Element

Forrestfield North Residential Precinct

Numerous Lots
Roe Highway, Berkshire Road and Dundas Road

17 November 2021

57806 / 139,342 (Rev 4)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

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1. Introduction

1.1 Background

In response to the State Government's Forrestfield Airport Rail Link-MetroNet project, The City of Kalamunda (CoK) is facilitating the design and subsequent implementation of the Forrestfield North District Structure Plan (DSP) process. The DSP area is approximately 190 ha and is bound by Roe Highway to the east, Sultana Road to the south, Dundas Road and railway to the west and Poison Gully Creek to the north.

The DSP is a guiding framework to maximise the opportunities, including the capacity for greater diversity in housing options, employment and economic development options while identifying and provide for the retention of key environmental assets.

To coordinate the development of the DSP area, the site has been divided into two Local Structure Plan (LPS) precincts:

- TOD Precinct (67.49 ha).
- Residential Precinct (123.05 ha).

This Environmental Assessment and Management Strategy (EAMS) has been developed to support the LSP for the Residential Precinct, the location of which is shown on Figure 1.1. The LSP Residential Precinct consists of the following elements (Appendix A):

- residential uses,
- aged care facility,
- primary school,
- public community purpose facility,
- public open space (POS) areas,
- existing Bush Forever sites, and
- environmental conservation areas.

1.1.1 Previous environmental planning amendments and considerations

In 2015, the precinct was amended from Rural to Urban under the MRS (1282/57). As part of this process the amendment was referred to the Environmental Protection Authority (EPA) who provided an assessment and advice, with no appeals. The EPA identified the following environmental factors as being relevant to the scheme:

- Flora and vegetation: Wavy-leaved Smokebush (*Conospermum undulatum*), and
- Terrestrial fauna: remnant vegetation providing roosting, foraging and potential breeding habitat for Carnaby's Cockatoo and Forest Red-tailed Black Cockatoos, and suitable habitat for the Quenda/Southern Brown Bandicoot.

The EPA (2015,2) noted the expectation that the local scheme text would be revised to include provisions for the management of specific environmental values:

"…specific mechanisms and adequately secure, protect and manage the significant environmental values within the amendment area".

In 2016, the CoK prepared amendment 75 to Local Planning Scheme No. 3 (the Scheme) to rezone the DSP from 'Light Industry', 'Industrial Development', and 'Special Rural' to 'Urban Development'. In accordance with the EPAs advice (2015, 2) the Scheme amendment included provisions for the

management of environmental values. Through the amendment process, the scheme was referred to the EPA. Following examination of the referral including the conduction of preliminary investigations and inquiries, the scheme amendment was not formally assessed. The EPA provided the following advice:

- *"the EPA expects that further detailed management plans and scheme provisions to address flora and vegetation will be addressed prior to the finalisation of the structure plan,*
- *the protection of declared rare flora, associated habitat, threatened fauna habitat, and low representation vegetation complexes in appropriately sized retention areas for conservation purposes. These retention areas shall be informed by Level 2 Flora and Vegetation and Fauna Surveys in accordance with EPA Guidance Statements 51 and 56 (or as revised), and targeted for Declared Rare Flora and threatened fauna, and associated habitat. The retention area size, location, protection and management mechanism shall be subject to OEPA advice prior to the WAPC endorsement of the structure plan, and*
- *all future subdivision and development proposals must be consistent with the retention areas agreed."*

1.1.2 Stakeholder consultation

The Kalamunda Environmental Advisory Committee (KEAC) was developed to make recommendations to the Council on matters relating to the environment and social/community. In the initiation of the LSP process the committee was consulted on the major considerations of the precinct (including noise/vibration, environment, water management, sustainability, ethnographic and public realm guidelines).

A Technical Advisory Group (TAG) made up of key agency and decision makers including the Department of Biodiversity, Conservation and Attractions (DBCA) and the Office of Environmental Protection Authority (OEPA) (now Department of Water and Environmental Regulation [DWER]) was established and chaired by the Department of Planning, Lands and Heritage (DPLH). During the LSP process TAG meetings were undertaken to discuss the key elements of the project including the rationale of LSP design and the inclusion of the key environmental attributes within the precinct.

Further to the DSP, a Community and Stakeholder Engagement and Communications Strategy was development by Element (formally TPG + Place Match) (2017) to guide community stakeholder consultation for the development of the LSP. This strategy includes two main phases of engagement, being the Preliminary Community and Stakeholder Engagement (May – June 2017), and the Public Advertising period (to be advised). The Preliminary engagement included the following:

- City of Kalamunda council briefing,
- landowners survey,
- landowner forum,
- community and stakeholder survey, and
- community and stakeholder workshop.

In late 2017, the EPA services branch and DBCA were consulted on the LSP design and the priority of key environmental factors and their retention within the Precinct. Preliminary State biodiversity advice from these agencies were received which subsequently was incorporated into the revised LSP design (refer to Appendix A) including the following:

- retention of large clusters of Wavy-leaved Smokebush plants within high quality vegetation that are considered viable in the long-term, and

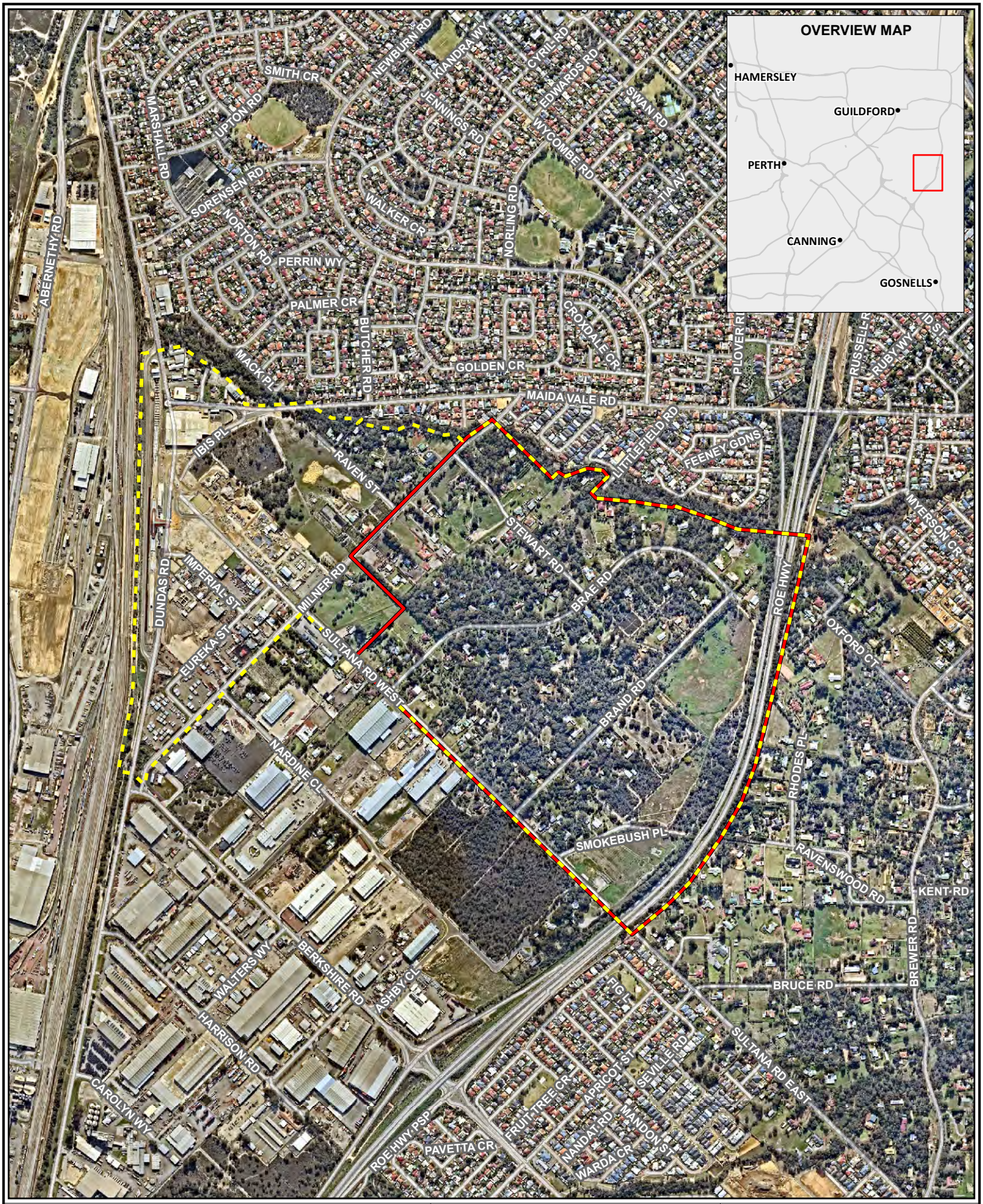
- retention of a functional ecological linkage between the Sultana Road West Bush Forever site (Bush Forever site 123) and Poison Gully Creek to assist in maintaining the ecological viability of both sites and the intervening retained areas within the corridor.

1.2 Objectives

This EAMS intends to meet the following objectives:

- describe the environmental and heritage values within the precinct and surroundings based on existing information, and
- identify potential opportunities to secure, protect and manage the significant environmental values on site and present management requirements.

To ensure that an integrated approach is developed for the precinct area the EAMS has been prepared in parallel with the Local Water Management Strategy (LWMS) and Bush Fire Management Plan (BMP), both prepared by Strategen-JBS&G (formally Strategen Environmental). These documents should be read in conjunction with this EAMS.



Legend:

- Residential precinct
- DSP area
- Roads (MRWA)

Scale 1:15,000 at A4

0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 57806

Client: Element

Version: A | Date: 21-Jul-2021

Drawn By: hsullivan | Checked By: CT

Forrestfield North Residential Precinct, WA

SITE LOCATION

FIGURE 1.1

strategen JBS&G

File Name: W:\Projects\1)Open\Element (TPG)\57806 - FF North TOD & Res LWMS\GIS\Maps\R01_Rev_B\57806_01_SiteLocation.mxd
Image Reference: www.nearmap.com© - Imagery Date: 3 July2021.

1.3 Legislation, policies, and guidelines

The following legislation, policies and guidelines and their implementation may be applicable for the redevelopment of the Residential Precinct.

1.3.1 Federal

1.3.1.1 Environmental Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Department of Agriculture, Water and the Environment (DAWE). The EPBC Act aims to protect and manage nine Matters of National Environmental Significance (MNES) throughout Australia including:

- World Heritage Properties,
- National Heritage Places,
- wetlands of international importance (listed under the Ramsar Convention),
- listed threatened species and ecological communities,
- migratory species protected under international agreements,
- Commonwealth Marine Areas,
- the Great Barrier Reef Marine Park, and
- nuclear actions (including uranium mines).

The MNES applicable to the site is listed threatened species and ecological communities:

- Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC)
- *Conospermum undulatum* (Wavy-leaved Smokebush)
- Black Cockatoo foraging habitat and breeding trees.

1.3.1.2 Assessment under the EPBC Act

Under the EPBC Act an action that could be a significant impact on any MNES in accordance with the Significant Impact Guidelines 1.1-Matters of National Significance (Department of the Environment, Water, Heritage and the Arts, 2013) should be referred to the DAWE for assessment by the Minister.

The existing environmental challenges for the site include the following:

- the distribution of MNES is across the precinct, and
- lots within the precinct (proposed Environmental Conservation Reserves -ECRs) are vested in different landowners (multiple stakeholders) and vary in size.

The potential impact on MNES that occurs within the precinct will be referred on a case-by-case basis by the landowner/proponent. While ECRs have been incorporated within the LSP design to retain a significant portion of MNES (i.e. Banksia Woodland TEC, black cockatoo foraging habitat and breeding trees and Wavy-leaved Smokebush individuals). An assessment to whether development of a particular area within the Residential Precinct would be considered a significant impact on any MNES in accordance with the Significant Impact Guidelines 1.1-Matters of National Significance (Department of the Environment, Water, Heritage and the Arts, 2013) and warrant referral under the EPBC Act would be at the landowner/proponent discretion.

1.3.1.3 Policy, recovery plans, and conservation advice

The recovery plans and conservation advice relevant to the precinct are summarised in Table 1.1.

Table 1.1: Federal recovery plans and conservation advice and policies

Policy, recovery plan, or advice.	Description/objective	Regulatory authority	Relevance
Conservation advice for the Banksia Woodlands of the Swan Coastal Plain Ecological Community.	To mitigate the risk of extinction of the Banksia Woodlands of the Swan Coastal Plain ecological community, and to assist in the recovery of its biodiversity and function.	DAWE, DBCA DWER, and CoK.	The removal and protection/restoration of the Banksia Woodlands of the Swan Coastal Plain ecological community within the precinct.
Wavy-leaved Smokebush (*Conospermum undulatum*) Recovery Plan (2009).	To maintain or improve the conservation status of *Conospermum undulatum* during the term of this plan through the abatement of identified threats.	DAWE, DBCA, DWER, and CoK.	The removal and protection/restoration of *Conospermum undulatum* within the precinct.
Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan (2013).	To prevent further decline in the distribution and abundance of Carnaby's Cockatoo through protecting the birds throughout their life cycle and enhancing habitat critical for their survival within the breeding and non-breeding range, and ensuring the reproductive capacity of the species is maintained or improved.	DAWE, DBCA, DWER, and CoK.	The removal and protection/restoration of significant habitat for the species within the precinct.
Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan (2008).	To prevent further decline in the breeding populations of Baudin's cockatoo and Forest Red-tailed Black Cockatoo and to ensure their persistence throughout their range in the south-west of Western Australia.	DAWE, DBCA, DWER, and CoK.	The removal and protection/restoration of significant habitat for the species within the precinct.
Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (2012).	To compensate for the significant, residual impacts of an action on the environment.	DAWE, CoK.	Any significant residual impacts caused by the development of the precinct.

The application of management measures and recommendations as specified within the above are discussed in Section 3.

1.3.2 State

Key legislation includes *Environmental Protection Act 1986* (EP Act), the *Planning and Development Act 2005* (PD Act), *Biodiversity Conservation Act 2016* (BC Act) and the *Planning and Development (Local Planning Schemes) Regulations 2015* (PD Regulations). Under the PD Regulations the CoK must seek comments in regard to proposed structure plan (LSP) from any public authority or service provider that the CoK considers appropriate.

Other legislation relevant to the management of the precinct are outlined in Table 1.2.

Table 1.2: Other key legislation

Legislation	Description	Regulatory Authority	Relevance
Aboriginal Heritage Act 1972 (AH Act)	Protection of amendment sites of Aboriginal heritage significance, both known and as yet unknown.	DPLH.	Disturbance to Aboriginal heritage sites.

Legislation	Description	Regulatory Authority	Relevance
Bush Fires Act 1954	Minimising dangers resulting from bush fires, and the prevention, control and extinguishment of bush fires.	Department of Fire and Emergency Services (DFES), and CoK.	Bushfire management and compliance.
Conservation and Land Management Act 1984	Preservation and conservation of flora and fauna.	DBCA.	Removal of Threatened or Priority flora and ecological communities.
Contaminated Sites Act 2003 (CS Act)	Regulation of matters relating to the identification, assessment, recording, management and clean-up of contaminated land.	DWER.	Presence and management of contamination and/or acid sulfate soils.
Dangerous Goods and Safety Act 2004	Safe storage, handling and transport of dangerous goods.	Department of Mines, Industry Regulation and Safety (DMIRS).	Proposed land uses within the precinct.
Electricity Act 1945	Licensing of persons carrying out works relating to electricity.	DMIRS.	Proposed land uses within the site.
Health Act 1911	Regulations concerning emissions disposal of sewage.	Department of Health (DoH).	Management of sewage.
Native Title (State Provisions) Act 1999	Recognition and protection of native title.	DPLH.	Registered heritage sites.
Rights in Water and Irrigation Act 1914 (RIWI Act)	Protection and licensing of water resources.	DWER.	Development within the Perth Groundwater Area.
Waterways Conservation Act 1976	Conservation and management of waterways and their associated environment.	DWER.	Management of waterways.

In addition to the above legislation, there are several policy and guidance documents which relate to specific environmental factors that are relevant to the development of the precinct. The assessment has been designed to address the recommendations of the State regulatory guidance as described in Table 1.3.

Table 1.3: Relevant policies, guidance statements, and technical guidelines

Document type and number	Title	Application	Relevance
Guidance statements			
3	Separation Distances between Industrial and Sensitive Land Uses.	Outlines generic separation distances between industrial and sensitive land uses to avoid conflict between land uses.	Management of impacts to surrounding land uses.
6	Rehabilitation of Terrestrial Ecosystems.	Outlines the principles to be applied during clearing in the areas that will be rehabilitated after construction. These areas may include batters, service infrastructure corridors and road verges.	Clearing of vegetation.
33	Environmental Guidance for Planning and Development.	Provides guidance on the environmental protection process in respect of the land use planning and development process.	Land use planning.

Document type and number	Title	Application	Relevance
41	Assessment of Aboriginal Heritage.	If Aboriginal heritage values are identified on or associated with the Project area, this guidance statement will be used to assess the impact of the project on those values.	Protection and management of heritage site values.
EP Act provisions			
Factor statement	Social Surroundings.	Provides guidance on the management of noise and dust in relation to proposals and surrounding land uses.	Management of impacts to surrounding land uses.
Factor statement	Flora and Vegetation.	Outlines how the factor Flora and Vegetation is considered by the EPA in the environmental impact assessment (EIA) process.	Management of impacts to flora and vegetation.
Factor statement	Terrestrial Fauna.	Outlines how the factor Terrestrial Fauna is considered by the EPA in the EIA process.	Management of impacts to flora and vegetation.
Technical guidance or guidelines			
Technical Guidance	Flora and vegetation surveys for Environmental Impact Assessment.	Provides guidance on the assessment on the biodiversity implications of vegetation clearing.	Clearing of vegetation, or impact to threatened vegetation or flora species.
Technical Guidance	Sampling methods for terrestrial vertebrate fauna.	Provides guidance on the assessment on the biodiversity implications of vegetation clearing on fauna habitat.	Clearing of vegetation, or impact to threatened fauna species.
Technical Guidance	Terrestrial fauna surveys.	Provides direction and information on general standards and protocols for terrestrial fauna surveys for environmental impact assessment.	Clearing of vegetation, or impact to threatened fauna species.
Guidelines	WA Environmental Offset Guidelines.	• Clarifies the determination and application of environmental offsets in Western Australia,	Environmental management.

Document type and number	Title	Application	Relevance
Guidelines	Statement of Environmental Principles, Factors and Objectives, and some factor guidelines.	• Communicates how, for the purposes of environmental impact assessment, the EPA, • Considers the object and principles of the EP Act, • Uses environmental factors and objectives to organise and systemise environmental impact assessment and reporting, • Takes a holistic view of the environment and a proposal or scheme's potential impact on the environment, and • Considers significance when determining whether to assess a proposal or scheme and recommend whether an assessed proposal or scheme may be implemented.	Environmental management.
Guidelines	Assessment and Management of Contaminated Sites guidelines (DER 2014).	Provides guidance on the assessment and management of contaminated sites in Western Australia (WA) within the legislative framework provided by: the CS Act and the Contaminated Sites Regulations 2006 (CS Regulations); and the revised national site assessment framework provided in the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM).	Environmental management.
Policies			
Government of Western Australia	WA Environmental Offsets Policy (EPA 2011).	Provides a framework for consistent application of environmental offsets to protect and conserve environmental and biodiversity.	Environmental management.
State Planning Policy 2	Environment and Natural Resources Policy (WAPC 2003).	Provides guidance on planning developments to conserve the natural environment.	Environmental management.
State Planning Policy 2.8	Bushland Policy for the Perth Metropolitan Region (WAPC 2010).	Provides guidance to ensure bushland protection in the Perth Metropolitan Region in the respect of land use planning.	Clearing of vegetation, or impact to threatened vegetation or flora species.

Document type and number	Title	Application	Relevance
State Planning Policy 2.9	Water Resources (WAPC 2006).	Provides guidance on how to protect, conserve, enhance and manage sustainable use of water resources of environmental value.	Impact on hydrological regime Urban water management.
State Planning Policy 3.7	Planning in Bushfire Prone Areas	Seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure.	Site within mapped bushfire prone area
State Planning Policy 4.2	Activity Centres for Perth and Peel.	Specify broad planning requirements for the planning and development of new activity centres and the redevelopment and renewal of existing centres in Perth and Peel.	The development of an activity Centre is proposed as part of the Project.
State Planning Policy 5.4	Road and Rail Transport Noise and Freight Considerations in Land Use Planning, Section 5.3 – Noise Criteria.	Seeks to minimise the adverse impact of transport noise, without placing unreasonable restrictions on noise-sensitive residential development or adding unduly to the cost of transport infrastructure.	Management of impacts to surrounding land uses.
State Planning Policy 7.2	Precinct Design	Guides the preparation and assessment of planning proposals for areas that require a high level of planning and design due to their complexity.	Guide the implementation of the Precinct structure plan.
Operational Policy 4.3	Identifying and establishing waterways foreshore areas (Department of Water 2012).	Describes the process for identifying and managing foreshore areas whose values are under pressure from land-use changes in the area around them.	Project area is located immediately adjacent to Poison Gully Creek.

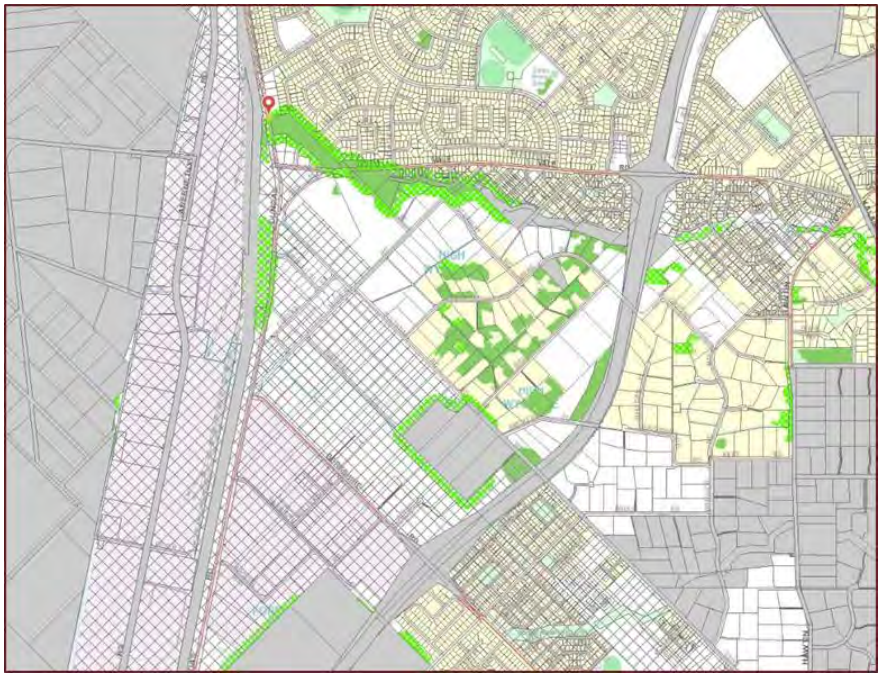
1.3.2.1 Perth and Peel green growth plan for 3.5 million

Perth and Peel @ 3.5 Million (WAPC 2018) indicates that there are specific commitments identified within the precinct area. The Green Growth Plan does not specify which specific commitments are depicted by the Specific Commitments layer, which may include:

- threatened flora and threatened ecological communities (refer to Section 3)
- conservation category wetlands and wetlands of international importance (refer to Section 3)
- vegetation complexes with less than 10 per cent remaining (refer to Section 3)
- Bush Forever areas (excluding those within the 'rural complementary' and 'negotiated planning solution' categories) (refer to Section 3)
- Short Tongued Bee (*Leioproctus douglasiellus*) distribution (not applicable) (Department of the Premier and Cabinet, 2015).

As of the 6 April 2018, the State Government suspended work and will be re-evaluating the Strategic Assessment of the Perth and Peel Regions (SAPPR) through an independent review. The Government has advised that "SAPPR sought to secure up front environmental approval for future

development and raw materials extraction for an identified development footprint for a 30-year period. It represents the largest and most complex land use reconciliation work, attempting to balance certainty for development and long-term environmental protection" (Department of the Premier and Cabinet, 2018). While the SAPPR has been suspended, the Specific Commitments mapping was reviewed and given due regard in formulating the design of the LSP. Refer to Plate 1.



Source: Government of Western Australia (2017)

Plate 1: Green Growth Plan for the Residential Precinct and surrounding DSP area

1.3.3 Local

The Strategies, Local Planning Policies and By-laws relevant to the CoK and precinct are presented in Table 1.4.

Table 1.4: Strategies, Local Planning Policies, and By-Laws

Reference No	Title	Application	Relevance to project
-	Local Biodiversity Strategy (2008) and Draft 2020 Kalamunda Local Biodiversity Strategy (2020a)	Strategically plan natural area protection so that biodiversity conservation is incorporated into the CoK's planning and decision-making processes.	Retention of Local Natural Areas (LNA).
ENV4	Flood and Stream Management	Management programs and retention of open lands and structures which do not obstruct water movement nor destroy natural public water areas within the CoK.	All lands within 15m of the banks of the Poison Creek and Crumpet Creek and areas defined as the 'Flood and Stream Management Area'.
-	Pest Plants (1979)	Council may request the owner or occupier of private land within the district to destroy, eradicate or otherwise control any pest plant on that land.	Land use management.
-	CoK Draft Urban Forest Strategy (2020b)	Implementation of action plan increase, maintain and protect the CoK urban forest.	Landscaping in POS areas and streetscapes.

2. Existing environment

2.1 Topography, geology and soils

2.1.1 Topography

The topography of the precinct ranges from approximately 46 m Australian Height Datum (AHD) in the north-eastern section to approximately 35 m AHD in the south-western corner. Topographic contours for the site are shown in Figure 2.1.

2.1.2 Geology and soils

Geological soil unit mapping indicates that the site is characterised by Sand (Figure 2.1), consisting of:

- S_{10}: Thin layer of SAND – very light grey at surface, yellow at depth, fine to medium grained, sub-rounded quartz, moderately well sorted, of eolian origin over alluvial silts and sands of the Guildford formation
- S_{12}: SAND – yellow, fine to medium grained, sub-angular to rounded quartz, with some feldspar, well sorted, variable silt content, of colluvial origin (Gozzard 1986).

In 2011, several bores were drilled across the precinct (Figure 2.3), the lithology of the bores were:

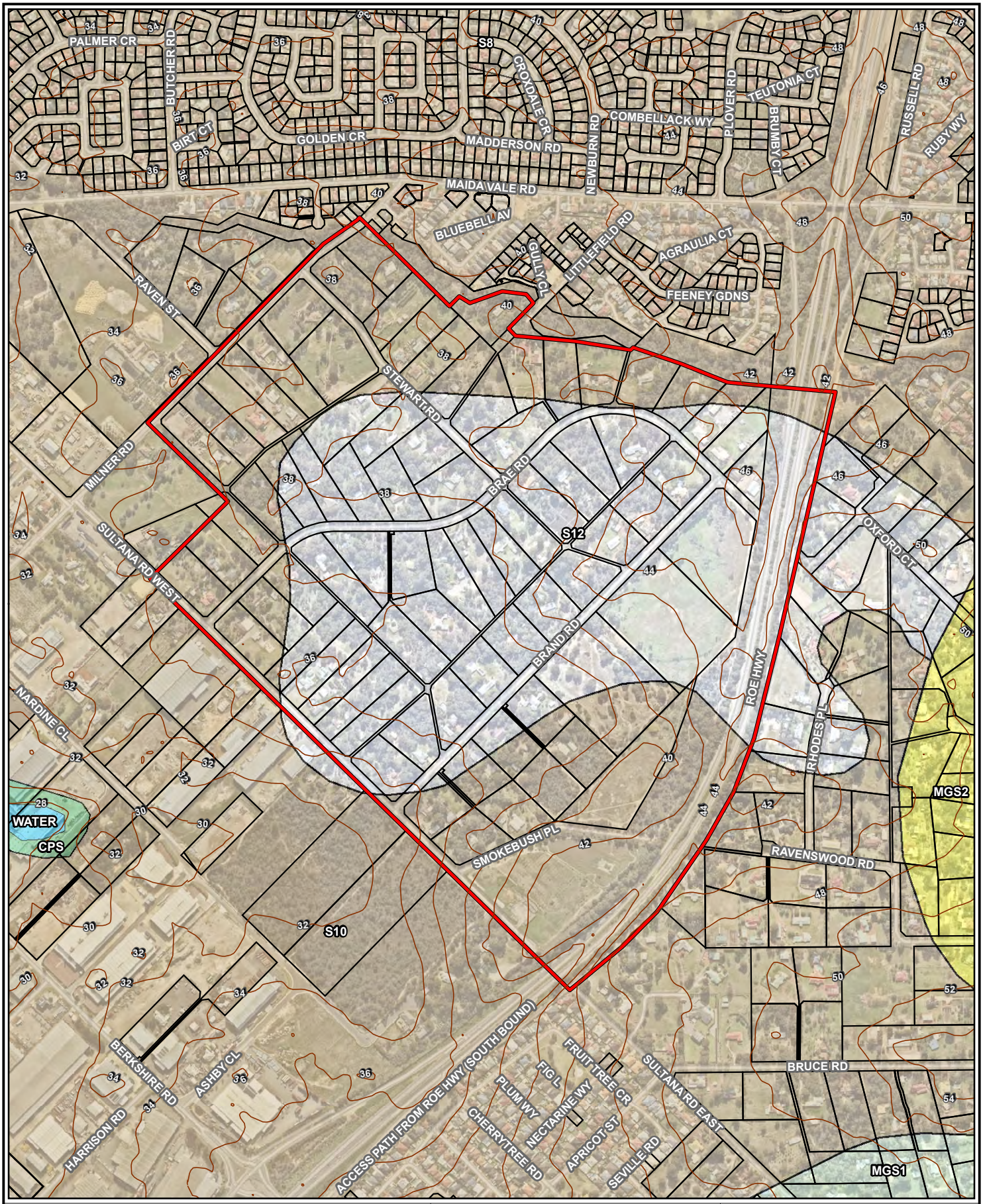
- MB02: predominantly sand with clayey sand at depth,
- MB04: gravelly sand at surface with sand at depth,
- MB05: predominantly sand (coarse to medium grained), and
- MB06: sand with clayey sand at depth (Strategen 2012a).

Relative permeability rates and Phosphorus Retention Index (PRI) for Bassendean Sands are 30+ m/day and 0-0.5 respectively (DoW nd). Currently, a geotechnical investigation for the precinct has not been undertaken to confirm soil properties/characteristics.

2.1.3 Acid Sulfate Soils

Acid Sulfate Soils (ASS) are naturally occurring, iron-sulphide rich soils, sediments, or organic substrates, formed under waterlogged conditions. If exposed to air, these sulphides can oxidise and release sulphuric acid and heavy metals. This process can occur due to drainage, dewatering or excavation.

Review of regional mapping indicates that the precinct has a low to moderate risk of ASS occurring within 3 m of natural soil surface (Class 2) (DER 2015). Nearest high to moderate risk of ASS occurring within 3 m of natural soil surface is approximately 400 m south east of the precinct (Figure 2.2)



Legend:

- Residential precinct
- Cadastral boundary
- Topographic contours (mAHD)
- Roads (MRWA)

Geology 1:50,000

- Cps
- Mgs1
- Mgs2
- S10
- S12
- S8
- Water

Scale 1:10,000 at A4 (0, 100, 200 metres)

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 57806

Client: Element

Version: A | Date: 30-Jul-2021

Drawn By: hsullivan | Checked By: CT

Forrestfield North Residential Precinct, WA

TOPOGRAPHY, GEOLOGY AND SOILS

FIGURE 2.1

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Image Reference: www.nearmap.com© - Imagery Date: 3 July 2021.

Legend:

- Residential precinct
- Cadastral boundary

Acid sulfate soil risk mapping (DWER)

- Moderate to low risk
- Roads (MRWA)

Scale 1:8,000 at A4 (0 100 200 metres)	**Forrestfield North Residential Precinct, WA**
Coord. Sys. GDA 1994 MGA Zone 50	**ACID SULFATE SOILS**
Job No: 57806	
Client: Element	**FIGURE 2.2**
Version: A / Date: 30-Jul-2021	strategen JBS&G
Drawn By: hsullivan / Checked By: CT	

File Name: W:\Projects\1)Open\Element (TPG)\57806 - FF North TOD & Res LWMS\GIS\Maps\R01_Rev_B\57806_02_2_ASS.mxd
Image Reference: www.nearmap.com© - Imagery Date: 3 July 2021.

2.2 Hydrology

A District Water Management Strategy (DWMS) was prepared by Strategen (2015) for the DSP area and approved by the Department of Water (DoW) (now Department of Water and Environmental Regulation [DWER]) and the CoK. The DWMS provides guidance on groundwater management, water sources for POS and sizing of stormwater systems.

A LWMS has also being prepared by Strategen-JBS&G (2020b) in accordance with *Better Urban Water Management* guidelines (WAPC 2008) on advice from DWER. The LWMS is consistent with regional and district scale urban water management planning, including the *State Water Plan* (DPC 2007) as well as *State Planning Policy 2.9 Water Resources* (WAPC 2006). The LWMS aims to meet the principles and objectives of stormwater management in Western Australia, as detailed in the *Stormwater Management Manual for Western Australia* (DoW 2007).

2.2.1 Groundwater

Groundwater attributes within the precinct are presented in Figure 2.3.

There are three aquifers underlying the DSP area; each assigned the name of the major geological unit in which the aquifer occurs (DWER 2017). In descending order of depth from natural surface they are:

- Superficial Aquifer (unconfined)
- Leederville Aquifer (confined)
- Yarragadee North (confined).

The Leederville and Yarragadee aquifers are both fully allocated in the Residential Precinct and adjacent areas. However, there are two options in satisfying future precinct groundwater requirements through the following options:

- a total of 137.4 ML is allocated for private use within the TOD and Residential Precinct areas. The two largest of these allocations are for 89.3 ML associated with a landscaping nursery and 32.1 ML associated with an orchard/market garden. Refer to LWMS (Strategen-JBS&G 2020b).
- the CoK currently have an allocation for irrigation of public open space (POS) in the superficial aquifer within the Perth Groundwater Area. This allocation is not being fully utilised and CoK has identified that 100 ML/year can be made available for irrigation within the DSP area if required (Varelis P [City of Kalamunda] 2017, pers. comm. 12 October).

Groundwater flow is in an approximately south-easterly direction. This is consistent with the findings of ENV (ENV 2012) reported in the LWMS for the adjacent industrial precinct and groundwater modelling (Strategen, 2018). There are currently no DWER groundwater bores within the precinct. The closest DWER bore with a long monitoring record is at the corner of Abernethy and Kewdale Roads in Kewdale, approximately 4 km south-east of the DSP area (DoE 2004). Groundwater levels within the Residential Precinct range from 28.5mAHD to 26mAHD (Figure 2.3).

Hydrogeological features of the DSP area are dominated by surface water/groundwater interactions resulting in variable groundwater gradients and flow directions across the site (EMRC, 2013). The local groundwater flow appears to be influenced by a combination of geology and drainage systems to the west and northwest of the site such as localised recharge features associated with industrial areas, Perth Airport and new developments (EMRC 2013:8).

As part of the LWMS, preliminary groundwater modelling (clearance from groundwater) has been completed. Depth to groundwater is indicated to be approximately 5 mbgl and is not considered likely to pose a constraint to development within the precinct.

Across the DSP area, groundwater is generally acidic to neutral with pH ranging between 4.62 to 7.21 (median of 5.84) (Strategen 2012). Groundwater is fresh with a median electrical conductivity (EC) level of 0.438 mS/cm. This mean EC level was identified to be within the expected range of 0.3–1.5 mS/cm for slightly disturbed ecosystems in south-west Australia (Strategen 2012).

Nutrient levels are slightly elevated. Groundwater monitoring conducted by Strategen in 2011 for the DWMS identified that total nitrogen (TN) levels varied from 0.31 mg/L to 25 mg/L throughout the monitoring period with a median of 2.1 mg/L. This median exceeds the Swan Canning Water Quality Improvement Plan's (SCWQIP) long-term and short-term target for TN (1 mg/L and 2 mg/L respectively) (Strategen 2012).

Total phosphorus (TP) results varied from <0.01 to 5.7 mg/L, with a median value of 0.72 mg/L. These levels are above the SCWQIP long-term and short-term target for TP (0.1 mg/L and 0.2 mg/L respectively) (Strategen 2012).

2.2.2 Surface water

Poison Gully Creek, is located immediately north and follows the precinct's cadastral boundary. Poison Gully Creek is an ephemeral creek that flows in a westerly direction via Limestone Creek (a tributary of Perth Airport Northern Main Drain) into the Swan River during the winter months. Previous monitoring has reported water present within September and October (Strategen 2011 and ERMC 2013).

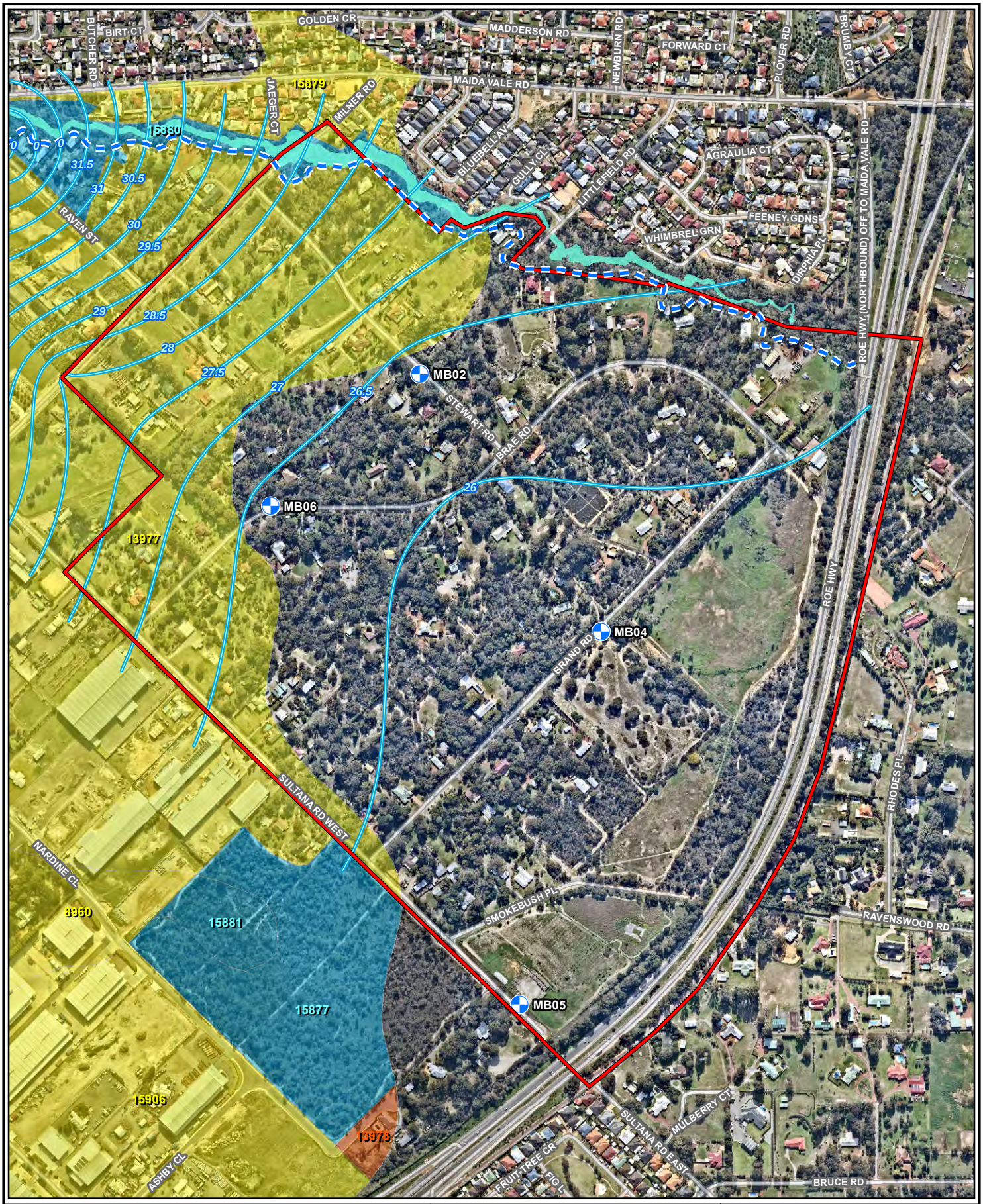
Poison Gully is part of the CoK's and the Water Corporation drainage network and has an extensive catchment to the east of the LSP area (Water Corporation 2010). It is estimated that Poison Gully has a catchment area of approximately 770 ha at the intersection of Maida Vale Rd and Dundas Rd.

No stream gauging data is publicly available for either drainage lines. It is understood that Water Corporation have previously maintained a stream gauging station for Poison Gully at Littlefield Rd (station 616015).

In 2012, a Foreshore assessment of Poison Gully was completed by Strategen and included in the DWMS which was approved by the Department of Water (now DWER) in 2015. The assessment considered the following biophysical criteria; vegetation, hydrology, soil type, geology, topography, habitat, land use and heritage, based on the guidelines in Determining Foreshore Reserves (WRC 2001). The Creek is deeply incised, with vertical exposed banks of 3 m to 5 m in height at some points, with the steepest gradient occurring on the eastern extent of the creek. Evidence of erosion was observed along the length of the creek line to varying degrees and is likely due to the steep gradient and degraded nature of fringing vegetation, which if intact would serve to stabilise the banks. Heavy infestation with a number of introduced plant species including Watsonia (*Watsonia bulbillifera*) and Spanish bamboo (*Arundo donax*) was recorded (Strategen 2012b). Poison Gully Creek's estimated foreshore boundary (in accordance with WRC, 2001 guideline) is depicted in Figure 2.3.

2.2.3 Flood potential

1 in 100-year Average Return Interval (ARI) flood level modelling for Poison Gully Creek was undertaken by the Water Corporation (2010). This flood modelling indicates a 1 in 100 year ARI flood level ranging between 39.81 mAHD at Roe Highway and 32.36 mAHD at Maida Vale Road (Strategen 2015), which is mostly contained within the valley area of the creekline. The flood height at Roe Highway was expected to be underestimated, as the invert level of the creek at this point is greater than 40 mAHD, above the Water Corporation Flood level. Based on the Water Corporation modelling, Poison Gully will overtop the road at Milner Road in the 1 in 100-year ARI event. However, as indicated, the 1 in 100-year ARI event is contained within the foreshore boundary.



