squarrosa	+		10	WR1-19	Laxmannia on stilts
	Lepidosperma sp.	+		35	WR1-15	Lepidosp pubisq

Leucopogon conostephioides	+	30	WR1-30	Leucopogon
Lomandra hermaphrodita	+	20	WR1-18	Lomandra hermaph
Lomandra preissii	+	30	WR1-50	Lomandra
Lomandra suaveolens	+	25	WR1-12,1-48	Lomandra
Lyginia barbata	+	40	WR1-24	Lyginia imberbis
Nuytsia floribunda	+ (<1%)	400		Nuytsia floribunda
Oxalis pes-caprae	+	5		Oxalis pes-caprae
Patersonia occidentalis var. angustifolia	+	30	WR1-17	Patersonia occid
Pelargonium capitatum	+	2		Pelar capit
Petrophile linearis	+	20		Petrophile linearis
Philotheca spicata	+	30		Philotheca spicata
Phlebocarya filifolia	+	25	WR1-45	Phleb ? pilos
Phyllangium divergens	+	5	WR1-40	Phyllangium
Poranthera sp.	+	2	WR1-36	herb
Pterostylis sp.	+	4		Pterostylis (sterile, grazed)
Quinetia urvillei	+	3	WR1-31	Quinettia urv
Schoenus curvifolius	+	30	WR1-34	Schoenus curv
Scholtzia involucrata	1	35		Scholtzia involucr
Siloxerus humifusus	+	2	WR1-37	? Siloxerus
Stirlingia latifolia	2	35		Stirlingia latif
Stylidium brunonianum	+	35	WR1-29	Stylid pnk grey/blue lin rosette
Stylidium repens	+	10	WR1-14	Stylidium repens
Stylidium saxifragoides	+	20	WR1-16	Stylidium ? cil
Thysanotus manglesianus/patersonii	+	40	WR1-42	Thysanotus ????????
Trachymene pilosa	+	3	WR1-25	Trachymene pilosa
Ursinia anthemoides	+	10		Ursinia art
Wahlenbergia capensis	+	3	WR1-23	Wahlenbergia capensis
Xanthosia huegelii	+	10	WR1-52	Xanth hueg

Warton Rd RPS **Site** WR2
Described KM **Date** 6/10/2010 **Type** Q 10x10
Season E **Uniformit**
Location
MGA Zone 50 396280 **mE** 6445069 **mN**
Habitat South-east facing, upper slope of dune.
Soil Pale grey sand over yellow sand.
Rock Type
Vegetation Banksia menziesii, Banksia attenuata (Nuytsia floribunda, Allocasuarina fraseriana) low woodland over Allocasuarina humilis shrubland over Hibbertia hypericoides low shrubland over Amphipogon turbinatus, Desmocladus flexuosus very open grassland/sedgeland.
Veg Condition (BF) Very Good to Excellent. (Low disturbance; some weeds (<5%); some dead Banksia).
Fire More than 5 years since fire.
Notes Bareground 15%. Litter 65%
SPECIES LIST:

Quad Name	Cove C	Heigh	Specime	Notes
Acacia applanata	+	40	WR2-07	Acac
Acacia stenoptera	+	40	WR2-08	Acac
Allocasuarina humilis	25	120		Allo humi humi
Amphipogon turbinatus	6	20		Amphi turbi
Anigozanthos humilis	+	10		Anigo humil
Astroloma xerophyllum	2	60	WR2-04	Astroloma sp
Austrodanthonia occidentalis	+	25	WR2-25	Austrodant
Austrostipa flavescens	+	25	WR2-12,24	Austrostip
Banksia attenuata	15	600		Bank atte (1% dead)
Banksia menziesii	6	500		Bank menz
Bossiaea eriocarpa	+	20		Bossi erioc
Briza maxima	+	20		Briza maxim
Burchardia congesta	+	30		Burch conge

Calytrix flavescens	2	30		Caly flav
Conostylis aurea	+	20	WR2-15	Conos ? aurea
Crassula colorata var. colorata	+	1	WR2-23	Crassula
Dasypogon bromeliifolius	+	20		Dasyp brome
Daviesia triflora	+	60	WR2-06	Davi ? tris
Desmocladus flexuosus	3	30	WR2-09	Desmo
Drosera erythrorhiza subsp. erythrorhiza	+	1		Dros eryth
Drosera menziesii subsp. penicillaris	+	20	WR2-16	Drose ? menz
Drosera pallida		60	WR2-28	Dros mac/pal (+ dead)
Ehrharta calycina	+	60		Ehrha calyc
Gastrolobium capitatum	+	30	WR2-03	Gast sp
Gladiolus caryophyllaceus	+	60		Gladi caryo
Gompholobium tomentosum	+	50		Gomph tome
Hibbertia huegelii	1	20	WR2-05	Hibb hueg
Hibbertia hypericoides	12	60		Hibb hype
Hypochaeris glabra	+	10		Hypo glab
Kunzea glabrescens	1	170	WR2-01	Kunz glab
Laxmannia squarrosa	+	10	WR2-11	Laxma squar
Lepidosperma pubisquameum	+	30		Lepid pubisquameumq
Leucopogon conostephioides	2	50	WR2-02	Leuc ? cono
Lomandra hermaphrodita	+	15	WR2-14	Loman (curly)
Lomandra preissii	+	60	WR2-18	Loman (spike)
Lomandra suaveolens	+	20	WR2-26	Lomandra
Lyginia imberbis	1	35		Lygin imber
Patersonia occidentalis var. angustifolia	+	30		Pater occid
Petrophile linearis	+	20		Petr line
Philotheca spicata	+	60		Philo spica
Podotheca angustifolia	+	2	WR2-17	P sp.
Quinetia urvillei	+	2		Quine urvil
Schoenus curvifolius	+	15	WR2-13	Loman ? caesp
Scholtzia involucrata	2	35		Scho invol
Stirlingia latifolia	1	40		Stir lati
Stylidium brunonianum	+	25	WR2-30	Styl 'brun'
Stylidium repens	2	10	WR2-27	Styli repe
Stylidium saxifragoides	+	2	WR2-21	Styli 'pilif'
Thysanotus manglesianus/patersonii	+	40	WR2-19	Thysa pat/man
Trachymene pilosa	+	5		Trach pilosa
Tricoryne elatior	+	30	WR2-10,29	Lily
Ursinia anthemoides	+	10		Ursin anth
Wahlenbergia capensis	+	10		Wahl capen
Wahlenbergia preissii	+	10	WR2-20	Wahle ? graci
Wurmbea sp.	+	2	WR2-22	Wurmbea ?

Warton Rd RPS **Site** WR3
Described CG **Date** 6/10/2010 **Type** Q 10mx10m
Season E **Uniformit**
Location
MGA Zone 50 396178 **mE** 6445103 **mN**
Habitat West-facing, mid to upper slope of dune
Soil Pale grey sand over yellow sand.
Rock Type None
Vegetation Banksia attenuata, Banksia menziesii, (Eucalyptus todtiana, Allocasuarina fraseriana) low woodland over Hibbertia hypercoides low open heath over Amphipogon turbinatus, Desmocladus flexuosus very open grassland/sedgeland.
Veg Condition (BF) Excellent. (Low disturbance).
Fire More than 5 years since fire.
Notes Bareground 30%. Litter 50%.

SPECIES LIST:

Quad	Name	Cove	C	Heigh	Specime	Notes
	Allocasuarina humilis	+		100		A. humilis
	Amphipogon turbinatus	3		25	WR3-1	Amphipogon
	Anigozanthos humilis	+		20		Anigozanthos humlis
	Austrodanthonia occidentalis	+		40	WR3-28	Poaceae sp (slender)
	Austrostipa flavescens	+		25	WR3-26	? Austrostipa
	Austrostipa variabilis	+		60	WR3-27	Tall native grass
	Banksia attenuata	6		550		Banksia attenuata (1% dead)
	Banksia menziesii	5		400		B. menziezii (2% dead)
	Bossiaea eriocarpa	+		20	WR3-21	Bossiaea eriocarpa
	Briza maxima	+		20		Briza maxima
	Burchardia congesta	+		30		Burchardia cong
	Calytrix flavescens	2		20	WR3-6	?Calytrix flavescens
	Conostylis aculeata subsp. preissii	+		20	WR3-18	Conostylis ? aurea
	Crassula colorata var. colorata	+		2	WR3-25	? Crassula
	Dampiera linearis	+		20		Dampiera linearis
	Dasypogon bromeliifolius	+		20		Dasypogon brom
	Daviesia triflora	+		40	WR3-16	Daviesia
	Desmocladus flexuosus	1		25	WR3-3	Desmocladus sp
	Drosera menziesii subsp. penicillaris	+		60	WR3-10	Drosera pink
	Drosera pallida/menziesii	+		5	WR3-24	Drosera
	Ehrharta calycina	+		50		Ehrharta calycina
	Eucalyptus todtiana	5		600		Eucalyptus todtiana
	Gladiolus caryophyllaceus	+		80		Gladiolus caryo
	Gompholobium tomentosum	1		40		Gompholobium toment
	Hibbertia huegelii	+		30	WR3-13	Hibbertia hueg
	Hibbertia hypericoides	40		60		Hibbertia hyp
	Laxmannia ramosa subsp. ramosa	+		10	WR3-12	Laxmannia
	Laxmannia squarrosa	+		20	WR3-14	Laxmannia on stilts
	Lepidosperma scabrum (Inland form)	+		40	WR3-20	Lepidosperma tevete
	Lepidosperma sp. Coastal Dunes	+		60	WR3-8	Lepidosperma ? pubisqu
	Leucopogon conostephioides	+		50	WR3-19	Epacrid small fwrs
	Lomandra caespitosa	+		25	WR3-5,30	Lomandra (narrow lf)
	Lomandra hermaphrodita	+		30	WR3-11,23	Lomandra bluish
	Lyginia barbata	+		50	(=WR1-24)	Lyginia imberbis
	Patersonia occidentalis var. angustifolia	+		30		Patersonia occident
	Petrophile linearis	+		30		Petrophile linearis
	Philotheca spicata	1		50		Philotheca spicata
	Podotheca angustifolia	+		3	WR3-22	Podotheca
	Schoenus curvifolius	+		25	WR3-29	? Schoenus
	Stirlingia latifolia	2		50		Stirlingia latifolia
	Stylidium brunonianum	+		25	WR3-9	Stilidium linear fleshy
	Stylidium repens	4		10	WR3-2	Stylidium repens
	Stylidium saxifragoides	+		15	WR3-15	Stylidium smll yellow
	Trachymene pilosa	+		5	(=WR1-25)	Trachymene pilosa
	Tricoryne elatior					Tricoryne elatior
	Ursinia anthemoides	+		15		Ursinia anthemoides

Warton Rd RPS **Site** WR4
Described BRM **Date** 6/10/2010 **Type** Q 10x10
Season E **Uniformit**
Location
MGA Zone 50 395973 **mE** 6444979 **mN**
Habitat North facing, very gently sloping to flat seasonal dampland.
Soil Grey sand.
Rock Type None
Vegetation Melaleuca preissiana, (Allocasuarina fraseriana) low open forest over Xanthorrhoea preissii, Astartea affinis open shrubland over Hypocalymma angustifolium scattered low shrubs over Dasypogon bromeliifolius open herbland to herbland and Chamaescilla corymbosa open annual herbland.
Veg Condition (BF) Excellent. (Low disturbance; some weeds (<5%))
Fire More than 5 years since last fire.
Notes Litter >90%.
SPECIES LIST:

Quad	Name	Cove	C	Heigh	Specime	Notes
	Acacia pulchella var. goadbyi	+		100	WR4-34	Acac pulc (o/hang + seedling)
	Aira caryophyllea	+		4	WR4-23	Aira
	Allocasuarina fraseriana	8		800		Allocasuarina
	Astartea affinis	4		190	WR4-2	Astartea
	Austrostipa flavescens	+		20	WR4-30	Austrost
	Avena barbata	+		25	WR4-21	Grass
	Baumea juncea	+		50	WR4-6	Baumea juncea (not collected!)
	Boronia ramosa subsp. anethifolia	+		20	WR4-27	Boronia
	Bossiaea eriocarpa	+		30		Bossiaea eriocarpa
	Briza maxima	+		30		Briza max
	Briza minor	+		10		Briza minor
	Burchardia congesta	+		30		Burch conge
	Caladenia flava subsp. flava	+		15		Caladenia flava var. flava
	Calandrinia corrigioloides	+		3	WR4-8,10	Calandrinia
	Centrolepis drummondiana	+		2	WR4-24	Centrolepis
	Chamaescilla corymbosa	15		20	WR4-3	Chamaescilla corym
	Conostephium pendulum	+		15		Conostep peno
	Conostylis juncea	+		20	WR4-13,33	Conostylis
	Crassula colorata var. colorata	+		1	WR4-22	Crassula
	Dasypogon bromeliifolius	25		40		Dasypogon brom
	Dianella revoluta var. divaricata	+		35		Dianella rev
	Drosera pallida	+		45	WR4-5	Drosera climber
	Eriochilus dilatatus subsp. multiflorus	+		15	WR4-14	Orchid spade lf
	Fumaria capreolata	+		10		Fumaria weed (white
	Gladiolus caryophyllaceus	+		70		Gladiolus caryo
	Hibbertia hypericoides	+		40		Hibbertia hypercoides
	Hibbertia subvaginata	+		25	WR4-20	Hibbertia vag
	Hovea trisperma	+		20		Hovea elliptica
	Hyalosperma cotula	+		4	WR4-7	daisy wte
	Hypocalymma angustifolium	+		50		Hypocalymma angust
	Hypochaeris glabra	+		1		Hypochaeris glabra
	Isolepis marginata	+		2	WR4-11	Isolepis ? mag
	Lagenophora huegelii	+		12		Lagenophora huegelii
	Lepidosperma sp.	+		45	WR4-15,29	Sedge
	Lepidosperma sp. K Boorabbin (K.L. Wilson	+		45	WR4-16	Sedge
	Lomandra caespitosa	+		20	WR4-19	Lomandra caespitosa
	Lomandra preissii	+		40	WR4-4	Lomandra preissii
	Melaleuca preissiana	60		700	WR4-1	Melaleuca preissiana
	Oxalis pes-caprae	+		30		Oxalis pes-caprae
	Phlebocarya ciliata	+		30	WR4-17,32	Conost acul
	Podotheca gnaphalioides	+		15	WR4-26	Podotheca ?grac /chrys
	Poranthera microphylla	+		3	WR4-18	? Poranthera micro
	Quinetia urvillei	+		2		Quinetia urvillei