Legend:

- Residential precinct
- Estimated 100 year flood area

Geomorphic Wetlands (DBCA)

- Resource Enhancement
- Multiple Use
- Not Applicable
- Groundwater monitoring bore
- Foreshore boundary
- Groundwater contour maximum (mAHD)
- Roads (MRWA)

Scale 1:8,000 at A4 (0 100 200 metres)		**Forrestfield North Residential Precinct, WA**
Coord. Sys. GDA 1994 MGA Zone 50		**HYDROLOGY**
Job No: 57806		
Client: Element		**FIGURE 2.3**
Version: A	Date: 30-Jul-2021	strategen JBS&G
Drawn By: hsullivan	Checked By: CT	

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Image Reference: www.nearmap.com© - Imagery Date: 3 July 2021.

2.2.4 Wetlands

A search of the Geomorphic Wetlands of the Swan Coastal Plain Database shows that the western section of the precinct is mapped as a Multiple Use Wetland (MUW; UFI 13977), and a portion of Poison Gully Creek is classified as a Palusplain Resource Enhancement Wetland (REW) (UFI 15880) (DBCA 2017). There is also a portion of REW mapped along the southern boundary of the precinct.

REW's are considered as priority wetlands where they have been partially modified but still support substantial ecological attributes and function. The ultimate objective is to manage, restore and protect towards improving their conservation value. No unauthorised development is permitted within a REW. A generic wetland buffer to protect the wetlands ecosystem is usually associated with REW, site buffer assessment can be undertaken to determine the buffer widths (EPA 2008). The existing buffer (generic 30m) associated with REW (UFI 15880) (Poison Gully) is semi developed (i.e. residential properties, cleared footprints and sheds). Refer to Figure 2.3. The Foreshore Assessment of Poison Gully undertaken in 2012 recommended the use of a 30m-50m buffer to the areas of REW (Strategen 2012c).

MUW's are the lowest management category assigned to wetlands by the DWER, and are generally considered appropriate for development, provided the hydrological regime is not disturbed (EPA 2008).

2.3 Potentially contamination activities

2.3.1 Contaminated Sites Register

The DWER (2017) Contaminated Site Database was searched and there are currently no registered contaminated sites within the precinct existing on the register.

2.3.2 Previous land uses

2.3.2.1 Brand Road Landfill

Brand Road landfill operations (Lot 13, 14 and 18 in plan 24292) commenced in approximately 1978. It was operated by Western Excavating from the beginning of the sand mining activities until 1989. The sanitary landfill operations started in 1989. The location of Brand Road Landfill is shown on Figure 2.4.

The DWER has classified the Site as "*Possibly Contaminated – Investigation Required*" under the CS Act (DEC Reference: DEC10015) and has requested further assessment of "current groundwater quality beneath this site, and delineation of the extent of any contamination identified, both beneath the site and off-Site".

A series of site investigations and reporting has been completed for the former landfill. A summary of is provided in Table 2.1

Table 2.1: Summary of contamination investigation and reports for Brand Road Landfill

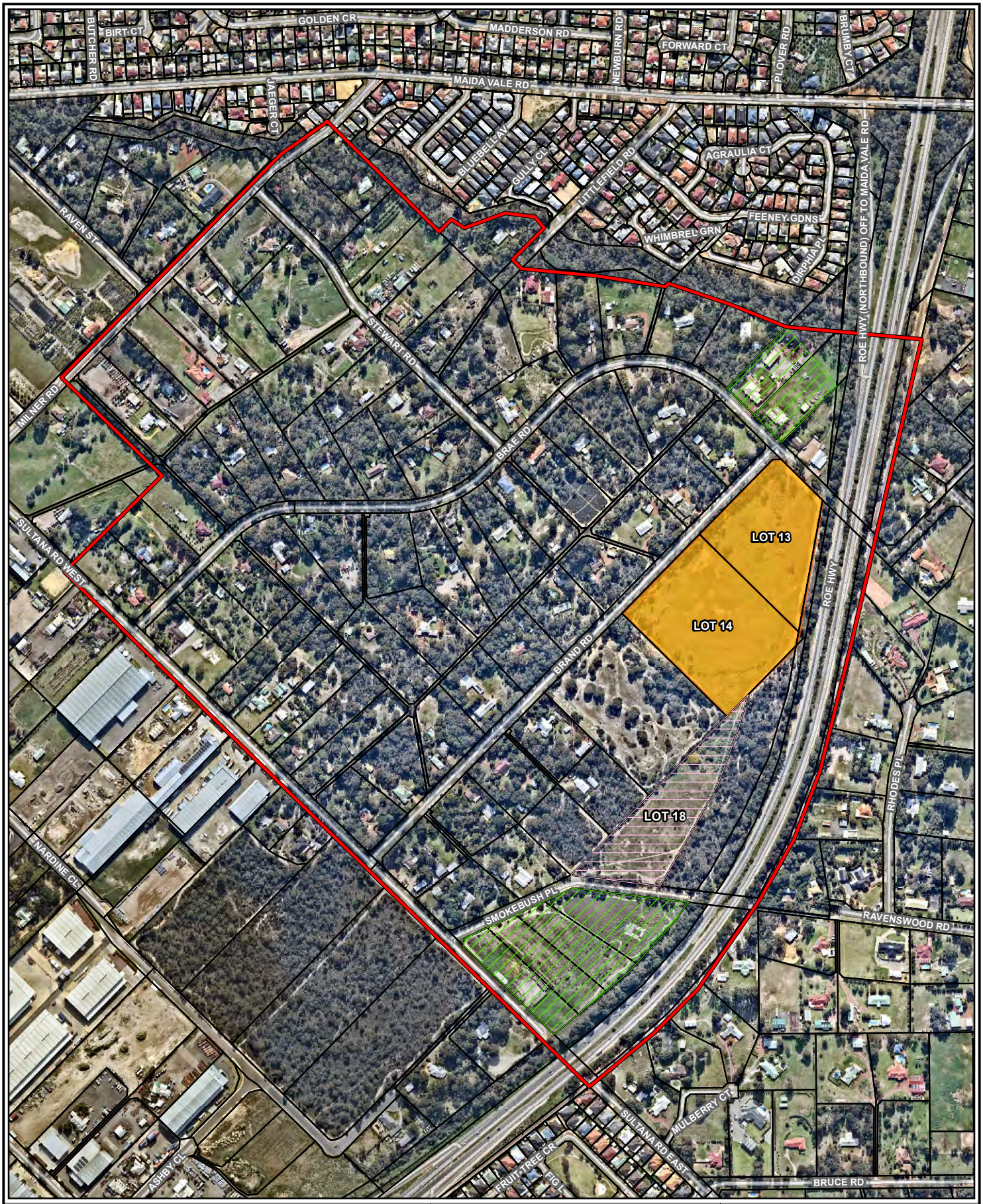
Report	Summary	Conclusion/Recommendation(s)
Preliminary Site Investigation (PSI) (GHD 2010)	• A PSI was conducted in 2010, the site had been referred to the DER Contaminated Sites Branch (CSB) previously and the site was classified as "Possibly Contaminated – Investigation Required" under the Contaminated Site Act 2003 as such the site was not added to the publicly available contaminated sites database. This is still the case with the site maintaining its current classification Brand Road landfill operations began just before 1978. It was operated by Western Excavating from the beginning of the sand mining activities until 1989. The sanitary landfill operations started in 1989. • Waste management activities formerly included the acceptance of municipal, commercial, demolition and	Further groundwater monitoring investigations.

Report	Summary	Conclusion/Recommendation(s)
	industrial wastes; however, the operations ceased in 1996. Part of the site was capped with clay and rehabilitated (levelled and grassed) for potential recreational use. • In 1996 Landfill Gas and Power commenced extraction of landfill gas as a means of reducing emissions and to provide an energy supply. • A review of previous groundwater investigations at the Site and in the immediate vicinity indicated the presence of contaminants in groundwater.	
Hydrogeological Assessment: Brand Road Landfill (EMRC 2013)	• Nine groundwater monitoring bores were sampled for inorganic and organic analysis. • Significant difference in groundwater quality exists between the Brand Rd bores and High Wycombe bores. • Groundwater quality monitored within the Brand Rd bores is being impacted by landfill leachate. However, based on the lack of gradient in groundwater flow it is estimated that it is unlikely that the plume would extensively migrate down-gradient. • Poison Gully shows no sign of contamination with surface water quality below the Department of the Environment (Now DWER) assessment levels for freshwater ecosystems.	Establishment of nested monitoring bores to the east of the Brand Road former landfill site to confirm whether groundwater contamination has migrated across the site and beyond the eastern boundary.
Bore Drilling: Brand Road Former Landfill (EMRC 2014)	• New groundwater monitoring bores were installed. • Groundwater quality from the newly installed bores was compared with the Brand Rd landfill bores and the surrounding High Wycombe bores showed that there is significant variability in groundwater quality within the site. • Overall, results are generally consistent with contamination by leachate within the boundary of the Brand Road old landfill. • The newly installed monitoring bores to the east and southeast of the landfill show no evidence of leachate contamination which indicates no lateral distribution of leachate contamination further away from the landfill.	Recommended that the Brand Rd network of monitoring bores be monitored on a biannual basis to allow for the assessment of analytical data, seasonal variations, and the identification of longer-term trends.
Biannual Water Monitoring Report (EMRC 2014a)	• Sampling (August 2014 and February 2015) of 12 GW monitoring wells and surface sample within Poison Gully. • Exceedances EC, Fem Cu NH) were recorded at one for more sample location against adopted assessment criteria.	• Continue monitoring Oxford Close and Smokebush Place bores to identify seasonal trends, especially for EC and ammonia concentrations. • Halogenated aliphatic compounds should continue to be analysed and closely monitored, particularly at site MW02I. • All sites should be monitored according to the current list of parameters to accommodate identification of trends.
Landfill Gas Contamination Assessment (EMRC 2015)	A subsurface landfill gas assessment and risk assessment was undertaken which classified most risks as low for existing commercial residential properties.	• Determine the extent of the landfill area at the eastern end where significant concentrations of methane were detected to confirm whether measurements were taken outside of the known landfill boundary. • Undertake an additional subsurface landfill gas investigation at the site to confirm results and if a series of permanent landfill gas bores

Report	Summary	Conclusion/Recommendation(s)
		should be installed across the site. • If permanent landfill gas bores are installed, data recorded can be used to undertake a Level 2 risk assessment in accordance with the NSW EPA Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases to gain a better understanding of the landfill gas risks associated with the site.
Brand Road Former Landfill Stage 1 (PSI) and Stage 2 Detailed Site Investigation (DSI) (360 Environmental 2018)	Data Gap Analysis and a Sampling Analysis and Quality Plan (SAQP) has been completed and endorsed by the Contaminated Site Auditor (CSA) DSI currently being undertaken to investigate the site as per the SAQP to develop a conceptual site model to ascertain the potential human and ecological risk factors.	To be confirmed and subject to the outcomes of the DSI.

2.3.2.2 Orchards

Based on historical aerial photography, there have been several hobby farms and/or orchards within Lots 94 and 98 Brae Road and Lots 100, 101, 102 and 103 Smokebush Place High Wycombe (Figure 2.4). These land uses and their associated activities are potentially contaminating due the uses of metals, Organochlorine pesticides, Organophosphate pesticides, Carbamate and fuels (Total petroleum hydrocarbons) (DoE 2004).



Legend:

- Residential precinct
- Cadastral boundary
- Historical orchard activity
- To be confirmed through further investigation
- Indicative landfill (source: GHD 2010)
- Roads (MRWA)

Scale 1:8,000 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 57806

Client: Element

Version: A | Date: 30-Jul-2021

Drawn By: hsullivan | Checked By: CT

Forrestfield North Residential Precinct, WA

POTENTIALLY CONTAMINATED SITES

FIGURE 2.4

strategen JBS&G

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2.4 Biodiversity and natural assets

2.4.1 Flora and vegetation

2.4.1.1 Pre-European vegetation

Vegetation occurring within the region was initially mapped at a broad scale (1:1 000 000) by Beard during the 1970s. This dataset has formed the basis of several regional mapping systems, including physiographic regions defined by Beard (1981) which led to the delineation of botanical districts as described in Beard (1990); the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia, IBRA) for Western Australia (DEE 2017a) and System 6 Vegetation Complex mapping undertaken by Heddle et al. (1980). The site is located within the Swan Coastal Plan 2 (SWA2) bioregion.

Beard (1980) vegetation association mapping indicates that the precinct resides within the 1001-Medium very sparse woodland; jarrah, with low woodland; banksia and casuarina. Remnant areas of the association are identified in Figure 2.5. WALGA (2017) estimates that there is approximately 22% of this vegetation complex within the IBRA subregion (GoWA 2019).

Heddle et al (1980) broadly mapped vegetation complexes across the Swan Coastal Plain. The precinct comprises the Southern River Complex and the Forrestfield Complex.

The Southern River Complex occurs in the western portion of the precinct area and is described as 'open woodland of *Eucalyptus calophylla* (now *Corymbia calophylla*) – *E. marginata* – *Banksia spp*. with fringing woodland of *E. rudis* – *M. rhaphiophylla* along creek beds' (Heddle et al 1980).

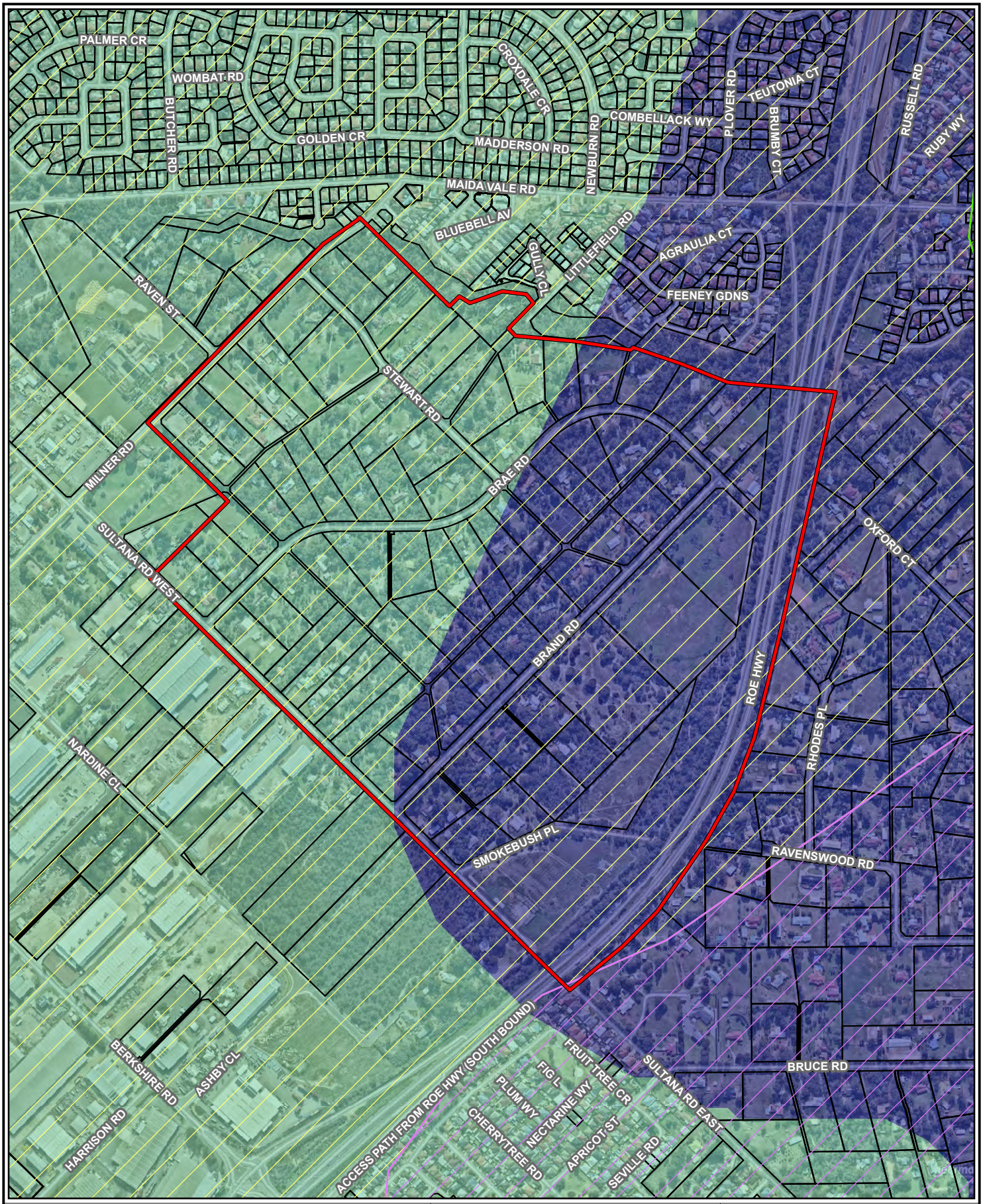
The Forrestfield Complex occurs in the eastern portion of the precinct area and is described as 'vegetation ranges from open forest of *Eucalyptus calophylla* (now *Corymbia calophylla*) – *E. wandoo* – *E. marginata* to open forest of *E. marginata* – *C. calophylla* – *C. Fraseriana* – *Banksia spp*. Fringing woodland of *E. rudis* in the gullies that dissect this landform' (Heddle et al 1980).

It is estimated that approximately 2,324 ha (11%) of the Forrestfield Complex and approximately 6,822 ha (17%) of the Southern River Complex remains in the Perth Peel Regional compared to the pre-European extent (GovWA 2019). Within the SCP area vegetation complexes that are less than 10% of the original extent are considered to be significant with focus on the retention of the remaining vegetation complex within the SCP, the remaining areas for both complexes are above the 10% threshold.

Table 2.2: Remnant vegetation complexes of the Perth and Peel regions for the Swan Coastal Plain and Jarrah Forest IBRA regions (GovWA 2019).

Vegetation complexes	Perth and Peel Region current 2019 (extent ha)	Perth and Peel Region remaining 2019 (%)	PRR reserved in region schemes P&R or ROS (%)
Forrestfield Complex	2324	11	2
Southern River Complex	6822	17	5

Remnant vegetation on site has been fragmented through semi-rural land development and clearing for building footprints, the remaining areas supporting mapped vegetation complexes within the precinct are represented in Figure 2.5 (WALGA 2017).



Legend:

- Residential precinct
- Cadastral boundary

Vegetation system associations (Beard)

- Bassendean 3
- Bassendean 1001
- Bassendean 1009

Vegetation complexes (Heddle)

- Forrestfield Complex
- Southern River Complex
- Roads (MRWA)

Scale 1:10,000 at A4	0 100 200 metres
Coord. Sys. GDA 1994 MGA Zone 50	
Job No: 57806	
Client: Element	
Version: A	Date: 30-Jul-2021
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Forrestfield North Residential Precinct, WA

REGIONAL VEGETATION ASSOCIATION AND COMPLEX

FIGURE 2.5

strategen JBS&G

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2.4.1.2 Vegetation communities and condition

In 2011, the CoK completed a flora and vegetation survey which broadly identified the vegetation type and condition for the DSP area, which was included within the Environmental Review for the MRS amendment (1282/57). It was noted at that time that there were several properties that were not included within the survey area (Strategen 2012). A subsequent spring flora and vegetation survey was completed by Strategen-JBS&G (then Strategen) for several lots and Poison Gully Creek which were not included within the 2011 survey.

To address the EPA recommendations associated with the MRS amendment (1282/57) and the 2016 listed Banksia Woodland of the Swan Coastal Plan Threatened Ecological Community (Banksia Woodland TEC) conservation advice (DEE 2016) a level 2 Flora and Vegetation assessment was completed by AECOM (2017; Appendix A) and included the following:

- ecological community mapping and vegetation condition mapping
- targeted threatened flora surveys for *Conospermum undulatum*
- develop a comprehensive species list
- threatened Ecological Community assessments for patches of native vegetation (Appendix A).

The primary objective of the biological assessments was to define the existing environment within the survey area and identify and map conservation significant flora, fauna and vegetation (AECOM 2017). Areas in the DSP which have not been covered by the AECOM (2017) survey will need to have a flora and vegetation survey conducted prior to development.

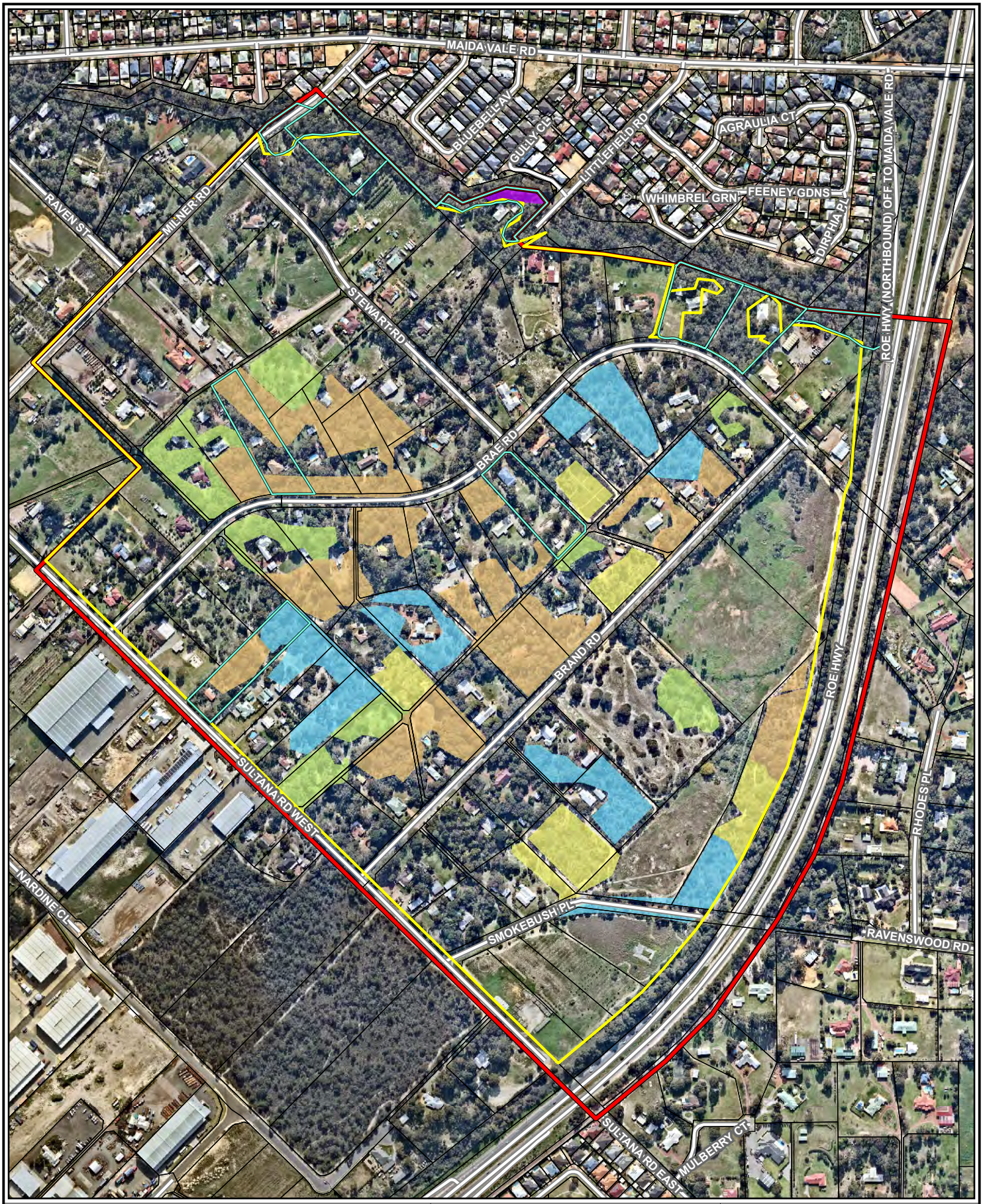
A total of 142 species from 96 genera and 33 families were recorded within the DSP area during the assessment. The total includes 131 (93%) locally native species. Families with the highest representation are Proteaceae (24 native taxa), Fabaceae (14 native taxa) and Myrtaceae (11 native taxa) (AECOM 2017:38).

Five vegetation communities (EmAcMt, EmToDo, AfHhMp, ErApEh and Native trees) totalling approximately 23.8ha were mapped within the precinct which ranged from 'Degraded' to 'Excellent' condition (Keighery. 1994) (AECOM 2017) Refer to Table 2.3 and Figure 2.6 and Figure 2.7 respectively.

Table 2.3: Vegetation communities and condition (adapted from AECOM 2017a and 2017b)

Vegetation community	Description	Area (ha) within precinct	FCT Analysis	Condition
AfHhMp	*Allocasuarina fraseriana, Banksia attenuata, Banksia menziesii* and *occasional Nuytsia floribunda* low woodland over *Xanthorrhoea preissii, Lambertia multiflora, Adenanthos cygnorum* subsp. *cygnorum* and *Xanthorrhoea acanthostachya* mid sparse shrubland over *Hibbertia hypericoides, Banksia dallanneyi* var. *dallanneyi, Bossiaea eriocarpa, Calothamnus torulosus* and *Petrophile macrostachya* low sparse shrubland with *Mesomelaena pseudostygia, Schoenus brevisetis, Lepidosperma leptostachyum, Caustis dioica* and *Tricostularia exsul* tall open sedgeland with *Dasypogon obliquifolius, Scaevola repens* var. *repens, Haemodorum laxum, Gladiolus caryophyllaceus*, Burchardia congesta* and *Anigozanthos manglesii* low sparse forbland.	5.71	46-52% similarity to FCT20a	'Good' to 'Excellent'
EmAcMt	*Eucalyptus marginata* and *Banksia menzies*ii low open woodland over *Adenanthos cygnorum* subsp. *cygnorum, Lambertia multiflora* and *Xanthorrhoea acanthostachya* mid open shrubland over *Melaleuca trichophylla, Hibbertia hypericoides, Eremaea pauciflora* var. *pauciflora, Allocasuarina humilis* and *Stirlingia latifolia* low shrubland with *Mesomelaena pseudostygia, Cyathochaeta avenacea, Tricostularia exsul* and *Lepidosperma leptostachyum* mid to low sedgeland over *Tricoryne elatior, Dasypogon obliquifolius, Lyginia barbata, Scaevola repens* var. *repens, Haemodorum laxum* and *Lomandra sericea* low sparse forbland.	3.23	46-52% similarity to FCT20a	'Good' to 'Excellent'
EmToDo	*Eucalyptus marginata* and *Allocasuarina fraseriana* mid woodland over *Banksia attenuata, Banksia menziesii* and *Persoonia elliptica* low woodland over *Lambertia multiflora* and *Xanthorrhoea preissii* mid open shrubland over *Banksia dallanneyi* var. *dallanneyi, Hibbertia hypericoides, Bossiaea eriocarpa, Stirlingia latifolia,* and *Gastrolobium capitatum* low shrubland with *Tetraria octandra, Mesomelaena pseudostygia, Mesomelaena tetragona* and *Lepidosperma leptostachyum* low sedgeland over *Dasypogon obliquifolius, Patersonia occidentalis, Dampiera linearis, Haemodorum laxum, Scaevola repens* var. *repens* and *Lomandra preissii* low sparse forbland.	10.34	Representing FCT20a	'Degraded' to 'Excellent'

Vegetation community	Description	Area (ha) within precinct	FCT Analysis	Condition
ErApEh	*Corymbia calophylla* and *Eucalyptus rudis* tall woodland over *Trymalium odoratissimum* thicket over *Acacia pulchella, Hibbertia hypericoides* and *Xanthorrhoea preissii* mid sparse shrubland over **Ehrharta calycina, *Cynodon dactylon*, **Gladiolus caryophyllaceus* and *Tetraria octandra* grassland/herbland on clay soils within Poison Gully.	0.15	N/A	'Very Good'
Native Trees	Areas mapped as trees comprise of scattered to clumps of native trees (mostly *Eucalyptus marginata*) located in either cleared paddocks, roadsides, or over planted vegetation. This vegetation unit was mapped using field survey observations. No quadrats were completed to represent this vegetation community as it lacks all native species except trees.	4.35	N/A	'Completely Degraded'



Legend:

- Residential precinct
- Aecom (2017) Survey Area
- Strategen (2015) Survey Area
- Cadastral boundary
- Roads (MRWA)

Vegetation communities

- AfHhMp
- EmAcMt
- EmToDo
- ErApEh
- Native Trees

Scale 1:7,500 at A4 (0 100 200 metres)

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 61542

Client: Element

Version: A | Date: 17-Nov-2021

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Forrestfield North Residential Precinct, WA

VEGETATION COMMUNITIES

FIGURE 2.6

strategen JBS&G

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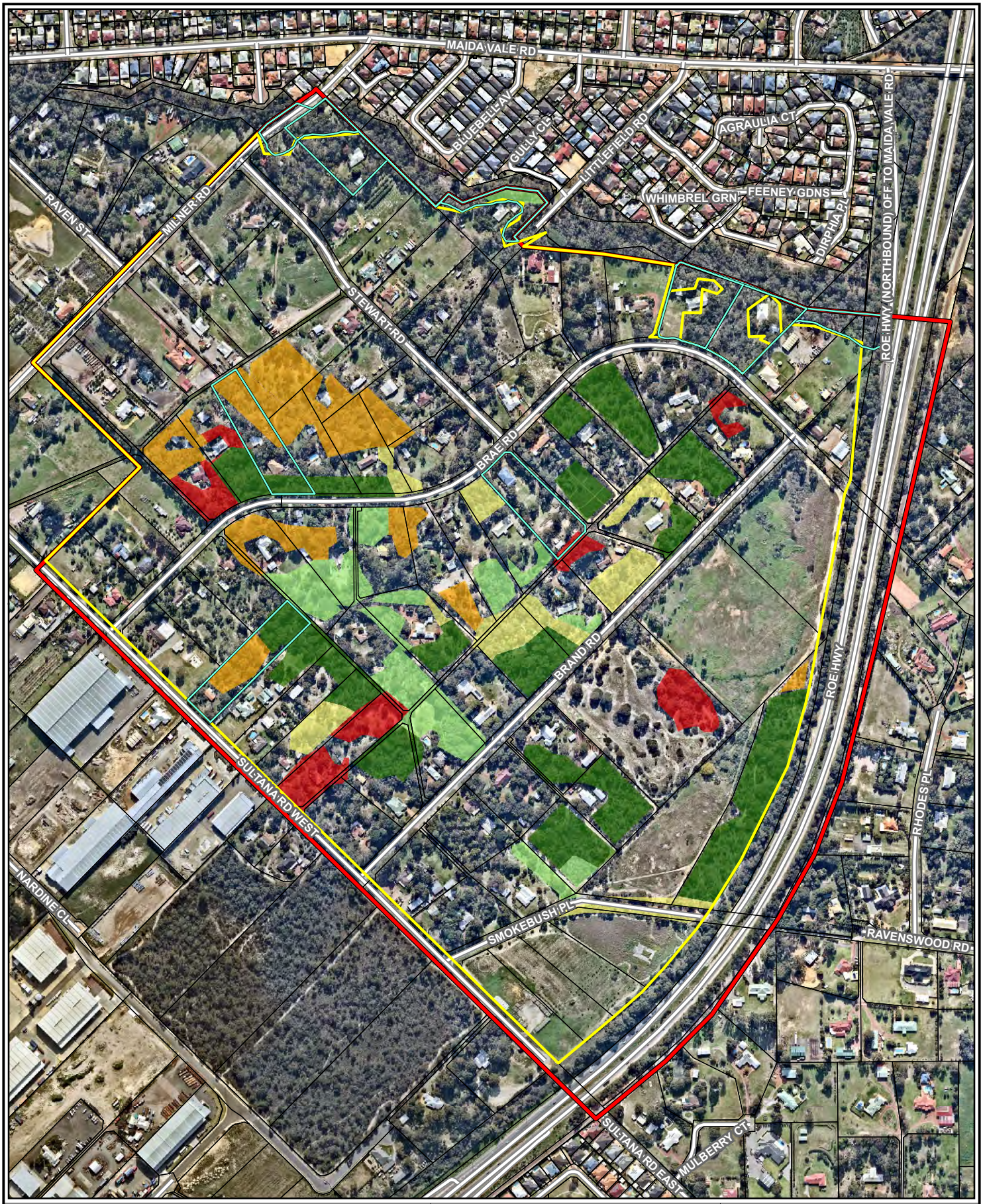

Legend:

- Residential precinct
- Aecom (2017) Survey Area
- Strategen (2015) Survey Area
- Cadastral boundary
- Roads (MRWA)

Vegetation condition

- Excellent
- Very good
- Good
- Degraded
- Completely degraded

Scale 1:7,500 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 61542

Client: Element

Version: A | Date: 17-Nov-2021

Drawn By: ianandagoda | Checked By: CT

Forrestfield North Residential Precinct, WA

VEGETATION CONDITION

FIGURE 2.7

strategen JBS&G

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Image Reference: www.nearmap.com© - Imagery Date: 3 July 2021.

2.4.1.3 Threatened and Priority Flora

The Threatened Wavy-leaved Smokebush (*Conospermum undulatum*) is listed as Vulnerable under the EPBC Act. A total of 520 individuals of *C. undulatum* were recorded within the Residential Precinct (Figure 2.8), out of 525 that were recorded within the entire DSP area. 11,453 individuals are known to occur within the SCP region according to recent population estimates by DBCA.

Isopogon drummondii, listed as Priority 3 by DBCA, was also recorded within the precinct area. Under the BC Act, there is no statutory mechanism for the protection of Priority species, however the individuals will be retained where possible.

2.4.1.4 Threatened and Priority Ecological Communities

The FCT analysis undertaken by AECOM (2017a) indicated that VTs AfHhMp, EmAcMt and EmToDo were representative of the EPBC Act-listed Banksia Woodlands of the Swan Coastal Plain (Appendix C). Five patches of banksia woodland vegetation were recorded within the precinct, all of which met all of the key diagnostic criteria provided by DEE (2016) including:

- location and physical environment
- soils and landform
- structure
- composition
- contra-indicators.

A summary of the TEC and PECs recorded within the precinct is provided in Table 2.4.

Table 2.4: Summary of TEC and PECs within the Residential Precinct

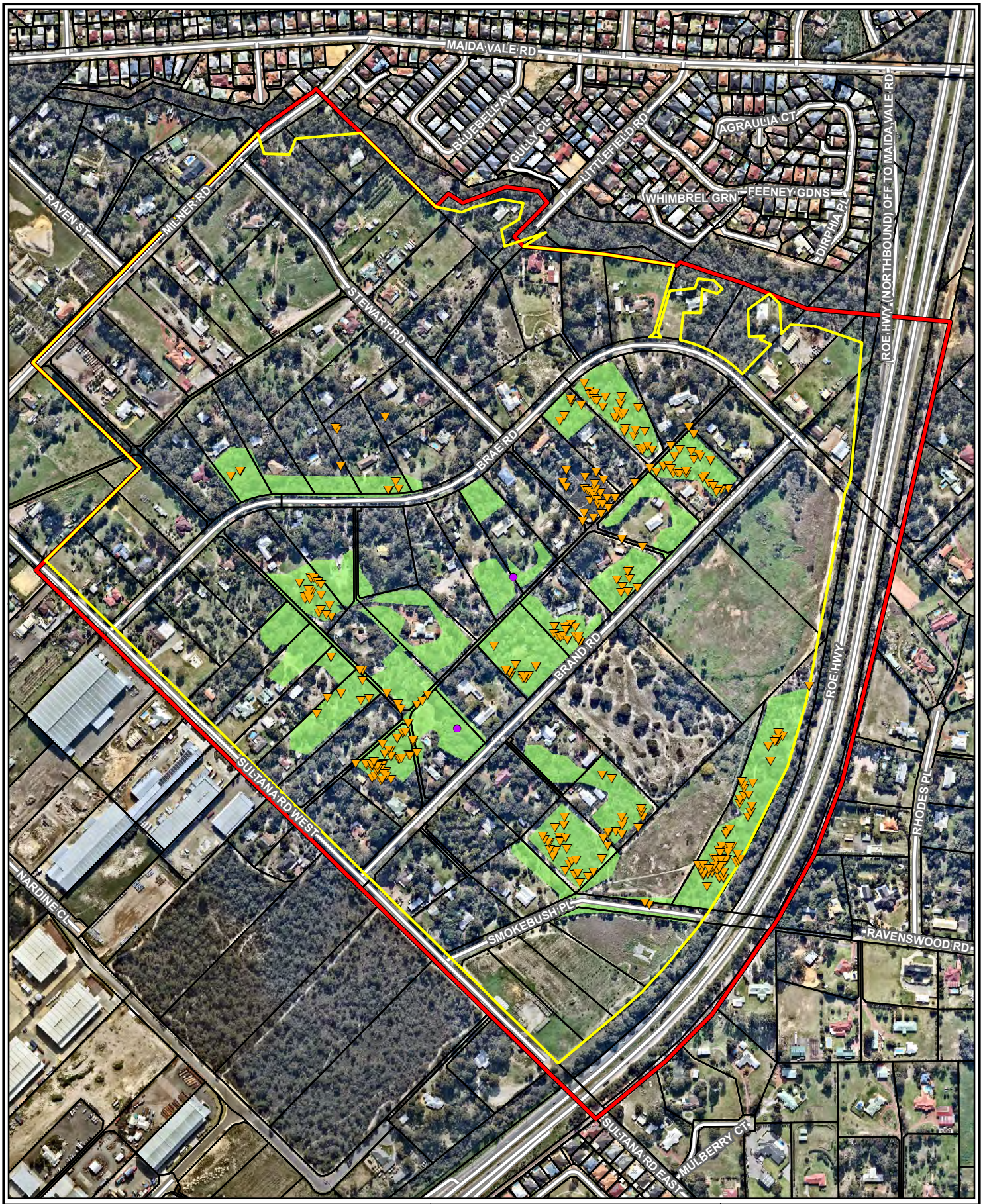
Ecological Community	Conservation status		Representative vegetation communities	Extent within the Residential Precinct
	State	Commonwealth		
Banksia woodlands of the Swan Coastal Plain.	Priority 3	Endangered	AfHhMp EmAcMt EmToDo	15.30 ha across five patches in 'Good' to 'Excellent' condition.
Banksia woodlands over species-rich, dense shrublands.	Threatened			

Banksia Woodland TEC/PEC within the precinct was co-dominated by a mix of *Banksia attenuata, Banksia menziesii, Allocasuarina fraseriana* and *Eucalyptus marginata subsp. marginata*. The vegetation varied from 'Good' to 'Excellent' condition. Many of these patches were found to support populations of *Conospermum undulatum*.

The FCT analysis (of quadrats undertaken) identified FCT20a Banksia Woodlands over Species-rich Dense Shrubland as the most representative FCT to survey area quadrats (AECOM 2017a; Table 2.3). As shown in Table 2.4, FCT 20a is also listed as Endangered.

2.4.1.5 Weeds

During the Strategen (2016) survey a total of 29 introduced (exotic) taxa were recorded within specific lots within the DSP, while AECOM (2017) recorded 11 species within the DSP area. Two species (*Zantedeschia aethiopica* [Arum Lily] and *Asparagus asparagoides* [Bridal Creeper]) recorded within the precinct are Declared Plant species in Western Australia pursuant to section 22 of the Biosecurity and Agriculture Management Act 2007 (BAM Act) according to the Western Australian Department of Agriculture and Food (DAFWA 2015) (Strategen 2016).



Legend:

- Residential precinct
- Aecom (2017) Survey Area
- Cadastral boundary
- TEC (FCT20a)/ Banksia Woodlands of the Swan Coastal Plain
- *Isopogon drummondii* (P3)
- *Conospermum undulatum* (T)
- Roads (MRWA)

Scale 1:7,500 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 61542

Client: Element

Version: A | Date: 17-Nov-2021

Drawn By: ianandagoda | Checked By: CT

Forrestfield North Residential Precinct, WA

THREATENED AND PRIORITY FLORA AND BANKSIA WOODLAND TEC

FIGURE 2.8

strategen JBS&G

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Image Reference: www.nearmap.com© - Imagery Date: 3 July 2021.

2.4.1.6 Dieback

A Dieback (*Phytophthora cinnamomi*) survey has not been completed for the precinct area. It was noted during the AECOM (2017) survey that no visual evidence of dieback existed within the DSP area (based on the health of Xanthorrhoea, Banksia, and Eucalyptus species).

2.4.2 Terrestrial fauna and habitat

A Level 1 Fauna Assessment was conducted in accordance with EPA Guidance Statement No. 56 (EPA 2004b) was completed by AECOM (2017) for the DSP area. Twelve fauna species were recorded during the AECOM (2017) field survey. This included nine birds, one mammal and two reptiles.

It was reported that four species of conservation significance including three birds and one mammal and three types of habitats were recorded within the precinct area (Table 2.5). These include:

- Carnaby's Cockatoo listed as Endangered under the EPBC Act and the BC Act
- Forest Red-tailed Black Cockatoo listed as Vulnerable under the EPBC Act and the BC Act
- Rainbow Bee-eater listed as Marine under the EPBC Act
- Quenda listed as Priority 4 by DBCA.

The Rainbow Bee-eater was seen and heard at one location in the DSP area. This species is listed as Marine and as such, is not considered protected unless it is in Marine areas (AECOM 2017).

Black Cockatoos

Carnaby's Cockatoos (CC), feed on the seeds, nuts and flowers, of a variety of native and introduced plant species and insect larvae (DEE 2017b). Food plants generally occur within proteaceous genera such as Banksia, Dryandra, Hakea and Grevillea, though are known to forage on eucalypt species in woodland areas. CC have also adapted to feeding on exotic species such as pines and cape lilac and weeds such as wild radish and wild geranium (DEE 2017b). CC usually breed between July and December in the hollows of live or dead eucalypts; primarily in Salmon Gum and Wandoo, but also within Jarrah, Marri and other eucalypt species (Johnstone 2010). Hollows are usually at least 2 m above ground, sometimes over 10 m and the depth of the hollow varies from 0.25 m to 6 m (DEE 2017b). The Western Australian Department of Parks and Wildlife (now DBCA), renewed the Carnaby's Cockatoo Recovery Plan in 2013, clearly mapping the distribution of likely breeding and non-breeding areas in southwest WA for CC (Parks and Wildlife 2013). Based on this map, the Residential Precinct is situated within the CC breeding range.

Forest Red-tailed Black-Cockatoos, listed as Vulnerable under the EPBC Act, depend primarily on Marri and Jarrah trees for both foraging and nesting. The seeds of both eucalypts are the favoured food source of the birds and hollows within live or dead individual trees are utilised for nesting purposes (Johnstone & Kirkby 1999). Breeding varies between years and occurs at times of Jarrah and Marri fruiting. These black cockatoos breed in woodland, forest or artificial nest boxes, but may also breed in former woodland or forest that has been reduced to isolated trees (DEE 2017b).

Quenda

The Quenda (*Isoodon obesulus*) is considered to likely occur in the DSP area. During the survey, evidence that Quenda are present within the precinct was observed. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (AECOM 2017).

2.4.2.1 Fauna habitat assessment

Four fauna habitats have been defined and mapped for the DSP area, three of these occur within the precinct.

Table 2.5: Fauna habitats within the Residential Precinct (AECOM 2017)

Type	Vegetation community present	Precinct area	Species habitat availability
Woodland	AfHhMp EmToDo EmAcMt	29.9ha	• Quenda habitat • Foraging and potential nesting for Forest Red-tail and Carnaby's Cockatoo.
Riparian	ErApEh	0.15ha	• Quenda habitat • Foraging habitat for Forest Red-tail and Carnaby's Cockatoo.
Jarrah and planted trees over garden	trees	4.35	• Foraging and potential nesting for Forest Red-tail and Carnaby's Cockatoo.

Foraging habitat

The Residential Precinct was divided into three different vegetation types (Table 2.5) all of which constitute foraging habitat for CC and FRTBC (AECOM, 2017).

Foraging habitat quality is displayed in Figure 2.9, as per the following (AECOM 2017):

- high quality: based on suitable foraging species, Jarrah woodlands, presence of water availability within 2 km, and support of trees with potential to be used for breeding, and
- valued quality: low quality vegetation comprised of native trees over planted vegetation or cleared paddocks, lack of suitable foraging plants present (mostly due to lack of complexity in vegetation structure).

AECOM (2017) identified 'Quality' habitat for FRTBC. This classification related to low quality vegetation for FRTBC but had a higher value due to the vegetation being near a known roosting site, water and other areas of quality foraging habitat. The boundaries for 'Quality' habitat for FRTBC are the same as 'Valued' quality for CC.

No foraging evidence was recorded for CC; however, all native vegetation, including trees with planted vegetation, was considered by AECOM (2017) to be suitable foraging habitat for CC. Vegetation communities AfHhMp, EmAcMt and EmToDo had 10-57% foliage cover of suitable foraging species (Table 2.5). The variety of cover is directly related to the condition of the vegetation. Degraded vegetation lacks the Proteaceous species in the understorey and has reduced Banksia cover. Suitable CC foraging species included 24 Proteaceous species and Jarrah trees (AECOM 2017).

All native vegetation within the DSP area is considered by AECOM (2017) to be suitable FRTBC foraging habitat. AECOM (2017) also identified ten observations of foraging evidence by FRTBC. Communities AfHhMp, EmAcMt, EmToDo and VdCd all support suitable foraging species. These are limited to three overstorey species including Jarrah, Sheoak and Snottygobble. The foliage cover of these species varies from 1.5–57%. The DSP area supports Eucalypt woodlands dominated by Jarrah, contains trees with potential to become breeding trees, supports a known large roost site (more than 10 birds), and is less than 2 km from a watering location (AECOM 2017). The trees with planted vegetation or in paddocks were classified as 'Quality' habitat and were located near known roosting site, water and other areas of quality foraging habitat (AECOM 2017).

Based on the results of the foraging assessment, the Residential Precinct contains a total of 23.64ha of foraging habitat for CC and FRTBC black cockatoos of which:

- 19.28 ha comprises of high quality foraging habitat, and

- 4.35 ha comprises of valued[1] quality foraging habitat.

Roosting habitat

Black Cockatoo roosting habitat is generally found in or near riparian vegetation, close to fresh water and typically is comprised of the tallest trees in these areas (AECOM 2017). There is a known roosting site located within the Precinct on Lot 47 Brae Road, as shown in DBCA Black Cockatoo observational data (AECOM 2017).

Breeding habitat

Breeding habitat for black cockatoos is defined in DSEWPaC (2012) as trees of species known to support breeding within the range of the species which either have a suitable nest hollow or are of a suitable DBH to develop a nest hollow (≥ 300 mm for salmon gum and wandoo, and ≥500 mm for other species). These trees are known as significant trees. Trees of this size may also be large enough to provide roosting habitat (i.e. trees which provide a roost or rest area for the birds).

A total of 458 potentially significant trees (with DBH ≥ 500 mm) were recorded in the DSP area, of which 411 are located within the Residential Precinct (Figure 2.9) (Table 2.6). 26 of these trees, contained a total of 42 suitable hollow(s)[2], within the DSP area. A total of 26 trees with suitable hollow(s) where within the Residential Precinct (Table 2.7). (AECOM 2017). No evidence of black cockatoo occupancy was identified within these hollows, there were signs of use by bees and/or galahs on some hollows (AECOM 2017).

Table 2.6: Summary of potentially significant trees recorded within the Residential Precinct (AECOM 2017)

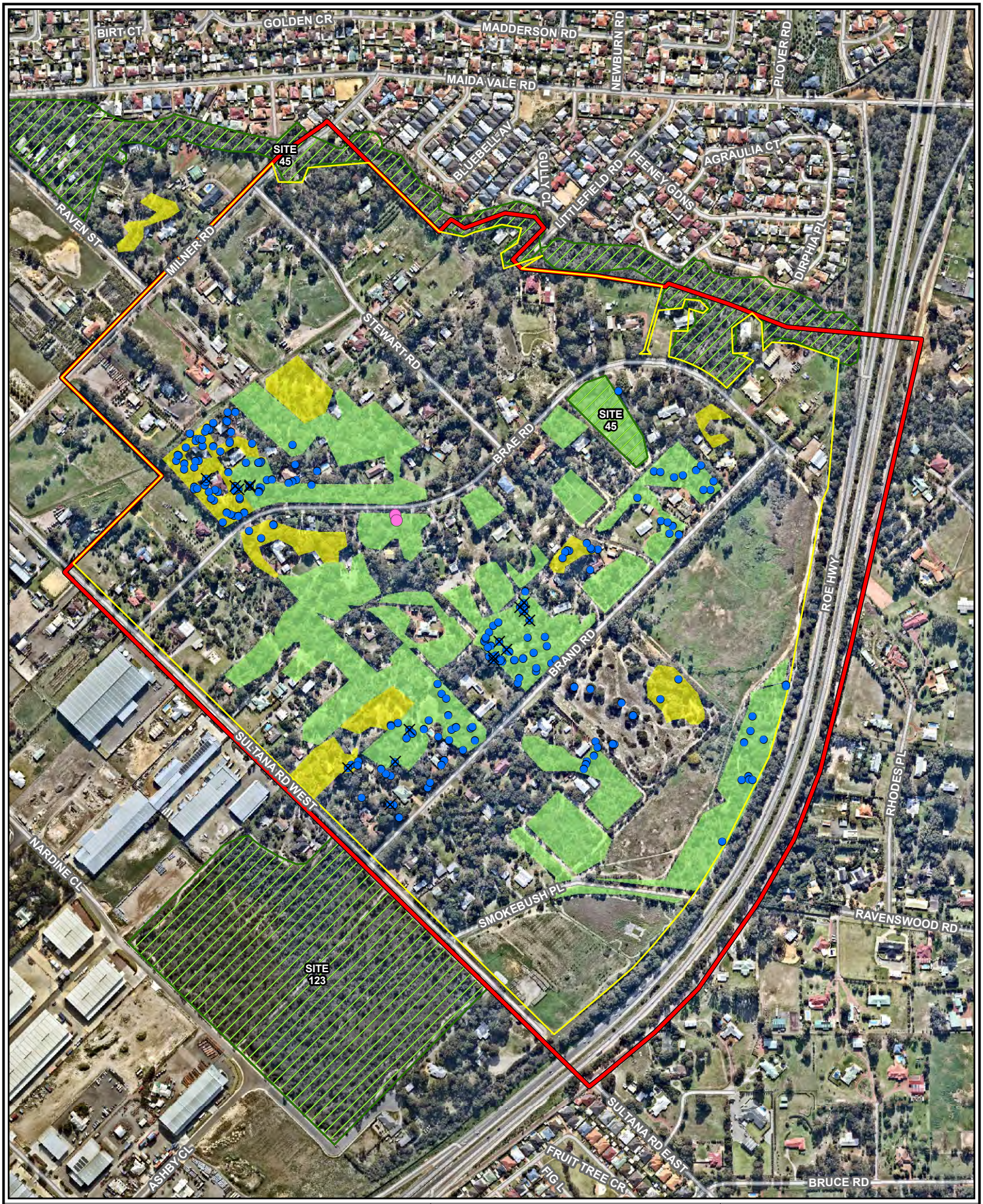
Species	Number of trees recorded within DSP Area	Number of trees recorded within Residential Precinct	Usage by Black Cockatoos	
			CC	FRTBC
Corymbia calophylla (Marri)	54	11	Roosting and breeding	Roosting and breeding
Eucalyptus gomphocephala (Tuart)	11	10	Roosting and breeding	Breeding
Eucalyptus marginata (Jarrah)	384	382	Roosting and breeding	Roosting and breeding
Eucalyptus megacarpa (Bullich)	1	1	Nil	Breeding
Unknown	8	7	Unknown	Unknown
Total	**458**	**411**		

Table 2.7: Summary of potential breeding trees with suitable hollows (AECOM 2017)

Species	Number of trees within DSP with suitable hollows	Number of trees within Residential Precinct with suitable hollows
Eucalyptus marginata	23	23
Unknown	3	3
Total	**26**	**26**

[1] AECOM (2017, 44) valued area (score 6) were considered to be 'low quality' due to the lack of suitable foraging plants present, however additional scores were given for potential breeding presence and within 2km of water near a roosting site.

[2] Not including currently occupied by bees. Some trees contained more than one hollow.



Legend:

- Residential precinct
- Survey area
- Bush forever site

Black cockatoo habitat

- High quality
- Valued quality
- Roosting tree location
- Black cockatoo habitat trees
- Black cockatoo habitat trees (with hollows)
- Roads (MRWA)

Scale 1:8,000 at A4 (0 100 200 metres)		**Forrestfield North Residential Precinct, WA**
Coord. Sys. GDA 1994 MGA Zone 50		**BLACK COCKATOO HABITAT**
Job No: 61542		
Client: Element		**FIGURE 2.9**
Version: A	Date: 13-Oct-2021	strategen JBS&G
Drawn By: cthatcher	Checked By: RM	

File Name: W:\Projects\1)Open\Element (TPG)\61542 - FF North Res Precinct EAMS Update\GIS\Maps\R01_Rev_B\61542_02_9_BCHab.mxd
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2.4.3 Bush Forever and local natural areas

Bush forever site No. 45 Poison Gully Bushland runs along the northern cadastral boundary of the precinct and extending into Lots 80 and 81. Lot 78 has recently been included within Bush forever site No. 45. Bush forever Site No. 123 Sultana Road West Bushland is located outside of the precinct and is located on the southern cadastral boundary of the precinct.

Local Natural Areas (LNA) have been identified for priority of retention, protection and management. These areas are usually the responsibility of the Local Government Area (Del Marco et al. 2004). The LNA within the precinct, mapped in the Draft Local Biodiversity Strategy 2020-2030 (City of Kalamunda 2020a) are shown Figure 2.10.

2.4.4 Ecological linkages

According to Del Marco et al. (2004) the importance of ecological linkage is to connect natural areas, preferably with continuous corridors of native vegetation, which assists in fauna movement between the areas and to access resources and habitats. The protection, management and buffering of existing natural areas within an ecological linkage is a higher priority than revegetation of cleared portions of the link. The precinct has been identified within the Perth Regional Ecological Linkage network (Figure 2.10).

2.4.5 Environmentally sensitive areas

Environmentally Sensitive Areas (ESAs) are areas that have been identified for protection due to their environmental significance as outlined in the Western Australian Environmental Protection (Environmentally Sensitive Areas) Notice 2005, which was gazetted on 8 April 2005.

Exceptions offered for clearing under Regulation 5 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 do not apply within ESAs. ESAs are protected under the EP Act, and include the following:

- declared World Heritage properties
- areas included on the Register of the National Estate
- defined wetlands and the area within 50m of the wetland
- vegetation within 50 m of a listed Threatened species
- TECs
- Bush Forever sites.

ESA mapping includes the entire precinct (WALGA, 2017). These are likely to be associated with the known presence of the Declared Rare Flora Wavy-leaved Smokebush (*Conospermum undulatum*), Bush Forever Sites and State listed TEC within and adjacent to the precinct.

2.4.6 Bushfire risk

Based on regional Bush Fire Prone Mapping (Department of Fire and Emergency Services, 2017) all of the precinct is mapped within the designated bushfire prone area (Plate 2).

As a result of the bushfire prone status of the site, a Bushfire Management Plan (BMP) is required to accompany the Structure Plan to address the following requirements of *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7; namely Policy Measure 6.3):

- Bushfire hazard level assessment or where lot layout is known a Bushfire Attack Level (BAL) assessment.
- Identification of any bushfire hazard issues arising from the above assessments.

- Assessment against the bushfire protection criteria requirements contained within the Guidelines demonstrating compliance can be achieved in subsequent planning stages.

The BMP is required to be prepared in accordance with *Guidelines for Planning in Bushfire Prone Areas* (the Guidelines). The BMP is a separate document and should be read concurrently with this EAMS.

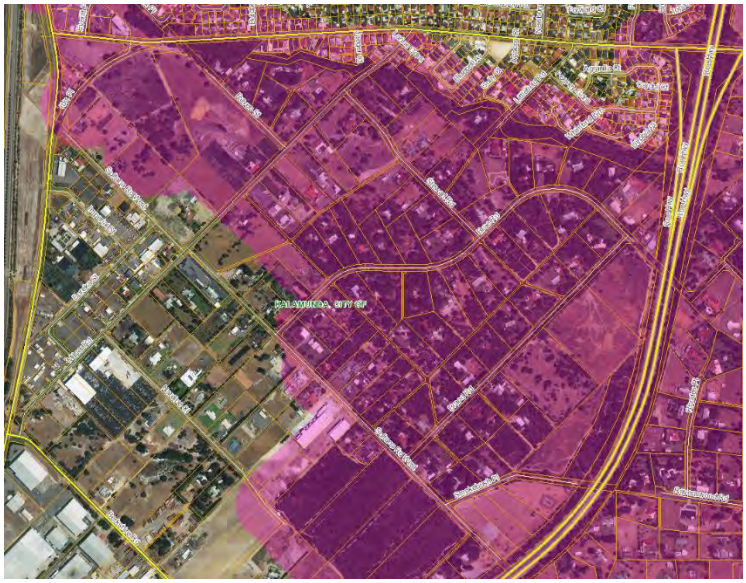
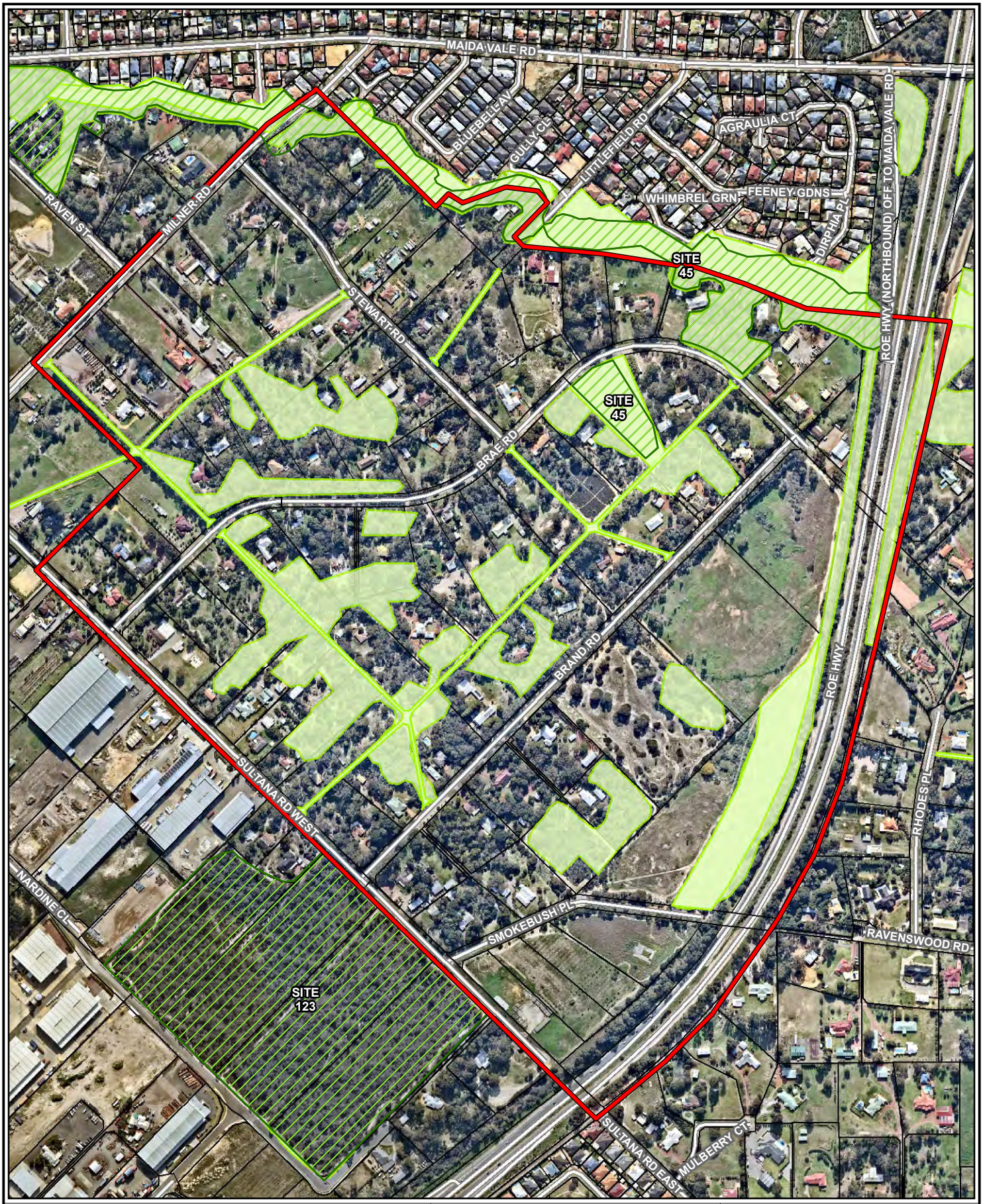


Plate 2: Bush fire prone area (DFES, 2017)



Legend:

- Residential precinct
- Cadastral boundary
- Bush forever site
- Local natural areas
- Roads (MRWA)

Scale 1:7,500 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 61542

Client: Element

Version: A | Date: 12-Nov-2021

Drawn By: ianandagoda | Checked By: CT

Forrestfield North Residential Precinct, WA

BUSH FOREVER SITES AND LOCAL NATURAL AREAS

FIGURE 2.10

strategen JBS&G

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2.5 Heritage and culture

2.5.1 Aboriginal Heritage

The Forrestfield area including the Residential Precinct and surrounds hold significant value to Nyungar people, and known to contain many places of major significance to Perth Nyungars i.e. Allawah Grove Reserve, Monday Swamp located at the Perth Airport and Poison Gully Creek, which is located along the northern boundary of the Residential Precinct. Ongoing heritage investigations in and around the airport indicate that Munday Swamp is still being used for hunting and foraging (Turner *et al*. (Ethnosciences) 2018).

Nyungar families have continued to use areas in and around Forrestfield for camping, hunting and rural-based employment. Of particular interest is the old Welshpool Reserve or Maamba (DPLH ID 3773) located in Forrestfield to the south of the DSP area. The old reserve(s), which is a Registered Aboriginal Site, is depicted on the AHIS as continuous with the boundaries of the present-day Hartfield Park, Forrestfield/Wattle Grove, Kalamunda, though the exact boundaries of the place are problematic as there seems to have been at least two Aboriginal reserves in the area with different reserve numbers and which may have overlapped (Turner *et al*. (Ethnosciences) 2018).

The Department of Planning and Lands and Heritage (2017) Aboriginal Heritage Inquiry System (AHIS) was searched are there is one registered site Poison Gully Creek (Site ID 25023) as it is a water source and a historical birth place. This place has been assessed as meeting Section 5 of the *Aboriginal Heritage Act 1972 (AHA)*. There is one Other Heritage site, High Wycombe Brooklands (ID3637) for Artefacts/Scatter. In regard to this site, information has been received by the Department of Planning Lands and Heritage in relation to the place, but an assessment has not been completed at this stage to determine if it meets Section 5 of *the* AHA.

2.5.1.1 Ethnographic heritage assessment

An ethnographic heritage assessment was completed by Turner *et al*. (Ethnosciences) (2018) for the Forrestfield North DSP area (which included the Residential Precinct). The assessment involved both desktop research and community consultation (South West Aboriginal Land and Sea Council [SWALSC] and selection of a panel of relevant Aboriginal people having association and knowledge of Poison Gully) and separate ethnographic consultations with women's and men's on-site meetings. A summary of the assessment outcomes is provided below. A copy of the full assessment is provided in Appendix D.

The search of the online AHIS and other archival sources confirmed that Poison Gully Creek (DPLH ID 25023) is the only Registered Aboriginal Site in the DSP study area. Two 'Other Heritage Places' (DPLH ID 3667 Crumpet Creek and DPLH ID 3637 High Wycombe: Brooklands Estate, both artefact scatters) are also listed.

Poison Gully Creek (DPLH ID 25023) was the only place within the Residential Precinct reported by the Aboriginal consultants that might reasonably be considered to be an Aboriginal Site within the meaning of s5 of the AHA. Turner *et al*. (Ethnosciences) (2018:27) reports that as the site file is 'Closed', the boundaries on the AHIS are 'restricted' and therefore 'dithered'; i.e., the spatial representation published on the AHIS website is broader than the actual boundary, because of the site's reported significance and hence confidentiality regarding the place's precise boundaries.

Turner *et al*. (Ethnosciences) (2018) discusses that areas around the Residential Precinct, such as the Perth Airport land and the Newburn Marshalling Yards, have been intensively surveyed and as a result many archaeological sites, typically artefact scatters, have been recorded. The Residential Precinct has not been surveyed in detail, forming only a part of a previous regional survey. Based on regional information it is reasonable to assume, that should an archaeological survey of the Forrestfield North DSP (including the Residential Precinct) be completed it is likely that additional

archaeological sites to DPLH ID 3667 and DPLH ID 3637 would be found. As noted above, the Forrestfield North DSP/LSP area has not been specifically surveyed archaeologically.

Both the women's and the men's consultations confirmed the cultural significance of Poison Gully Creek and highlighted its importance to Nyungar women in particular as a 'birthing place' with associated rituals and still seen as a place for teaching and learning about traditional cultural knowledge, both specific to the site and country more generally. The key issues raised during the consultation included:

- protection of remnant vegetation and creek and foreshore between Dundas Road and Milner Road and in particular the open space adjacent to the Dundas Road crossing,
- improvement and restoration of water flow and water quality within Poison Gully Creek to reflect the waterways original state,
- Poison Gully Creek as a place of significant values and is related to other significant areas such as Munday Swamp and Allawah Grove, traditionally linked by the flow of water and the bidi or tracks and part of a meshwork in which place is to be understood as an outcome of movement, practice and event, which result in the experience of 'biographical entanglements',
- continuing access to and control of the land as its traditional owners and custodians, and
- linkages between the Forrestfield North DSP/LSP area and the surrounding landscape.

2.5.2 European heritage

The State Heritage Register (2017) was searched for registered sites, there are currently no sites within the precinct area.

3. Management Strategy

As part of the formulation of the LSP, the documentation and assessment of the opportunities and constraints of the existing environment (refer to Section 3) was undertaken which influenced the design of the precinct including the placement of POS areas, drainage basins/swales and environmental conservation reserves (ECRs) and ecological linkages.

3.1 Landforms

3.1.1 Policy and management objectives

Where possible, maintain the gentle sloping topography across the precinct and to retain the rural lifestyle amenity of the precinct. To also ensure that the subdivision and development of land containing ASS is planned and managed to avoid potential adverse effects on the natural and built environment.

3.1.2 Local Structure Plan considerations

The opportunity and constraints analysis of regional landform mapping (i.e. topography, soils and potential ASS) environmental elements has indicated that there are no significant elements that are required to be considered or potentially impede development opportunities.

3.1.3 Management requirements

Management measures have been identified to assist in achieving the Landforms management objectives (Table 3.1).

Table 3.1: Management measures for Landforms

Parameter	Management actions	Timing/Responsibility
Geotechnical	Complete a geotechnical assessment (infiltration rates) of key drainage areas.	Once drainage design has been confirmed (refer to the LWMS). Developer in consultation with the City of Kalamunda.
Erosion	Development of a Construction Management Plan (pre-and during construction) which details sediment and erosion control management measures including the requirement for engineering drawings to demonstrate balanced earthworks outcome including minimising soil import and spoil	Prior to subdivision. Developer in consultation with the City of Kalamunda.
ASS	Confirm if dewatering below the water table or the excavation of more than 100 m^3 is required as part of earthworks for the Residential Precinct.	Prior to earthworks commencing within the precinct. City of Kalamunda/developer.
	Complete an ASS desktop investigation and completion of a self-assessment form to confirm whether ASS investigations are required.	Completion and finalisation precinct earth works plans (cut and fill, infrastructure, drainage services). City of Kalamunda/developer.
	Prepare an ASS Management Plan (if ASS is present, and site works will intersect ASS areas) that includes: • potential environmental impacts—groundwater drawdown, disruption to existing bore users, vegetation stress, reduction in water quality, noise and air impacts, • earthwork strategy—soil extraction methods, stockpile management, soil treatment/neutralisation, calculated liming rate and disposal techniques, • dewatering strategy—procedure and control measures, treatment and disposal options, contingency measures if acidification of groundwater occurs, and • monitoring program—soil, groundwater, vegetation, noise and air.	Before earthworks commence onsite (Subdivision). Developer in consultation with the City of Kalamunda.

3.1.4 Expected outcomes

Through the implementation of the management recommendations outlined in Table 3.1, the quality of land and soils can be maintained so that landform values within the Residential Precinct are incorporated through LPS design.

3.2 Potential contamination and future land use

3.2.1 Potential impacts

As described in Section 2.3.2, the Brand Road former landfill (Lot 13, 14 and 18 in plan 24292) is within the precinct, without further investigation (and potential remediation) there are currently limited opportunities to re-develop and/or effectively utilise the site.

3.2.2 Policy and management objectives

To incorporate the former Brand Road Landfill within the Residential Precinct.

3.2.3 Local Structure Plan considerations

Within the CoK there is a lack of active recreation open space. The Residential Precinct LSP has identified the former Brand Road landfill area as a potential recreation field area which will meet the existing and future recreation needs for the regional catchment.

3.2.4 Management requirements

A series of site investigations and reporting have already been completed for the former landfill. A preliminary review of the key site investigation reports provided highlighted the following:

- preliminary indications are that contamination by leachate is within the boundary of the former Brand Road Landfill and is consistent with previous land use. Further testing is necessary to determine the nature and extent of leachate
- further landfill gas assessments should be undertaken to determine the potential risk to surrounding land use and to determine if permanent landfill gas bores should be installed
- it appears there have been no soil investigations on-site, and this should be undertaken to determine the suitability of the soil for any proposed change in land use
- it was noted that an Accredited Contaminated Sites Auditor has not been engaged for this site.

Management measures have been identified to assist in achieving the management objectives (Table 3.2) and to ascertain with certainly the incorporation and transformation of this area into a key regional recreational facility.

Table 3.2: Management measures for contamination assessment and confirmation

Parameter	Management actions	Timing/Responsibility
Asbestos Containing material (ACM)	Undertake an ACM audit of existing structures (buildings sheds) particularly those erected prior the mid-1980s.	Prior to subdivision Developer
Appointment of a Contaminated Sites Auditor and Undertake Gap Analysis	Data Gap Analysis has been completed and endorsed by the Contaminated Site Auditor (CSA). DSI currently being undertaken to investigate the site as per the SAQP to develop a conceptual site model to ascertain the potential human and ecological risk factors.	Completed
Sampling and Analysis Quality Plan (SAQP) for the former landfill	A Sampling Analysis and Quality Plan (SAQP) has been completed and endorsed by the Contaminated Site Auditor (CSA).	Completed
Potential Intrusive Site Investigations (Landfill)	**Soil sampling and Leachate Potential** The following identifies potential soil, groundwater and vapour assessments that may be required to be undertaken to further delineate the site's	During the implementation of the precinct LSP (prior to development occurring adjacent to or within the landfill area).

Parameter	Management actions	Timing/Responsibility
	contamination risk and potential for the proposed future land use. Where possible, soil sampling may be undertaken in conjunction with geotechnical investigations. Based on the existing environmental studies, it appears that no soil investigations have been undertaken on site. Therefore, it is recommended undertaking an intrusive soil sampling program, including analysis of data. • soil sampling should be conducted in accordance with National Environment Protection (Assessment of Site Contamination) Measure', National Environment Protection Council, December 1999, as amended 2013 (NEPM) and the approved SAQP and DER (2014) *Assessment and management of contaminated sites - Contaminated sites guidelines,* • soil bores should be installed to a minimum depth of 1 m below the maximum depth of the landfill, • soil bores should be advanced using a sonic push core and/or hand auger. Alternatively (if suitable) soil sampling can be undertaken concurrently with other programs such geotechnical site investigations provided direct push drilling is utilised, • all soil samples should be submitted to a NATA accredited laboratory. Target analytes will be in accordance with the Department of Water and Environmental Regulation Landfill Waste Classification (as amended 2009) guidelines and include: o Metals o Cyanide o volatile hydrocarbons o speciated phenols, total phenols, total petroleum hydrocarbons, polycyclic aromatic hydrocarbons o chlorinated acidic pesticides o OC/OPs and PCBs • quality control (QC) samples should be collected in accordance with those recommended by the DWER and will include the collection of duplicate and triplicate samples (1 per 20 primary samples collected) as well as rinsate and field blank samples as required.	
	Classification of waste into waste types and landfills The investigation of landfill sites is completed using the steps identified in the Department of Environment and Conservation Landfill Waste Classification and Waste Definitions 1996 (DEC as amended 2009).	During the implementation of the precinct LSP (prior to development occurring adjacent to or within the landfill area).
	Site Characterisation-Soil leachate testing Subject to the classification of waste investigation, if the classification of the soil results is not acceptable, or any contaminant concentration exceeds the relevant contaminant threshold value, the ASLP leachate concentrations for all relevant contaminants must be determined.	During the implementation of the precinct LSP (prior to development occurring adjacent to or within the landfill area).

Parameter	Management actions	Timing/Responsibility
	Groundwater Monitoring Ongoing groundwater monitoring from July 2010 confirms groundwater beneath the site and the immediate vicinity of the site has been impacted. The results of the latest biannual groundwater monitoring event identified exceedances in contaminants of concern, above the adopted assessment criteria (EMRC, 2014). Continue the ongoing biannual groundwater monitoring program to delineate the nature and extent of groundwater contamination and to determine the groundwater impact on-site and off-site. Appoint an Auditor to review the groundwater program undertaken to date to confirm the suitability of future biannual groundwater monitoring events.	During the implementation of the precinct LSP (prior to development occurring adjacent to or within the landfill area).
	Landfill Gas Assessment Appoint an Auditor to review the landfill gas assessment program undertaken to date to confirm the suitability of the program going forward. Based on the outcomes of the above continue landfill gas assessment program to confirm the risk of landfill gas potentially migrating towards sensitive receptors (i.e. proposed school site).	During the implementation of the precinct LSP (prior to development occurring adjacent to or within the landfill area).

3.2.5 Predicted environmental outcomes

Further investigations (as recommended above) have commenced within the landfill area and will confirm the appropriateness and suitability of changing the current land use to support recreation facilities and identify appropriate controls for the operation / management of the site into the future.

3.2.6 Secondary approval requirements

Sites where potential contamination exists will be managed through the land use planning process in accordance with the *Contaminated Sites Act 2003* (CS Act). The CS Act specifies that to clear any conditions relating to the assessment and management of contaminated sites requires the approval of resulting investigations by a Western Australian accredited contaminated sites auditor. Approval to commence recreational activities/facilities within the former Brand Road landfill area will be required under the CS Act and prior to subdivision.

3.3 Hydrology

Previous site investigations (DWMS, 2012a) demonstrate that the hydrology features within the Residential Precinct are influenced by a combination of relatively complex geology, surface water/groundwater interactions resulting in variable groundwater gradients and flow directions across the DSP area.

3.3.1 Potential impacts

While the precinct pre-development and post-development surface water flows are to coincide in accordance with the WAPC (2008) Better Urban Water Management Guidelines, the estimated surface water volumes are expected to increase through urbanisation within the precinct. Therefore, the allocation of detention or infiltration basins and underground storage are proposed as per the LWMS.

As discussed in Section 2.2, a generic buffer to REWs are usually required as per EPA policy (EPA, 2008). The lower sections of Poison Gully are categorised as a REW. The area surrounding the southern REWs within the Residential Precinct is highly modified and currently provides minimal protection to the wetland function area i.e. management of land degradation processes - edge

effects, weed encroachment, rubbish dumping and uncontrolled access. As discussed in the foreshore assessment undertaken by Strategen (2012), the area within the foreshore boundary is anticipated to remain as a REW and the foreshore to the east of this area is considered to be of a similar or better quality to the foreshore within the REW area. The foreshore will act as a buffer (30m-50m) similar to that applied to areas of REW (Strategen 2012).

There is no requirement for a buffer associated with the REWs along the southern boundary of the precinct (UFI 15881 and UFI 15877) as it is bounded by a hard edge (i.e. road).

3.3.2 Policy and management objectives

The key principles and objectives for sustainable water management for the Residential Precinct is provided in the following:

- *Liveable Neighbourhoods Edition 4* (WAPC 2009)
- *Water Resources Statement of Planning Policy 2.9* (WAPC 2004)
- *Draft State Planning Policy 2.9 Planning for Water* (WAPC 2021)
- *Stormwater Management Manual for WA* (Department of Water 2007)
- *Decision Making Process for Stormwater in Western Australia* (Decision Process, DWER 2017)
- *Better Urban Water Management* (WAPC 2008)
- *Interim: Developing a Local Water Management Strategy* (DoW 2008)
- *Forrestfield North District Water Management Strategy* (Strategen 2015).

The key points of these policies are discussed in Table 3.3. For further information refer to the LWMS.

Table 3.3: Water management principles and objectives

Category	Principles	Objectives
Water use	• consider all potential water sources in water supply planning, • integration of water and land use planning, and • sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	• minimise the use of potable water where drinking water quality is not essential, and • achieve a significant reduction in water use below the 100 kL/person/year State Water Plan (Government of Western Australia 2007) target.
Groundwater and surface water quantity	• to retain natural drainage systems and protect ecosystem health, • to protect from flooding and water-logging, • to implement economically viable stormwater systems , and • post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	• where there are identified impacts on significant ecosystems, maintain or restore desirable environmental flows and/or hydrological cycles, and • for flood management, manage up to the 1 in 100-year ARI event within the development area to pre-development flows and the requirements of Water Corporation (Water Corporation 2010).

Category	Principles	Objectives
Groundwater and surface water quality	• to maintain or improve groundwater and surface water quality, • where waterways/open drains intersect the water table, minimise the discharge of pollutants from groundwater, and • where development is associated with an ecosystem dependent upon a particular hydrologic regime, minimise discharge or pollutants to shallow groundwater and receiving waterways and maintain water quality in the specified environment.	• maintain surface water and groundwater quality, and • ensure that the 1 in 1 year, 1 hour event (16 mm) receives treatment prior to discharge to a receiving environment.

3.3.3 Local Structure Plan considerations

The LSP northern boundary is aligned along Poison Gully Creek, there is one section of a REW (Poison Gully) intersects the Residential Precinct, the design of the LSP has incorporated the following:

- REW (UFI 15880) and most of the associated buffer (30m) is within POS 7. Other areas along Poison Gully Creek area are bounded by a hard edge (i.e. road). Fencing (i.e. conservation style) can be incorporated to control access along this interface as described in the Strategic Conservation Management Plan (SCMP)
- Poison Gully Creek foreshore area which intersects the LSP has been incorporated within ECR areas (i.e. No. 9, 10, 12 and 13)
- Establishment of a formal pedestrian connection between Littlefield Road and the LSP area (where there is an existing road/culvert over Poison Gully)
- Detention/infiltration basins (refer to LWMS).

3.3.4 Management requirements

Management measures have been identified to assist in achieving the hydrology management objectives (Table 3.4). Refer to the LWMS for management objectives for specific surface water/drainage basin requirements for the project.

Table 3.4: Management measures for hydrology

Parameters	Management actions	Timing/Responsibility
Retention of Resource Enhancement Wetland and ECR areas along Poison Gully Creek (excluding existing Bush Forever Sites)	Development of a SCMP for all ECRs, that considers the conservation objectives in DEC (2009) Waxy-leaved Smokebush Recovery Plan and to include (but not limited to): • areas to be rehabilitated (including revegetation low fuel plant species [FESA, 2011), KPIs planting densities, weed control) • controlled access and fencing requirements particularly along the interface of passive recreation and conservation areas • rubbish control • pathogen risk reduction and hygiene control • pest animal management • contingency measures • monitoring program implementation and responsibilities.	The SCMP was endorsed as part of the original LSP and commissioned by DPLH. Management of ECR's will be by CoK. Timing is to be prior to development commencing within each subdivision Stage.

Parameters	Management actions	Timing/Responsibility
Works proposed within the Poison Gully foreshore area (also refer to Section 4.6 Heritage)	Development of a Construction Management Plan (pre-and during construction): • consultations with the Nyungar community • environmental outcomes and performance indicators • risk assessment and management measures • monitoring • contingency response and corrective action • report and review.	Timing is to be prior to development/earth works within the creek foreshore area.

3.3.5 Secondary approval requirements

Refer to Section 2.5 - Heritage for further information regarding the AH Act and the LWMS.

3.4 Biodiversity and natural assets

3.4.1 Potential impact

The following potential impacts have been identified associated with the redevelopment of the residential; precinct in accordance with the DSP:

- removal of *Conospermum undulatum* (T) *and is Isopogon drummondii* (P3) plants
- removal of TEC (FCT20a)/ Banksia Woodlands of the Swan Coastal Plain
- removal of significant black cockatoo trees and foraging habitat for black cockatoos
- potential removal of a roosting site
- potential reduction of ecological linkage extent.

3.4.2 Policy and management objectives

The overall management objective for biodiversity and natural assets is to consolidate existing, fragmented environmental areas and to retain and conserve viable significant flora, TEC and fauna habitat. The intention of the management strategy is to create a planning outcome that will facilitate the long-term protection and enhancement of the proposed ECRs. The retention of these matters (i.e. black cockatoo habitat trees) within proposed POS areas is subject to drainage, landscaping, bushfire and engineering requirements and will be finalised during subsequent planning processes.

3.4.3 Local Structure Plan considerations

Vegetation, Flora and Fauna

As part of the opportunity and constraints analysis of environmental matters within the precinct, the outcomes of AECOM (2017) Level 2 Flora and Fauna Survey and previous documentation (Strategen, 2012) was analysed, which included the following key matters:

- TEC (FCT20a)/ Banksia Woodlands of the Swan Coastal Plain
- *Conospermum undulatum* (Wavy-leaved Smokebush)
- *Isopogon drummondii*
- black cockatoo habitat trees
- black cockatoo foraging habitat
- ecological linkage.

Figure 3.1 provides a spatial representation of the clustering of environmental values within the Residential precinct. In this way, the figure indicates which areas have the highest density of Threatened Flora, black cockatoo habitat trees, and TEC. This allowed for visual interpretation of where conservation areas and areas of POS would be best placed to provide the maximum retention of environmental values, and therefore conservation priorities. Consultation with Stakeholders (KEAC, TAG, DWER (OEPA) DBCA) confirmed that the key natural areas containing Banksia Woodland TEC, threatened flora and black cockatoo foraging, and potential breeding trees are of state significance. Of particular note is the importance of retaining and conserving the *Conospermum undulatum* population within the Residential Precinct given its conservation status and substantial presence within the Precinct.

Consideration was given to mapped regional ecological linkages (WALGA 2004) as well as local ecological linkages identified by Strategen (2012) during the design of the Residential Precinct. The POS width within the linkage between Bush Forever Site 123 and Poison Gully Creek ranges from 50m to 100m. This was designed based on the recommended ecological linkage width of 50 m (Del Marco et al. 2004).

In response to the above, proposed ECRs were developed and are depicted in the Forrestfield North LSP (Appendix A; Figure 3.1). Table 3.5 and Figure 3.1 describe and illustrate the environmental values proposed for retention within conservation areas and areas of POS. Matters to be retained include:

- TEC (FCT20a)/ Banksia Woodlands of the Swan Coastal Plain
- *Conospermum undulatum* and *Isopogon drummondii* individuals
- Black cockatoo habitat trees including those with hollows
- Black cockatoo foraging habitat.

The environmental and recreational values (i.e. vegetation type, condition and usage) of POS within the Precinct will significantly contribute to the ecological function between Sultana Road West Bush Forever site (No. 123) and Poison Gully Creek, which will in turn assist in maintaining the ecological viability of the ECRs and fauna corridor (linkage).

Table 3.5: Proposed environmental conservation reserves for retention and conservation of key environmental matters within the Residential Precinct

Environmental matter	Extent within LSP area	Extent proposed to be retained within conservation areas	Extent proposed to be retained within POS areas
Conospermum undulatum (Wavy smoke bush)	525 plants	Conservation: 416 Parks and Recreation: 38 Total: 454 (86.5%)	23 plants (4.4%)
Isopogon drummondii	2 plants	Conservation: 0 Parks and Recreation: 0 Total: 0 (0%)	1 plant (50%)
TEC (FCT20a) / Banksia Woodlands of the SCP	15.5 ha	Conservation: 5.67 ha Parks and Recreation: 0.80 ha Total: 6.47 (41.7%)	2.81 ha (18.1%)
Potential habitat trees for black cockatoos	411 trees (26 with hollows)	Conservation: 63 (8 with hollows, 3 with suitable hollows) Parks and Recreation: 1 (no hollow) Total: 64 (9 hollows, 3 suitable) (15.6%; 34.6%)	118 trees (17 hollows, 13 suitable) 28.7% (65.4%)
High quality foraging habitat for black cockatoos	19.25 ha	Conservation: 6.15 ha Parks and Recreation: 0.80 ha Total: 6.95 ha (36.1%)	2.82 ha (14.6%)

3.4.4 Management requirements

Management measures have been identified to assist in achieving the Biodiversity and Natural Assets management objectives (Table 3.6).

Table 3.6: Management measures for Biodiversity and Natural Assets

Parameter	Management actions	Timing/Responsibility
Bushfire Risk	Implementation of the Bushfire Management Plan.	Once BMP approved by relevant government agencies- Ongoing. City of Kalamunda /developer/landowner.
Various ownership of lots within the ECR and POS areas	Consolidation of lot ownership and investigation into options of acquiring lots through state and/or local planning provisions.	Once LSP has been approved. City of Kalamunda/ WAPC/ Department of Planning.
Assessment of existing infrastructure (buildings) and remediation responsibilities	Complete an audit on buildings to be retained/decommission and removed within POS or adjacent to ECRs.	Once LSP has been approved. City of Kalamunda/Developer.
Protection of ECRs	Development of a Strategic Conservation Management Plan (SCMP) for all ECRs, that considers the conservation objectives in DEC (2009) Waxy-leaved Smokebush Recovery Plan and to include (but not limited to): • areas to be revegetated (including revegetation low fuel plant species [FESA, 2011), KPIs planting densities, weed control) • controlled access and fencing requirements particularly along the interface of passive recreation and conservation areas • contingency measures • monitoring program • implementation and responsibilities.	The SCMP was endorsed as part of the original LSP and commissioned by DPLH. City of Kalamunda in consultation with OEPA (DBCA).
	Development of a construction environmental management plan to incorporate environmental elements during pre-construction and during construction: • areas to be rehabilitated (including revegetation low fuel plant species [FESA, 2011), KPIs planting densities, weed control) • controlled access and fencing requirements particularly along the interface of passive recreation and conservation areas • rubbish control • pathogen risk reduction and hygiene control • pest animal management • native fauna management (including trapping and relocation management) • vegetation clearing protocols including demarcation of vegetation/trees for retention • contingency measures • monitoring program	Once LSP has been approved and prior to the commencement of redevelopment within 100m of the ECRs. City of Kalamunda / developer.