Siloxerus humifusus	+	1	WR4-31	Siloxeros
Sonchus oleraceus	+	2		Sonchus oleraceus
Thelymitra sp.	+	20	WR4-25	Thelymitra orchid
Thysanotus manglesianus/patersonii	+	20		Thysanotus mang/pat
Trachymene pilosa	+	5		Trachymene pilosa
Wahlenbergia preissii	+	20	WR4-9,12,28	Wahlenb (native)
Xanthorrhoea preissii	7	180		Xanth preissii

Warton Rd RPS **Site** WR5
Described BRM **Date** 6/10/2010 **Type** Q 10mx10m
Season E **Uniformit**
Location
MGA Zone 50 396012 **mE** 6444933 **mN**
Habitat Flat dampland.
Soil Grey sand.
Rock Type None
Vegetation Acacia pulchella var. goadbyi scattered shrubs over Hypocalymma angustifolium, Pericalymma ellipticum scattered low shrubs over Baumea juncea, Schoenus subfascicularis closed sedgeland.
Veg Condition (BF) Excellent. (Low disturbance; some weeds, rabbits).
Fire More than 5 years since fire.
Notes Bareground 3%. Litter 30%.
SPECIES LIST:

Quad	Name	Cove	C	Heigh	Specime	Notes
	Acacia pulchella var. goadbyi	1		140	WR5-2	Acacia pulchella
	Aira caryophyllea	+		12	WR5-4	grass
	Anagallis arvensis	+		12		Anagallis arvensis (sterile)
	Astartea affinis	+		10	WR5-7	Astartea (juv)
	Austrostipa flavescens	+			WR5-17	?Austrostipa
	Baumea juncea					
	Boronia ramosa subsp. anethifolia	+		35	WR5-11,20	Boronia ?racemosa
	Briza maxima	+		20		Briza max
	Carpobrotus edulis	+		3		Carpobrotus (pigface)
	Chamaescilla corymbosa	+		5	??(=WR4-3)	Chamaescilla (?grazed; finished flrg)
	Dasypogon bromeliifolius	+		50		Dasypogon brom
	Ehrharta calycina	+		45		Ehrhata calyc
	Euchilopsis linearis	2		40	WR5-6	pea orange flr
	Gladiolus caryophyllaceus	+		70		Gladiolus car (pk flr)
	Hyalosperma cotula	+		5	(=WR4-7)	daisy
	Hypocalymma angustifolium	+		80		Hypocalymma angust
	Hypochaeris glabra	3		3		Hypochaeris glabra (cats tongue)
	Pericalymma ellipticum	+		70	WR5-1	Pericalymma/ Leptosperm
	Phlebocarya ciliata	+			WR5-18	? Phlebocarya
	Phyllangium divergens	+		4	WR5-14	Phyllangium
	Quinetia urvillei	+		3		Quinetia urvillei
	Rhodanthe citrina	+		5	WR5-12	? Waitzia
	Schoenus subfascicularis	90		60	WR5-3	Schoenus
	Selaginella gracillima	+		2	WR5-15	Herb
	Siloxerus humifusus	+		2	WR5-16	Herb? Siloxerus
	Sonchus oleraceus	+				Sonchus oleracaceus
	Stylidium brunonianum	+			WR5-19	Stylidium
	Thysanotus manglesianus/patersonii	+		40		Thysanotus mang/pat
	Trachymene pilosa	+		3		Trachymene pilosa
	Ursinia anthemoides	+		5		Ursinia art
	Vulpia myuros forma myuros	+		40	WR5-10	Grass (?Vulpia)
	Wahlenbergia preissii	+		4	WR5-13	Whalenbergia

Warton Rd RPS **Site** WR6
Described CG **Date** 6/10/2010 **Type** Q 10mx10m
Season E **Uniformit**
Location
MGA Zone 50 396375 **mE** 6444859 **mN**
Habitat Flat at base of dune (wetland transition)
Soil Pale grey to white sand.
Rock Type None
Vegetation Kunzea glabrescens scattered tall shrubs over Adenanthos cygnorum shrubland over Hypocalymma angustifolium low open shrubland over Hypolaena exsulca very open sedgeland with Dasypogon bromeliifolius and Phlebocarya ciliata herbland.
Veg Condition (BF) Very Good to Excellent. (Low disturbance).
Fire More than 5 years since last fire.
Notes Bareground 20%. Litter 5%.
SPECIES LIST:

Quad	Name	Cove	C	Heigh	Specime	Notes
	Adenanthos cygnorum	7		200		Adenanthos cygnorum
	Astartea affinis	2		80	WR6-3	Astartea affinis
	Calandrinia corrigioloides	+		1	WR6-1	Calandrinia
	Crassula colorata var. colorata	+		1	WR6-10	Crassula
	Dasypogon bromeliifolius	20		40		Dasypogon brom
	Ehrharta calycina	+		70		Ehrharta caly
	Ehrharta longiflora	+			WR6-16	Poaceae (mini)
	Gladiolus caryophyllaceus	+		80		Glady caryo
	Gonocarpus pithyoides	+			WR6-5,12	Small linear leaf shrub
	Hibbertia huegelii			25		Hibbertia hueg (nealry dead)
	Hibbertia subvaginata	+		20	WR6-8	Hibbertia ? subvag
	Hibbertia vaginata	+		30	WR6-4	Hibbertia vaginata
	Hyalosperma cotula	+		7	WR6-2	? Hyalosperma
	Hypocalymma angustifolium	5		60		Hypocalymma
	Hypochaeris glabra	+		10		Hypochaeris glabra
	Hypolaena exsulca	+			WR6-13	Restio (?Hyplaena)
	Jacksonia furcellata	+		100		Jacksonia furc
	Kunzea glabrescens	1		250		Kunzea glabrescens
	Laxmannia squarrosa	+		10	WR6-7	Laxmannia
	Lechenaultia floribunda	2		30	(=WB12)	Lechenaultia
	Lomandra caespitosa	+		30	WR6-6	Lomandra
	Lyginia imberbis	4		40	(=WC opp)	Lyginia ? barbata
	Monotaxis occidentalis	+		10	WR6-11	Herb to 10cm
	Pentaschistis airoides subsp. airoides	+		10	WR6-9	Aira
	Pericalymma ellipticum	+		70		Pericalymma
	Phlebocarya ciliata	15		30		Phlebocarya
	Pultenaea ochreata	+		60	(=WK22)	Pea
	Siloxerus humifusus	+		2	(=WB21)	Siloxerus
	Stylidium repens	1		5	(=WR1-14)	Stylidium repens
	Trachymene pilosa	+		4		Trachymene pilosa
	Tricoryne elatior	+		25		Tricoryne elator
	Ursinia anthemoides	+		10		Ursinia anthem
	Xanthorrhoea preissii	+				Xanthorrhoea preissii

APPENDIX SIX. Releve and mapping note descriptions and species lists for the Rocla Warton Rd survey area

Note: these site descriptions do not have a complete species list, but list representative species under 'Associated species'.