Parameter	Management actions	Timing/Responsibility
	• implementation and responsibilities.	
	Assess the viability of the retention of the black cockatoo roosting site development area. If possible, incorporate into future development design.	Subdivision design.
	Creation/ enhancement of fauna habitat through landscaping of LOS/POS areas and streetscaping using local native species.	Once LSP approved and prior to subdivision design. Developer in consultation with the CoK
	Development adjacent to conservation areas/ fauna habitat to include fauna sensitive road design (eg. slow points, wildlife crossing signage etc.).	Subdivision design. Developer in consultation with the CoK
Ecological linkage of POS area between Bush Forever site No. 123) and Poison Gully Creek	• Complete a Landscape Feature and Tree Retention Plan, which location, species, size and structural health of significant trees (>50cm DBH) on site • Assess the feasibility of bushland retention in response to bushfire and recreational requirements.	Once LSP approved and prior to subdivision design. Developer in consultation with the CoK
	• Where possible retention of Black cockatoo habitat trees- with priority to trees containing hollows.	Prior to subdivision design. Developer in consultation with the CoK.
	• Complete feasibility assessment whether existing bridle trails (Crown reserve 37320) can be retained within the POS areas.	Prior to subdivision design. Developer in consultation with the CoK.
	POS design will be undertaken to ensure that sustainable outcomes which reduce water and fertiliser use, are the implemented through the principles identified in the LWMS.	UWMP- when required. Developer.
	Developers of roads intersecting the ecological corridor should investigate potential for fauna crossing i.e. fauna underpass.	Prior to subdivision design. Developer in consultation with the CoK.

3.4.5 Predicted environmental outcome

ECRs have been committed to by the CoK, which have been reflected in the LSP (Appendix A). Within the Residential Precinct these retention areas conserve:

- 42% TEC (FCT20a)/Banksia Woodlands of the SCP
- 87% C*. undulatum* (wavy-leaved smoke bush) and 50% *Isopogon drummondii*
- 16% Black cockatoo habitat trees (35% of those containing hollows)
- 36% Black cockatoo foraging habitat.

3.4.6 Secondary approval process

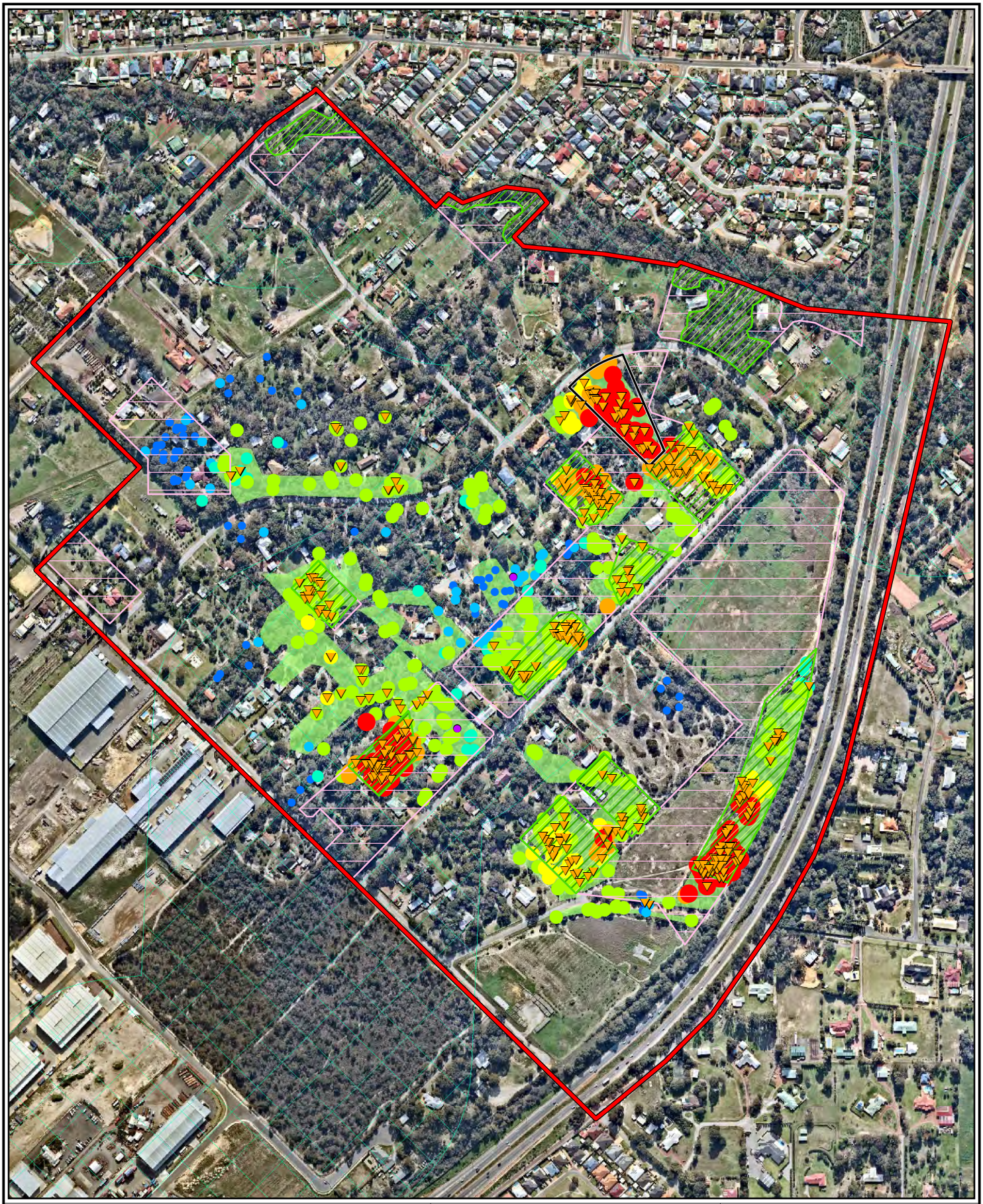
As discussed in Section 2.1, due to the presence of MNES within the precinct, the LSP or its implementation (developable areas and areas to be retained) may be subject to an EPBC Act referral subject to the proposed action and the significance of potential impact.

It is considered that there will be residual adverse impacts on key biodiversity values whereby a measure of environmental counterbalance (i.e. environmental offsets) will be required through the

BC Act and EPBC Act in the future. These residual impacts and where required environmental offsets will ultimately be considered as part of multiple individual/separate proponent-driven environmental approval processes, rather than as one single consolidated action (Emerge 2019).

Taking or disturbing of threatened flora requires an authorisation from the Minister for Environment or delegate under section 40 of the BC Act. Furthermore, there is a requirement under the BC Act that any modification of an occurrence of a TEC will require approval under section 45 of the BC Act. If therefore, the Minister for Environment lists an ecological community that occurs within the Precinct as Threatened prior to development then authorisation under section 45 will need to be sought.

Under the DP Act, application for subdivision to implement the development areas will be required. It is likely that there will be subdivision conditions associated with key environmental matters identified in 3.4.1.



Legend:

- Residential precinct
- Environmental conservation
- Local open space
- Parks and recreation
- Regional ecological linkages
- TEC (FCT20a)/ Banksia Woodlands of the Swan Coastal Plain
- *Isopogon drummondii* (P3)
- *Conospermum undulatum* (T)

Environmental values

- Lowest concentration
- Highest concentration

Scale 1:7,500 at A4 (0 100 200 metres)		**Forrestfield North Residential Precinct, WA**
Coord. Sys. GDA 1994 MGA Zone 50		**SPATIAL REPRESENTATION OF THE CONCENTRATED RETENTION OF ENVIRONMENTAL VALUES**
Job No: 61542		
Client: Element		**FIGURE 3.1**
Version: A	Date: 13-Oct-2021	strategen JBS&G
Drawn By: cthatcher	Checked By: RM	

File Name: W:\Projects\1)Open\Element (TPG)\61542 - FF North Res Precinct EAMS Update\GIS\Maps\R01_Rev_B\61542_03_1_EnvtlValues.mxd
Image Reference: www.nearmap.com© - Imagery Date: 3 July 2021.

3.5 Bushfire risk

3.5.1 Policy and management objective

Ensure that the bushfire risks to future life, property and environmental assets are minimised through appropriate development design and implementation of bushfire management measures.

3.5.2 Local Structure Plan considerations

- a Strategic Bushfire Overlay was provided initially to inform early design stages of the LSP (Residential Precinct). The indicative bushfire advice assumed post-development conditions (i.e. all land within proposed development cells would be cleared, with any temporary internal hazards to be managed through specialised staging works). The following was provided/recommended at that time
- key areas of intact vegetation that may pose a post-development bushfire risk were identified
- application of BAL ratings via AS 3959 will need to be considered for any proposed development located within 100 m of classified vegetation
- critical bushland interfaces were depicted, which may result in development being situated in areas of BAL-40 or BAL-FZ, which would be non-compliant in regard to the siting and location of development under current bushfire planning guidelines
- these interfaces should be considered for potential redesign to introduce road reserves at the bushland interface and/or actively managed, low fuel POS areas. Should these options not be achievable, then the development cells will need to cater for internal building setbacks to ensure the future buildings within the cells are not situated in areas of BAL-FZ/40 and can achieve a rating of BAL-29 or lower. It is noted that some of the development cells identified at the critical bushland interfaces (particularly residential cells to the north) may be too small to fully cater for the necessary internal building setbacks. Some setbacks may be required to be as large as 20-27 m, particularly those adjacent to down-slope forest vegetation, which is likely to be the case along the northern interface with Poison Gully Creek
- eight potential cul-de-sacs/dead-ends in the early concept plan may be considered non-compliant with guideline requirements
- potential Vulnerable Land Uses (as defined under the Guidelines) i.e. Primary School appear capable of achieving the necessary bushfire compliance requirements and will require preparation of an Emergency Evacuation Plan at the Development Application stage
- all other areas of the proposed development site appear to be capable of achieving the necessary bushfire compliance requirements. Staging measures (e.g. clearing in advance, POS implementation in advance and provision of access in advance), will be an important consideration throughout any proposed staged subdivision to ensure active stages of development are not subject to unnecessary/temporary BAL impact or non-compliances imposed by adjacent undeveloped stages
- the subsequent LSP incorporated or considered the above recommendations, as shown in Appendix A. The BMP for the precinct has been prepared and should be read in conjunction with this EAMS, which includes the following:
    - proposal details
    - environmental considerations

- bushfire assessment results, including results of site assessment (classified vegetation, effective slope and exclusions) and bushfire hazard level assessment for pre-and post-development conditions
- identification of bushfire hazard issues
- assessment against the bushfire protection criteria of the Guidelines
- responsibilities for implementation and management.

3.5.3 Management requirements

Management measures have been identified to assist in achieving the Bushfire management objectives (Table 3.7).

Table 3.7: Management measures for bushfire risk

Parameter	Management actions	Timing/Responsibility
Bushfire Risk	Implementation of the Bushfire Management Plan.	Once BMP approved by relevant government agencies- Ongoing. City of Kalamunda /developer/landowner.

3.5.4 Predicted environmental outcome

The revegetation within the POS areas including ECRs particularly along the urban interface (development area) will need to incorporate bush fire requirements and management measures (i.e. low threat status). Refer to the BMP for further information.

3.6 Heritage and culture

3.6.1 Policy and management objectives

Ensure that the heritage values associated with Poison Gully Creek are preserved and where possible incorporated into the POS landscape design.

3.6.2 Local Structure Plan considerations

The LSP is reflective to the heritage values associated with Poison Gully Creek including:

- incorporating existing crossing (Maida Vale Road, Milner Road and Littlefield Road). Littlefield road will be a pedestrian/cycle access linking Maida Vale area with the DSP area
- control access along the interface of the precinct and Poison Gully foreshore area through designated paths, bollards, and fencing
- ECR has been allocated where the creek foreshore area impedes the precinct boundary, while potential drainage storage and outflow (via upgrades to existing culverts may be required), the focus of these areas will be passive recreation and revegetation to compliment the natural assets of the creek
- ecological linkage connection from Bush forever site 321 through the precinct and along Poison Gully Creek (Bush forever site 45) which will assist with fauna movement within the area.

3.6.3 Management requirements

Management measures have been identified to assist in achieving the Heritage management objectives (Table 3.8).

Table 3.8: Management measures for Heritage and Culture

Parameter	Management actions (Turner et al 2018)	Timing/Responsibility
Preservation of heritage values	CoK and key stakeholders to continue their consultations with the Nyungar	Ongoing.

Parameter	Management actions (Turner et al 2018)	Timing/Responsibility
	community in respect of the Forrestfield North DSP, particularly as this might impact on Poison Gully Creek (DPLH ID 25023).	The SCMP will be implemented by the COK Subdivision phase- Developer
	Nyungars are invited to engage in any works associated with Poison Gully Creek, including the rehabilitation of the creek and revegetation with native vegetation. This is relevant to implementation to the SCMP (refer to Section 4.4.4) for ECRs which have an interface with Poison Gully Creek i.e. ESR 10, 11, 12 and 13.	
Any required construction works within Poison Gully Creek and/or foreshore	Determine whether a s.18 permit is likely to be required under the *Aboriginal Heritage Act 1972* or approval under Regulation 10 from the Register of Aboriginal Site: consultation with DPLH and relevant Aboriginal groups to confirm the significance of existing Aboriginal Heritage sites, and to confirm whether an Aboriginal Heritage survey and/or s 18 permit is likely to be required an Aboriginal Heritage survey of the Project to provide further detail on the significance and location of Aboriginal Heritage sites, and prepare an s18 notice form under the AH Act, if required.	Prior to disturbing works- process approximately 6 months. CoK/ Developer.
Heritage education and opportunities	In conjunction with Nyungar women, examine ways in which the natural bush and creek between Dundas Road and Milner Road can be enhanced as a Nyungar women's place The potential incorporation of public art and interpretative/education signs within POS to reflect the heritage importance of the area.	Subdivision phase- CoK and Developer.
Further archaeological survey	Archaeological survey be undertaken for the Residential Precinct area.	Prior to the commencement of development-CoK and/or developer.

3.7 Acquisition of environmental conservation reserve and POS areas

3.7.1 Bush forever sites

The management structure of the existing Bush Forever sites within the Residential Precinct, includes the following:

Table 3.9: Management structure of Bush Forever sites

Site	Name	Management structure
45	Poison Gully Bushland, High Wycombe. Poison Gully Bushland runs along the northern cadastral boundary of the precinct and extending into Lots 80 and 81. Lot 78 has recently been included within Bush forever site No. 45	Crown Land Vested in Local Government, part Private
123	Sultana Road West Bushland, High Wycombe	Western Australian Planning Commission

It is proposed that the current management regime of existing Bush Forever sites is upheld and any future Bush Forever sites (including ECR becoming bush forever sites) are purchased under the Metropolitan Region Improvement Fund (MRIF). The MRIF has previously been used to purchase Swan River foreshores, to protect the face of the Darling scarp, to implement the Bush Forever program and has also enabled the WAPC to create the outstanding system of regional open space which is emblematic of Perth (WAPC, 2007).

3.7.2 Environmental conservation reserve areas

The LSP identifies approximately 10 ha of land within 13 areas for environmental conservation purposes. These thirteen environmental conservation areas contain vegetation of state and national significance (Appendix A), warranting both the reservation of the sites and the use of public funds to secure their acquisition.

The sites will therefore be progressively acquired by the WAPC, using the Metropolitan Region Improvement Fund (MRIF) which becomes available through an amendment to the MRS, reserving the sites as 'Parks and Recreation.' This process can take up to 18 months to finalise, so to provide greater certainty to affected landowners and to ensure the protection to biodiversity values from development in the meantime, the WAPC intends to declare a Planning Control Area (PCA) over the environmental conservation areas under Part 7 of the *Planning and Development Act 2005*. It is noted that this level of statutory intervention by the WAPC is not typical and is only provided in this instance to support timely development of the Forrestfield North Residential Precinct as a METRONET related project, given the significance of the values and importance to achieving conservation outcomes. (Emerge 2019).

3.7.3 POS and drainage area

A Development Contribution Plan (DCP) has been prepared for the Residential Precinct in accordance with WAPC (2016) SPP 3.6-Development Contributions for Infrastructure. The DCP report contains:

- infrastructure funding principles
- strategic context of and basis for the DCP
- LSP areas and development scenario information
- infrastructure project list and details
- development contribution charging rates (cost apportionment method and schedule)
- administrative and procedural matters.

POS and drainage storage areas will be purchased through the DCP. The operation and maintenance of POS areas and the drainage system will initially be the responsibility of the developer until handover to the CoK (refer to the LWMS).

4. Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

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

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Forrestfield North Local Structure Plan

LEGEND

Structure Plan Boundary

Region Scheme Reserves

Parks and Recreation

Primary Regional Road

Notice of Delegation

Bush Forever

Land Use and Residential Density

Environmental Conservation

Local Open Space

PS — Public Purposes - Primary School

Residential Medium Density (R30 - R60)*

Residential High Density (R60 - R100)*

Other Categories

District Integrator A (Existing / Proposed)

District Integrator A (Potential Future)

District Integrator B (Existing / Proposed)

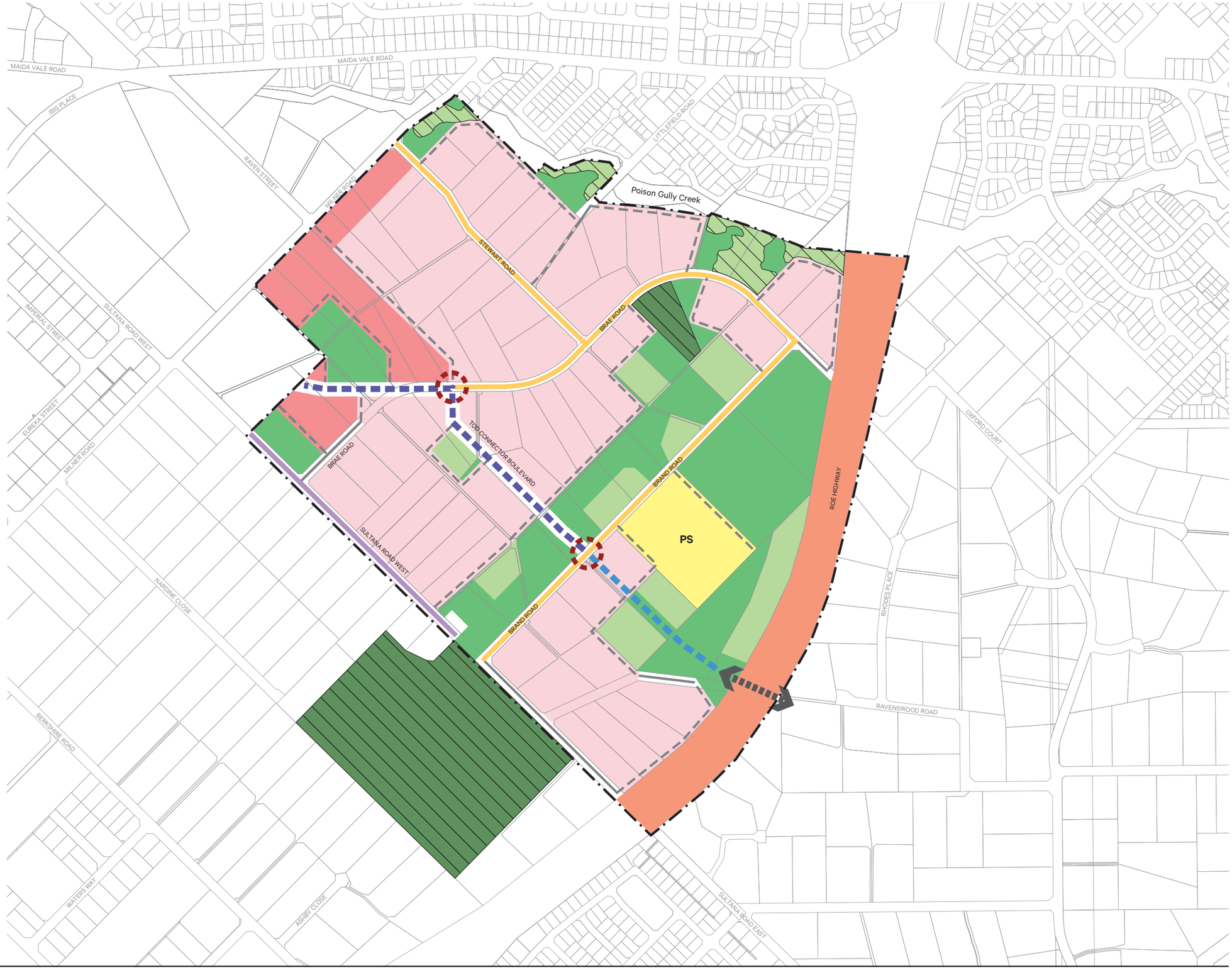
Neighbourhood Connector (Existing / Proposed)

Local Street (Existing / Proposed)

Proposed Roundabout

Potential Future Fly-Over Roe Highway

* *Applications for subdivision or development at the higher end of the density band shall be assessed against a range of criteria. Refer Part One, Section 4.2 of the Local Structure Plan.*



Plan 1: Structure Plan

Forrestfield North Residential Precinct

0 80 160m

Date: 21 Jun 2021 Scale: 1:8000@ A3 1:4000 @ A1 File: **17-527 ST-1 A** Staff: MC GW Checked: MC

element.

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Appendix B AECOM (2017a) Forrestfield North Level 2 Flora and Fauna Survey

AECOM

Shire of Kalamunda
15-Mar-2017

Forrestfield North Level 2 Flora and Fauna Survey

Forrestfield North Level 2 Flora and Fauna Survey

Client: Shire of Kalamunda

ABN: 60 741 095 678

Prepared by

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15-Mar-2017

Job No.: 60527304

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document Forrestfield North Level 2 Flora and Fauna Survey

Ref 60527304

Date 15-Mar-2017

Prepared by F de Wit

Reviewed by L Kirchner

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	23-Dec-2016	Draft for Internal Review	L Kirchner Associate Director - Environment	
B	23-Jan-2017	Draft for client review	L Kirchner Associate Director - Environment	
0	15-Mar-2017	Final for Issue	L Kirchner Associate Director - Environment	

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Executive Summary

Shire of Kalamunda required biological assessments for a proposed development area associated with the Forrestfield Airport Link railway station being constructed in High Wycombe. The outcome of the assessment will inform management plans and the development of a retention plan required prior to rezoning and redeveloping the area. The survey area includes 112 private properties and includes areas with native and non-native vegetation. The primary objective of the biological assessments was to define the existing environment within the survey area and identify and map conservation significant flora, fauna and vegetation.

A level 2 flora and vegetation assessment was undertaken including targeted Threatened flora searches, an assessment for Banksia Woodlands of the Swan Coastal Plain (SCP) threatened ecological community (TEC), and mapping vegetation communities and condition. Eighteen quadrats were installed and floristic data collected by Floora de Wit (collection licence SL011912) and Lyn van Gorp (collection licence SL011913).

A level 1 fauna assessment and targeted Black Cockatoo survey was undertaken by Jared Leigh and Floora de Wit simultaneously with the flora and vegetation assessment. The fauna survey included five micro-habitat searches, mapping and characterising fauna habitats supported by fauna habitat sites and the flora and vegetation data, and targeting Quenda habitat. The Black Cockatoo assessment included mapping all potential Black Cockatoo breeding trees and completing a foraging quality assessment.

All field investigations were undertaken between 22 and 23 November and 28 and 29 November. In summary:

- One TEC listed as Endangered under the *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act) occurs in the survey area. All native vegetation in 'Good' or better condition within the survey area has met the key diagnostic criteria for the Banksia Woodlands of the Swan Coastal Plain TEC. This TEC extends for 14.22 ha.
- The Banksia Woodlands of the SCP TEC relates to one State-listed TEC *Banksia attenuata* woodlands over species rich dense shrublands, and one DPaW-listed priority ecological community (PEC) Banksia Woodlands of the SCP. Lack of detailed descriptions for this TEC means it was difficult to accurately delineate these TECs, and therefore all native vegetation in 'Good' or better condition could be considered the State-listed TEC which represents the highest conservation category.
- Five vegetation communities were recorded and mapped. Four of these are considered regionally significant as they represent a federally listed TEC. Many also support populations of the Threatened *Conospermum undulatum.*
- One Threatened flora species, *Conospermum undulatum* (Wavy-leaved Smokebush) was recorded extensively throughout the survey area. This species is listed as Vulnerable under both the EPBC Act and WC Act. One population comprising 525 individuals were recorded within the survey area. Current information shows a total of 25 populations occur on the SCP, comprising approximately 11,453 individuals.
- Two Declared Pest species listed under the BAM Act were recorded, including *Zantedeschia aethiopica* (Arum Lily) and *Asparagus asparagoides* (Bridal Creeper).
- Four conservation significant fauna species were recorded during the survey including the Carnaby's Black Cockatoo listed as Endangered under the EPBC Act and the WC Act, Forest Red-tailed Black Cockatoo listed as Vulnerable under the EPBC Act and the WC Act, Rainbow Bee-eater listed as Marine under the EPBC Act and the Quenda listed as Priority 4 by DPaW.

- Four fauna habitats were mapped within the survey area, including
  - 22.97 ha of suitable Quenda habitat
  - 25.15 ha of Black Cockatoo potential breeding habitat
  - 19.32 ha of High quality foraging habitat for Carnaby's and Forest Red-tailed Black Cockatoos and 8.29 ha mapped as Valued foraging habitat for Carnaby's and Quality foraging habitat for Forest Red-tailed Black Cockatoos.

There were no significant limitations identified that may have affected the field survey results. The timing of the field survey in late November may not be considered optimal due to dry preceding months and lack of orchids and ephemerals able to be identified. However, this was not considered to have a large impact on the project. The Threatened targeted flora species was easily identified, and species richness was still considered high in all areas of native vegetation in 'Very Good' to 'Excellent' condition. Therefore no further work is recommended.

1.0 Introduction

1.1 Background

In June 2014, the State Government announced the Forrestfield Airport Link, a $2 billion train line connecting with the Midland line near Bayswater Station, servicing the airport and finishing in the Forrestfield/High Wycombe area. The State Government requested the Shire of Kalamunda (the Shire) explore the opportunities that a new train station could bring to the surrounding area. This meant moving away from the industrial land uses, previously proposed, and focusing on residential and retail/commercial uses more suitable for a train station precinct. The new focus resulted in the Forrestfield North District Structure Plan (the DSP) being prepared which planned for the delivery of high density residential uses, a new activity centre and a commercially focused Transit Oriented Development precinct based around the new train station. The DSP was approved by the Western Australian Planning Commission (WAPC) in late September 2016.

As part of exploring these opportunities, the Shire proposes to rezone approximately 138 hectares (ha) in Forrestfield / High Wycombe to Urban Development as part of Local Planning Scheme No.3 (LPS3) Scheme Amendment 75 (Amendment 75). The rezoning is proposed to facilitate the detailed structure planning of the precincts within the approved DSP.

The EPA has considered Amendment 75 in accordance with the requirements of the *Environmental Protection Act 1986* (EP Act). The EPA advised that the potential impacts of Amendment 75 can be adequately managed to meet the EPA's objectives through the development and implementation of future structure plans and implementation of the responsible authority's scheme provisions that specifically address the environmental factors of flora and vegetation and terrestrial fauna. The EPA expects that further detailed management plans and scheme provisions to address flora and vegetation will be addressed prior to the finalisation of the structure plans.

Further information is required for the environmental values of the proposed development area before management plans and structure plans can be finalised. This will ensure that environmental assets and conservation significant factors are adequately protected and managed during the redevelopment process.

1.2 Location

The survey area is located in High Wycombe in the suburbs of Perth, Western Australia. The survey area is located between Maida Vale Road (north), Dundas Road (west), Sultana Road West (south) and Roe Highway (east). The survey area includes 144 ha of land, of which 116.2 ha is cleared and 27.80 ha is considered native vegetation.

The location and extent of the survey area is shown in Figure 1.

1.3 Objectives

The primary objective of the biological assessments was to define the existing environment within the survey area and identify and map conservation significant flora, fauna and vegetation. The assessment accordingly included the collection of information relating to flora, vegetation, fauna, and habitats.

The specific objectives included:

- Complete a desktop assessment to identify significant flora, vegetation and fauna that potentially occur in the area and collate existing information from available sources to develop a comprehensive overview of the survey area
- Undertake a Level 2 flora and vegetation assessment in accordance with relevant standards and technical guides
    - complete ecological community mapping and vegetation condition mapping
    - complete targeted Threatened flora surveys for *Conospermum undulatum*

  - develop a comprehensive species list
  - complete Threatened Ecological Community assessments for patches of native vegetation
- Undertake a Level 1 fauna assessment in accordance with relevant standards and technical guides
  - identifying suitable habitat for conservation significant species
  - defining fauna habitat values and potential presence of significant fauna species
- Survey and map Black Cockatoo potential breeding and foraging habitat.

The methods and results of the biological assessments are presented in this technical report.

PROJECT ID	60507828
CREATED BY	RNM
APPROVED BY	FdeWit
LAST MODIFIED	20 JAN 2017

AECOM
www.aecom.com

1:12,500 when printed at A4
DATUM GDA 1994, PERTH COASTAL GRID94
0 100 200 300 400
Meters

LEGEND
- Survey Area
- Highway
- Minor Road

Survey Area

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure 1

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig1_SurveyArea_v2_A4.mxd (fotheringhamd)

A4 size

2.0 Existing Environment

2.1 Climate

The climate of the Perth Metropolitan Region is described as Warm Mediterranean (Mitchell et al 2002). A Mediterranean climate is characterised by warm to hot dry summers and mild to cool wet winters. The Mediterranean climate in Australia is a result of the Indian Ocean High, a high pressure cell that shifts towards the poles in summer and the equator in winter, playing a major role in the formation of the deserts of Western Australia, and the Mediterranean climate of southwest and south-central Australia. Precipitation occurs during winter months, with the possibility of some summer storms.

The closest meteorological station to the Study area with comprehensive data is Perth Airport (Station 009021), which is located 2.6 km south east of the Study area. Perth Airport meteorological station is maintained by the Bureau of Meteorology (BoM) and commenced recording in 1944.

Perth airport has experienced an average annual rainfall of 765.2 mm, with the majority of rainfall occurring between May and September. In the twelve months preceding the survey rainfall was near average for most months, with the exception of June and July (Figure 2). These months show a decline in rainfall by more than 20 mm for that month. In June 2016 only 86.4 mm of rainfall was recorded compared to the average 157 mm for that month. This, and the timing of the field surveys in late November, may have affected the ability to record ephemeral and orchid species.

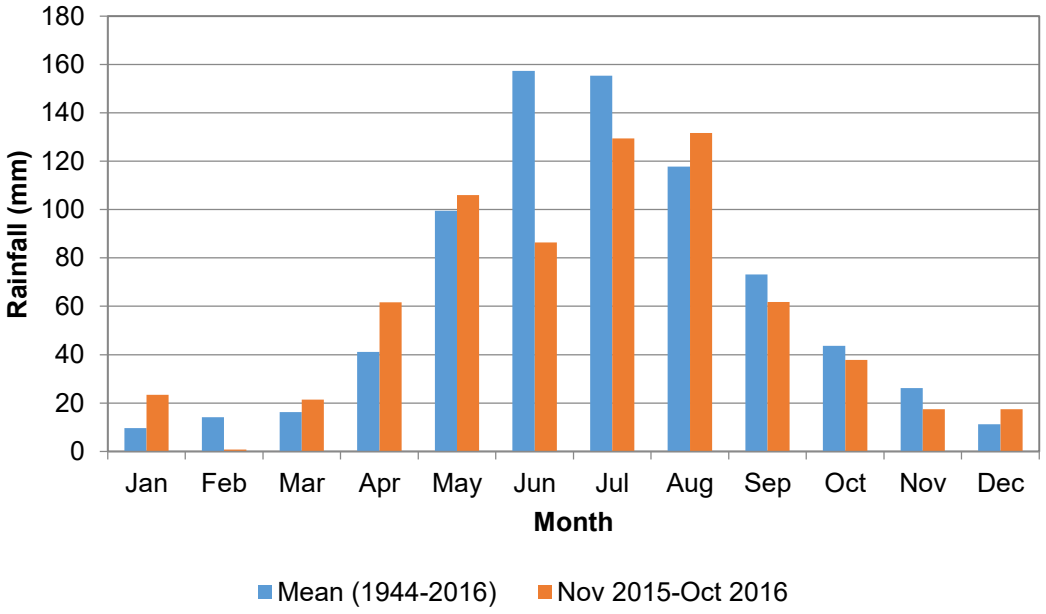


Figure 2 Rainfall data from weather station Perth Airport (009021) showing mean monthly rainfall and rainfall received in the 12 months preceding the field survey (source: BOM, 2016)

2.1 IBRA Regions

The Survey Area is located on the Swan Coastal Plain bioregion described in CALM (2002), including Perth and the outer suburbs (excluding the Hills suburbs). The Swan Coastal Plain consists of the Dandaragan Plateau and the Perth Coastal Plain and is comprised of a narrow belt less than 30 km wide of Aeolian, alluvial and colluvial deposits of Holocene or Pleistocene age incorporating a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestone and several offshore islands. Younger sandy areas and limestone are dominated by heath and/or Tuart woodlands, while *Banksia* and *Jarrah-Banksia* woodlands are found on the older dune systems.

The Swan Coastal Plain subregion, described by Mitchell *et al.* (2002), is a low-lying coastal plain covered with woodlands dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The area includes a complex series of seasonal wetlands and includes Rottnest, Carnac and Garden Islands. Land use is predominantly cultivation, conservation, urban and rural residential. The area contains a number of rare features including Holocene dunes and wetlands and a large number of threatened species and ecological communities.

2.2 Vegetation

The Environmental Protection Authority's (EPA) objective is to retain at least 30% of all pre-European Heddle *et al.* (1980) vegetation complexes, which is consistent with recognised retention levels (EPA, 2002; EPA, 2015). In the metropolitan area a 10% threshold applies.

There is one Beard (1981) vegetation association mapped within the survey area. Vegetation association 1001: Medium very sparse woodland; Jarrah, with low woodland; Banksia and Casuarina has an estimated 22.43% of pre-European extent remaining on the Swan Coastal Plain (Government of Western Australia, 2015).

Heddle *et al.* (1980) completed vegetation complex mapping which used to assess the extent of pre-European vegetation. Two vegetation complexes are mapped within the survey area (Table 1).

Table 1 Vegetation complex mapping (Heddle *et al.* 1980) that intersect with the Survey Area showing percent remaining in the Perth-Peel region as published in EPA Perth @ 3.5 million (EPA, 2015)

Vegetation Complex	Percent Remaining
Forrestfield: vegetation ranges from open forest of *Corymbia calophylla – Eucalyptus wandoo – E. marginata* to open forest of *E. marginata – C. calophylla – A. fraseriana – Banksia* spp. with fringing woodland of *E. rudis* in the gullies that dissect this landform	10.3%
Southern River: open woodland of Marri-Jarrah-banksia on the elevated areas and a fringing woodland of Eucalyptus rudis-Melaleuca rhaphiophylla along the streams.	16.8%

3.0 Legislative Framework

3.1 Overview

Table 2 summarises the key legislation governing the protection and management of Western Australia's conservation significant species and communities, which are further discussed below and in Appendix A.

Table 2 Relevant legislation, regulations and guidance

Legislation	Purpose
Commonwealth of Australia	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity.
EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species.	To assist in determining whether an action needs to be referred to the Australian Government. Also provides guidance on Black Cockatoo survey methodology.
Western Australia	
Wildlife Conservation Act 1950 (WC Act)	Provides for the conservation and protection of Western Australia's wildlife.
Biodiversity Conservation Act 2016	Provides coverage for flora and fauna, communities, habitats, threatening processes, environmental pests and weeds. Objective is to conserve and protect biodiversity and biodiversity components in the State and promote the ecologically sustainable use of biodiversity components in the State.
Environmental Protection Act 1986 (EP Act)	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
Biosecurity and Agriculture Management Act 2007 (BAM Act)	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally.
Land Administration Act 1997 (LAA)	An Act to consolidate and reform the law about Crown land and the compulsory acquisition of land generally, to repeal the *Land Act 1933* and to provide for related matters. The Act allows for the
Rights in Water and Irrigation Act 1914 (RIWI Act)	An Act relating to rights in water resources, to make provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes.

3.2 EPBC Act

3.2.1 Matters of National Environmental Significance

Matters of national environmental significance include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties

- national Heritage places
- Great Barrier Reef Marine Park
- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

If an action is likely to have a significant impact on a MNES this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

3.2.2 Flora and fauna

The EPBC Act is the main piece of Federal legislation protecting biodiversity in Australia. Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 3.

Table 3 Categories of Species Listed under Schedule 179 of the EPBC Act (Commonwealth)

Conservation	Code Category
Ex	Extinct Taxa
ExW	Extinct in the Wild
CE	Critically Endangered
E	Endangered
V	Vulnerable
CD	Conservation Dependent
OS	Other specially protected fauna

3.2.3 Vegetation Communities

Communities can be classified as Threatened Ecological Communities (TECs) under the EPBC Act. The EPBC Act protects Australia's ecological communities by providing for:

- identification and listing of ecological communities as threatened
- development of conservation advice and recovery plans for listed ecological communities
- recognition of key threatening processes
- reduction of the impact of these processes through threat abatement plans.

Categories of federally listed TECs are described in Table 4.

Table 4 Categories of TECs that are listed under the EPBC Act

Conservation Code	Category
CE	Critically Endangered If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
E	Endangered If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
V	Vulnerable If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

3.3 Western Australian legislation

3.3.1 Flora and fauna

Plants and animals that are considered Threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the WC Act. These categories are defined in Table 5.

Table 5 Conservation codes for WA flora and fauna listed under the *Wildlife Conservation Act 1950* updated November 2015

Code	Category
CR	Critically endangered species / Schedule 1
EN	Endangered species / Schedule 2
VU	Vulnerable species / Schedule 3
EX	Presumed extinct species / Schedule 4
IA	Migratory birds protected under an international agreement (fauna only) / Schedule 5
CD	Special conservation (fauna only) / Schedule 6
OS	Special protection for reasons other than those already mentioned (fauna only)

Species that have not yet been adequately surveyed to warrant being listed under the WA Act are added to a Priority flora List by the State Minister of Environment. Categories and definitions of Priority Flora and Fauna species are provided in Table 6 and expanded in Appendix A.

Table 6 Conservation codes for WA flora and fauna as listed by DPaW and endorsed by the Minister for Environment

Conservation Code	Category
Priority One	Poorly Known Species
Priority Two	Poorly Known Species
Priority Three	Poorly Known Species
Priority Four	Rare, Near Threatened and other species in need of monitoring

3.3.2 Vegetation Communities

State listed TECs are not protected under any legislation, rather they are endorsed by the Minister for Environment. Categories of TECs are defined in Table 7. PECs are endorsed by the Minister for Environment as having insufficient information available to be considered a TEC, or which are rare but not currently threatened. These categories are described in Table 8.

Table 7 Conservation codes for State listed Ecological Communities

Conservation Code	Category
PD	Presumed Totally Destroyed
CR	Critically Endangered
EN	Endangered
VU	Vulnerable

Table 8 Categories for Priority Ecological Communities

Conservation	Code Category
P1	Priority One: poorly-known ecological communities
P2	Priority Two: poorly-known ecological communities
P3	Priority Three: poorly known ecological communities
P4	Priority Four: ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list.

3.3.3 Biosecurity and Agriculture Management Act 2007

Biosecurity is the management of the risk of animal and plant pests and diseases entering, emerging, establishing or spreading in WA to protect the economy, environment and community. Biosecurity is managed under the BAM Act which came into effect 1 May 2013. Exotic animals and plants can become an invasive species if they can establish in new areas where local conditions are favourable for their growth.

Under the BAM Act declared pests are placed in one of three categories, as explained in Table 9. Many of the declared pest plant species are also on the list of Weeds of National Significance. This list was compiled to prioritise future management and allocation of resources for weed control. Species were selected based on their invasiveness and impact characteristics, potential and current area of spread and their environmental, industrial or socioeconomic impacts.

Table 9 Declared Pest categories under the BAM Act

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

3.3.4 Land Administration Act 1997

The *Land Administration Act 1997* (LAA) is Western Australia's legislation dealing with the disposition of State land. The LAA is administered by the Minister for Lands, assisted by the Department of Regional Development and Lands (RDL).

Class A Reserves are established under the LAA. They are afforded the greatest degree of protection for Crown land and this classification is used solely to protect areas of high conservation or high community value. Should a proposal require development within a Class A Reserve, the subject land would require excision from the Class A Reserve. The process of excision requires that the proposal be tabled before, and gain approval from, both Houses of Parliament.

3.3.5 *Environmental Protection Act 1986* (and Clearing Regulations)

Section 38 (Part IV) of the EP Act provides that any person may refer a significant proposal (one that is likely to have a significant effect on the environment) to the EPA. The EP Act also states that where the environmental impact of a proposal can be adequately assessed and managed through other legislative mechanisms the proposal is unlikely to require formal environmental impact assessment.

If a proposal is not formally assessed by the EPA under Part IV of the EP Act, a Part V native Vegetation Clearing Permit may be required. Under Section 51C of the EP Act, clearing of native vegetation without a Native Vegetation Clearing Permit is an offence unless an exemption applies. Exemptions offered for clearing under Regulation 5 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* do not apply within Environmentally Sensitive Areas (ESA).

3.3.6 Rights in Water and Irrigation Act 1914

A licence under the RIWI Act is required if water is proposed to be taken from a watercourse or groundwater aquifer. In addition, a permit is required under the RIWI Act for any activity that will disturb the bed and banks of a watercourse or wetland.

4.0 Methodology

The flora and vegetation assessment of the Survey area was conducted in accordance with Environmental Protection Authority (EPA) Guidance Statement No. 51, Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a) and EPA Position Statement No.3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002).

4.1 Desktop Assessment

The desktop assessment involved gathering background information for the local area. Desktop database searches were requested from the following government databases (including a 10 km buffer from Survey area boundary):

- Department of Parks and Wildlife (DPaW) Threatened and Priority Flora List
- WA Herbarium (WAH) records
- DPaW Threatened and Priority Ecological Communities database (received 9 Dec 2016)
- *Environment Protection and Biodiversity Conservation Act* (EPBC Act) Protected Matters database.

All flora of conservation significance identified in the desktop assessment were assessed for their likelihood of occurrence within the survey area (Table 10). Available literature was consulted to identify broad vegetation types and describe the existing environment. References included Beard (1981) vegetation mapping, the Biodiversity Audit of Western Australia (CALM 2002), and Heddle et al. (1980) vegetation mapping.

Table 10 Categories of likelihood of occurrence for species and communities

Likelihood Category	Flora	Fauna	Communities
Likely to occur	Habitat is present in the Survey area and the species has been recorded in close proximity to the Survey area	Survey area is within the known distribution of the species, habitat is present in the Survey area and the species has been recorded in close proximity to the Survey area	Known occurrences of the community in close proximity to the Survey area. Vegetation looks the same within the known occurrence and Survey area based on aerial imagery. Geographic location is similar to the Survey area
May occur	Habitat may be present and/or the species has been recorded in close proximity to the Survey area	Survey area is within the known distribution of the species, marginal habitat may be present and/or the species has been recorded in close proximity to the Survey area	Known occurrence of the community in the local area, and/or vegetation looks the same within known occurrence and Survey area based on aerial imagery. Geographic location is similar to the Survey area
Unlikely to occur	No suitable habitat is present and the species has not been recorded in close proximity to the Survey area	Survey area is outside the known distribution for the species, or no suitable habitat is present and the species has not been recorded in close proximity to the Survey area	Known occurrence of the community in close proximity to the survey area however geographic location does not occur in Survey area

4.2 Flora and Vegetation Survey

A Flora and Vegetation Assessment was conducted in accordance with EPA Guidance Statement No. 51 and the Flora Survey Technical Guide (EPA & DPaW, 2015). The Flora and Vegetation Assessment was conducted by two botanists Floora de Wit (Collection Permit SL011555) and Lyn van Gorp (Collection Permit SL011558) between 22-23 November and 29-30 November. Any species unable to be identified in the field were collected for identification in AECOM's in-house herbarium and the specimens and taxonomic references and keys at the Western Australian Herbarium (WAH). Naming of species followed the convention of the WAH.

Floristic data was collected at sample point locations using a combination of 10 x10 m non-permanent quadrats and relevés to document the floristics, vegetation composition and structure, condition, and other identifying features of the vegetation community. Floristic data was collected at 18 sample point locations within the Survey area. Sample point locations were selected to ensure accurate representation of native vegetation within the Survey area with a minimum of two quadrats in each vegetation community, supported by relevés where necessary.

The following parameters were recorded for each quadrat:

- location – Australian Map Grid (AMG) coordinates recorded in Geocentric Datum of Australia (GDA) 94 datum using a handheld Global Positioning System (GPS) unit, to an accuracy of 5 m
- photograph – taken from the north-west corner
- habitat, including a description of landform and soils
- a complete inventory of the observed flora species present within each quadrat at the time of the survey, including their height and proportionate cover within the quadrat
- vegetation condition rating of the vegetation within the quadrat using Keighery (1994) scale (Table 12).

4.2.1 Vegetation mapping

Quantitative flora species data were used to define the vegetation communities. Vegetation communities were described and mapped based on changes in dominant species composition and landform. Vegetation community descriptions were based on the National Vegetation Information System (NVIS) framework (Commonwealth of Australia, 2003).

Delineation of vegetation communities was supported by analysing floristic data collected within quadrats. The program PC Ord was used to assess the similarity between sites and review dendrograms using Ward's distance measure. This identified those sites that are most similar to one another and suitable for representing the same vegetation community. The analysis was done using presence absence data and scaled percentage cover applying the Braun-Blanquet scale as outlined in Table 11.

Areas that consisted of native trees only were mapped as such. It is possible that some native trees (as identified in the Black Cockatoo potential breeding tree assessment) are not captured in a 'Trees' polygon. In these instances, native trees are isolated and occur over planted or cleared land. Trees in paddocks were not captured in the 'Trees' category.

Areas previously mapped by Strategen were further refined in the survey area. These areas include Lot 105 Sultana Road West and 32 Bray Road. Communities mapped by Strategen (2015) that have not been altered have been included in this report to ensure that a comprehensive overview of the survey area is documented.

Table 11 Braun-Blanquet scale (Braun-Blanquet et al. 1932)

Scale	Range of cover
5	75-100
4	50-75
3	25-50
2	5-25
1	<5 numerous individuals
+	<5 few individuals
R	Solitary, with small cover

Vegetation condition was determined using the scale developed by M.E. Trudgen and published by the Wildflower Society WA (Keighery, 1994) condition scale (Table 12). The scale is based on disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure and site ecology.

Table 12 Bushland condition ratings (Keighery, 1994)

Descriptor	Explanation
Pristine	Pristine or nearly so, no obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
Very Good	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	Vegetation structure significantly altered by very obvious signs of multiple disturbances. 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	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing
Completely Degraded	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

4.3 Fauna survey

A Level 1 Fauna Assessment was conducted in accordance with EPA Guidance Statement No. 56 (EPA, 2004b). Fauna species and habitat data was collected at sample point locations within the Survey area considered representative of the vegetation types and fauna habitat types present. Various habitat features were assessed and used to inform the fauna habitat map and be used to determine suitability of habitat for conservation significant fauna species, including consideration of structural diversity and refuge opportunities for fauna.

In addition to recording all observed fauna and birds identified from distinctive calls, details of indirect evidence such as scats, tracks and diggings was documented. In particular, attention was given to conservation significant species identified in the desktop assessment as having the potential to occur in the area.

Fauna occupancy searches were undertaken in microhabitats likely to support fauna species. Techniques include overturning logs and rocks, searching beneath the bark of trees, investigating dead trees and logs, investigating overhangs and crevices, and investigating burrows.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians used is in accordance with the Western Australian Museum's Checklist of Vertebrates of Western Australia (WAM, 2016), and for bird species the Bird's Australia Checklist of Australian Birds based on Christidis and Boles (2008) is used.

4.4 Black Cockatoos

A Black Cockatoo survey was conducted to identify potential breeding and foraging habitat for the three Threatened Black Cockatoo species that occur in WA. This survey focussed on the two species most likely to be present; the EPBC Act and WC Act listed Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*: Carnaby's), and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii subsp. naso*: FRTBC). Foraging habitat quality was also quantified Black Cockatoo species. The surveys were undertaken in accordance with:

- Referral guidelines for three species of Western Australian black cockatoos species: Carnaby's Cockatoo (endangered), Baudin's Cockatoo (vulnerable), Forest Red-tailed Black Cockatoo (vulnerable) (Department of Sustainability, Environment, Water, Populations and Communities [DSEWPaC], 2012)
- Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA & DEC [Department of Environment and Conservation], 2010).

4.4.1 Breeding habitat

The Black Cockatoo breeding habitat assessment focussed on quantifying potential breeding trees and associated habitat. Table 13 defines breeding habitat and identifies those trees that Black Cockatoos will utilise as breeding trees, according to DSEWPaC (2012). The following information was collected for all potential breeding trees with a Diameter at Breast Height (DBH) >500 mm:

- location
- tree species
- number of hollows
- number of potentially suitable hollows.

Suitable hollows are hollows with an entrance bigger than 10cm diameter.

The results from the Bamford (2012) Black Cockatoo survey, in particular location of potential breeding trees, has been merged with the AECOM results to provide a comprehensive overview of environmental values for Black Cockatoo species.

Table 13 Potential Breeding Habitat (source: DSEWPaC, 2012)

	Carnaby's	FRTBC
Specific breeding habitat	Nest in hollows in live or dead trees of *E. salmonophloia, E. wandoo, E. gomphocephala*, *E. marginata*, *E. rudis*, *E. loxophleba* subsp. *loxophleba, E. accedens, E. diversicolor* and *Corymbia calophylla*.	Nest in hollows in live or dead trees of *E. diversicolor* and *Corymbia calophylla, E. wandoo, E. megacarpa*, *E. patens*, *E. gomphocephala* and *E. marginata*.
Definition of breeding habitat	'Breeding habitat' is defined in these referral guidelines as trees of species known to support breeding within the range of the species which either have a suitable nest hollow OR are of a suitable DBH to develop a nest hollow. For most tree species, suitable DBH is 500 mm. Note that *E. wandoo* is DBH >300 mm.	

4.4.2 Foraging habitat

The Black Cockatoo foraging habitat assessments focussed on mapping the area of potential foraging habitat within the Survey Area. Table 14 defines the foraging species for the FRTBC and Carnaby's. Vegetation communities and floristic data collected from quadrats were assessed for their potential to provide foraging habitat.

The quality of foraging habitat not only reflects the availability of food sources, but also the proximity to reliable water sources, connectivity to other suitable habitat, presence of potential breeding trees, and proximity to confirmed roost and breeding sites (amongst others). These parameters were utilised by the DotEE to produce a draft quality of foraging habitat scoring system (Table 15). This scoring system was utilised to assess potential foraging habitat for each Black Cockatoo species.

The scoring tool is used by initially defining the quality of the overall habitat present (i.e. High, Quality, Valued, Low) and then adding or subtracting points from this depending on the ecological values of the habitat (i.e. proximity to water, proximity to a known roost site, evidence of foraging material etc.). This determines an overall quantitative rating. These scores were then used as representative scores for that vegetation unit. Table 16 defines the levels of foraging habitat quality used during the assessment.

Table 14 Black Cockatoo suitable foraging species (sources: DSEWPaC, 2012; Johnstone *et al*., 2013)

Carnaby's	FRTBC
Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. *Banksia* sp., *Hakea* sp. and *Grevillea* sp.) as well as eucalypt woodland and forest that is dominated by foraging species. Also will feed on Callistemon, seeds of introduced species such as *Pinus* species and *Erodium* species, wild radish, canola, almonds and pecan nuts and occasionally apples and persimmons.	The principal foods of the FRTBC are the seeds of Marri and Jarrah. Other less important foods include Blackbutt *E. patens, E. wandoo,* Sheoak *A. fraseriana,* Snottygobble *P. longifolia*, *Hakea* spp., also introduced species (including Cape Lilac *Melia azedarach,* Spotted Gum *C. maculata,* Lemon-scented Gum *C. citriodora,* Silver Princess *E. caesia,* Illyarrie *E. erythrocorys* and Kaffir Plum *Harpephyllum caffrum*) and in southern forests Albany Blackbutt *E. staeri* and Karri *E. diversicolor*. Rarely observed grubbing for insect larvae on *Allocasuarina* spp.
Any area within the range of Black Cockatoo species that contains known food or nesting plant species is considered to be potential habitat for the Black Cockatoo species.	

Table 15 Quality of foraging habitat scoring tool for the three Threatened Black Cockatoos

Score	Carnaby's	Forest Red-tailed
≥10 High	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing, and / or is Quality habitat described below with attributes contributing to meet a score of 10 or greater	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing, and / or is Quality habitat described below with attributes contributing to meet a score of 10 or greater
7 Quality	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. *Banksia* sp., *Hakea* sp. and *Grevillea* sp.) as well as eucalypt (not mallee) woodland and forest that is dominated by foraging species. Does not include orchards, canola, or areas under a RFA	Jarrah and Marri woodlands and forest, and edges of Karri forests, including Wandoo and Blackbutt, within the range of the subspecies. Does not include areas under a RFA
5 Valued	Pine plantation or introduced eucalypts	Introduced eucalypts as well as the introduced Cape lilac (*Melia acedarach*)

Score	Carnaby's	Forest Red-tailed
2 Moderate	Native shrubland, heathland and woodland that contains foraging species (that are not dominant)	Habitats not dominated by foraging species
1 Low	Individual foraging plants or small stand of foraging plants (≤2 ha)	Individual foraging plants or small stand of foraging plants (≤2 ha)
Additions: Context adjustor – attributes improving habitat quality		
+3	Is within the Swan Coastal Plain	Jarrah and/or Marri shows good recruitment (i.e. evidence of young trees)
+3	Contains trees known to be used for breeding	Contains trees known to be used for breeding
+2	Primarily comprises Marri	Primarily contains Marri and/or Jarrah
+2	Contains trees with potential to be used for breeding (DBH ≥500 mm or ≥300 mm for Salmon Gum and Wandoo	
+2	Is <6 km from a known large or key roosting site	
+1	Contains evidence of foraging by species	
+1	Is <12 km from known breeding location	
+1	Is <2 km from a watering point	
+1	Is used for roosting	
Subtractions: Context adjustor – attributes reducing habitat quality		
-3	Contain less than 25% Marri and proteaceous species	
-2	No other foraging habitat within 6 km	
-1	Is >6km from known roosting site	
-1	Does not contain evidence of foraging by species	
-1	Is >12 km from known breeding location	
-1	Is >2 km from watering point	
-1	Disease present (e.g. *Phytophthora cinnamomi* or Marri canker)	

Table 16 Black Cockatoo foraging assessment scoring

Score	Foraging Quality
1 - 3	Low
4 - 6	Valued
7 - 9	Quality
10	High

4.5 Survey Limitations

Factors that may have affected the completeness (and therefore the results) of the survey are addressed in Table 17. The EPA published these proposed limitations as a minimum requirement for level 2 flora and vegetation assessments (EPA, 2004a).

Table 17 Consideration of limitations that may affect the biological survey completeness

Limitation	Flora and Vegetation assessment	Fauna assessment
Competency/experience of consultant conducting survey	**Not a constraint.** The flora and vegetation assessment was led by Floora de Wit who has 8 years' experience addressing similar scopes on the Swan Coastal Plain.	**Not a constraint.** Jared Leigh is an Ecologist with over 14 years' experience in the environmental industry and has conducted fauna surveys and Black Cockatoo assessments in a range of bioregions within Western Australia.
Scope (i.e. what life forms were sampled)	**Not a constraint.** The level 2 flora and vegetation assessment included quadrat-based sampling in Spring, 2016 in accordance with Guidance Statement 51 (EPA, 2004a) and Flora Survey Technical Guide (EPA & DPaW, 2015).	**Not a constraint.** The Level 1 fauna survey assessed all fauna habitats within the Survey Area, documented secondary evidence (scats, diggings, burrows etc.) and fauna sightings, and included microhabitat searches at appropriate sites. Black Cockatoo foraging sites were undertaken simultaneously with the flor and vegetation quadrats.
Proportion of flora/fauna identified, recorded and/or collected (based on sampling, timing and intensity)	**Not a constraint.** To meet the objective of the project, the field sampling focussed on areas of 'Good' or better condition vegetation. Weeds and planted species were not opportunistically recorded. The weed species list is therefore not considered comprehensive. This is not considered to affect the outcome of the survey.	**Not a constraint.** Information gained for a Level 1 fauna survey was sufficient. Fauna were observed (through direct or indirect evidence) during daylight hours (0700 and 1800hrs).
Sources of information	**Not a constraint.** Sources of information included publicly available contextual information such as pre-European vegetation mapping and climate data. DPaW and WA Herbarium database results and historical surveys including the Environmental Review (Stragenen, 2012) and previous flora and vegetation assessment (Strategen, 2016) were utilised to inform the field survey and data analysis.	**Not a constraint.** The DPaW threatened fauna database, naturemap and Bamford (2012) fauna survey report were utilised to inform the field survey.
Completion (is further work needed)	The scope of the field surveys was adequate to meet the objective of the project. This included quadrat-based sampling, targeted flora surveys, and TEC assessments.	**Not a constraint.** The objectives of the Level 1 fauna survey and Black Cockatoo assessment were met and no further work is required.

Limitation	Flora and Vegetation assessment	Fauna assessment
Timing, weather, season, cycle	**Not a constraint.** Field surveys were undertaken in late November, 2016. Dry June and July months, and low rainfall in October and November may have affected the ability to record ephemeral and orchid species. Majority of orchids recorded were dying or already dead.	**Not a constraint.** The field survey was undertaken during Spring between 22-23 and 28-29 November, 2016. The weather was warm. No rainfall was received during the survey. Sufficient rainfall had been received in the preceding months of the survey.
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	**Minor constraint.** The survey area is within the metropolitan area of Perth and incorporates 112 private properties. Disturbances including infrastructure, clearing, firebreaks, regular removal of fuel load both manually and by burning were observed. Some patches of native vegetation of varying condition were cryptic to determine the original vegetation community they may have represented.	**Not a constraint.** Clearing for infrastructure, weed invasion and regular burning were observed however were not considered to impact the survey results.
Intensity (was the intensity adequate)	**Not a constraint.** Twelve quadrats and six relevés were completed. Vegetation communities were represented by three or more quadrats, with the exception of one isolated community which was represented by two quadrats. Species area curves compared to the Chao asymptote show that more than 70% of anticipated species richness has been captured within each vegetation community (Appendix B).	**Not a constraint.** The survey area was traversed on foot over four days. This time allowed for adequate targeted surveying for Quenda and Black Cockatoo habitat which formed the primary objective of the scope.
Completeness (was relevant area fully surveyed)	**Not a constraint.** The entire survey area was traversed on foot.	
Resources (degree of expertise available in plant/animal identification)	**Not a constraint.** The field surveys were undertaken by experienced Botanists. Plant taxonomy was undertaken by Floora de Wit at the WA Herbarium.	**Not a constraint.** The resources (time, equipment and expertise) were sufficient for a Level 1 fauna survey and the Black Cockatoo assessment.
Remoteness and/or access problems	**Minor constraint.** Access was not granted to 41 Brae Road. Native vegetation was confirmed as present. Extrapolation of mapping data was undertaken to determine vegetation communities and condition. *C. undulatum* could be present on the property.	**Not a constraint.** Black Cockatoo potential breeding trees were not mapped for 41 Brae Road as access was not granted.
Availability of contextual information on the region	All historical survey effort was provided priori to commencing the field surveys. This, along with publicly available information and desktop database results were adequate to provide contextual information.	

5.0 Desktop Assessment Results

5.1 Environmentally Sensitive Areas and Conservation Estates

5.1.1 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are areas that have been identified for protection due to their environmental significance as outlined in the Western Australian Environmental Protection (Environmentally Sensitive Areas) Notice 2005, which was gazetted on 8 April 2005.

Exceptions offered for clearing under Regulation 5 of the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 do not apply within ESAs. ESAs are gazetted due to supporting environmental values of State or Commonwealth importance and, in this situation, include:

- Declared World Heritage properties (EPBC Act)
- areas included on the Register of the National Estate
- defined wetlands and associated buffers
- vegetation within 50 m of rare flora
- TECs.

A total of two ESAs occur within the survey area. These are likely to be associated with the Bush Forever Sites in the local area, and Threatened Ecological Communities.

5.1.2 Bush Forever

No Bush Forever sites are located within the survey area. Two Bush Forever sites are located directly adjacent to the survey area, detailed in Table 18.

Table 18 Bush Forever sites of the survey area

Site number	Bush Forever Site
45	Poison Gully Woodland, High Wycombe
123	Sultana Road West Bushland, High Wycombe

5.1.3 Conservation Estates

There are no conservation estates within or directly adjacent to the survey area.

5.2 Wetlands

The locations of wetlands have been determined using the Geomorphic Wetlands of the Swan Coastal Plain dataset adapted from *Hill et al* (1996). The dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands of the Swan Coastal Plain.

One Resource Enhancement and one Multiple Use wetland occur within the survey area as outlined in Table 19.

Table 19 Wetlands of the survey area

Wetland	Management category	Geomorphic classification
11441	Resource Enhancement	Palusplain
4810	Multiple Use	Palusplain

5.3 Threatened and Priority Ecological Communities

The database searches identified two Threatened Ecological Communities (TECs) (Table 20). These communities directly overlap one another and both are encompassed in the recently listed Banksia Communities of the Swan Coastal Plain TEC, listed as Endangered under the EPBC Act. The description for the EPBC Act listed Banksia Communities of the SCP has been provided to encompass the TECs identified in the desktop assessment.

The Banksia Woodlands TEC, described by the Threatened Species Scientific Committee (TSSC, 2016) incorporates Woodland of *Banksia* species with scattered eucalypts and other tree species over a species rich mix of sclerophyllous shrubs, graminoids, and forbs. The community shows high endemism and considerable local variation in species composition across its range. It is restricted to the southwest of WA on the Swan Coastal Plain. It occurs mainly on deep Bassendean and Spearwood sands or occasionally on Quindalup sands.

Table 20 Threatened Ecological Communities identified in the desktop assessment

	State Listing	Commonwealth Listing
Banksia attenuata woodlands over species rich dense shrublands (FCT20a)	Endangered	Endangered
Banksia dominated woodlands of the Swan Coastal Plain	Priority 3	Endangered

5.4 Conservation Significant Flora

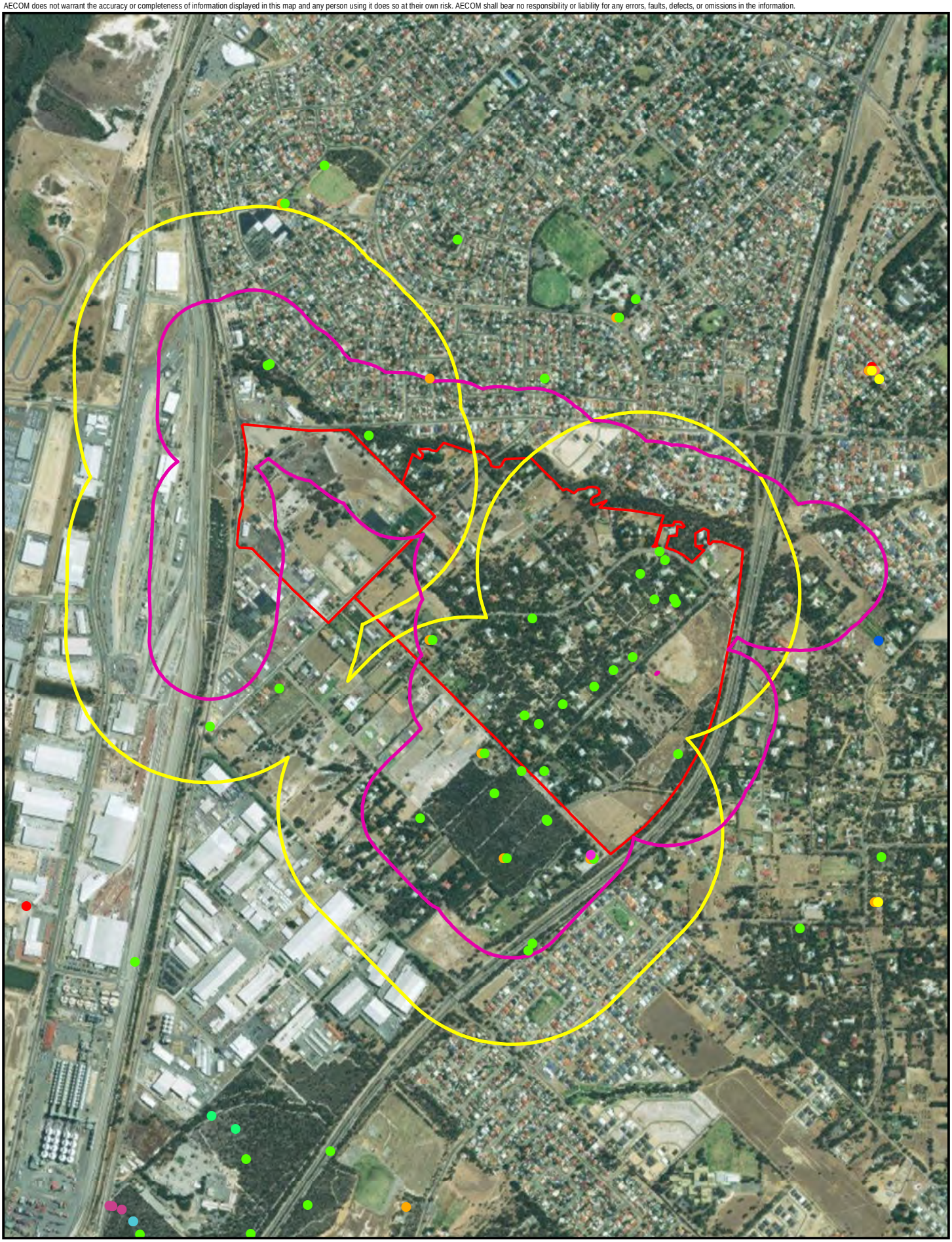
A total of 57 Threatened and Priority flora species were identified from the database search as potentially occurring within the survey area. Of these species, 22 are listed as Threatened under the WC Act and also under the EPBC Act. The remaining 35 species are listed as Priority Flora. The spatial location of desktop assessment results are shown in Figure 3

Based on desktop assessment of specimen records and preferred habitat, it has been determined that six flora species of conservation significance are likely to occur in the survey area and four flora species of conservation significance may occur in the survey area (Table 21). One species, *Conospermum undulatum* is known to occur, identified by DPaW as population 4. The remaining 46 flora species are considered unlikely to occur in the survey area. Many of these are associated with the Darling Scarp just east of the survey area, and are therefore considered unlikely to occur. The complete desktop assessment results are provided in Appendix A.

Table 21 Desktop results for Threatened and Priority Flora identified from DPaW database searches, the EPBC Protected Matters Report and previous reports

Species	Conservation Code	Habitat[1]	Likelihood of Occurrence in Survey area
Caladenia huegelii	EPBC Act: E WC Act: CR	Found between Perth and Capel growing in deep sandy soil in *Banksia-Eucalyptus marginata* woodland.	**May occur**. Habitat present, no known records in the vicinity.
Conospermum undulatum	EPBC Act: V WC Act: VU	Grey or yellow-orange clayey sand.	**Known to occur**. Database records within survey area.
Drakaea elastica	EPBC Act: E WC Act: CR	Found on coastal plain between Ruabon and Cataby growing in sandy soil in *Banksia* woodlands and tall shrubs (Brown *et al.,* 2013).	**May occur**. Suitable habitat present but no known records in vicinity.
Haemodorum loratum	DPaW: P3	Grey or yellow sand and gravel. Record from 1995.	**Likely to occur**. Suitable habitat and record in close proximity to survey area.
Isopogon drummondii	DPaW: P3	No information available on WAH (1998-). Database results describe flats on grey brown sand with or without gravel in Banksia woodlands.	**Likely to occur**. Numerous records in vicinity of survey area.
Jacksonia sericea	DPaW: P4	Calcareous and sandy soils. Record from 1962.	**May occur**. Suitable habitat may present, old record in vicinity.
Macarthuria keigheryi	EPBC Act: E WC Act: EN	White or grey sand. Records from north of Perth to Dandaragan.	**Likely to occur**. Suitable habitat present, numerous records in close proximity.
Melaleuca viminalis	DPaW: P2	No information available on WAH (1998-). Recorded in 2005 on brown sandy clay over clay.	**May occur**. Suitable habitat may be present, one record in the vicinity of the survey area.
Platysace ramosissima	DPaW: P3	Sandy soils.	**Likely to occur**. Suitable habitat present and three records in vicinity.
Schoenus griffinianus	DPaW: P4	White sand. One record from 2006.	**Likely to occur**. Suitable habitat present, one record in vicinity.
Verticordia lindleyi subsp. *lindleyi*	DPaW: P4	Grows in white to grey and yellow sand, often with or over clay and gravel, usually low-lying and winter-wet (George, 2002). Frequently in association with a few other verticordias in heath, shrubland and open woodland (George, 2002).	**Likely to occur**. Suitable habitat present, several records in close proximity.

1. Sourced from Florabase (WAH, 1998-) and DotEE (2016) unless otherwise referenced



PROJECT ID	60507828
CREATED BY	RNM
APPROVED BY	FdeWit
LAST MODIFIED	20 JAN 2017

AECOM
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DATUM GDA 1994, PERTH COASTAL GRID94

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Meters

LEGEND

Survey Area

TEC-PEC

Banksia Dominated Woodlands of the SCP (P3)

Banksia attenuata woodlands over species rich dense shrublands (EN)

Both listed under EPBC Act as endangered

- *Banksia pteridifolia subsp. vernalis*
- *Conospermum undulatum*
- *Haemodorum loratum*
- *Isopogon drummondii*
- Macarthuria keigheryi
- *Ornduffia submersa*
- *Platysace ramosissima*
- Schoenus pennisetis
- *Thelymitra magnifica*
- *Thelymitra stellata*
- *Verticordia lindleyi subsp. lindleyi*

Desktop results for Communities and Flora species

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure 3

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig3_DesktopResultsFlora_v1_A4.mxd (fotheringhamd)

A4 size

5.5 Conservation Significant Fauna and Fauna Habitat

5.5.1 Fauna species

Eight Threatened, Priority and Migratory fauna species were identified from the database searches. This includes six birds and two mammals. Of these, three species are known to occur, two species may occur and three species are considered unlikely to occur. Database search results and the analysis of these are provided in Table 22.

Table 22 Records of Threatened and Priority Fauna from the vicinity of the survey area from DPaW database results, information obtained from DotEE (2017)

Species	Conservation Status	Habitat	Latest Observation Date	Likelihood of Occurrence
Ardea modesta Great Egret	EPBC Act: Mig & M WC Act: VU	The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2003). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2007).	27/11/2001	**Unlikely to occur.** No suitable habitat present in the survey area.
Calyptorhynchus banksii subsp. *naso* Forest red-tailed black cockatoo	EPBC Act: V WC Act: VU	The Forest red-tailed black cockatoo requires tree hollows of Karri (*E. diversicolor*), Jarrah (*E. marginata*) and Marri (*Corymbia calophylla*) forests to nest and breed. Flocks move out onto the Swan Coastal Plain in search of food from exotic trees such as the White Cedar (Johnstone et al, 2010). The foraging habitat for the species consists of Jarrah and Marri woodlands and forest within its range. Black Cockatoo observational data shows five records of 120 individuals recorded within and in vicinity of survey area.	03/04/2016	**Known to occur**. Suitable habitat present. Known roosting site on Lot 47 Brae Road.
Calyptorhynchus baudinii Baudin's Black-Cockatoo	EPBC Act: V WC Act: EN	The Baudin's Black Cockatoo's habitat is critical to its survival; including forests of Karri (*E. diversicolor*), Jarrah (E. *marginata*) and Marri (*C. calophylla*), in areas of 600 mm average rainfall per year. Individuals typically move north through the Perth region from March to May and south through the Perth region from August to October. The species ranges from Gidgegannup and Hoddy Well in the north and west to the Eastern Strip of the Swan Coastal Plain. It includes West Midland in the north, heading south through Armadale, Byford and south and towards the coast until Lake Clifton where it continues to hug the coastline to east of Albany (Johnstone *et al,* 2010). Black Cockatoo observational data shows no records of this species from the vicinity of the survey area.	04/04/2014	**Unlikely to occur**. Less favoured habitat present, no known records in vicinity of survey area.

Species	Conservation Status	Habitat	Latest Observation Date	Likelihood of Occurrence
Calyptorhynchus latirostris Carnaby's Black-Cockatoo	EPBC Act: E WC Act: EN	Carnaby's Cockatoo is a postnuptial nomad and typically moves west soon after breeding. The species nests in hollows of smooth-barked eucalypts, particularly Salmon Gum (*Eucalyptus salmonophloia)* and Wandoo (*E. Wandoo)* but is not limited to these eucalypts. Diet consists of an array of Proteaceous and Eucalypt species prevalent on the Swan Coastal Plain. Foraging habitat, including *banksia* woodlands, is considered to be habitat critical to the survival of the species (Johnstone *et al.,* 2010). Cockatoo observational data shows 159 records of 509 individuals recorded in vicinity of survey area.	04/04/2014	**Known to occur**. Suitable habitat present and known records from within survey area.
Dasyurus geoffroii Western Quoll, Chuditch	EPBC Act: V WC Act: CR	Following European settlement the range of this species contracted dramatically, from much of the continent to a small area in the south west. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (Van Dyck & Strahan, 2008). The majority of records are found in the contiguous Jarrah forests of the south west of Western Australia (DotEE, 2017). Recent records exist within the Gnangara pine forest and Walyunga National Park.	20/11/2013	**May occur**. Less favoured habitat present (i.e. not continuous Jarrah Forest, but disjointed native vegetation). Records from northeast of
Isoodon obesulus subsp. *fusciventer* Quenda	DPaW: P4	The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).	29/11/2015	**Known to occur**. Suitable habitat present and four records from within survey area.
Merops ornatus Rainbow Bee-eater	EPBC Act: M	The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. It is possible that this species will occupy open woodland areas within the survey area. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2003).	14/11/2014	**May occur**. No suitable habitat present however recent record suggest species may occur.

Species	Conservation Status	Habitat	Latest Observation Date	Likelihood of Occurrence
Pandion haliaetus Osprey	EPBC Act: Mig & M	The breeding range of the Eastern Osprey includes the northern coast of Australia from Albany in WA to Lake Macquirie in NSW. This bird is moderately common in Australia, mostly in northern Australia. Eastern Osprey occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. Found mostly in coastal areas but can travel inland along major rivers. Areas of open fresh, brackish or saline water for foraging is essential for their habitat, visiting various wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps and broad rivers, reservoirs and large lakes. They can also occur over atypical habitats such as heath, woodland or forest when travelling between foraging sites.	24/11/1995	**Unlikely to occur**. No suitable habitat present in survey area. May fly over.

Conservation categories are outlined in Section 3.0 Legislative Framework.

6.0 Field Survey Results and Discussion

6.1 Vegetation

6.1.1 Threatened and Priority Ecological Communities

Banksia Woodlands of the Swan Coastal Plain – EPBC Act-listed as Endangered

The presence of the EPBC Act-listed Banksia Woodlands of the Swan Coastal Plain has been confirmed as occurring within the survey area. The native vegetation within the survey area was grouped into patches. A patch was considered an area of continuous vegetation.

The survey area was divided into five patches. Of these, patches 1 – 4 met all key diagnostic features as published in the conservation advice for the TEC (TSSC, 2016). The vegetation within these patches was often co-dominated by a mix of *Banksia attenuata, Banksia menziesii, Allocasuarina fraseriana* and *Eucalyptus marginata* subsp. *marginata*. The vegetation varied from 'Good' to 'Excellent' condition. Many of these patches also support populations of the Threatened flora species, *Conospermum undulatum*.

The total area of native vegetation representing this TEC is 14.22 ha.

A detailed assessment of each of these patches is provided in Appendix C.

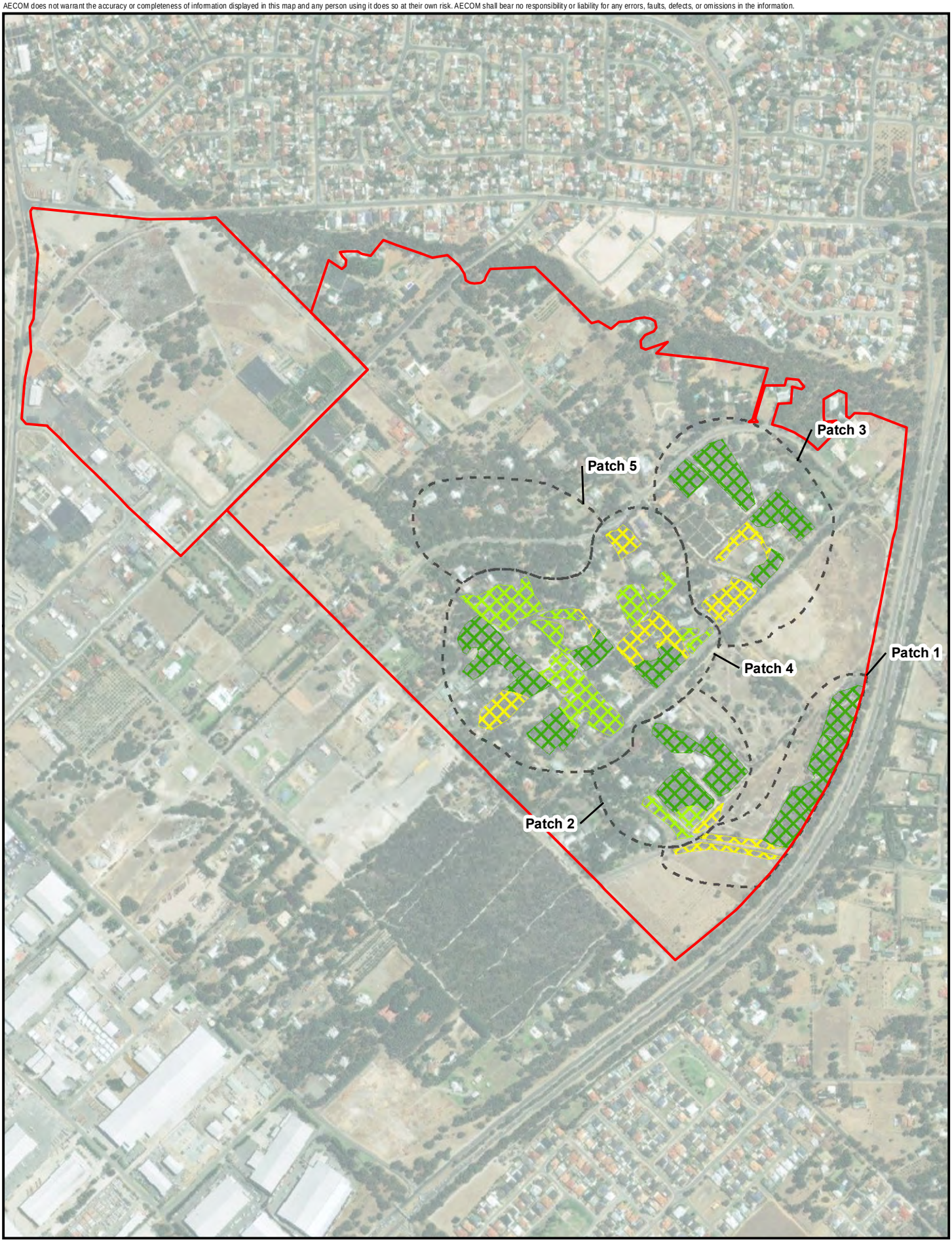
***Banksia attenuata* woodlands over species rich dense shrublands – State-listed as Endangered**

It is likely that all patches in 'Good' or better condition represent the State-listed TEC "*Banksia attenuata* woodlands over species rich dense shrublands (FCT20a)". Gibson *et al.* (1994) describes FCT20a as being recorded on sandy soils at the base of the Scarp at Forrestfield covering the Southern River land system. The survey area lies on the Southern River land system, near Forrestfield at the base of the scarp. Furthermore, species richness was high for all vegetation quadrats completed in areas of 'Very Good' to 'Excellent' condition, exceeding 40 species within a 10x10 m quadrat.

Detailed FCT analysis was undertaken by Plantecology for Strategen (2016). These results showed one area (15 Milner Road) showed similarity to Gibson *et al.* (1994) FCT20. A number of limitations were recognised in undertaking data analysis for inferring FCTs. Results are often cryptic and require a variety of analysis methods in order to accurately infer the FCT. Lacking this detailed analysis, and given the description of the State-listed TEC, it is assumed that all vegetation mapped as the EPBC Act-listed community also represents the State-listed TEC.

Banksia woodlands of the Swan Coastal Plain – Priority 3

This community has no additional description other than it is not encompassed in FCT20a. It could be assumed that all vegetation considered the Banksia Woodlands EPBC Act-listed TEC also represents this Priority 3 PEC.



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LEGEND

Survey Area

Banksia Woodlands of the Swan Coastal Plain

Excellent Condition

Very Good Condition

Good Condition

Threatened Ecological Communities

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

4

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig4_ThreatenedCommunities_v4_A4.mxd (fotheringhamd)

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6.1.2 Vegetation Communities

Five vegetation communities were described and mapped over 22.80 ha of native vegetation within the survey area. This encompassed:

- three woodlands
- one heath
- one riparian vegetation community.

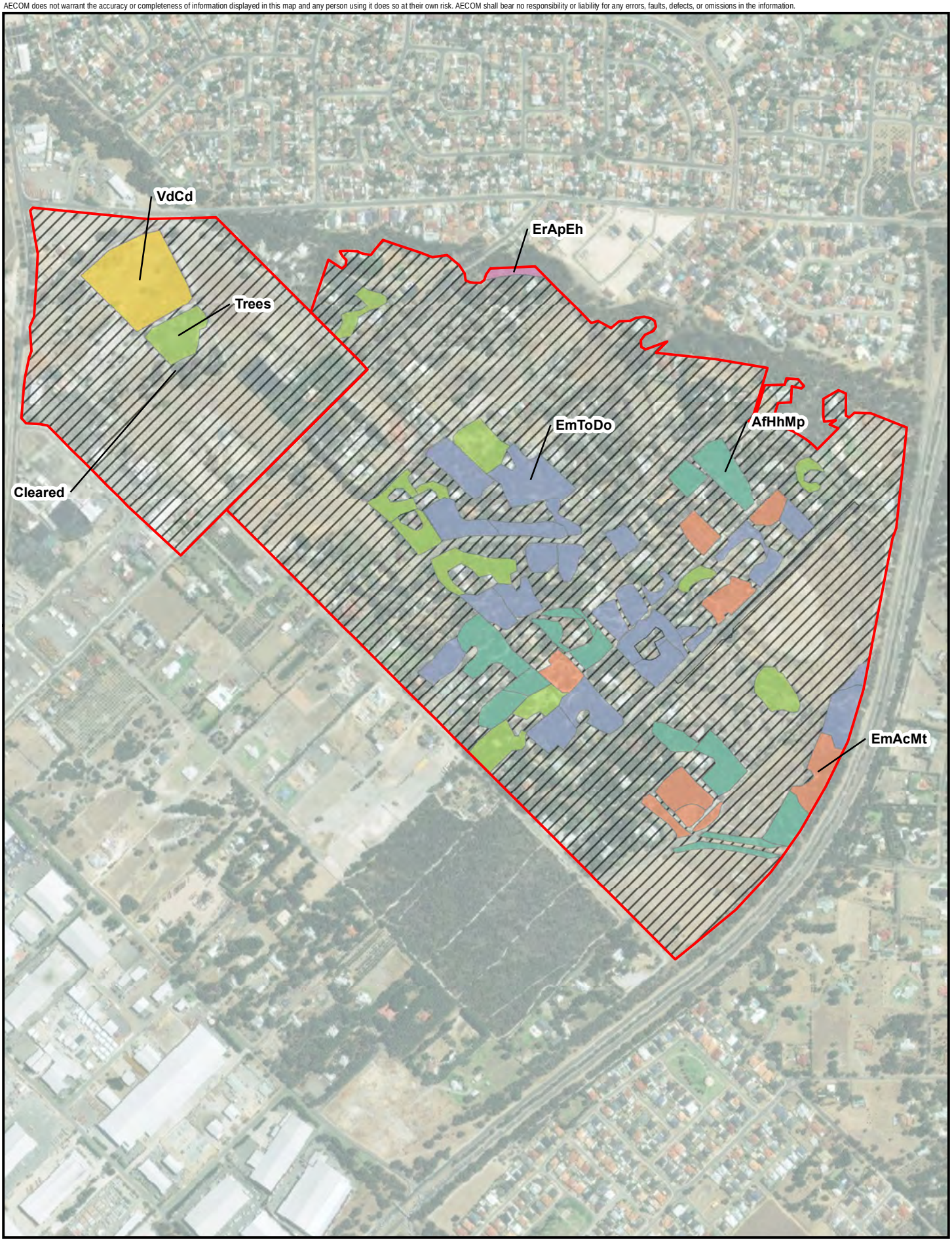
Details of vegetation communities, survey effort, extent, and photograph are presented in Table 23. Vegetation mapping is provided in Figure 5.