RELEVES
Rocla Warton Rd - Site WCR1
Described by CG Date 7/10/2010
Location:
Photo: CG12-14
AMG: Zone50 396360mE, 6444812mN (WGS84)
Habitat: Flats adjacent to dune.
Soil: Pale grey sand.
Rock Type:
Vegetation: *Melaleuca preissiana, Banksia menziesii, Banksia attenuata,* (*Nuytsia floribunda, Eucalyptus todtiana)* low woodland over *Xanthorrhoea preissii, Adenanthos cygnorum* subsp. *cygnorum* shrubland over *Hibbertia subvaginata* low open shrubland with *Dasypogon bromeliifolius* herbland.
Assoc. species: *Banksia ilicifolia, Jacksonia furcellata, *Gladiolus caryophyllaceus, Allocasuarina humilis, Hypocalymma angustifolium, Acacia pulchella*.
Veg Condition (BF): Very Good.
Fire Age: More than 5 years since last fire.
Notes: Transitional vegetation along the edge of the lower dune slopes.

Rocla Warton Rd - Site WCR2
Described by CG Date 7/10/2010
Location: North-west corner of survey area.
Photo: CG20,21.
AMG: Zone50 396161mE, 6445272mN (WGS84)
Habitat: Slight depression on flat (wetland).
Soil: Sand.
Rock Type:
Vegetation: *Pericalymma ellipticum* closed heath over *Daviesia incrassata* subsp. *incrassata, Euchilopsis linearis, Acacia pulchella* scattered low shrubs (*Hypocalymma angustifolium* low shrubland in outer parts of vegetation unit) over *Dasypogon bromeliifolius* open herbland, *Phlebocarya ciliata* open herbland (near edge of unit) and *Lyginia imberbis, Hypolaena exsulca* very open sedgeland.
Assoc. species: *Jacksonia furcellata, Adenanthos cygnorum* subsp. *cygnorum, Regelia inops*.
Veg Condition (BF): Excellent.

MAPPING NOTES
Rocla Warton Rd - Site MNB1
Described by BRM Date 7/10/2010
Location: South-west corner of survey area.
Photo: KM26-28.
AMG: Zone50 395918mE, 6444948mN (WGS84)
Habitat: Flats beside sand dune.
Soil: Grey sand.
Vegetation: *Eucalyptus marginata, Melaleuca preissiana* woodland over *Allocasuarina fraseriana* low open woodland over *Xanthorrhoea preissii* scattered shrubs to open shrubland over *Hibbertia hypericoides* low open shrubland over *Dasypogon bromeliifolius* very open herbland.
Assoc. species:
Veg Condition (BF): Very Good.

Rocla Warton Rd - Site MNB2
Described by BRM Date
Location: South-west corner of survey area.
Photo: BM1,2.
AMG: Zone50 395946mE, 6445014mN (WGS84)
Habitat: Flats (seasonal damplands).
Soil: Grey sand.
Vegetation: *Melaleuca preissiana, Banksia littoralis, Banksia ilicifolia* scattered low trees over *Adenanthos cygnorum* subsp. *cygnorum* scattered tall shrubs over *Pericalymma ellipticum* closed heath (80-90%) over *Lyginia imberbis* scattered sedges with areas of *Scheonus subfascicularis* sedgeland.
Assoc. species: *Acacia pulchella, Jacksonia furcellata, Hypolaena exsulca, Hypocalymma angustifolium, Regelia inops, Melaleuca teretifolia* (patches of open shrubland).
Veg Condition (BF): Very Good to Excellent (very little weed).
Note: This transitional vegetation grew around the perimeter of areas *Pericalymma ellipticum* heath and *Scheonus subfascicularis* sedgeland.

Rocla Warton Rd - Site MNK1
Described by KM Date 7/10/2010
Location: North-west corner of survey area.
Photo: KM013.
AMG: Zone50 396180mE, 6445215mN (WGS84)
Habitat: Very gentle lower slope at base of dune.
Soil: Sand.
Vegetation: *Melaleuca preissiana, Banksia ilicifolia, Nuytsia floribunda, Eucalyptus todtiana, Banksia menziesii* low woodland over *Xanthorrhoea preissii, Adenanthos cygnorum* subsp. *cygnorum* shrubland over *Dasypogon bromeliifolius* open herbland.
Assoc. species: *Melaleuca thymoides, Chamaescilla corymbosa* var. *corymbosa, Jacksonia furcellata, Calytrix flavescens, Scholtzia involucrata*.
Veg Condition (BF): Very Good (weeds present).
Notes: Transitional vegetation along the edge of the lower dune slopes.

APPENDIX SEVEN. Banksia tree death locations noted in the survey area.

Site	Location		Comments
	Easting	**Northing**	
WR1	396281	6444986	recent Banksia deaths
WR2	396280	6445069	some dead Banksia's
SW corner, lower slopes	395954	6444943	Extensive recent deaths, incl. Banksia, Allocasuarina fraseriana and Jarrah deaths.
Eastern side	396334	6445037	*B. attenuata*, *B. menziesii* recent deaths. Also *Dasypogon brom*. and *A. fraseriana* deaths.

APPENDIX EIGHT Reproduction of a report 'FCT Analysis Warton Rd Sites' by Mr Ted Griffin

1.0 INTRODUCTION

1.1 Purpose of this report

The current report is intended to help clarify the assignment of Floristic Community type (FCT) designation to vegetation community (site) data. FCTs were defined by Gibson et al (1994) based on site data collected from vegetation on the Swan Coastal Plain. In particular, the potential that a Threatened Ecological Community (English and Blyth 1997) is represented by the data collected needs to be clarified.

1.2 Location of Warton Sites

The sites were apparently from the Warton Rd area.

1.3 Brief background to floristic analysis of vegetation on the Swan Coastal Plain

Floristic analysis (ie., analysis of variation in vegetation based on the species present, rather than description of structural variation and dominance) as a significant component of the understanding of the variation present in the native vegetation of the Swan Coastal Plain dates to Gibson *et al* (1994 – all references to the SCP survey in the current report refer to this publication), the first publication to document the floristics of the vegetation of a large part of the Swan Coastal Plain. While the SCP survey is based on a very significant amount of work, it must be viewed as a "first pass" survey, limited, in the context of the great variety of vegetation present in the very large area surveyed, by the relatively limited number (509) of sites (quadrats) it is based on. To a limited degree, this limitation has subsequently been addressed in an "update" to the work of the SCP survey (which describes additional units). However, there is no detailed publication of the results of this update available and the additional data used are not readily available in an appropriate form (ie., one that would enable ready comparison of new data to the overall data set).

The units described by the SCP survey are a series of "floristic community types", a "unit" whose rank is defined by the use within a study. The SCP survey surveyed a very large survey area and defined a relatively small number of floristic community types. Consequently, the floristic community types they have described are of a very high order (see Trudgen 1999, volume 1, for further discussion of this point). This is an extremely important point to fully grasp in interpreting the analysis presented by the SCP survey and in understanding the meaning of analysis of other data sets when they are compared to the floristic community types of the SCP survey.