Table 23 Vegetation communities recorded in the Survey area including code and description using the NVIS system, size of community, representative photograph and survey effort

Community Description	Additional Details	Photograph
AfHhMp *Allocasuarina fraseriana*, *Banksia attenuata, Banksia menziesii* and occasional *Nuytsia floribunda* low woodland over *Xanthorrhoea preissii, Lambertia multiflora, Adenanthos cygnorum* subsp. *cygnorum* and *Xanthorrhoea acanthostachya* mid sparse shrubland over *Hibbertia hypericoides, Banksia dallanneyi* var. *dallanneyi, Bossiaea eriocarpa, Calothamnus torulosus* and *Petrophile macrostachya* low sparse shrubland with *Mesomelaena pseudostygia, Schoenus brevisetis, Lepidosperma leptostachyum*, *Caustis dioica* and *Tricostularia exsul* tall open sedgeland with *Dasypogon obliquifolius*, *Scaevola repens* var. *repens*, *Haemodorum laxum*, *Gladiolus caryophyllaceus**, *Burchardia congesta* and *Anigozanthos manglesii* low sparse forbland. Regionally significant: supports *C. undulatum* populations and listed under EPBC Act as Banksia Woodlands of Swan Coastal Plain TEC. The community condition ranged from 'Good' to 'Excellent'.	Survey effort: four quadrats (1, 4, 6, 9) Species richness: 92 native and seven weed species. Area: 5.5 ha	
EmAcMt *Eucalyptus marginata* and *Banksia menziesii* low open woodland over *Adenanthos cygnorum* subsp. *cygnorum*, *Lambertia multiflora* and *Xanthorrhoea acanthostachya* mid open shrubland over *Melaleuca trichophylla*, *Hibbertia hypericoides, Eremaea pauciflora* var. *pauciflora, Allocasuarina humilis* and *Stirlingia latifolia* low shrubland with *Mesomelaena pseudostygia*, *Cyathochaeta avenacea, Tricostularia exsul* and *Lepidosperma leptostachyum* mid to low sedgeland over *Tricoryne elatior, Dasypogon obliquifolius, Lyginia barbata, Scaevola repens* var. *repens, Haemodorum laxum* and *Lomandra sericea* low sparse forbland. One isolated area (Lot 59 Brae Road) lacked any overstorey species. The understorey layers were however composed of similar species. No quadrats were completed on this block due to the small size and isolated occurrence of the community. Regionally significant: supports *C. undulatum* populations and listed under EPBC Act as Banksia Woodlands of Swan Coastal Plain TEC. The community condition ranged from 'Good' to 'Excellent'.	Survey effort: three quadrats (2, 5, 10) one relevè (14). Species richness: 79 native and four weed species, Area: 3.51 ha	

Community Description	Additional Details	Photograph
EmToDo *Eucalyptus marginata* and *Allocasuarina fraseriana* mid woodland over Banksia *attenuata, Banksia menziesii* and *Persoonia elliptica* low woodland over *Lambertia multiflora* and *Xanthorrhoea preissii* mid open shrubland over *Banksia dallanneyi* var. *dallanneyi, Hibbertia hypericoides, Bossiaea eriocarpa*, *Stirlingia latifolia*, and *Gastrolobium capitatum* low shrubland with *Tetraria octandra, Mesomelaena pseudostygia, Mesomelaena tetragona* and *Lepidosperma leptostachyum* low sedgeland over *Dasypogon obliquifolius*, *Patersonia occidentalis, Dampiera linearis, Haemodorum laxum, Scaevola repens* var. *repens* and *Lomandra preissii* low sparse forbland. Regionally significant: supports *C. undulatum* populations and listed under EPBC Act as Banksia Woodlands of Swan Coastal Plain TEC. The community condition ranged from 'Degraded to 'Excellent'.	Survey effort: five quadrats (3, 11, 13, 16, 17) three relevès (12, 15 and 18). Species richness: 87 native and eight weed species. Area: 10.32 ha	
ErApEh *Corymbia calophylla* and *Eucalyptus rudis* tall woodland over *Trymalium odoratissimum* thicket over *Acacia pulchella*, *Hibbertia hypericoides* and *Xanthorrhoea preissii* mid sparse shrubland over **Ehrharta calycina, *Cynodon dactylon, *Gladiolus caryophyllaceus* and *Tetraria octandra* grassland/herbland on clay soils within Poison Gully. This community was mapped by Strategen (2015), no additional effort was spent on this community. The community condition was mapped as 'Very Good'.	Area: 0.18 ha	No photograph taken.

Community Description	Additional Details	Photograph
VdCd *Eucalyptus marginata* subsp. *marginata* mid isolated trees over *Verticordia densiflora* var. *densiflora, Daviesia angulata, Hypocalymma angustifolium, Stirlingia latifolium* and *Banksia bipinnatifida* subsp. *bipinnatifida* low open shrubland with *Caustis dioica, Mesomelaena tetragona, Tetraria octandra* and *Schoenus brevisetis* tall open sedgeland over *Patersonia occidentalis, Lyginia barbata, Haemodorum spicatum*, *Tricoryne elatior* and *Anigozanthos manglesii* low open forbland. The community condition was mapped as 'Excellent'.	Survey effort: two quadrats (7, 8) Species richness: 45 native and five weed species. Area: 2.65 ha	
Trees Areas mapped as trees comprise of scattered to clumps of native trees (mostly *Eucalyptus marginata*) located in either cleared paddocks, roadsides, or over planted vegetation. This vegetation unit was mapped using field survey observations. No quadrats were completed to represent this vegetation community as it lacks all native species except trees. The condition is mapped as 'Completely Degraded'.	Area: 5.64 ha	



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LEGEND

Survey Area

Community

- Cleared
- AfHhMp
- EmAcMt
- EmToDo
- ErApEh
- Trees
- VdCd

Vegetation Mapping

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

5

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig5_VegetationMapping_v2_A4.mxd (fotheringhamd)

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6.1.3 Vegetation Condition

Vegetation condition within the Survey area varied from 'Excellent' to 'Completely Degraded'. The majority was mapped as 'Excellent', extending over 12.17 ha (comprising 43.76 % of the total vegetated area). Vegetation condition has been mapped in Figure 6.

A major cause of degradation includes weeds and clearing of native vegetation. Weed invasion is a result of edge effects, plant escapes and invasion from cleared paddocks. Weeds can modify ecosystem processes and function by changing community structure. This is evident in some areas where understorey native vegetation has been displaced by more competitive and hardy perennial grasses.

Illegal rubbish dumping was observed in the native vegetation patch alongside Roe Highway (Plate 1).Clearing by land owners is occurring as the land is further developed. Areas that historically show native vegetation are now occupied by infrastructure and tracks (including firebreaks).

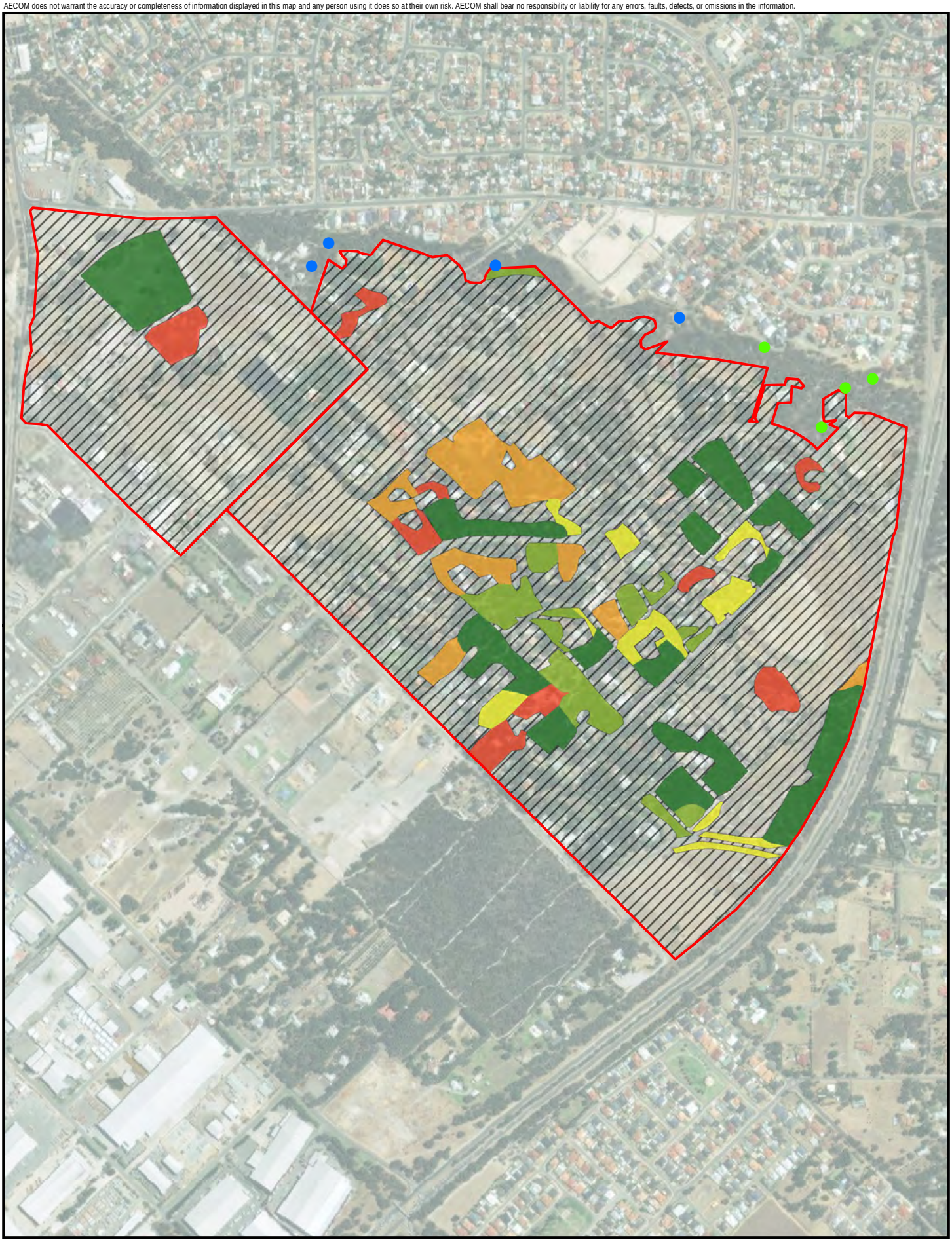
No evidence of dieback was observed during the field survey. This is a preliminary observation based on the presence and health of *Xanthorrhoea, Banksia* and *Eucalyptus* species.

Cleared area was mapped for 116.20 ha of the survey area. This was not included in the percentage calculations in Table 24.

Table 24 Vegetation Condition mapped within the Survey area

Condition Rating	Area (ha)	Percentage of Survey area (%)
Excellent	12.17	43.76
Very Good	4.00	14.40
Good	2.87	10.32
Degraded	5.04	18.11
Completely Degraded	3.73	13.40
Total	27.80	100

Plate 1 Examples of declining condition



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LEGEND

Survey Area

Declared Pests

- Asparagus asparagoides
- Zantedeschia aethiopica

Vegetation Condition

- Cleared
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

Condition Mapping

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

6

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig6_ConditionMapping_v1_A4.mxd (fotheringhamd)

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6.2 Flora

6.2.1 Threatened and Priority Flora

One species listed as Threatened under the EPBC Act and WC Act was recorded extensively within the survey area. *Conospermum undulatum* is listed as Vulnerable under the EPBC Act and WC Act, and was known to occur within the survey area.

A recovery plan is available for this species (DEC, 2008), from where the following information was sourced. *C. undulatum* is an erect shrub up to 1.5 m tall (Plate 2). The leaves have three distinct, parallel veins and characteristic wavy margins. The woolly flowers have white hairs and are held well above the leaves. The species occurs on sand and sandy clay soils often over laterite on flat or gently sloping sites between the Swan and Canning Rivers.

One disjointed population was recorded in the survey area. It is considered one population as all individuals are within 100 metres of other individuals and are not considered to be significantly geographically isolated from one another. It is therefore likely that all individuals are breeding and cross-pollinating in the area. A total of 525 individuals were recorded (Table 25), as mapped in Figure 7.

C. undulatum has been historically recorded within the survey area by Shire of Kalamunda (2012) and reported by Strategen (2012). It is known to DPaW as population 4.

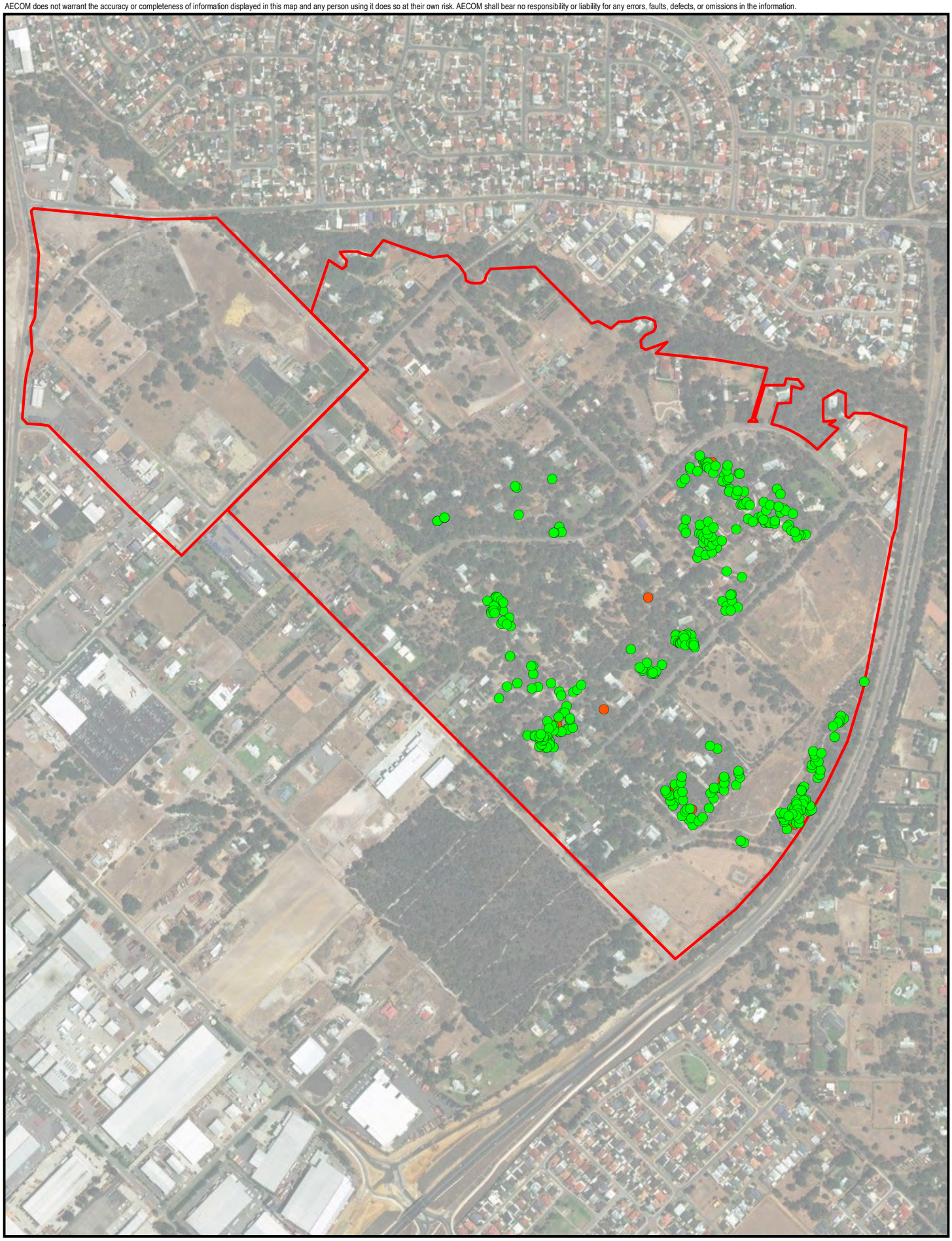
Plate 2 ***Conospermum undulatum*** **leaves, flowers and habitat which can vary from Excellent to Good condition**

Table 25 ***C. undulatum*** **population information within and in vicinity of survey area**

Parameter	AECOM		DPaW	
	Populations	Individuals	Populations	Individuals
Within survey area	1	525		
In vicinity of survey area (local context)	NA	NA		
Total in State (regional context)	NA	NA	25	11,453

One Priority 3 species, *Isopogon drummondii*, was recorded in the survey area. At the time of the field survey, this species was not known to be a Priority therefore individual counts were not obtained. The specimen was submitted to DPaW for identification in December 2016.

This species was recorded in nine quadrats (Figure 7). It varied in cover from 0.2% to 3%. There are 19 WA Herbarium records of this species in the local region. It has been recorded in Bush Forever site 123 located directly adjacent to the survey area. It is likely that this Priority 3 species is locally common in patches of native vegetation in the local area.



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Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND

- ***Conospermum undulatum*** (T)
- ***Isopogon drummondii*** (P3)
- Survey Area

Threatened and Priority Flora

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure 7

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig7_Conosperumumundulatum_v1_A4.mxd (rob.mcgregor)

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6.2.2 Inventory of Flora Species

A total of 142 species from 96 genera and 33 families were recorded within the survey area during the field assessment. The total includes 131 (93%) locally native species.

Families with the highest representation are Proteaceae (24 native taxa), Fabaceae (14 native taxa) and Myrtaceae (11 native taxa).

The full list of vascular flora species recorded and representative communities in which they occur in are presented in Appendix D. Qualitative data recorded from individual quadrats is presented in Appendix E.

6.2.3 Weed Species

In total, nine introduced species were recorded from the survey area and two planted species. It should be noted that quadrats were specifically placed within vegetation in good condition. For this reason weed species count was low. However, there are likely to be more weeds present in the survey area.

Strategen recorded two Declared Pests are listed under the *Biosecurity and Agricultural Management Act 2007* (BAM Act). Pursuant to the BAM Act, these species are subject to restrictions on movement or sale and landholders are obliged to carry out control measures to prevent their spread. These listed species include *Asparagus asparagoides* (Bridal Creeper), and *Zantedeschia aethiopica*. Locations of these are shown on Figure 6.

6.3 Fauna and Fauna Habitat

6.3.1 Threatened, Migratory and Priority Fauna Species

Four species of conservation significance were recorded in the survey area including three birds and one mammal. These include:

- Carnaby's Black Cockatoo listed as Endangered under the EPBC Act and the WC Act
- Forest Red-tailed Black Cockatoo listed as Vulnerable under the EPBC Act and the WC Act
- Rainbow Bee-eater listed as Marine under the EPBC Act
- Quenda listed as Priority 4 by DPaW.

The Rainbow Bee-eater was seen and heard at one location in the survey area. This species is listed as Marine and as such, is not considered protected unless it is in Commonwealth land. All other conservation significant species are discussed below.

6.3.1.1 Carnaby's Cockatoo

Carnaby's Black Cockatoo is endemic to the southwest of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin (DotEE, 2017). This black cockatoo has a white patch on its cheek, white bands on its tail, and a strong curved bill.

Carnaby's Black Cockatoo feed on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include the various proteaceous species (e.g. *Banksia, Grevillea* and *Hakea*), *Corymbia calophylla* (Marri*), Eucalyptus* (e.g. Jarrah [*Eucalyptus marginata*]), and seeds from the cones of Pine trees (*Pinus* sp.).

Carnaby's Black Cockatoo display strong pair bonds and nest in the hollows of live or dead mature eucalypts including Salmon Gum (*Eucalyptus salmonophloia*), York Gum (*Eucalyptus loxophleba* subsp. *loxophleba*), Flooded Gum (*Eucalyptus rudis*), Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala* [DSEWPaC, 2012]). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone & Storr,1998). The species appears to be expanding its current breeding range westward and south into the Jarrah-Marri forests of the Darling Range and into the Tuart forests of the SCP (Johnstone & Kirkby, 2006). After breeding, Carnaby's Black Cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July (DPaW, 2013). Breeding has been recorded from early July to mid-December.

Carnaby's Black Cockatoo has undergone a dramatic decline of approximately 50 percent in the past 45 years, with the main contributing factors the clearing of core breeding habitat in the Wheatbelt, the deterioration of nesting hollows, and clearing of foraging habitat.

Evidence of the Carnaby, potential breeding trees, and foraging habitat quality is discussed in Section 6.4.

6.3.1.2 Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo (Forest Red-tail) is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests which receive more than 600 mm average annual rainfall (DSEWPaC, 2012). The species has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) seeds, but also feeding in Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri (*Eucalyptus diversicolor*), Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*) (Johnstone, 2016 pers. comm.). Forest Red-tailed Black Cockatoo are monogamous and pairs nest in tree hollows from 6.5–33 m above ground. Most nests are in very large and very old, mature Marri (*Corymbia calophylla*) Johnstone *et al.*, 2013), though they will nest in other eucalypts such as Tuart (Johnstone, 2016 pers. comm.).

The modelled distribution of Forest Red-Tailed black Cockatoos in the *Referral Guidelines for three threatened black cockatoo species* (DSEWPaC, 2012) ranges from Perth to Albany encompassing the south west of the state. Formerly common, but now rare to uncommon and patchily distributed, the Forest Red-tailed Black Cockatoo has disappeared from about 30% of its former range. It has suffered a marked decline in numbers over the past 60 years because of the destruction and fragmentation of habitat (especially Jarrah-Marri forest), the apparent decline in Marri along the eastern side of the Darling Scarp (possibly due to climate change), logging, the impact of competitors for nest hollows, and fire (Chapman, 2008).

According to Johnstone *et al.* (2013) the foraging ecology of the Forest Red-tail is changing as their range is expanding. New foraging species, including introduced species, are being added to their diet. Lack of food and the discovery of new food sources is leading this change in foraging range. Sedentary flocks are now becoming regular visitors to the Swan coastal Plain, particularly for breeding. Principal foods are Marri and Jarrah with less important foods including Blackbutt, Sheoak, Hakea, introduced eucalypts and cape lilac.

Evidence of the Forest Red-tail, potential breeding trees, and foraging habitat quality is discussed in Section 6.4.

6.3.1.3 Quenda

The Quenda is considered likely to occur in the Survey Area. It is classified as a Priority 4 species. It is found in woodland, heath and shrub communities on the Swan Coastal Plain and prefers a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).

The Quenda is likely to utilise all native (and potentially non-native) vegetation within the survey area. Landowners at Lot 12 Brand Road confirmed numerous Quendas present during their time at the property (20 years).

A total of 22.97 ha of Quenda habitat was mapped in the survey area. Eleven Quenda observations were made during the field survey including diggings and scats shown in Plate 3 and Figure 8.

Plate 3 Quenda evidence a) digging b) digging and scat c) tunnel run

6.3.2 Inventory of Fauna Species

Twelve fauna species were recorded during the field survey. This included nine birds, one mammal and two reptiles (Table 26).

Table 26 Fauna Species recorded within the Survey area

Species	Common Name	Observation Type
Birds		
Acanthorhynchus superciliosus	Western spinebill	Heard/seen
Anthus novaeseelandiae	Australasian pipit	Heard/seen
Anthochaera carunculata	Red Wattlebird	Heard/seen
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	Foraging evidence
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	Heard/seen
Conopophila whitei	Grey honeyeater	Heard/seen
Lichmera indistincta	Brown honeyeater	Heard/seen
Merops ornatus	Raibow Bee-eater	Heard/seen
Rhipidura leucophrys	Willie Wagtail	Heard/seen
Reptiles		
Cryptoblepharus plagiocephalus	Skink	Seen
Tiliqua rugosa rugosa	Southwestern Bobtail	Seen
Mammals		
Isoodon obesulus fusciventer	Quenda	Scats and diggings

6.3.3 Fauna Habitat

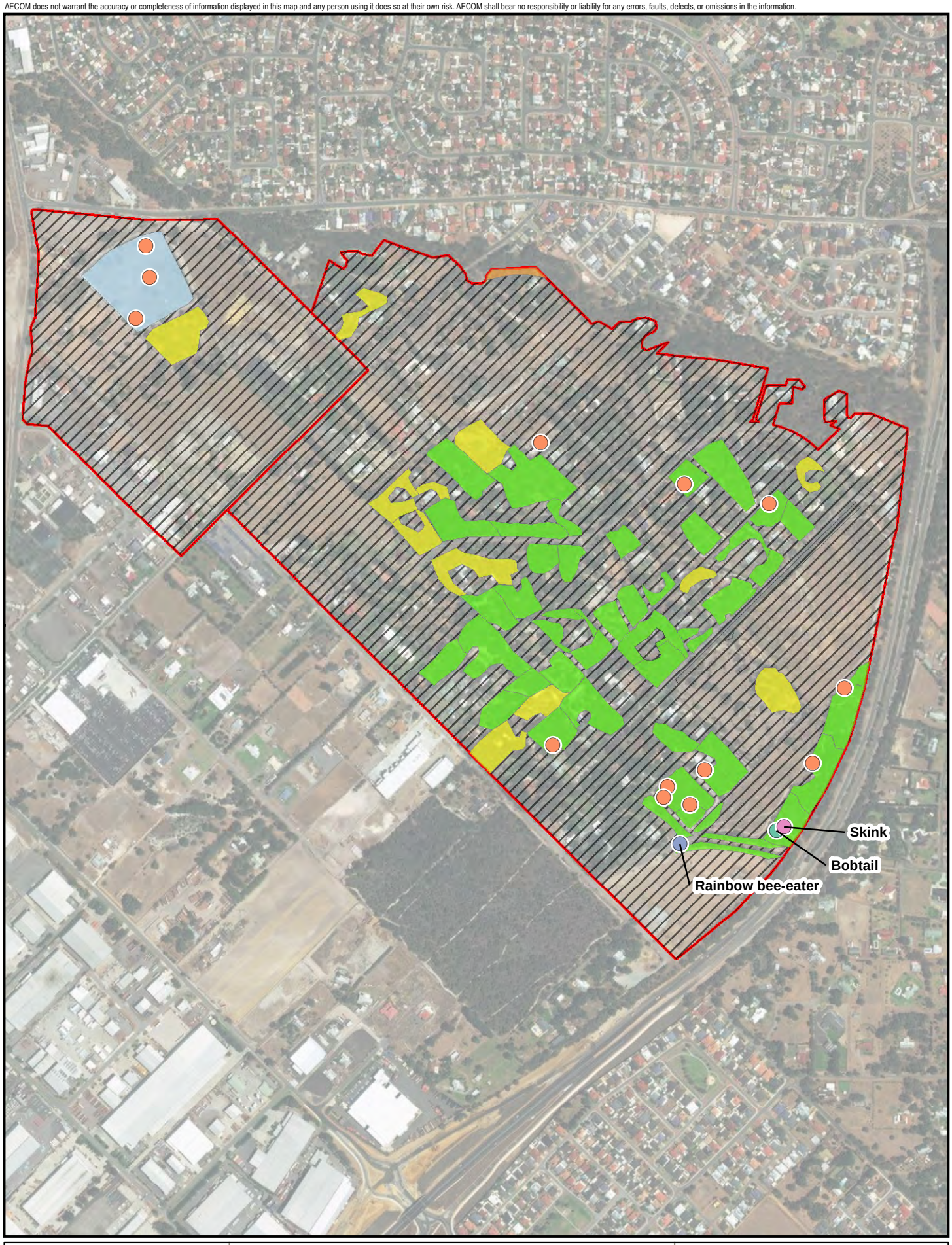
Four fauna habitats have been defined and mapped for the survey area based on the results of the field assessment (Figure 8). These habitats are described as follows:

- one woodland habitat
- one heath habitat
- one riparian habitat
- one mixed native and planted trees over gardens.

Table 27 Fauna habitats recorded within the survey area

Description	Photographs
Woodland The most common habitat (excluding cleared area). The woodland habitat is comprised of parcels of land (mostly private property) with an emergent tree stratum of Jarrah, over mixed Banksia and Sheoak low woodland over species rich shrublands including sclerophyllous shrubs, forbs, rushes and sedges. The habitat provides cover in both tree and understorey strata (depending on condition, as condition declines species diversity shifts to perennial grasses). Leaf litter is high and sandy soils provide ideal burrowing and digging substrate. This habitat coincides with vegetation communities AfHhMp, EmToDo, and EmAcMt. Detailed descriptions provided in Section 6.1.2 and Table 23. Area: 19.32 ha Significance: • Quenda habitat • Foraging and potential nesting for Forest Red-tail and Carnaby's Black Cockatoo	 
Heath Isolated to one area (Stage 2). This community is fairly open with isolated trees over approximately 60% heath cover. Areas of bare sand exposed to the sun (and potential predators). This habitat coincides with vegetation community VdCd. As evident in the photographs, bare ground and density of understorey varies across the patch of native vegetation. Area: 2.65 ha Significance: • Quenda habitat • foraging habitat for Forest Red-tail and Carnaby's Black Cockatoo.	 

Description	Photographs
Riparian Restricted to the edge of Poison Gully Creek located on Lot 15A Milner Road. This habitat is comprised of Flooded Gum over introduced species, predominantly grasses. This community is represented by ErApEh in the vegetation community descriptions. Area: 0.18 ha Significance: • Foraging and/or nesting and roosting potential for Forest Red-tail and Carnaby's Black Cockatoo species • Near important water source for all fauna species.	No photographs taken.
Native Trees Extensive in the survey area, native trees with planted vegetation was recorded on private properties including residents backyards, roadsides and paddocks. It includes native trees over grasses, native trees with planted trees, and native trees over planted understorey species. As evident from the photographs, the degree of degradation from clearing, weeds, and general maintenance of private properties varied. This community is represented as 'Trees' in the vegetation community mapping and description. Area: 5.64 ha Significance: • Foraging and potential breeding for Forest Red-tail and Carnaby's Black Cockatoo species.	 



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1:10,000 when printed at A4
DATUM GDA 1994, PERTH COASTAL GRID94
0 100 200 300 400
Meters

LEGEND

Survey Area

Fauna Habitat
- Cleared
- Heath
- Jarrah and planted
- Riparian woodland
- Woodland

Fauna Observations
- Bobtail
- Quenda
- Rainbow bee-eater
- Skink

Fauna Habitat

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

8

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig8_FaunaHabitat_v3_A4.mxd (rob.mcgregor)

A4 size

6.4 Black Cockatoos

6.4.1 Breeding

Within the Study area, 458 trees are considered to be potential Black Cockatoo breeding habitat trees, in accordance with the Commonwealth guidelines (DSEWPaC, 2012). This includes Bamford (2012) field survey results and the AECOM field results. Potential breeding trees recorded are shown in Figure 9.

Of the 458 trees, 42 trees had potential suitable breeding hollows. Suitable hollows were defined as those that have an entrance diameter greater than 10cm.

Forty two trees had potential hollows, with 38 hollows recorded that were deemed large enough and did not show signs of occupancy from other fauna species. These are considered potentially suitable for use by Carnaby's and Forest Red-Tailed Black Cockatoo (>10 cm). Further investigation regarding occupancy included recording signs of use by bees and/or galahs. Thirteen bee hives were recorded as occupying hollows. These hollows were excluded from being considered suitable.

6.4.2 Roosting

Black Cockatoo roosting habitat is generally found in or near riparian vegetation, close to fresh water and typically is comprised of the tallest trees in these areas (DSEWPaC, 2012a). A known roosting site is located in the survey area on Lot 47 Brae Road, as provided in DPaW Black Cockatoo observational data.

No additional roosting sites were confirmed during the field survey.

6.4.3 Foraging habitat

6.4.3.1 Carnaby's Black Cockatoo

All native vegetation, including trees with planted vegetation, was considered suitable foraging habitat for Carnaby's. An assessment of floristic data was undertaken to determine the total foliage cover of suitable foraging species present within each quadrat.

Communities AfHhMp, EmAcMt and EmToDo show anywhere between 10-57% foliage cover of suitable foraging species. The variety of cover is directly related to the condition of the vegetation. Degraded vegetation lacks the Proteaceous species in the understorey and has reduced Banksia cover. Suitable Carnaby's foraging species included 24 Proteaceous species and Jarrah trees.

Foraging quality of all native vegetation within the survey area was scored as 12 (rated as 'high') in accordance with the scoring tool (see Section 4.4.2). The area contains suitable foraging species, Jarrah woodlands, there is water available within 2 km, and it supports trees with potential to be used for breeding.

The vegetation comprised of native trees over planted vegetation or cleared paddocks was scored at 6 ('valued'). These areas are originally considered 'low quality' due to lack of suitable foraging plants present (mostly due to lack of complexity in vegetation structure). However additional scores were given for potential breeding tree presence, within 2km of water, and near a known roosting site.

No foraging evidence was recorded for Carnaby's.

In total, 19.32 ha is considered quality foraging habitat with a score of 12 (rated as High) and 8.29 ha was scored at 6 (rated as Valued). This is shown on Figure 10.

6.4.3.2 Forest Red-tailed Black Cockatoo

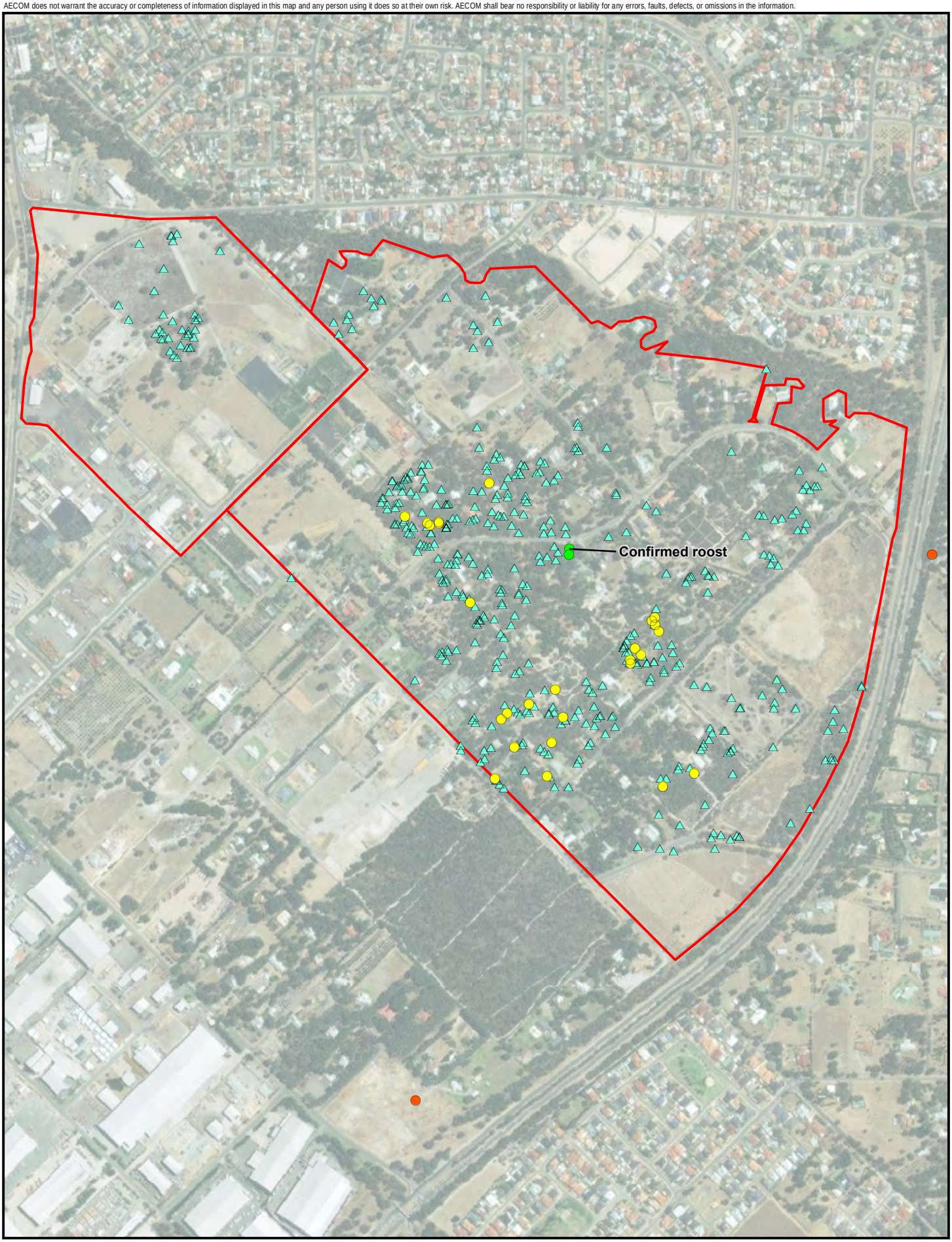
Similar to the Carnaby's foraging habitat assessment, all native vegetation within the survey area is considered suitable Forest Red-tail foraging habitat. Communities AfHhMp, EmAcMt, EmToDo and VdCd all support suitable foraging species. These are limited to three overstorey species including *Jarrah, Sheoak* and *Snottygobble.* The foliage cover of these species varies from 1.5-53%.

Forest Red-tailed foraging quality for the native vegetation was calculated as 13 ('high'). The survey area supports Eucalypt woodlands dominated by Jarrah, contains trees with potential to become breeding trees, supports a known large roost site (more than 10 birds), and is <2km from a watering point. This evaluation was supported by ten foraging evidence observations.

The trees with planted vegetation or in paddocks were scored at 7. These areas are considered low quality foraging habitat however the score was increased due to the additional context of being near known roosting site, water and other areas of quality foraging habitat.

In total, 19.32 ha is considered quality foraging habitat with a score of 13 (rated as High), and 8.29 ha was scored at 7 (rated as Quality). Foraging evidence records and foraging quality mapping is shown in Figure 10.