The important effects of the limited size data set used by the SCP survey and of the relatively small number of floristic community types defined by them, can be summarised by the following points:

1. the definition of all but two of the Threatened Ecological Communities for vegetation on the Swan Coastal Plain (English and Blyth 1997) has been based on the floristic community types of the SCP survey. It therefore follows, that with two exceptions, only vegetation units from one study that are different at a very high order of floristics are treated as rare by Government. No account is taken of other important differences, such as differences in structure and dominance;

2. for the definition of floristic community types to be robust, a sufficient sized database is needed to give adequate precision in their definition. About half of the floristics community types (or sub types) of the SCP survey are based on less than 10 sites. It is likely that with a larger data set there would be significant alteration in the classification of those floristic community types from the SCP survey based on small numbers of sites.

3. as noted above, many (if not most) of the floristic community types defined by the SCP survey are very broad. They contain very significant variation in floristics, structure and dominance. Some (or in more highly cleared parts of the Swan Coastal Plain much) of this variation may be rare by any reasonable definition, but it is currently "buried" within larger groups;
4. there is likely to be significant variation not sampled by the SCP survey. This includes some variation at a high level of floristic difference (see Trudgen 1999, volume 1, for an example of this) and undoubtedly quite significant (large!) amounts of variation at "medium" and "low" levels.

5. the document, and its use by Government, has focussed attention in the environmental impact assessment process on the high level of units described, deflecting attention from the layers of variation beneath these units that also have significant conservation value.

From these points it is obvious that there is a need for a major "upgrade" to the floristic analysis of the vegetation of the Swan Coastal Plain to provide a more detailed floristic classification that considers not only more of the variation present, but explicitly recognises more of the variation present in formally described units.

Obviously, such a reworking would have some effect on what vegetation is considered rare on the Swan Coastal Plain. It needs to be stressed that it would be very unlikely to find that any of the vegetation currently considered to be rare on the basis of the SCP survey*'s* classification was not rare. On the other hand, it is likely that such a review would very probably consider to be rare some vegetation which is not currently considered rare.

1.4 Data provided

It is very important in comparing different sets of floristic data that they are comparable in the application of names, in the intensity of the survey (ie., the effort of searching resulting in similar proportion of the flora at sites being recorded) and in the size of the site recorded. If the data from different data sets is not comparable in these ways, it reduces the clarity of the results of the analyses carried out. If the discrepancy in the comparability of the data sets is large, the results may become meaningless.

A brief observation suggest that these Warton sites appears to have similar number of species from groups such as Orchids.

2.0 METHODS

2.1 Data Preparation

The data from the Warton sites were provided into a standard MS Access based database designed for this type of data. One virtue of the database is that the species recorded at each site are stored against standard codes (numbers, those used by the Western Australian Herbarium) for each species. This facilitates ready comparison of data from different surveys stored in the same system.

After the data were incorporated into the database (containing the data from other projects), a process of reconciliation of flora species names with those used in the SCP survey was undertaken. This step was necessary at least because of changes in nomenclature over the last ten years and the potential of survey specific variations in the application of names. The reconciliation involved:

- reducing some infra-specific names to the relevant species name,
- combining some taxa where confusion is known to have occurred in field observations and identifications, and
- omitting some names (mostly, where a species had only been identified to genus).

The reconciliation process was relatively straight forward as most of the names had already been standardised. Most reconciliation was to conform with the methods that the SCP survey used to manage confusing taxa plus some nomenclatural changes (see Appendix).

2.2 Comparability of datasets

It was concluded that the datasets were probably compatible to obtain reliable determinations.

2.3 Comparisons made

The data from the 6 sites plus the 509 sites from the SCP survey of the southern part of the Swan Coastal Plain (south of Gingin) were combined. This enabled various analyses to be performed.

The main purpose was intended to assign the individual sites to the Floristic Community Types (FCTs) defined in the SCP survey.

These data are provided in BM_Warton.mdb.)

2.4 Analyses carried out

The approach was the use of numerical classification techniques (PATN) based on the similarity of the floristic composition of the Warton sites to sites in the SCP survey data set.

2.4.1 PATN

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The parameter values were the same as used by the SCP survey used to ensure consistency of analysis with that study.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification based on the results of ASO), DEND (representation of classification) and NNB (determination of sites most similar to each site – nearest neighbours). The results of the analyses were imported into a database (BM_Eglington.mdb) so that site characteristics and previous classifications (eg., Floristic Community Types derived in earlier classifications) could be associated and various analyses based on these data could be performed.

The assignment of floristic community types to the Warton sites was made by summarising the results of two different methods:

- the classification, and
- the ten nearest neighbours.

Experience demonstrates that the results of these are likely to vary, but that from nearest neighbours is likely to make more sense.

To the classification dendrogram of the combined dataset the FCT assigned by the SCP survey was associated with the SCP survey sites. The apparent FCTs were assigned to the Warton sites by interpreting the position of these sites in the dendrogram (particularly by the way they joined to the SCP sites.

The 10 sites in the combined data set that were most similar to each of the Warton sites were obtained from the nearest neighbour method (NNB). By associating those nearest neighbours from the SCP survey, the most likely FCTs for each of the Warton sites were determined.

An attempt was then made to reconcile these different assignments of a Floristic Community Type.

3.0 LIMITATIONS

It has been found in earlier projects that the addition of new sites to the SCP survey data set to produce a combined classification disrupts the original classification. The more data added, the higher the level of the disruption. This problem can make it difficult to assign Floristic Community Types to new sites using this method.

Secondly, it is common for new data to group to their cohorts. In some cases this has proven to result from common deficiencies in the data, ie. whole groups of species missing. This absence tends to draw them together. The more sites in the added batch, the tighter they draw together.

The analyses are conducted without personal knowledge of the sites and no photographs were provided.

4.0 RESULTS

4.1 Determination of floristic community type by classification

The classifications suggested that the sites appeared to belong to several FCTs: 4, 5 and 23a (Figure 1).

Figure 1. Relevant portions of Dendrogram

site	FCT	#sp	dendrogram
			05/10/11 06:42:15.30 dend BRM Warton with SCP May 2011
			0.2050 0.3656 0.5261 0.6867 0.8472
KOOLJ-1	4	20	
MELA-1	4	23	
PLINE-4	4	22	
WHITE-2	4	37	
WR6		33	
AUSTB-4	5	28	
AUSTB-6	5	32	
GUTHR-2	5	39	
GUTHR-4	5	36	
HARRY-3	5	25	
MILT-1	5	37	
WR4		50	
WR5		32	
PLINE-5	5	23	
BANK-2	23a	61	
hurst03	23a	67	
MODO-4	23a	62	
low13b	23a	66	
BULL-3	23a	70	
WHITE-1	23a	58	
YULE-1	23a	56	
YULE-2	23a	57	
WR1		68	
WR2		54	
WR3		46	

Warton Road Sites WR

Table 2 provides a summary of the “most likely” FCT for this classification.

4.2 Determination of floristic community type using Nearest Neighbour method

The nearest neighbour analysis suggests that the sites also belong to a number of communities but principally FCT 23a, 5, 28 and 22.

Table 1. Results of Nearest Neighbour analysis

s	s1	fct1	v1	s2	fct2	v2	s3	fct3	v3	s4	fct4	v4	s5	fct5	v5
WR1	WR2		0.2333	WR3		0.3514	hurst03	23a	0.3534	WARB-3	23a	0.4101	YULE-2	23a	0.4146
WR2	WR3		0.2323	WR1		0.2333	hurst03	23a	0.3719	WIRR-1	23a	0.4154	YULE-2	23a	0.4234
WR3	WR2		0.2323	WR1		0.3514	hurst03	23a	0.375	WAND-1	23a	0.4314	YULE-2	23a	0.4314
WR4	WR5		0.4937	hurst03	23a	0.5652	NEER-5	28	0.5682	HARRY-1	28	0.5745	hurst02	23a	0.5789
WR5	WR4		0.4937	GUTHR-2	5	0.5714	HARRY-3	5	0.6071	MILT-1	5	0.6176	WR6		0.625
WR6	WHITE-2	4	0.6	WR5		0.625	MELA-5	22	0.6338	BANK-1	22	0.6364	hurst03	23a	0.64

Table 1 (cont)

s	s6	fct6	v6	s7	fct7	v7	s8	fct8	v8	s9	fct9	v9	s10	fct10	v10
WR1	WIRR-2	23a	0.4307	YULE-1	23a	0.4426	NINE-2	21a	0.45	WIRR-1	23a	0.4507	MODO-4	23a	0.4531
WR2	WHITE-1	23a	0.4464	YULE-1	23a	0.4545	WARB-3	23a	0.4646	MODO-4	23a	0.4655	BULL-3	23a	0.4677
WR3	WHITE-1	23a	0.4369	BULL-3	23a	0.4609	DEJONG-c	21c	0.4651	WIRR-1	23a	0.4711	MODO-4	23a	0.4766
WR4	WR1		0.5789	hurst01	23a	0.5789	BULLER-3	21c	0.5842	CORON-1	21a	0.5842	GUTHR-3	21a	0.6
WR5	GUTHR-1	4	0.6429	WR1		0.6495	AUSTB-6	5	0.6508	low08	5	0.6571	MODO-6	4	0.661
WR6	MODO-2	21c	0.6471	WR4		0.6543	GUTHR-2	5	0.6667	MODO-1	4	0.6716	MODO-6	4	0.6721

s – the site being compared
s1 to s10 – the 1st to 10th most similar sites
f1 to f10 – the FCT of the similar sites (only for SCP sites)
v1 to v10 – the dissimilarity value between the site and the similar sites (values above 0.6 tend to indicate low similarity)

4.3 Combining the results

It is common for the classification to indicate a simple result and the nearest neighbour analysis to be less conclusive. This is more a product of the classification process often suggesting an over simplified view than of inconsistency of the analyses.

There appeared to be reasonable accord in that both methods suggested the same FCT for 4 of the 6 sites.

Table 2 Summary of results

Site	Dendrogram FCT	NNB FCT	Summary FCT
WR1	23a	23a	23a
WR2	23a	23a	23a
WR3	23a	23a	23a
WR4	5	23a/28	23a/5
WR5	5	5	5
WR6	4	4/22/23a	4?

4.0 REFERENCES

Belbin, L. (1987) *PATN Reference Manual* (313p), *Users Guide* (79p), *Command Manual* (47p), and *Example Manual* (108p). CSIRO Division of Wildlife and Ecology, Lynham, ACT.

English, V., and Blyth, J. (1997) *Identifying and conserving threatened ecological communities (TECs) in the South West Botanical Province*. ANCA National Reserves System Cooperative Program: Project Number N702, Australian National Conservation Agency, Canberra

Gibson, N.G., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M (1994). *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished report by the Department of Conservation and Land Management and the Conservation Council of Western Australia to the Australian Heritage Commission.

Trudgen, M.E. (1999). *A flora and vegetation survey of Lots 46 and 47 Maralla Road and Lexia Avenue, Ellenbrook*. Volumes 1-4. Unpublished report prepared for the Crown Solicitors Office, Government of Western Australia. December 1999.

5.0 APPENDIX

Appendix 1 Species combinations made to assist in reconciling taxonomic changes and identification difficulties between this survey and SCP data.

FCODE	Species_LUP.name	Species_LUP_1.name
031	Aira caryophyllea	Aira caryophyllea/cupaniana group
031	Austrostipa variabilis	Austrostipa semibarbata/campylachne
031	Avena barbata	Avena barbata/fatua
031	Pentaschistis airoides subsp. airoides	Pentaschistis airoides/pallida
031	Vulpia myuros forma myuros	Vulpia myuros
032	Lepidosperma pubisquameum	Lepidosperma angustatum/squamatum
032	Lepidosperma scabrum (Inland form)	Lepidosperma scabrum
032	Lepidosperma sp.	Lepidosperma angustatum/squamatum
032	Lepidosperma sp. Coastal Dunes	Lepidosperma angustatum/squamatum
032	Lepidosperma sp. K Boorabbin (K.L. Wilson 2579)	Lepidosperma angustatum/squamatum
032	Lepidosperma squamatum	Lepidosperma angustatum/squamatum
032	Schoenus subfascicularis	Baumea juncea
039	Lyginia imberbis	Lyginia barbata
054E	Dianella revoluta var. divaricata	Dianella revoluta
054F	Chamaescilla corymbosa	Chamaescilla spiralis/corymbosa
054F	Laxmannia ramosa subsp. ramosa	Laxmannia ramosa
054F	Thysanotus manglesianus/patersonii	Thysanotus patersonii/manglesianus
054J	Burchardia congesta	Burchardia umbellata/congesta
055	Conostylis aculeata subsp. aculeata	Conostylis aculeata
055	Conostylis aculeata subsp. preissii	Conostylis aculeata
060	Patersonia occidentalis var. angustifolia	Patersonia occidentalis
066	Caladenia flava subsp. flava	Caladenia flava
066	Eriochilus dilatatus subsp. multiflorus	Eriochilus dilatatus
066	Pterostylis sp.	
066	Thelymitra sp.	
143	Drosera pallida/menziesii	
149	Crassula colorata var. colorata	Crassula colorata
163	Acacia applanata	Acacia willdenowiana
163	Acacia pulchella var. goadbyi	Acacia pulchella
165	Gastrolobium capitatum	Nemcia capitata
165	Hovea trisperma	Hovea trisperma var. trisperma
175	Boronia ramosa subsp. anethifolia	Boronia ramosa
273	Astartea affinis	Astartea aff. fascicularis
273	Hypocalymma sp.	
273	Kunzea glabrescens	Kunzea ericifolia
302	Phyllangium divergens	Phyllangium paradoxum
343	Stylidium saxifragoides	Stylidium piliferum
345	Lagenophora huegelii	Lagenifera huegelii

RPS

APPENDIX 3

Aboriginal Heritage Inquiry System Search

38 Station Street, Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au

LEGEND
- Site Boundary
- Mining Tenement
- Cadastre
- Proposed Sand Mining Footprint
- Aboriginal Heritage Site

S00197 - Artefacts / Scatter

RPS

Job Number: L10590
Date: 17.08.2010
Scale: 1:7500 @ A3
Revision: A
Drafted by: HT & SC
Source: Orthophoto, Cadastre - Landgate, 2011 Mining Tenement - Landgate, 2010 Aboriginal Heritage Sites - DIA, 15.08.11

0 37.5 75 150 225 300 metres

Aboriginal Heritage Sites

Search Criteria

Site 3301

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Legend

Restriction		Access	
N	No restriction	C	Closed
M	Male access only	O	Open
F	Female access	V	Vulnerable

Coordinate Accuracy

Accuracy is shown as a code in brackets following the site coordinates.