Plate 4 Foraging evidence



PROJECT ID 60507828
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LAST MODIFIED 20 JAN 2017

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1:10,000 when printed at A4
DATUM GDA 1994, PERTH COASTAL GRID94
0 100 200 300 400
Meters

LEGEND

- Survey Area
- *Calyptorhynchus banksii naso*
- *Calyptorhynchus latirostris*

Potential Black Cockatoo Breeding Trees

- Suitable Hollows
- No Suitable Hollows

Black Cockatoo Potential Breeding Trees

SHIRE OF KALAMUNDA

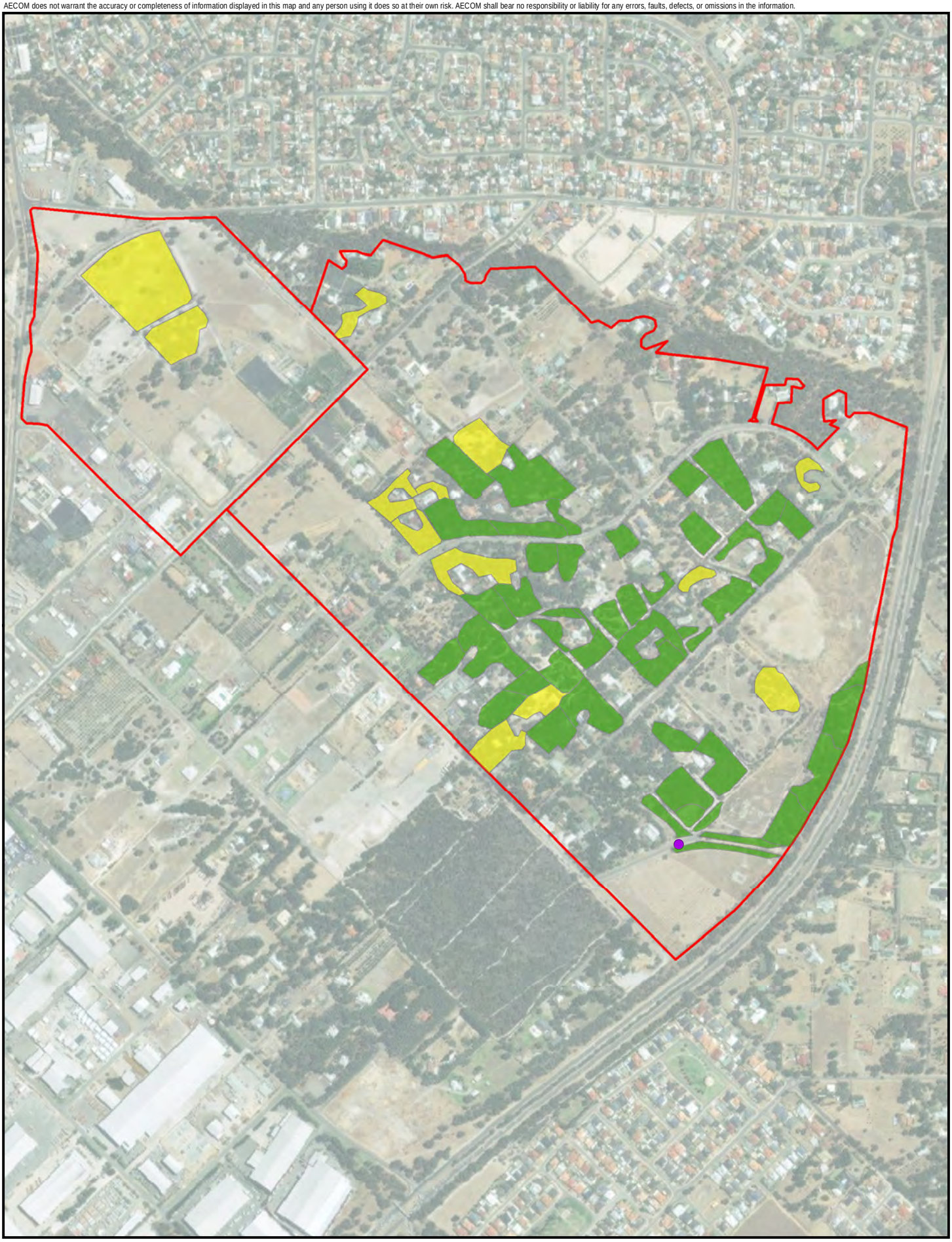
FORRESTFIELD NORTH

Figure

9

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig9_BlackCockatooBreedingTrees_v2_A4.mxd (fotheringhamd)

A4 size



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1:10,000 when printed at A4
DATUM GDA 1994, PERTH COASTAL GRID94
0 100 200 300 400
Meters

LEGEND

- Survey Area
- **ENV_FRTBCForaging**
- **Observations**
  - Seen and Heard, Carnaby
- High Quality Habitat
- Valued Quality Habitat

Carnaby's Foraging Habitat

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

10

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig10_BlackCockatooForaging_v2_A4.mxd (fotheringhamd)

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DATUM GDA 1994, PERTH COASTAL GRID94
0 100 200 300 400
Meters

LEGEND

Survey Area

ENV_FRTBCForaging

Observations

Foraging Evidence, Frtbc

Foraging Evidence, Frtbc Potentally

Forest Red-tail Foraging Habitat

High Quality Habitat

Quality Habitat

Forest Red-tail Foraging Habitat

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

11

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig11_ForestRedTailForaging_v1_A4.mxd (fotheringhamd)

A4 size

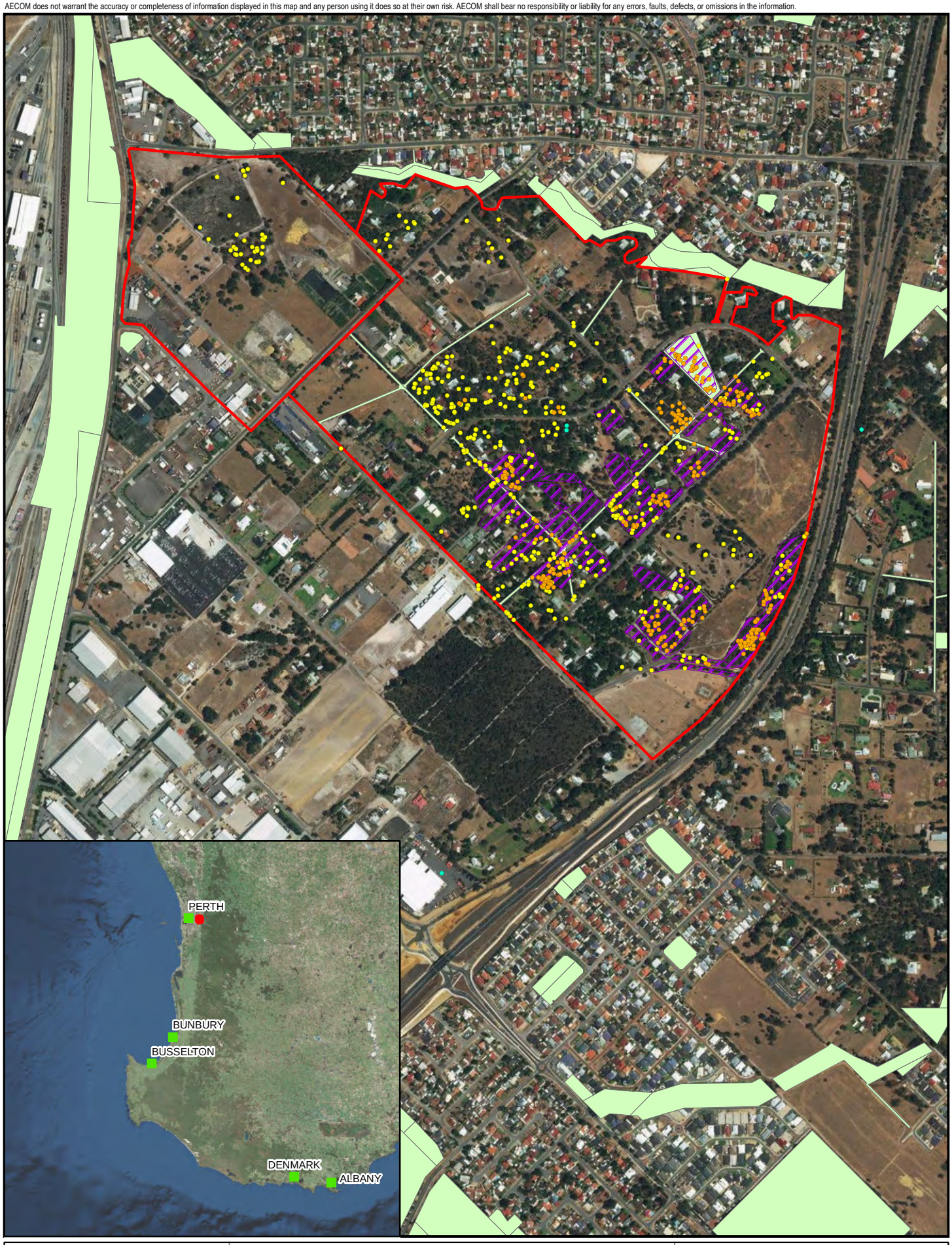
7.0 Conclusions and Recommendations

The significant ecological findings from the assessment of the survey area are:

- One TEC listed as Endangered under the EPBC Act occurs in the survey area. All native vegetation in 'Good' or better condition within the survey area has met the key diagnostic criteria for the Banksia Woodlands of the Swan Coastal Plain TEC. This TEC extends for 14.22 ha.
- The Banksia Woodlands of the SCP TEC relates to one State-listed TEC *Banksia attenuata* woodlands over species rich dense shrublands, and one DPaW-listed PEC Banksia Woodlands of the SCP. Lack of detailed descriptions for this TEC means it was difficult to accurately delineate these TECs, and therefore all native vegetation in 'Good' or better condition could be considered the State-listed TEC which represents the highest conservation category.
- Five vegetation communities were recorded and mapped. Four of these are considered regionally significant as they represent a federally listed TEC. Many also support populations of the Threatened *Conospermum undulatum.*
- One Threatened flora species, *Conospermum undulatum* (Wavy-leaved Smokebush) was recorded extensively throughout the survey area. This species is listed as Vulnerable under both the EPBC Act and WC Act. One population comprising 525 individuals were recorded within the survey area. Current information shows a total of 25 populations occur on the SCP, comprising approximately 11,453 individuals.
- Two Declared Pest species listed under the BAM Act were recorded, including *Zantedeschia aethiopica* (Arum Lily) and *Asparagus asparagoides* (Bridal Creeper).
- Four conservation significant fauna species were recorded during the survey including the Carnaby's Black Cockatoo listed as Endangered under the EPBC Act and the WC Act, Forest Red-tailed Black Cockatoo listed as Vulnerable under the EPBC Act and the WC Act, Rainbow Bee-eater listed as Marine under the EPBC Act and the Quenda listed as Priority 4 by DPaW.
- Four fauna habitats were mapped within the survey area, including
    - 21.97 ha of suitable Quenda habitat
    - 25.15 ha of Black Cockatoo potential breeding habitat
    - 19.32 ha of High quality foraging habitat for Carnaby's and Forest Red-tailed Black Cockatoos
    - 8.29 ha mapped as Valued for Carnaby's and Quality for Forest Red-tailed Black Cockatoos

The regionally significant ecological values have been captured on the environmental constraints map (Figure 12).

Due to the presence of several Matters of National Environmental Significance, a referral under the EPBC Act is recommended prior to any clearing of native vegetation.



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DATUM GDA 1994, PROJECTION MGA ZONE 50

0 90 180 270 360
metres

1:12,289 when printed at A4

LEGEND

- ***Conospermum undulatum*** individuals
- Potential Black Cockatoo Breeding Trees
- ***Calyptorrhynchus banksii naso*** confirmed roost
- Survey Area
- TEC Extent
- Reserves

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Base Data: (c) Based on information provided by and

Environmental Constraints

Forrestfield North

SHIRE OF KALAMUNDA

VEGETATION AND FAUNA SURVEY

Figure 12

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig12_EnvironmentalConstraints_v1_A4.mxd (rob.mcgregor)

A4 size

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Appendix A

Desktop Flora Results

Appendix A – Desktop Flora Results

Species	Conservation Code	Habitat[1]	Likelihood of Occurrence in Survey area
Acacia anomala	EPBC Act: V WC Act: VU	Grows on laterite in shallow sand, loam, clay or gravel that is brown, yellow or grey. Found on ridges, slopes and low plains. It grows entangled amongst other low shrubs in dense vegetation. Known from 13 populations including Kalamunda/Bickley, Chittering/Bullsbrook, and Pickering Brook.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Acacia aphylla	EPBC Act: V WC Act: VU	Associated with laterite and granite outcrops on hillsides. Grows in open forest dominated by *Eucalyptus marginata, Corymbia calophylla* or *Eucalyptus loxophleba.*	**Unlikely.** No suitable habitat in survey area. Known from Darling Scarp.
Acacia horridula	DPaW: P3	Gravelly soils over granite, sand. Rocky hillsides.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Andersonia gracilis	EPBC Act: E WC Act: VU	Known from Badgingarra, Dandaragan and Kenwick areas where it is found on seasonally damp, black sandy clay flats near margins of swamps in low open vegetation with species such as *Calothamnus hirsutus, Verticordia densiflora* and *Kunzea recurva*.	**Unlikely**. No suitable habitat in survey area. Known from Darling Scarp.
Anthocercis gracilis	EPBC Act: V WC Act: VU	Known from nine populations growing on steep granite slopes along the Darling Scarp in shallow, humus-rich sandy or loamy soils.	**Unlikely**. No suitable habitat in survey area. Known from Darling Scarp.
Asteridea gracilis	DPaW: P3	Sand, clay, gravelly soils.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Banksia pteridifolia subsp. *vernalis*	DpaW: P3	White/grey sand over laterite. Last record from 1998.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Banksia mimica	EPBC Act: E WC Act: VU	Flat to gentle slopes on grey sand in open woodlands. Known from 14 populations from Mogumber, Darling Range and the Whicher Range.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Beaufortia purpurea	DPaW: P3	Lateritic or granitic soils. Rocky slopes.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.

Species	Conservation Code	Habitat[1]	Likelihood of Occurrence in Survey area
Boronia humifusa	DPaW: P3	Gravelly clay loam over laterite. Mainly in Jarrah-Marri open forest.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Boronia tenuis	DPaW: P4	Laterite, stony soils. Granite. Recorded in 1953.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Byblis gigantea	DPaW: P3	Sandy-peat swamps and seasonally wet areas.	**Unlikely**. No suitable habitat in survey area.
Caladenia huegelii	EPBC Act: E WC Act: CR	Found between Perth and Capel growing in deep sandy soil in *Banksia-Eucalyptus marginata* woodland.	**May occur**. Habitat present, no known records in the vicinity.
Calothamnus accedens	DPaW: P4	Sandy soils over laterite. Road verge.	**Unlikely**. No suitable habitat in survey area.
Calytrix breviseta subsp. *breviseta*	EPBC Act: E WC Act: CR	This species has been recorded in the Kenwick area of Perth where it is restricted to winter-wet clay flats with low shrubs or Jarrah Forest.	**Unlikely**. No suitable habitat in survey area.
Chamelaucium sp. Gingin (N.G. Marchant 6)	EPBC Act: E WC Act: VU	Confined to the Gingin/Chittering area within a 3km range. Occurs on white/yellow sand supporting open low woodlands of *Eucalyptus todtiana, Banksia attenuata* and *Hibbertia* species.	**Unlikely**. No suitable habitat in survey area. Known from Darling Scarp.
Carex tereticaulis	DPaW: P3	Black peaty sand.	**Unlikely**. No suitable habitat in survey area.
Conospermum undulatum	EPBC Act: V WC Act: VU	Grey or yellow-orange clayey sand.	**Known to occur**. Database records within survey area.
Darwinia apiculata	EPBC Act: WC Act: EN	Lateritic soils.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Diuris micrantha	EPBC Act: V WC Act: VU	Recorded between Perth and Boyup Brook growing ins seasonally-wet flats amongst sedges and scattered shrubs.	**Unlikely**. No suitable habitat and no known records.
Diuris purdiei	EPBC Act: E WC Act: EN	Recorded between Perth and Yarloop, gorwing under dense shrubs in seasonally-wet swamps and drainage lines (Brown *et al.,* 2013).	**Unlikely**. No suitable habitat and no known records.
Drakaea elastica	EPBC Act: E WC Act: CR	Found on coastal plain between Ruabon and Cataby growing in sandy soil in *Banksia* woodlands and tall shrubs (Brown *et al.,* 2013).	**May occur**. Suitable habitat present but no known records in vicinity.

Species	Conservation Code	Habitat[1]	Likelihood of Occurrence in Survey area
Eleocharis keigheryi	EPBC Act: V WC Act: VU	Known from north of Eneabba and south-east of Qualeup. Grows in small clumps in a substrate of clay or sandy loam. It is emergent in freshwater creeks and transient waterbodies.	**Unlikely.** No suitable habitat and no known records.
Eucalyptus x balanites	EPBC Act: E WC Act: CE	Recorded on light coloured sandy soils over laterite including gently sloping heathlands, open mallee woodland over shrubland or heathland with emergent mallees. Known from two populations including one in Badgingarra National Park and one in the City of Armadale.	**Unlikely.** No suitable habitat and no known records.
Grevillea curviloba subsp. *incurva*	EPBC Act: E WC Act: EN	Confined to area between Muchea and Badgingarra. Grows in open heath in winter-wet areas on sand over limestone or over ironstone.	**Unlikely.** No suitable habitat and no known records.
Grevillea manglesii subsp. *dissectifolia*	DPaW: P3	Gravelly loam, moist. Roadsides.	**Unlikely**. No suitable habitat in survey area, no records in vicinity.
Grevillea pimeleoides	DPaW: P4	Gravelly soils over granite. Rocky hillsides.	**Unlikely**. No suitable habitat in survey area, no records in vicinity.
Haemodorum loratum	DPaW: P3	Grey or yellow sand and gravel. Record from 1995.	**Likely**. Suitable habitat and record in close proximity to survey area.
Halgania corymbosa	DPaW: P3	Gravelly soils, soils over granite. Records from 1919 and 1977.	**Unlikely**. No suitable habitat in survey area, records on Darling Scarp.
Hibbertia montana	DPaW: P4	Granite rocks, lateritic ridges and boulders, hills. Record from 1985.	**Unlikely**. No suitable habitat in survey area, old record from golf course unlikely to be correct, more likely from Darling Scarp.
Hydrocotyle striata	DPaW: P1	Clay, springs.	**Unlikely**. No suitable habitat in survey area. No records in vicinity.
Hypocalymma sp. Cataby (G.J. Keighery 5151)	DPaW: P2	Grey sand.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Isopogon drummondii	DPaW: P3	No information available on WAH (1998-). Database results describe flats on grey brown sand with or without gravel in Banksia woodlands.	**Likely**. Numerous records in vicinity of survey area.
Jacksonia gracillima	DPaW: P3	No information available on WAH (1998-). No known records in vicinity.	**Unlikely**. No known records in vicinity.

Species	Conservation Code	Habitat[1]	Likelihood of Occurrence in Survey area
Jacksonia sericea	DPaW: P4	Calcareous and sandy soils. Record from 1962.	**May**. Suitable habitat may present, old record in vicinity.
Lasiopetalum bracteatum	DPaW: P4	Sandy clay, clay, lateritic gravel. Along drainage lines, creeks, gullies, and granite outcrops. Record from 1992 and 1997.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Lasiopetalum glutinosum subsp. *glutinosum*	DPaW: P3	No information available on WAH (1998-). Records from 1897.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Lasiopetalum pterocarpum	EPBC Act: E WC Act: CE	Occurs on slopes of Darling Range near Serpentine National Park. Occurs in riparian community with *Eucalyptus rudis.*	**Unlikely.** No suitable habitat and no known records.
Lepidosperma rostratum	EPBC Act: E WC Act: EN	Restricted to two seasonally wet swamps. Grows on peaty sand and clay amongst low heath in winter-wet swamps.	**Unlikely.** No suitable habitat and no known records.
Lepyrodia curvescens	DPaW: P2	Sand, laterite. Seasonally inundated swampland.	**Unlikely**. No suitable habitat present. Two records from Roe/Great Eastern Highway interchange.
Macarthuria keigheryi	EPBC Act: E WC Act: EN	White or grey sand. Records from north of Perth to Dandaragan.	**Likely**. Suitable habitat present, numerous records in close proximity.
Melaleuca viminalis	DPaW: P2	No information available on WAH (1998-). Recorded in 2005 on brown sandy clay over clay.	**May**. Suitable habitat may be present, one record in the vicinity of the survey area.
Ornduffia submersa	DPaW: P4	No information available on WAH (1998-). Records from 1989 and 1995 from shallow claypans with Melaleuca fringing vegetation.	**Unlikely**. No suitable habitat in survey area.
Pimelea rara	DPaW: P4	Lateritic soils.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Pithocarpa corymbulosa	DPaW: P3	Gravelly or sandy loam. Amongst granite outcrops. Recorded in 1996.	**Unlikely**. No suitable habitat in survey area.
Platysace ramosissima	DPaW: P3	Sandy soils.	**Likely**. Suitable habitat present and three records in vicinity.

Species	Conservation Code	Habitat[1]	Likelihood of Occurrence in Survey area
Schoenus griffinianus	DPaW: P4	White sand. One record from 2006.	**Likely**. Suitable habitat present, one record in vicinity.
Schoenus pennisetis	DPaW: P3	Grey or peaty sand, sandy clay. Swamps and winter-wet depressions. Recorded in 1995.	**Unlikely**. No suitable habitat present.
Senecio gilbertii	DPaW: P1	Peaty sand, swamps and slopes. Record from 1957 and 1994.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Stylidium longitubum	DPaW: P4	Sandy clay and clay. Seasonal wetlands.	**Unlikely**. No suitable habitat present.
Stylidium striatum	DPaW: P4	Records from 1897.	**Unlikely**. No suitable habitat in survey area. Records on Darling Scarp.
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	EPBC Act: CE WC Act: CR	Endemic to Pinjarra Plain of WA, known from five subpopulations south of Perth from Serpentine to Dardanup. Occurs on grey, clayey sand with lateritic pebbles in low woodland near winter-wet flats.	**Unlikely.** No suitable habitat and no known records.
Tetratheca sp. Granite (S. Patrick SP1224)	DPaW: P3	Clay, moist loam, clayey sand. Granite boulders. Recorded in 1990.	**Unlikely**. No suitable habitat in survey area.
Thelymitra dedmaniarum	EPBC Act: E WC Act: CR	Recorded near Gidgegannup in Darling Range on granite slopes and in open Wandoo woodland.	**Unlikely**. No suitable habitat in survey area.
Thelymitra magnifica	DPaW: P1	Stony ridges. Recorded on edge of Darling Scarp amongst dense heath in rocky soils surrounding exposed granite outcrops (Brown *et al.*, 2013).	**Unlikely**. No suitable habitat in survey area.
Thelymitra stellata	EPBC Act: E WC Act: EN	Sand, gravel, lateritic loam. Grows in *Eucalyptus marginata* forests or in low heath on rocky tops of small hills (Brown *et al.*, 2013).	**Unlikely**. No suitable habitat in survey area.
Verticordia lindleyi subsp. *lindleyi*	DPaW: P4	Grows in white to grey and yellow sand, often with or over clay and gravel, usually low-lying and winter-wet (George, 2002). Frequently in association with a few other verticordias in heath, shrubland and open woodland (George, 2002). Records from 1990 and 1994.	**Likely**. Suitable habitat present, several records in close proximity.

1. Sourced from Florabase (WAH, 1998-) and DotEE (2016) unless otherwise referenced

Appendix B

Statistical Analysis

Appendix B – Statistical Analysis

1.0 Dendrograms

The following dendrograms justify the survey sample intensity. All vegetation communities are considered suitably represented by quadrats and relevès based on a higher than 70% representation for each community. The estimated total species richness is based on the Chao asymptote which is a nonparametric estimator considered universally valid for all species abundance distributions (Chao & Chiu, 2006).

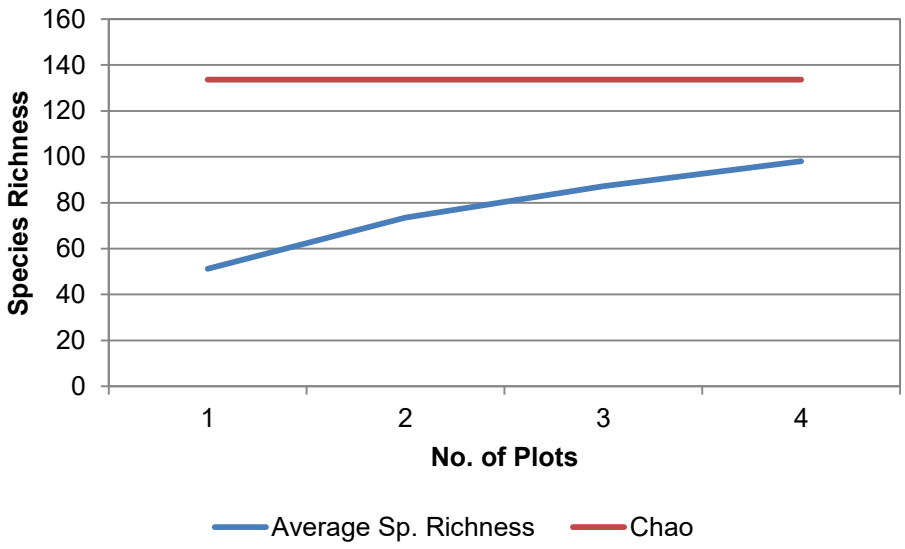
1.1 AfHhMp

Survey effort: 4 quadrats

Species richness: 98 species in total

Chao estimate: 133.64

Percent total species captured: 73.33%



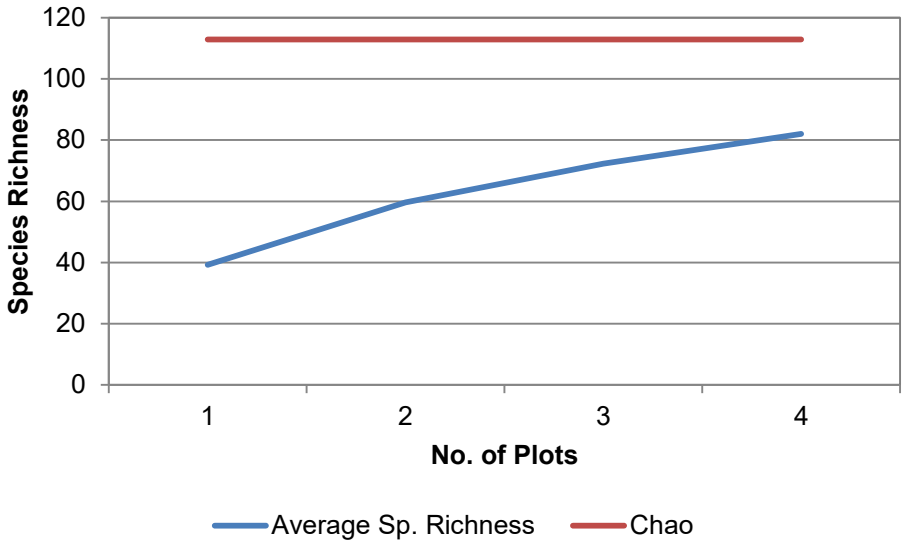
1.2 EmAcMt

Survey effort: 4 quadrats

Species richness: 82 species in total

Chao estimate: 112.87

Percent total species captured: 72.65%



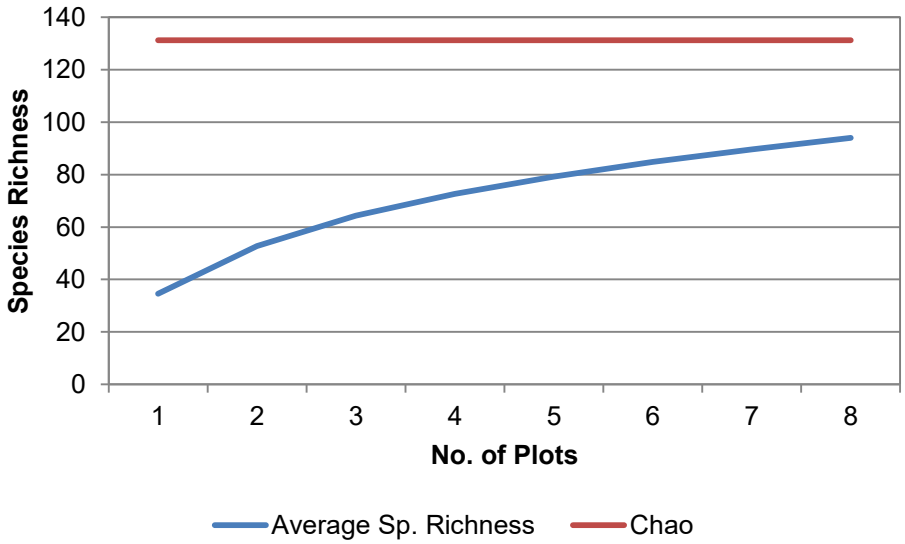
1.3 EmToDo

Survey effort: 8 quadrats

Species richness: 94 species in total

Chao estimate: 131.19

Percent total species captured: 71.65%



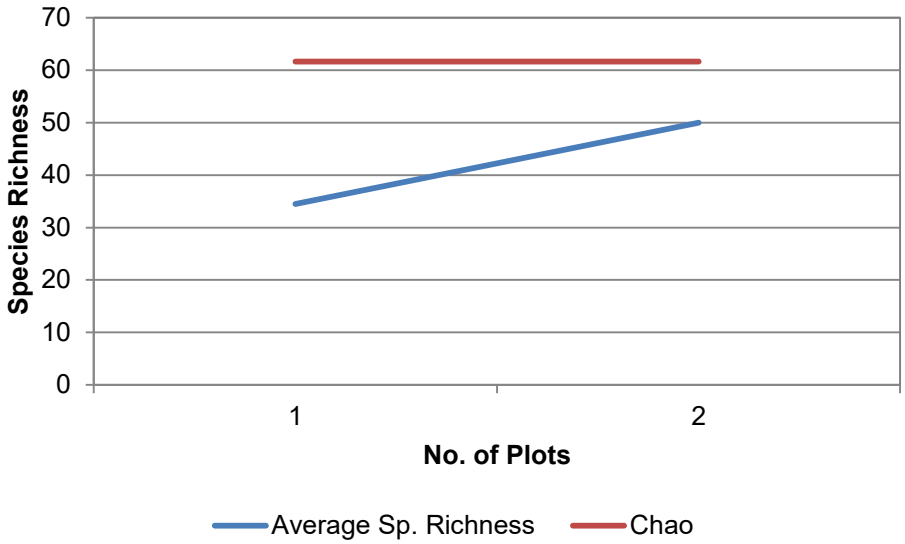
1.4 VdCd

Survey effort: 2 quadrats

Species richness: 50 species in total

Chao estimate: 61.62

Percent total species captured: 81.14%

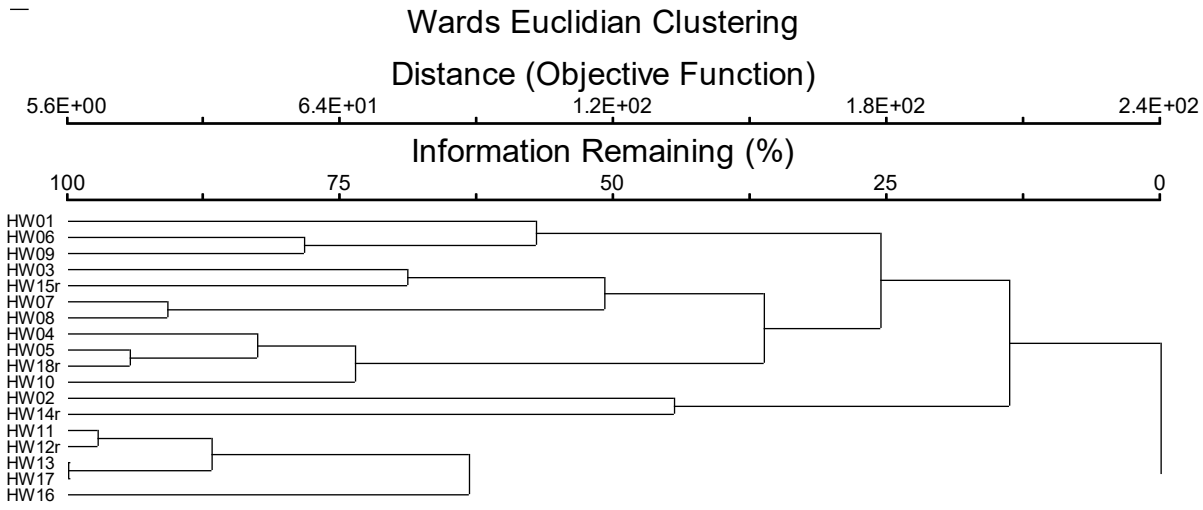


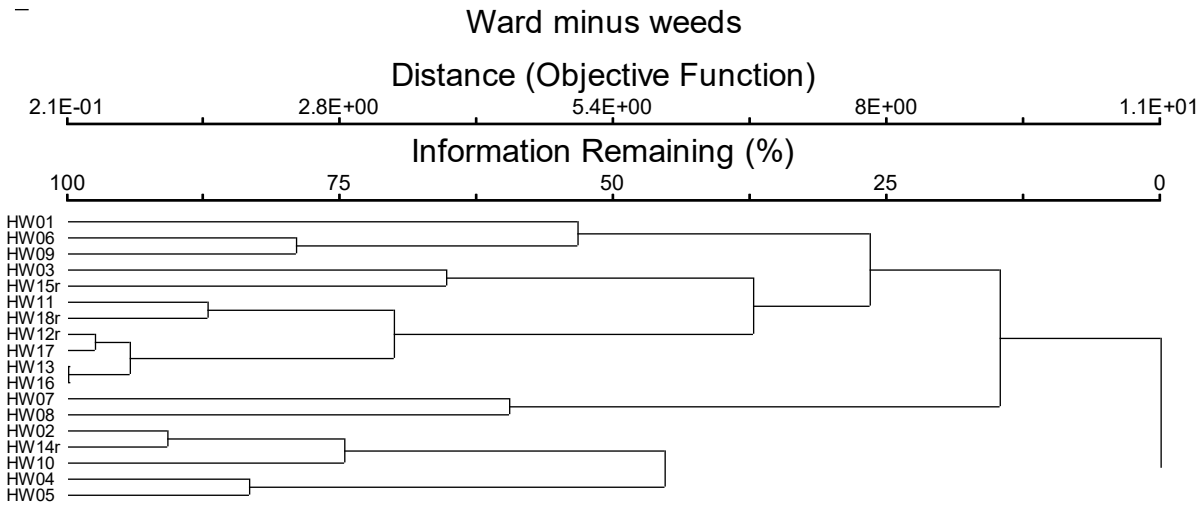
2.0 Dendrograms

Cluster analysis was undertaken using a variety of distance measures. This was done to overcome the cryptic response likely associated with the varying condition of quadrats.

2.1 Ward's Method

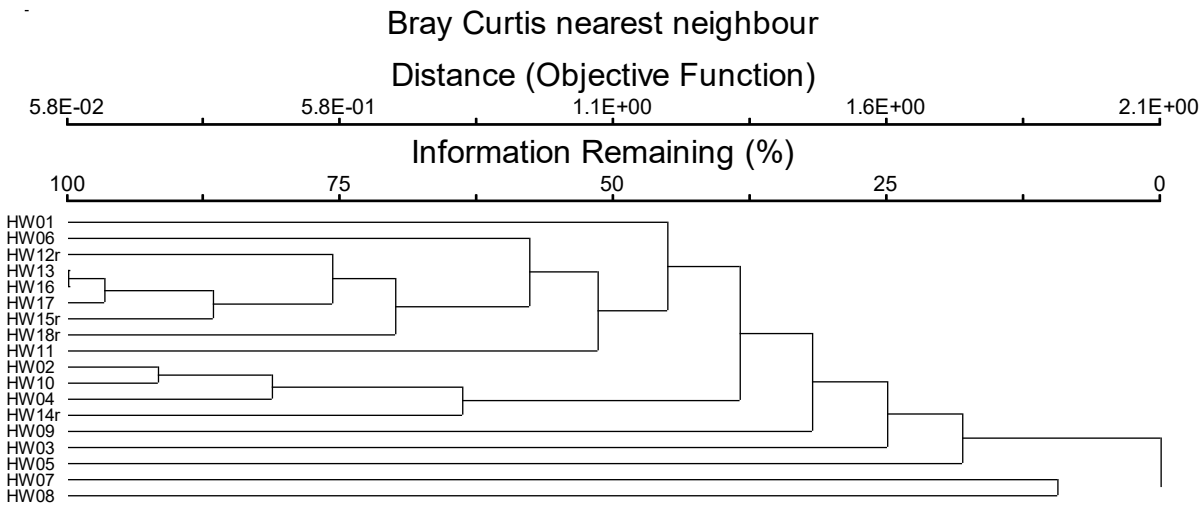
Ward's method using the relative Euclidean distance measure is recommended for ecological community analysis as it avoids distortion (McCune & Grace, 2002).



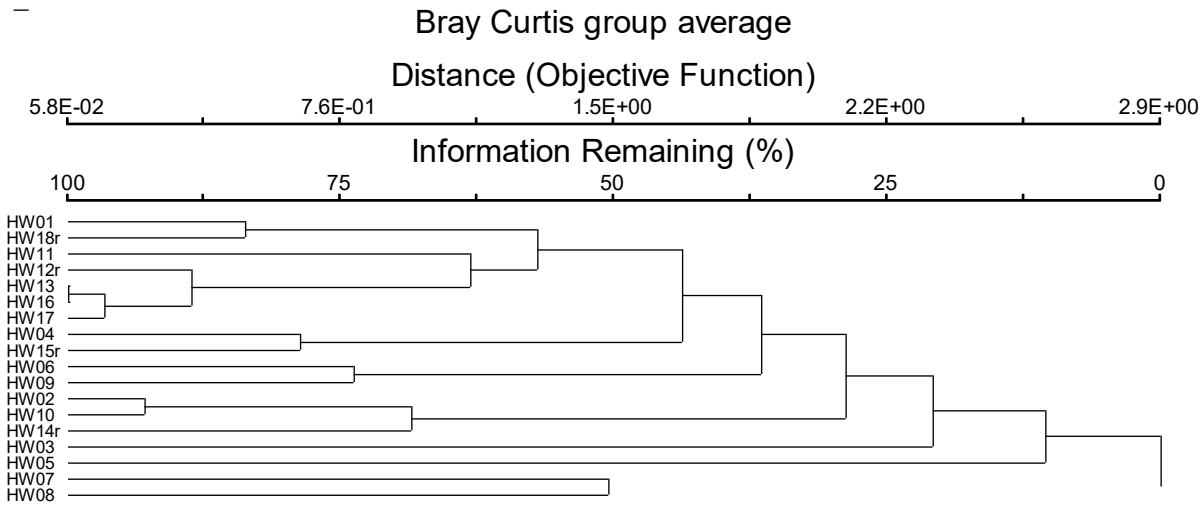


2.2 Bray Curtis

The nearest neighbour measure was used to identify the closest relation for some quadrats not grouping well using Wards method.



The group average distance measure was used as a comparison. Results were similar to nearest neighbour.


Bray Curtis group average
Distance (Objective Function)
5.8E-02
7.6E-01
1.5E+00
2.2E+00
2.9E+00
Information Remaining (%)
100
75
50
25
0
HW01
HW18r
HW11
HW12r
HW13
HW16
HW17
HW04
HW15r
HW06
HW09
HW02
HW10
HW14r
HW03
HW05
HW07
HW08

Appendix C

Banksia Woodlands of the SCP Assessment

Appendix C – Banksia Woodlands of the SCP Assessment

1.0 Banksia Woodlands of the Swan Coastal Plain

1.1 Introduction

The Banksia woodlands of the Swan Coastal Plain encompasses a large natural variation across its range. Furthermore it is subject to varying degrees of disturbance and degradation that have influenced the quality of patches.

The Threatened Species Scientific Committee (TSSC) published the approved Conservation Advice for this community in September 2016. This document details the key diagnostic features applicable for determining the presence of this TEC. Patches must meet the following kei diagnostic characteristics, condition thresholds, and minimum patch sizes:

- Step 1: use key diagnostic characteristics to determine if TEC is present
- Step 2: determine condition of patch
- Step 3: consider if patch meets minimum size threshold
- Step 4: surrounding context of a patch must be taken into account when considering factors that add to the importance of a patch that meets the condition thresholds.

These steps are detailed in the following sections.

1.2 Key Diagnostic Features

Patches are defined as a discreet and mostly continuous area of the ecological community. All native vegetation in Good or better condition has been considered for an assessment against the key diagnostic criteria for the TEC. The native vegetation has been separated into five patches:

- Patch 1 = quadrats 1, 2, 3
- Patch 2 = quadrats 4, 5, 6
- Patch 3 = quadrats 12, 13, 14, 16 and 18
- Patch 4 = quadrats 9, 10, 11, 14, 15
- Patch 5 = quadrat 17

The key diagnostic features have been assessed using patch quadrat data, field observations and mapped vegetation communities in areas under-represented by quadrats (i.e. patch 6).

Table 1 key diagnostic features including location and physical environment, soils and landform, structure, and species composition

Key diagnostic characteristics	1	2	3	4	5
Location and physical environment					
The Banksia Woodlands ecological community primarily occurs on the Swan Coastal Plain IBRA bioregion. Pockets of the community also extent into the adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest IBRA bioregion to the immediate east and south of the Swan Coastal Plain.	Y	Y	Y	Y	Y
Soils and landform					
Typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands. Is also common on sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau In other less common scenarios (transitional substrates, sandflats)	Y	Y	Y	Y	Y
Structure					
A distinctive upper sclerophyllous layer of low trees (occasionally large shrubs more than 2 m tall), typically dominated or co-dominated by one or more of the *banksia* species identified below; AND	Y	Y	Y	Y	N – no *Banksia* species dominant
Emergent trees of medium or tall (<10 m) height *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND	Y – *E. marginata* and *A. fraseriana*	Y – *E. marginata, A. fraseriana*	Y – *E. marginata, A fraseriana*	Y – *E. marginata, A. fraseriana*	Y – *E. marginata, A. fraseriana*
A often highly species-rich understorey that consists of:	Y – 33 sclerophyllous	Y – 36 sclerophyllous	Y – 36 sclerophyllous	Y – 36 sclerophyllous	N – 12 sclerophyllous

Key diagnostic characteristics	1	2	3	4	5
• A layer of sclerophyllous shrubs of various heights • A herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses. The development of a ground layer may vary depending on the density of the shrub layer and disturbance history.	shrubs, 11 rushes and sedges, and 35 forbs.	shrubs, 7 sedges and rushes, and 18 forbs.	shrubs, 9 rushes and sedges, and 17 forbs.	shrubs, 10 rushes and sedges, and 28 forbs.	shrubs, 3 sedges, 12 forbs.
Composition					
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND	Y – 6% *B. attenuata*	Y – 8% *B. attenuata,* 3% *B. menziesii*	Y – 2-8% *B. attenuata,* 2-10% *B. menziesii*	Y – *B. menziesii* 0-15%, *B. attenuata* 0-1%	N – No *Banksia* species recorded, predominantly *E. marginata*
Patch must include at least one of the following diagnostic species: • *Banksia attenuata* • *Banksia menziesii* • *Banksia prionotes* • *Banksia ilicifolia*	Y	Y	Y	Y	N
If present, the emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND	Y – up to 15% *E. marginata*	Y – scattered groups of *E. marginata*	Y – up to 5-40% *E. marginata*	Y – up to 25% *E. marginata*	Y – 20% *E. marginata*
Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*; AND	Y – *A. fraseriana* trees co-dominate	Y – clusters of *A. fraseriana*	Y – 0-10% *A. fraseriana*	Y – 0-10% *A. fraseriana, 0-2% Nuytsia floribunda*	Y – 10% *A. fraseriana*
Understorey typically contains high to very high diversity of shrub and herb species that often vary from patch to patch.	Y – 92 total species richness (n=3)	Y – 66 total species richness (n=3)	Y – 86 total species richness (n=5)	Y – 83 total species richness (n=5)	Y – 32 total species richness (n=1)

Key diagnostic characteristics	1	2	3	4	5
Contra-indicators					
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	N	N	N	N	N
Patches clearly dominated by *Banksia burdettii* are not the TEC	N	N	N	N	N
FCT 20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	N	N	N	N	N

1.3 Condition

The condition of vegetation of each patch needs to be determined in accordance with the following:

- The condition assessment of a patch should be centred on the area of highest native floristic diversity and/or cover of the patch.
- Timing of surveys and recent disturbance should be taken into account
- Surrounding context of a patch should be considered
- Certain vegetation components of Banksia Woodlands community merit consideration as critical elements to protect. Three components are recognised as threatened in their own right i.e. Priority Ecological Communities
- A relevant expert may be useful to help identify the ecological community and its condition.
- Vegetation must be in 'Good' or better condition in accordance with Table 2.

Table 2 Condition Table

Keighery (1994) Vegetation Condition Scale	Indicative condition measures/thresholds	
	Typical native vegetation composition	Typical weed cover
Pristine No obvious signs of disturbance	Native plant species diversity fully retained or almost so[1]	Zero or almost no weed cover/abundance
Excellent Vegetation structure intact, disturbance only affecting individual species, weeds are non-aggressive species.	High native plant species diversity[1]	Less than 10%
Very Good Vegetation structure altered, obvious signs of disturbance (e.g. repeated fires, dieback, logging, grazing). Aggressive weeds present.	Moderate native plant species diversity[1]	5 – 20%
Good Vegetation structure altered but retains basic vegetation structure or ability to regenerate it. Obvious signs of disturbance (from partial clearing, dieback, logging, grazing). Presence of very aggressive weeds.	Low native plant species diversity[1]	5 – 50%
Degraded Basic vegetation structure severely impacted by disturbance. Requires intensive management. Disturbance evident such as partial clearing, dieback, logging and grazing. Presence of very aggressive weeds at high density.	Very low native plant species diversity[1]	20 – 70%
Completely Degraded Vegetation structure is no longer intact and the area is completely or almost completely without native flora. Equivalent to 'Parkland Cleared'.	Very low to no native species diversity[1]	Greater than 70%

1. relative to expected natural range of diversity for that vegetation unit e.g. Floristic Community Type where comparative data exists.

1.4 Minimum Patch Size

Different minimum patch sizes apply to different levels of condition, as outlined below:

- Pristine – no minimum patch size
- Excellent – 0.5 ha or 5,000 m^2 (50 x 100 m)
- Very Good – 1 ha or 10,000 m^2 (100 x 100 m)
- Good – 2 ha or 20,000 m^2 (200 x 100 m)

1.5 Further Information

The following information should be taken into consideration when applying the key diagnostic criteria and condition thresholds:

- Land use history and landscape position of patch including position relative to surrounding vegetation
- A patch is a discreet and mostly continuous area of the ecological community and may include small-scale variations (<30 m), gaps and disturbances such as tracks paths or breaks that do not significantly alter the overall functionality of the ecological community.
- Variation in canopy cover, quality or condition of vegetation across a patch should not be considered evidence of multiple patches
- A buffer zone is a contiguous area immediately adjacent to a patch of the ecological community. The recommended minimum buffer zone is 20-50 m. larger buffer zones should be considered for patches of particularly high conservation value, or if patches are down slope of drainage lines or a source of nutrient enrichment, or groundwater drawdown.
- Restored vegetation is not excluded provided it meets the key diagnostic criteria, condition threshold and patch size.
- Sampling protocols includes developing a quick map of the vegetation, landscape qualities and management history. Following this, a thorough sampling exercise must be undertaken to represent the range of variation. At least one hour per plot in early to mid-spring and a second survey in late spring may be required to detect the majority of species. plots to be at least 100 m^2 (10 x 10 m). Search effort (number of person hours per plot across entire patch) and surveyor's level of expertise can be useful for future reference.
- Timing of surveys should allow a reasonable interval after a disturbance. Surveys at least one year post fire may be required to assess a site against the key diagnostic characteristics and minimum condition thresholds.
- Surrounding environment, landscape context and other significance considerations:
    - patches that are more species rich and less disturbed are likely to provide greater biodiversity value.
    - Patches that provide corridors or linkages within a largely modified landscape are particularly important.