[Reliable]	The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
[Unreliable]	The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L - Lodged	→	IA - Information Assessed	→	ACMC Decision Made
Information lodged, awaiting assessment		Information Awaiting ACMC Decision Assessment Only		R - Registered Site I - Insufficient information S - Stored Data

*Explanation of Assessment

Sites lodged with the Department are assessed under the direction of the Registrar of Aboriginal Sites. These are not the final assessment.

Final assessment and decisions will be determined by the Aboriginal Cultural Material Committee (ACMC).

Spatial Accuracy

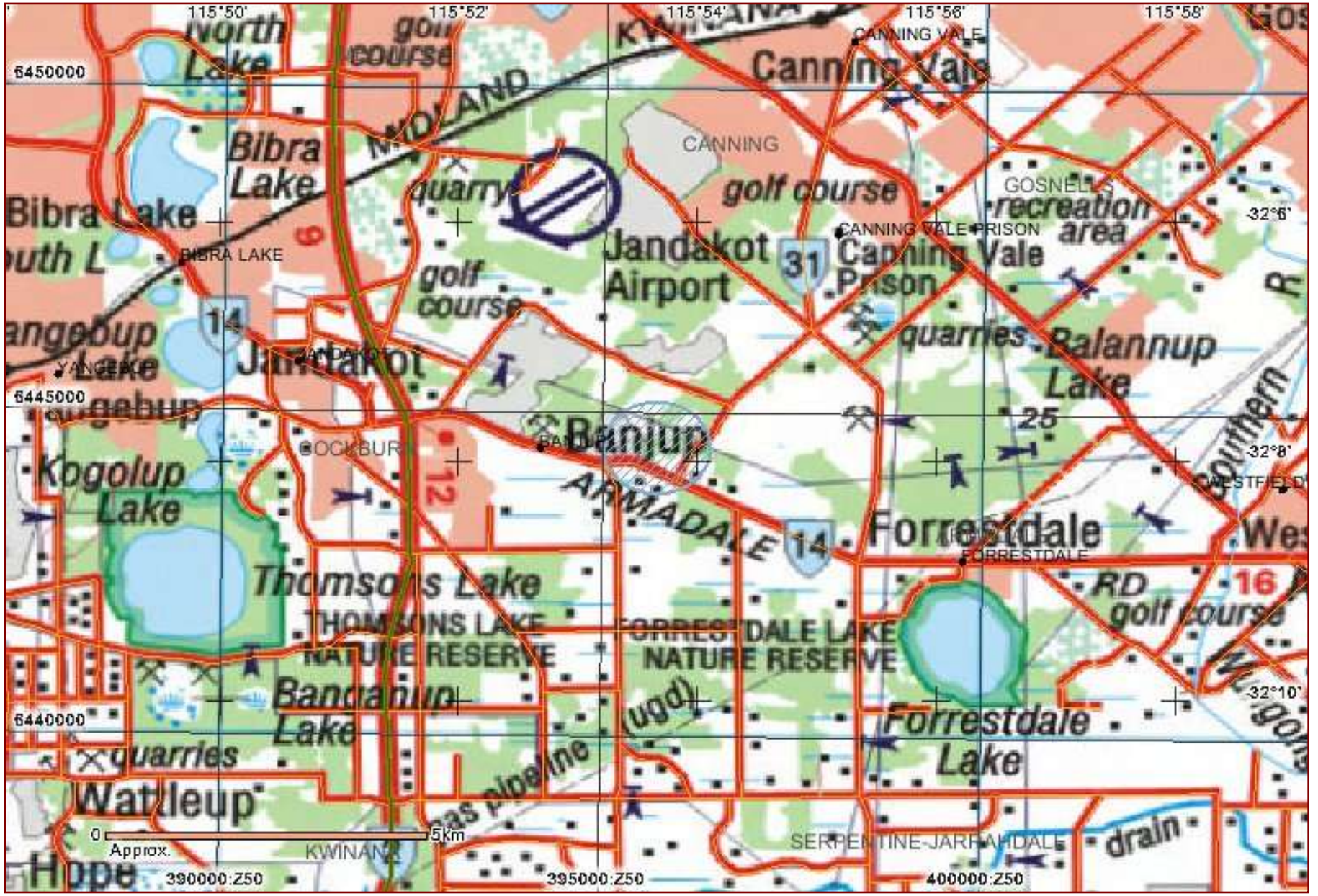
Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code “closed” or “vulnerable”. Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000:Z50' means Easting=5000000, Zone=50.

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
3301	S	O	N	Banjup: Calsil.	Artefacts / Scatter	Camp		395707mE 6444461mN Zone 50 [Reliable]	S00197



Legend

Selected Heritage Sites

Other Heritage Places

Town

Map Area

Search Area

Search Criteria

Survey 2274

Disclaimer

Heritage Surveys have been mapped using information from the reports and / or other relevant data sources. Heritage Surveys consisting of small discrete areas may not be visible except at large scales. Reports shown may not be held at DIA. Please consult report holder for more information. Refer to www.dia.wa.gov.au/heritage for information on requesting reports held by DIA.

Copyright

Legend

Access

Some reports are restricted. The type of restriction is shown as a code in brackets following the catalogue number. No code indicates an unrestricted report.

[CLOSED]	Closed
[OWE]	Open with exception
[TBD]	To be determined
[RESTRICTED PENDING]	Restricted pending

Spatial Accuracy

The following legend strictly applies to the spatial accuracy of heritage survey boundaries as captured by DIA.

Very Good	Boundaries captured from surveyed titles, GPS (2001 onwards) submitted maps georeferenced to within 20m accuracy.
Good	Boundaries captured from GPS (pre 2001) submitted maps georeferenced to within 250m accuracy.
Moderate	
Unreliable	Boundaries captured from submitted maps georeferenced to an accuracy exceeding 250m.
Indeterminate	Surveys submitted with insufficient information to allow boundary capture.

Survey 2274

Project	The Perth Area.
Start Date	01 Apr 1970
Proponents	University of Western Australia
Consultants	University of Western Australia
Survey Types	Archaeological and Archaeological and Ethnographic
Aboriginal People Consulted?	No

Related Reports

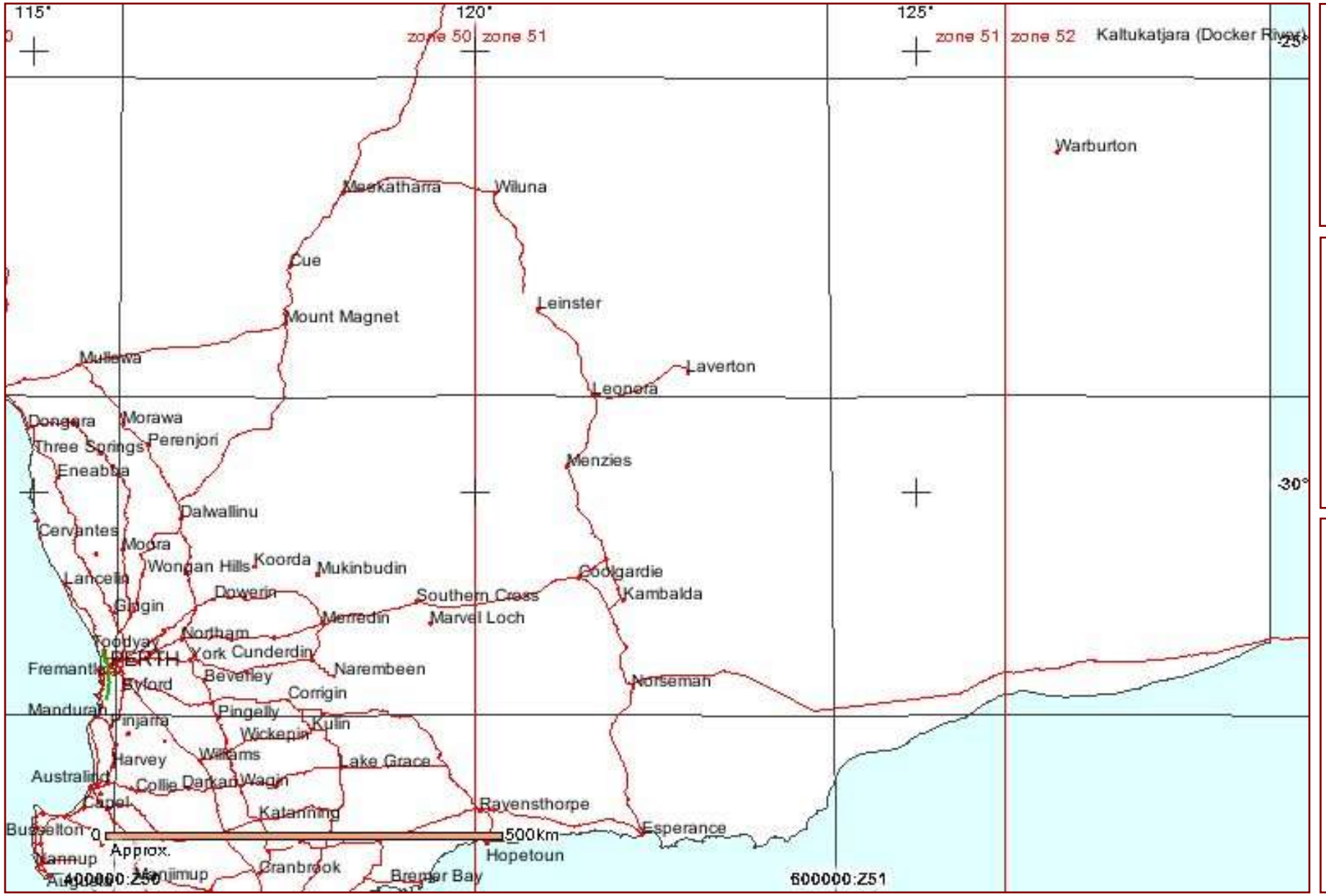
Report ID	Catalogue Number	Title	Recorders	Held At
103564	HSR MW 1972 UWA	An Archaeological Survey Project: The Perth Area, Western Australia. Apr 1972.	University of Western Australia H. Polach	DIA
104023	Not in Catalogue	An Archaeological Survey Project. The Perth Arch. Area. Western Australia Report no.4 April 1971.	University of Western Australia H. Polach	DIA

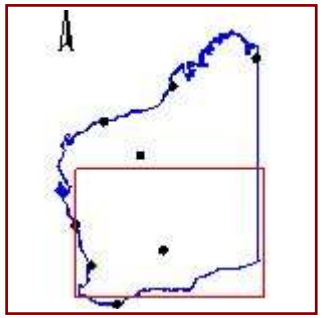
Related Survey Areas

Area Number	Survey Type	Area Description	Survey Methodology	Spatial Accuracy	Field / Desktop
1	Archaeological	The Perth Area. 103 site locations in 67 site groups were investigated.	Site Identification	Indeterminate	Field and Desktop
2	Archaeological	The Perth Area. Sites included id's 3350, 4404, 3846	Site Identification	Unreliable	Field and Desktop
3	Archaeological and Ethnographic	The Perth Area. Closed site id 2887	Site Identification	Indeterminate	Field and Desktop

Aboriginal Heritage Inquiry System

Heritage Survey Database





Legend

Selected Heritage Surveys

- Heritage Survey
- Town
- Map Area
- Search Area

Search Criteria

Survey 3737

Disclaimer

Heritage Surveys have been mapped using information from the reports and / or other relevant data sources. Heritage Surveys consisting of small discrete areas may not be visible except at large scales. Reports shown may not be held at DIA. Please consult report holder for more information. Refer to www.dia.wa.gov.au/heritage for information on requesting reports held by DIA.

Copyright

Legend

Access

Some reports are restricted. The type of restriction is shown as a code in brackets following the catalogue number. No code indicates an unrestricted report.

[CLOSED]	Closed
[OWE]	Open with exception
[TBD]	To be determined
[RESTRICTED PENDING]	Restricted pending

Spatial Accuracy

The following legend strictly applies to the spatial accuracy of heritage survey boundaries as captured by DIA.

Very Good	Boundaries captured from surveyed titles, GPS (2001 onwards) submitted maps georeferenced to within 20m accuracy.
Good	Boundaries captured from GPS (pre 2001) submitted maps georeferenced to within 250m accuracy.
Moderate	
Unreliable	Boundaries captured from submitted maps georeferenced to an accuracy exceeding 250m.
Indeterminate	Surveys submitted with insufficient information to allow boundary capture.

Survey 3737

Project	Ballaruk, (Traditional Owners of Whadjuk territory) Site Recording Project
Start Date	01 Jan 1994
Proponents	Heritage Council of Western Australia
Consultants	Tamora Pty Ltd
Survey Types	Ethnographic
Aboriginal People Consulted?	Yes

Related Reports

Report ID	Catalogue Number	Title	Recorders	Held At
21817	HSR MW 1994 MAC	Ballaruk (traditional owners) Aboriginal site recording project	Barrie Machin	Department of Indigenous Affairs
21818	HSR MW 1995 MAC	Ballaruk (traditional owners of Whadjuk territorial boundaries the lands of the Ballaruk Peoples) Aboriginal site recording project : additional material	Barrie Machin	

Related Survey Areas

Area Number	Survey Type	Area Description	Survey Methodology	Spatial Accuracy	Field / Desktop
1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Site Identification	Unreliable	Field and Desktop

Aboriginal Heritage Inquiry System

Heritage Survey Database

Legend

Selected Heritage Surveys

Heritage Survey

Town

Map Area

Search Area