The Conservation Advice provides an additional ten indicators to be considered when assessing impacts of actions or proposed actions under the EPBC Act. These are not further listed here.

1.6 Protected in Reserves

The level of protection in reserves has been published based on estimated extent of major and partially corresponding vegetation system associations. This is shown in Table 3.

Table 3 Extent of Banksia Woodlands ecological community estimated to be protected in reserves

Subregion	Current extent (ha)	Extent in reserves (ha)	% Protected
Dandaragan (SWA01)	81,067.8	24,671.2	30.43
Perth (SWA02)	253,540.6	57,054.9	22.50
Jarrah Forests (JAF01/02)	1,881.4	105.9	5.63
TOTAL	**336,489.9**	**81,832.0**	**24.32**

2.0 Results

2.1 Patch 1

Patch 1 incorporates native vegetation along Smokebush Way and Roe Highway. This patch meets all the key diagnostic features as published in the approved conservation advice (TSSC, 2016). There are three vegetation communities mapped within this patch including two *Eucalyptus marginata* and *Banksia* communities and one *Allocasuarina fraseriana* community (EmToDo, EmAcMt and AfHhMp). *E. marginata* and *A. fraseriana* comprise 10-15% of the canopy cover, with *Banksia menziesii* and *Banksia attenuata* representing less than 10%. Despite this co-dominance of other species, the desktop results show the presence of the TEC at this location.

Condition varied from 'Excellent' to 'Very Good'. This patch meets the minimum size requirement, extending 2.33 ha. The condition of the patch is rated at its best mapped condition (Excellent). It therefore is considered to meet the minimum patch size criteria.

Plate 1 Patch 1 photographs

2.3 Patch 2

Patch 2 includes native vegetation on 9, 29, 31 and 37 Brand Road. This patch meets all the key diagnostic features as published in the approved conservation advice (TSSC, 2016). There are three quadrats representing patch 2 including 4, 5 and 6. Two vegetation communities have been mapped within this patch including AfHhMp and EmAcMt. Co-dominant overstorey species include *Allocasuarina fraseriana* and *Eucalyptus marginata* subsp. *marginata*.

One area within patch 2 has been assumed to have been historically cleared. Bare ground is high, and colonising species including *Banksia sessilis* and *Adenanthos cygnorum* dominate the tall shrub stratum. However over time it is likely that this community will regenerate to become a Banksia dominated community as it is surrounded by 'Excellent' condition vegetation all representing the Banksia woodlands TEC.

Condition varied from 'Excellent' to 'Very Good'. This patch meets the minimum size requirement, extending 2.13 ha. The condition of the patch is rated at its best mapped condition (Excellent). It therefore is considered to meet the minimum patch size criteria.

Plate 2 Patch 2 vegetation in 'Excellent' and 'Very Good' condition

2.4 Patch 3

Patch 3 includes native vegetation on 105, 111, 117, 123, and 129 Sultana West Road and 23, 35, 39, and 41 Brae Road and 12, 22, 32 and 42 Brand Road. It was represented by only four quadrats (12, 13, 14, 16 and 18). This patch meets all the key diagnostic features as published in the approved conservation advice (TSSC, 2016). *Eucalyptus marginata* is the dominant to co-dominant overstorey species of this community, in one quadrat representing 40% of the foliage cover. However, this sometimes reflects the small size of a quadrat and importance of quadrat placement.

This patch is in varying condition ranging from 'Good' to 'Excellent' (Plate 3). Areas in 'Good' condition maintained overstorey native species and some understorey species however invasive grasses such as **Ehrharta calycina* and **Avena barbata* dominated on the sandy soils. Patch 3 is 2.76 ha, thereby meeting minimum patch requirements.

Plate 3 Patch 3 vegetation in 'Good' and 'Excellent' condition

2.5 Patch 4

Patch 4 includes native vegetation on Lots 59, 63 and 67 Brae Road and 62, 70, 78 Brand Road. This patch is represented by Quadrats 9, 10, 11, 14, and 15. This patch meets all the key diagnostic features as published in the approved conservation advice (TSSC, 2016). Similar to patch 3, some areas show a high foliage cover of *Eucalyptus marginata*, however the patch is predominantly *Banksia* woodlands.

Vegetation is in 'Good' to 'Excellent' condition (Plate 4). Minimum size thresholds have been met as the patch extends for 29.56 ha, with the majority of area mapped as Very Good. This meets the minimum patch size criteria.

Plate 4 Patch 4 vegetation in 'Good' and 'Excellent' condition

2.6 Patch 5

This patch encompasses Lot 24, 28, 32 and 38 Bray Road and is represented by one quadrat (17) and field observations. The patch is mapped as community EmToDo. This patch does not meet the key diagnostic features and is therefore not considered to represent the Banksia woodlands of the SCP TEC.

The quadrat data and field observations show that *Banksia* species do not form the dominant or co-dominant overstorey species. The overstorey is dominated by *Eucalyptus marginata* and *Allocasuarina fraseriana*.

Appendix D

Flora Species by Family and Community

Appendix D - Flora Species by Family and Community

Family	Cons. Code	Taxon	AfHhMp	EmAcMt	EmToDo	VdCd
Amaranthaceae						
		Ptilotus manglesii		x		
Anarthriaceae						
		Lyginia barbata	x	x	x	x
Apiaceae						
		Xanthosia huegelii	x		x	x
Araliaceae						
		Trachymene pilosa	x			
Asparagaceae						
		Lomandra hermaphrodita	x			
		Lomandra micrantha				x
		Lomandra preissii	x		x	
		Lomandra sericea	x	x	x	
		Lomandra suaveolens	x			
		Thysanotus affinis	x			
		Thysanotus arbuscula	x	x	x	
		Thysanotus patersonii				x
Asteraceae						
	PL	Asteraceae (planted)			x	
		Hyalosperma cotula				x
	*	*Hypochaeris glabra*	x		x	
		Rhodanthe citrina	x			
	*	*Ursinia anthemoides*	x	x	x	x
		Vellereophyton dealbatum	x	x	x	
Casuarinaceae						
		Allocasuarina fraseriana	x	x	x	
		Allocasuarina humilis	x	x	x	x
Colchicaceae						
		Burchardia congesta	x	x	x	x
Cyperaceae						
		Caustis dioica	x		x	x
		Cyathochaeta avenacea	x	x	x	x
		Lepidosperma leptostachyum	x	x	x	
		Lepidosperma sp.			x	
		Mesomelaena pseudostygia	x	x	x	
		Mesomelaena tetragona	x		x	x
		Schoenus brevisetis	x	x	x	x
		Tetraria octandra	x	x	x	x
		Tricostularia exsul	x	x	x	
Dasypogonaceae						
		Dasypogon bromeliifolius	x	x	x	x
		Dasypogon obliquifolius	x	x	x	
Dillenaceae						
		Hibbertia huegelii	x			
		Hibbertia hypericoides	x	x	x	x
Ericaceae						
		Astroloma stomarrhena		x		
		Conostephium pendulum	x	x	x	
		Leucopogon ?conostephioides			x	
		Leucopogon sp.		x		
		Lysinema pentapetalum		x		
Euphorbiaceae						
		Monotaxis grandiflora var. *grandiflora*	x	x	x	
		Stachystemon vermicularis	x		x	

Family	Cons. Code	Taxon	AfHhMp	EmAcMt	EmToDo	VdCd
Fabaceae						
		Acacia pulchella var. *pulchella*	x	x		
	PL	*Acacia* sp.			x	
		Bossiaea eriocarpa	x	x	x	x
		Daviesia angulata	x	x		x
		Daviesia divaricata	x		x	
		Daviesia nudiflora subsp. *nudiflora*	x	x	x	
		Daviesia preissii		x	x	x
		Gastrolobium capitatum	x	x	x	x
		Gompholobium confertum	x	x	x	
		Gompholobium knightianum	x		x	
		Gompholobium tomentosum	x	x	x	
		Jacksonia floribunda	x	x	x	
		Jacksonia lehmannii	x	x		x
		Kennedia prostrata		x		
Goodeniaceae						
		Dampiera alata			x	
		Dampiera linearis	x	x	x	
		Goodenia caerulea				x
		Lechenaultia biloba	x		x	
		Scaevola canescens	x			x
		Scaevola repens var. *repens*	x	x	x	x
Haemodoraceae						
		Anigozanthos manglesii	x		x	x
		Conostylis aurea		x	x	x
		Conostylis juncea	x			x
		Conostylis serrulata		x		
		Conostylis setigera	x	x		
		Conostylis setosa		x		
		Haemodorum laxum	x	x	x	x
		Haemodorum sp.		x	x	
		Haemodorum spicatum	x	x		x
Hemerocallidaceae						
		Agrostocrinum scrabrum				x
		Caesia micrantha	x	x	x	x
		Johnsonia pubescens subsp. *pubescens*		x		
		Tricoryne elatior	x	x	x	x
Iridaceae						
	*	*Gladiolus caryophyllaceus*	x	x	x	x
		Patersonia occidentalis	x	x	x	x
Lamiaceae						
		Hemiandra linearis	x		x	
		Hemiandra pungens	x	x	x	
		Hemiphora bartlingii	x	x	x	
Loranthaceae						
		Nuytsia floribunda	x	x	x	
Malvaceae						
		Thomasia macrocarpa	x			

Family	Cons. Code	Taxon	AfHhMp	EmAcMt	EmToDo	VdCd
Myrtaceae						
		Babingtonia camphorosmae			x	x
		Calothamnus quadrifidus subsp. *quadrifidus*			x	
		Calothamnus torulosus	x	x		
		Calytrix sp.	x			
		Eremaea pauciflora var. *pauciflora*		x		
		Eucalyptus gomphocephala			x	
		Eucalyptus marginata subsp. *marginata*	x	x	x	x
		Hypocalymma angustifolium				x
		Kunzea glabrescens		x		
		Melaleuca trichophylla	x	x	x	
		Verticordia densiflora var. *densiflora*			x	x
Orchidaceae						
		Caladenia sp.		x		
		Microtis media			x	
Phyllanthaceae						
		Phyllanthus calycinus	x			
Pittosporaceae						
		Billardiera fraseri		x		
		Cheiranthera preissiana			x	x
Poaceae						
	*	*Aira caryophyllea*	x			
		Amphipogon strictus		x		
	*	*Avena barbata*	x			
	*	*Briza maxima*	x	x	x	x
	*	*Ehrharta calycina*	x	x	x	x
	*	*Eragrostis curvula*			x	
	*	*Pentameris airoides subsp. airoides*				x
Proteaceae						
		Adenanthos cygnorum subsp. *cygnorum*	x	x	x	
		Banksia armata var. *armata*	x	x	x	
		Banksia attenuata	x	x	x	
		Banksia dallanneyi	x		x	
		Banksia dallanneyi var. *dallanneyi*	x	x	x	x
		Banksia grandis	x		x	
		Banksia menziesii	x	x	x	
		Banksia sessilis var. *sessilis*			x	
		Banksia sphaerocarpa		x	x	
	T	*Conospermum undulatum*	x	x	x	
		Grevillea bipinnatifida subsp. *bipinnatifida*				x
		Hakea conchifolia	x		x	
		Hakea costata			x	
		Hakea incrassata	x			
		Hakea lissocarpha	x			
	P3	*Isopogon drummondii*	x	x	x	
		Lambertia multiflora	x	x	x	
		Persoonia elliptica			x	
		Petrophile macrostachya	x	x	x	
		Petrophile rigida	x			
		Petrophile linearis	x	x	x	
		Stirlingia latifolia	x	x	x	x
		Synaphea sp.	x	x	x	
		Xylomelum occidentale	x		x	

Family	Cons. Code	Taxon	AfHhMp	EmAcMt	EmToDo	VdCd
Restionaceae						
		Alexgeorgea nitens	x	x	x	x
		Desmocladus fasciculatus	x	x	x	x
		Desmocladus flexuosus		x		
		Hypolaena exsulca			x	x
Rubiaceae						
		Opercularia vaginata	x		x	
Rutaceae						
		Boronia ramosa subsp. *anethifolia*	x	x	x	x
		Philotheca spicata	x		x	x
Stylidiaceae						
		Levenhookia pusilla	x			
		Stylidium diuroides subsp. *diuroides*	x			
		Stylidium piliferum	x	x		
Thymelaeaceae						
		Pimelea ciliata subsp. *ciliata*	x	x	x	
Xanthorrhoeaceae						
		Xanthorrhoea acanthostachya	x	x	x	
		Xanthorrhoea gracilis		x	x	
		Xanthorrhoea preissii	x	x	x	x

Appendix E

Quadrat Data

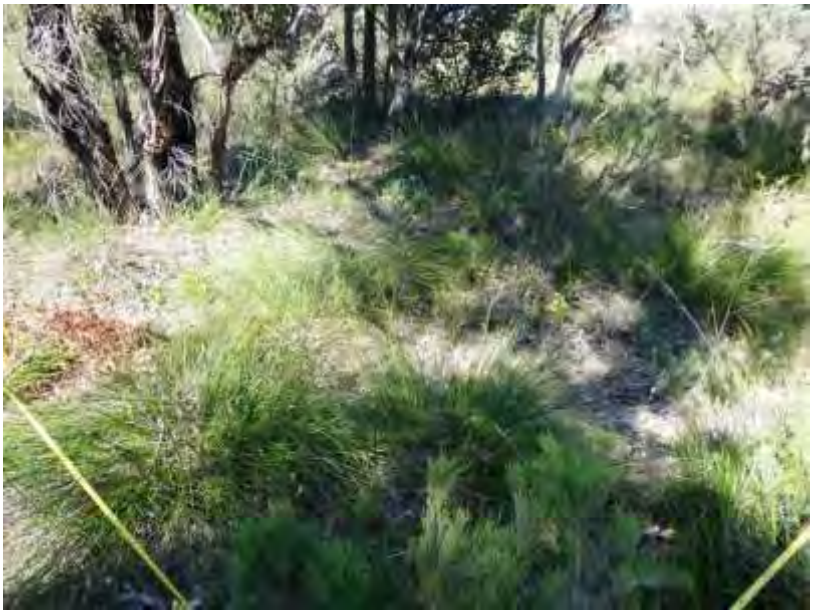
Plot Data

Site No: HW01	Type: Quadrat	Longitude: 116.009195	Latitude: -31.96267
Date: 11/22/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition: E. Edge Effect			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		250	2
Aira caryophyllea	*	10	0.1
Alexgeorgea nitens		5	2
Allocasuarina fraseriana		800	10 in landscape
Allocasuarina humilis			Oppo
Anigozanthos manglesii		60	0.3
Banksia attenuata			Oppo
Banksia dallanneyi var. *dallanneyi*		10	3
Banksia menziesii		500	2
Bossiaea eriocarpa		20	0.3
Briza maxima	*	30	0.5
Burchardia congesta		30	0.2
Caesia micrantha		70	0.1
Calothamnus torulosus			Oppo
Caustis dioica			Oppo
Conospermum undulatum			
Conostephium pendulum			Oppo
Dampiera linearis		15	0.1
Dasypogon obliquifolius		30	1
Daviesia divaricata			Oppo
Daviesia nudiflora subsp. *nudiflora*		50	0.3
Desmocladus fasciculatus		5	0.1
Ehrharta calycina	*	100	0.3
Eucalyptus marginata subsp. *marginata*		1200	8 in landscape
Gastrolobium capitatum		40	0.1
Gladiolus caryophyllaceus	*	50	0.5
Gompholobium knightianum		2	0.1
Gompholobium tomentosum			Oppo
Haemodorum laxum		120	0.5
Hakea conchifolia			Oppo
Hakea incrassata			Oppo
Hibbertia hypericoides		30	2
Hypochaeris glabra	*	30	0.1
Jacksonia floribunda			Oppo
Lambertia multiflora		100	2
Lepidosperma leptostachyum		80	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Levenhookia pusilla		5	0.1
Lomandra preissii		40	0.3
Lomandra sericea		30	0.1
Lomandra suaveolens		10	0.1
Melaleuca trichophylla		40	4
Mesomelaena pseudostygia		30	10
Mesomelaena tetragona		50	1
Nuytsia floribunda			Oppo
Opercularia vaginata		15	2
Patersonia occidentalis			Oppo
Petrophile macrostachya			Oppo
Petrophile linearis		40	0.5
Philotheca spicata			Oppo
Phyllanthus calycinus			Oppo
Pimelea ciliata subsp. *ciliata*			Oppo
Rhodanthe citrina		10	0.1
Scaevola canescens		3	0.2
Scaevola repens var. *repens*		15	3
Schoenus brevisetis		30	8
Stirlingia latifolia			Oppo
Stylidium diuroides subsp. *diuroides*		10	0.1
Isopogon drummondii	P3	100	0.5
Boronia ramosa subsp. *anethifolia*		30	0.2
Synaphea sp.			Oppo
Tetraria octandra		30	6
Trachymene pilosa		4	0.1
Tricoryne elatior		25	0.2
Tricostularia exsul		80	0.5
Ursinia anthemoides	*	20	0.1
Xanthorrhoea acanthostachya		100	8
Xanthorrhoea preissii			Oppo
Xanthosia huegelii		10	0.1

Site No: HW02	Type: Quadrat	Longitude: 116.009435	Latitude: -31.962045
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmAcMt		Fire History: 10+	
Vegetation Condition: E. Rubbish, Edge effect			



Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		350	6
Allocasuarina humilis		60	2
Astroloma stomarrhena		5	0.1
Banksia dallanneyi var. *dallanneyi*		30	2
Banksia menziesii		500	6
Bossiaea eriocarpa		15	0.2
Briza maxima	*	30	0.1
Burchardia congesta		30	0.1
Caesia micrantha			oppo
Caladenia sp.		5	0.1
Calothamnus torulosus		40	0.2
Conospermum undulatum		160	0.3
Conostylis aurea		20	0.1
Conostylis serrulata			oppo
Conostylis setigera		15	0.1
Conostylis setosa			oppo
Cyathochaeta avenacea		100	1
Dasypogon bromeliifolius			oppo
Dasypogon obliquifolius		20	1
Daviesia angulata		100	0.6
Daviesia nudiflora subsp. *nudiflora*		40	0.3
Desmocladus fasciculatus		10	0.1
Desmocladus flexuosus		30	0.6
Eucalyptus marginata subsp. *marginata*		600	10
Gastrolobium capitatum		20	0.1
Gastrolobium capitatum		40	0.1
Gladiolus caryophyllaceus	*	50	0.1
Gompholobium tomentosum			oppo
Haemodorum laxum		140	1
Hemiphora bartlingii		20	0.1
Hibbertia hypericoides		30	6
Jacksonia lehmannii		40	0.1
Kennedia prostrata			oppo
Lambertia multiflora		80	1
Lepidosperma leptostachyum		60	1
Lomandra sericea		30	0.2
Lyginia barbata			oppo

Taxon	Cons. Code	Height (cm)	% Alive
Melaleuca trichophylla		40	6
Mesomelaena pseudostygia		50	15
Patersonia occidentalis		30	0.4
Petropile linearis		30	0.2
Pimelea ciliata subsp. *ciliata*		20	0.1
Scaevola repens var. *repens*		10	1
Stirlingia latifolia		50	0.3
Stylidium piliferum		10	0.1
Boronia ramosa subsp. *anethifolia*		30	0.1
Synaphea sp.		40	0.1
Tetraria octandra		60	15
Thysanotus arbuscula		30	0.1
Tricoryne elatior		30	0.1
Tricoryne elatior		30	1
Tricostularia exsul		100	3
Ursinia anthemoides	*	10	0.1
Vellereophyton dealbatum		5	0.1
Xanthorrhoea acanthostachya		230	0.5
Xanthorrhoea gracilis		60	5

Site No: HW03	Type: Quadrat	Longitude: 116.010158	Latitude: -31.960788
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E. Weeds			

Taxon	Cons. Code	Height (cm)	% Alive
Alexgeorgea nitens		30	25
Allocasuarina fraseriana		250	2
Banksia attenuata		500	4
Banksia dallanneyi var. *dallanneyi*		20	2
Bossiaea eriocarpa		30	1.5
Briza maxima	*	30	0.2
Burchardia congesta		60	0.2
Calothamnus quadrifidus subsp. *quadrifidus*			oppo
Conospermum undulatum		50	0.2
Cyathochaeta avenacea		100	4
Dampiera alata		30	0.2
Dasypogon obliquifolius		30	0.2
Daviesia nudiflora subsp. *nudiflora*		40	0.5
Ehrharta calycina	*	100	0.4
Eragrostis curvula	*	130	1
Eucalyptus marginata subsp. *marginata*		1300	15
Gastrolobium capitatum		40	0.1
Gladiolus caryophyllaceus	*	80	0.1
Gompholobium confertum			oppo
Gompholobium knightianum		10	0.1
Haemodorum laxum		130	2
Hemiandra pungens		20	0.3
Jacksonia floribunda		40	0.2
Lepidosperma sp.		30	15
Lomandra sericea		30	0.2
Lomandra sericea		40	0.3
Melaleuca trichophylla		40	0.3
Petrophile linearis		50	0.1
Scaevola repens var. repens		10	4
Schoenus brevisetis		40	1
Stirlingia latifolia		50	0.6
Synaphea sp.		20	1
Thysanotus arbuscula		80	0.1
Tricoryne elatior		40	0.5
Xanthorrhoea preissii		100	5

Site No: HW04	Type: Quadrat	Longitude: 116.006648	Latitude: -31.962009
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		350	15
Allocasuarina fraseriana		300	0.5
Allocasuarina humilis		70	1
Banksia attenuata		500	2
Banksia dallanneyi		30	0.2
Banksia dallanneyi var. *dallanneyi*		20	4
Banksia grandis		500	5
Bossiaea eriocarpa		30	0.4
Burchardia congesta		40	0.2
Caesia micrantha		70	0.1
Calothamnus torulosus		20	0.1
Calytrix sp.			Oppo
Conospermum undulatum		20	0.1
Conostylis juncea		5	0.1
Cyathochaeta avenacea		110	0.2
Dampiera linearis		5	0.1
Dasypogon bromeliifolius		50	3
Dasypogon obliquifolius		20	0.5
Daviesia nudiflora subsp. *nudiflora*		30	0.2
Desmocladus fasciculatus		10	0.1
Eucalyptus marginata subsp. *marginata*		1400	20
Gastrolobium capitatum		30	0.1
Gompholobium confertum			Oppo
Haemodorum laxum		20	0.1
Haemodorum spicatum		100	0.1
Hakea lissocarpha		80	0.5
Hemiphora bartlingii			Oppo
Hibbertia huegelii		20	0.1
Hibbertia hypericoides		40	4
Lambertia multiflora		90	0.5
Lomandra hermaphrodita		20	0.1
Lomandra sericea		30	0.1
Lyginia barbata		60	1
Melaleuca trichophylla		40	0.5
Mesomelaena tetragona		50	10
Patersonia occidentalis		40	0.5
Petrophile linearis		30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Petrophile macrostachya		50	0.4
Philotheca spicata		100	0.2
Scaevola repens var. *repens*		15	1
Stachystemon vermicularis		40	1
Stirlingia latifolia		50	1.5
Isopogon drummondii	P3	80	1
Thysanotus affinis		20	0.1
Tricoryne elatior		30	0.1
Tricostularia exsul		80	15
Xanthorrhoea acanthostachya		80	4
Xylomelum occidentale		30	0.1

Site No: HW05	Type: Releve	Longitude: 116.007014	Latitude: -31.962401

Date: 11/23/2016
Topography: Flat
Rocky Type:
Community: EmAcMt
Vegetation Condition: VG.

Soil Types: Sand
Soil Colour: Grey
Soil Condition:
Fire History:

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		400	25
Allocasuarina fraseriana		250	0.5
Allocasuarina humilis		80	0.5
Bossiaea eriocarpa		30	0.2
Conospermum undulatum			Oppo
Cyathochaeta avenacea		120	0.5
Dampiera linearis		10	0.1
Dasypogon obliquifolius		40	0.1
Daviesia nudiflora subsp. *nudiflora*			Oppo
Eremaea pauciflora var. *pauciflora*		50	0.5
Eucalyptus marginata subsp. *marginata*		300	1
Gompholobium confertum		20	0.1
Gompholobium tomentosum		40	0.3
Haemodorum laxum			Oppo
Hemiphora bartlingii		30	0.2
Hibbertia hypericoides		30	1
Johnsonia pubescens subsp. *pubescens*			Oppo
Kunzea glabrescens		250	1
Lambertia multiflora		100	0.5
Lyginia barbata		50	0.2
Lysinema pentapetalum			Oppo
Petrophile linearis			Oppo
Schoenus brevisetis			Oppo
Stirlingia latifolia		40	0.5
Isopogon drummondii	P3	60	0.4
Synaphea sp.			Oppo
Tricostularia exsul		100	20
Xanthorrhoea preissii		80	3

Site No: HW06	Type: Quadrat	Longitude: 116.007671	Latitude: -31.961865

Date: 11/23/2016
Topography: Flat
Rocky Type:
Community: AfHhMp
Vegetation Condition: E.

Soil Types: Sand
Soil Colour: Grey
Soil Condition: Dry
Fire History: 10+

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		700	8
Allocasuarina humilis		60	2
Banksia attenuata		500	8
Banksia dallanneyi var. *dallanneyi*		10	1
Banksia menziesii		400	3
Bossiaea eriocarpa		30	0.2
Briza maxima	*	30	0.1
Burchardia congesta		40	0.1
Calothamnus torulosus		30	1
Caustis dioica		40	0.3
Conostephium pendulum		40	0.1
Cyathochaeta avenacea		100	0.5
Dasypogon bromeliifolius		30	0.5
Dasypogon obliquifolius		30	2
Daviesia nudiflora subsp. *nudiflora*		50	0.2
Ehrharta calycina	*	100	4
Gastrolobium capitatum		20	0.1
Gladiolus caryophyllaceus	*	60	0.2
Gompholobium confertum		25	0.1
Gompholobium tomentosum		30	0.1
Haemodorum laxum		70	0.1
Hemiandra pungens		20	0.2
Hemiphora bartlingii		25	0.1
Hibbertia hypericoides		40	2
Lepidosperma leptostachyum		60	1
Mesomelaena pseudostygia		30	5
Petrophile macrostachya		40	0.3
Petrophile rigida		40	0.2
Scaevola repens var. *repens*		10	0.2
Schoenus brevisetis		40	1
Isopogon drummondii	P3	100	3
Tricoryne elatior		30	0.1
Tricostularia exsul		60	1
Xanthorrhoea preissii		100	6

Site No: HW07	Type: Quadrat	Longitude: 115.995246	Latitude: -31.952148

Date: 11/23/2016
Topography: Flat
Rocky Type:
Community: VdCd
Vegetation Condition: VG.

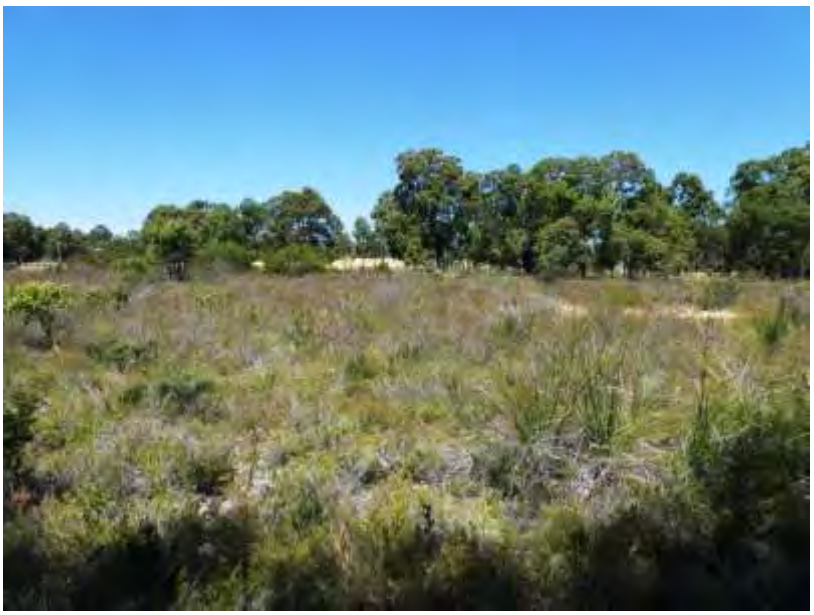
Soil Types: Sand
Soil Colour: White
Soil Condition: Dry
Fire History: 10+

Taxon	Cons. Code	Height (cm)	% Alive
Alexgeorgea nitens		15	0.2
Anigozanthos manglesii		30	0.3
Banksia dallanneyi var. *dallanneyi*		10	0.2
Briza maxima	*	30	0.1
Caesia micrantha		25	0.1
Caustis dioica		30	2
Conostylis juncea		20	0.1
Cyathochaeta avenacea		120	0.5
Dasypogon bromeliifolius			Oppo
Daviesia angulata		60	0.3
Ehrharta calycina	*	120	0.3
Eucalyptus marginata subsp. *marginata*		2000	2
Gladiolus caryophyllaceus	*	40	0.1
Grevillea bipinnatifida subsp. *bipinnatifida*		40	0.3
Haemodorum spicatum		100	1
Hypocalymma angustifolium			Oppo
Hypolaena exsulca		25	0.1
Jacksonia lehmannii		15	0.1
Lomandra micrantha		25	0.1
Lyginia barbata		50	1
Mesomelaena tetragona		60	0.5
Patersonia occidentalis		40	1
Pentameris airoides subsp. *airoides*	*	20	0.5
Scaevola canescens		10	0.1
Schoenus brevisetis		50	1
Stirlingia latifolia		60	2
Boronia ramosa subsp. *anethifolia*		20	0.1
Tricoryne elatior		30	0.2
Ursinia anthemoides	*	15	1
Verticordia densiflora var. *densiflora*		50	6
Xanthorrhoea preissii		70	0.5

Site No: HW08	Type: Quadrat	Longitude: 115.995632	Latitude: -31.953041

Date: 11/23/2016
Topography: Flat
Rocky Type:
Community: VdCd
Vegetation Condition: E.

Soil Types: Sand
Soil Colour: Grey
Soil Condition: Dry
Fire History: 10+



Taxon	Cons. Code	Height (cm)	% Alive
Agrostocrinum scabrum		30	0.1
Allocasuarina humilis		60	1
Anigozanthos manglesii		60	0.2
Babingtonia camphorosmae		30	0.2
Banksia dallanneyi var. *dallanneyi*		20	0.1
Bossiaea eriocarpa		30	0.2
Briza maxima	*	30	0.2
Burchardia congesta		40	0.2
Caustis dioica		50	10
Cheiranthera preissiana			0.1
Conostylis aurea		15	0.2
Dasypogon bromeliifolius		30	1
Daviesia angulata		90	8
Daviesia preissii			Oppo
Desmocladus fasciculatus		10	0.1
Eucalyptus marginata subsp. *marginata*		2500	5
Gastrolobium capitatum		20	0.2
Gladiolus caryophyllaceus	*	40	0.2
Goodenia caerulea		15	0.1
Grevillea bipinnatifida subsp. *bipinnatifida*		30	0.6
Haemodorum laxum		80	0.1
Hibbertia hypericoides		50	0.4
Hyalosperma cotula		10	0.1
Hypocalymma angustifolium		50	3
Hypolaena exsulca		20	0.4
Hypolaena exsulca		30	0.2
Lyginia barbata		40	1
Mesomelaena tetragona		70	3
Patersonia occidentalis		30	2
Philotheca spicata		60	0.3
Scaevola repens var. *repens*		10	0.2
Stirlingia latifolia		50	0.5
Boronia ramosa subsp. *anethifolia*		20	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria octandra		40	2
Thysanotus patersonii			0.1
Tricoryne elatior		20	0.6
Verticordia densiflora var. *densiflora*		50	1
Xanthorrhoea preissii		80	2
Xanthosia huegelii		15	0.2

Site No: HW09	Type: Quadrat	Longitude: 116.007428	Latitude: -31.956075
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition:			

Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		80	0.6
Adenanthos cygnorum subsp. *cygnorum*		200	
Alexgeorgea nitens		10	0.2
Allocasuarina fraseriana		600	10
Allocasuarina humilis			Oppo
Anigozanthos manglesii		60	0.2
Avena barbata	*		Oppo
Banksia armata var. *armata*			Oppo
Banksia attenuata		400	
Banksia dallanneyi var. *dallanneyi*		20	1
Bossiaea eriocarpa		40	2
Briza maxima	*	20	0.2
Burchardia congesta		50	0.2
Caesia micrantha			Oppo
Calothamnus torulosus		30	0.2
Caustis dioica		50	8
Conostephium pendulum			Oppo
Conostylis setigera		15	0.1
Cyathochaeta avenacea		110	0.4
Dampiera linearis		15	0.1
Dasypogon obliquifolius		30	0.5
Daviesia angulata		60	0.4
Daviesia nudiflora subsp. *nudiflora*			Oppo
Desmocladus fasciculatus		10	1
Ehrharta calycina	*		Oppo
Gastrolobium capitatum		30	0.5
Gladiolus caryophyllaceus	*	50	0.2
Haemodorum laxum		130	2
Haemodorum spicatum			Oppo
Hakea conchifolia		60	0.4
Hemiandra linearis			Oppo
Hemiphora bartlingii			Oppo
Hibbertia hypericoides		60	20
Jacksonia lehmannii		25	0.1
Lambertia multiflora		150	8
Lechenaultia biloba			Oppo
Lepidosperma leptostachyum		40	0.5

Taxon	Cons. Code	Height (cm)	% Alive
Lomandra sericea		30	0.4
Lyginia barbata		40	0.2
Mesomelaena pseudostygia		50	6
Mesomelaena tetragona		50	2
Monotaxis grandiflora var. *grandiflora*			Oppo
Nuytsia floribunda		700	2
Patersonia occidentalis			Oppo
Petrophile macrostachya		50	0.8
Philotheca spicata		60	0.2
Pimelea ciliata subsp. *ciliata*		50	0.1
Scaevola repens var. *repens*		10	0.2
Schoenus brevisetis		40	0.4
Stylidium piliferum		10	0.1
Isopogon drummondii	P3		Oppo
Synaphea sp.			Oppo
Thomasia macrocarpa			Oppo
Thysanotus arbuscula		20	0.2
Vellereophyton dealbatum		5	0.1
Xanthorrhoea preissii		120	1

Site No: HW10	Type: Quadrat	Longitude: 116.008553	Latitude: -31.957151
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmAcMt		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. *pulchella*		100	1.5
Alexgeorgea nitens		10	0.2
Allocasuarina humilis		80	4
Banksia armata var. *armata*			Oppo
Banksia attenuata		400	1
Banksia dallanneyi var. *dallanneyi*		10	1
Banksia menziesii		500	15
Banksia sphaerocarpa		40	1
Bossiaea eriocarpa		30	0.5
Briza maxima	*	30	0.1
Burchardia congesta		40	0.1
Calothamnus torulosus			
Conospermum undulatum		80	0.2
Conostephium pendulum		50	0.2
Conostylis aurea			Oppo
Dasypogon obliquifolius		20	1
Daviesia nudiflora subsp. *nudiflora*		40	0.2
Desmocladus fasciculatus		10	0.1
Eremaea pauciflora var. *pauciflora*		40	2
Eucalyptus marginata subsp. *marginata*		2000	10
Gastrolobium capitatum			Oppo
Gladiolus caryophyllaceus	*	40	0.2
Haemodorum laxum			Oppo
Haemodorum sp.		10	0.1
Hemiandra pungens			Oppo
Hibbertia hypericoides		40	8
Jacksonia floribunda		50	0.2
Lambertia multiflora		100	2
Lepidosperma leptostachyum		40	2
Leucopogon sp.		40	0.1
Lomandra sericea		30	0.1
Lyginia barbata		40	1
Melaleuca trichophylla		40	3
Mesomelaena pseudostygia		40	1
Monotaxis grandiflora var. *grandiflora*		5	0.2
Patersonia occidentalis			Oppo
Petrophile macrostachya		50	1.5

Taxon	Cons. Code	Height (cm)	% Alive
Scaevola repens var. *repens*		15	0.3
Stirlingia latifolia		40	1
Isopogon drummondii	P3	80	3
Synaphea sp.		50	0.5
Tricoryne elatior		30	0.7
Tricostularia exsul		40	10
Xanthorrhoea preissii		90	1

Site No: HW11	Type: Releve	Longitude: 116.009061	Latitude: -31.957063

Date: 11/23/2016
Topography: Flat
Rocky Type:
Community: EmToDo
Vegetation Condition: E.

Soil Types:
Soil Colour:
Soil Condition:
Fire History:

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		1300	15
Allocasuarina humilis		60	0.5
Banksia sphaerocarpa		50	0.5
Bossiaea eriocarpa		30	1
Burchardia congesta		40	0.3
Cheiranthera preissiana			0.1
Eucalyptus marginata subsp. *marginata*		1600	20
Gladiolus caryophyllaceus	*	40	0.1
Gompholobium knightianum		40	0.1
Hakea conchifolia		70	0.2
Hemiandra pungens			Oppo
Lyginia barbata			Oppo
Mesomelaena pseudostygia		40	10
Nuytsia floribunda		200	1
Patersonia occidentalis		30	1
Petrophile macrostachya		200	1
Scaevola repens var. *repens*		10	0.5
Tetraria octandra		30	20
Xanthorrhoea preissii		90	2

Site No: HW12r	Type: Releve	Longitude: 116.005128	Latitude: -31.960586
Date: 11/28/2016		Soil Types: Loam sand	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: VG.			

Taxon	Cons. Code	Height (cm)	% Alive
Acacia sp.	PI		Oppo
Adenanthos cygnorum subsp. *cygnorum*			Oppo
Allocasuarina fraseriana		400	10
Allocasuarina humilis			Oppo
Asteraceae (planted)	PI	60	2
Banksia attenuata		350	8
Banksia dallanneyi		30	4
Banksia grandis		60	0.1
Banksia menziesii		400	2
Banksia sessilis var. *sessilis*			Oppo
Briza maxima	*	40	2
Conostephium pendulum			Oppo
Dampiera linearis		20	0.2
Dasypogon bromeliifolius		30	0.2
Dasypogon obliquifolius			Oppo
Desmocladus fasciculatus			Oppo
Eucalyptus marginata subsp. *marginata*		700	40
Haemodorum laxum			Oppo
Hibbertia hypericoides			Oppo
Hypochaeris glabra	*		0.5
Lambertia multiflora			Oppo
Lepidosperma leptostachyum		40	2
Mesomelaena tetragona			Oppo
Patersonia occidentalis		40	0.2
Persoonia elliptica		400	3
Petrophile macrostachya			Oppo
Stirlingia latifolia		40	0.2
Isopogon drummondii	P3	80	0.2
Tetraria octandra		40	10
Tricostularia exsul			Oppo
Xanthorrhoea preissii		100	0.5

Site No: HW13	Type: Quadrat	Longitude: 116.006285	Latitude: -31.959895
Date: 11/28/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		400	15
Banksia dallanneyi var. *dallanneyi*		30	10
Banksia grandis			Oppo
Bossiaea eriocarpa		40	1
Briza maxima	*	30	3
Burchardia congesta		40	0.2
Conospermum undulatum		100	0.4
Conostephium pendulum		40	0.1
Cyathochaeta avenacea		70	0.2
Dampiera alata		20	0.1
Dampiera linearis		15	0.2
Dasypogon obliquifolius		40	2
Daviesia divaricata		20	0.1
Daviesia nudiflora subsp. *nudiflora*		50	0.3
Desmocladus fasciculatus		10	1
Ehrharta calycina	*	80	0.1
Eucalyptus marginata subsp. *marginata*		1800	10
Gladiolus caryophyllaceus	*	60	0.1
Gompholobium knightianum		20	0.2
Gompholobium tomentosum		40	0.2
Haemodorum laxum		100	0.2
Hakea conchifolia			Oppo
Hemiandra pungens		20	1
Hemiphora bartlingii			Oppo
Hibbertia hypericoides		20	0.5
Lambertia multiflora		160	8
Lechenaultia biloba		5	0.1
Lepidosperma leptostachyum		50	2
Leucopogon ?conostephioides		30	0.2
Lomandra preissii		20	0.1
Lyginia barbata		40	0.5
Melaleuca trichophylla		50	0.5
Mesomelaena pseudostygia		40	4
Mesomelaena tetragona		40	0.5
Monotaxis grandiflora var. *grandiflora*		20	0.1
Opercularia vaginata		30	0.1
Patersonia occidentalis		30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Persoonia elliptica			Oppo
Petrophile linearis		15	0.2
Pimelea ciliata subsp. *ciliata*		30	0.2
Scaevola repens var. *repens*		10	0.2
Stirlingia latifolia			Oppo
Boronia ramosa subsp. *anethifolia*		20	0.1
Synaphea sp.		30	0.3
Tetraria octandra		40	8
Tricoryne elatior		20	0.2
Tricostularia exsul		60	2
Vellereophyton dealbatum		5	0.1
Xanthorrhoea acanthostachya		70	0.3
Xanthorrhoea preissii		80	8

Site No: HW14r	Type: Releve	Longitude: 116.007548	Latitude: -31.958775
Date: 11/29/2016		Soil Types:	
Topography: Flat		Soil Colour:	
Rocky Type:		Soil Condition:	
Community: EmAcMt		Fire History:	
Vegetation Condition: G.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		350	15
Alexgeorgea nitens			Oppo
Allocasuarina fraseriana			Oppo
Allocasuarina humilis		40	0.2
Amphipogon strictus		20	0.5
Banksia attenuata			Oppo
Banksia dallanneyi var. *dallanneyi*		20	0.5
Banksia menziesii		400	5
Billardiera fraseri			0.2
Briza maxima	*	30	5
Cyathochaeta avenacea		130	0.3
Dasypogon obliquifolius			Oppo
Daviesia preissii		60	0.2
Desmocladus fasciculatus			Oppo
Ehrharta calycina	*	100	20
Eremaea pauciflora var. *pauciflora*		30	5
Eucalyptus marginata subsp. *marginata*		700	5
Gladiolus caryophyllaceus	*		Oppo
Haemodorum spicatum		100	0.1
Lambertia multiflora		220	0.5
Lyginia barbata		40	0.5
Melaleuca trichophylla		40	6
Mesomelaena pseudostygia		50	3
Nuytsia floribunda		400	Oppo
Petrophile linearis			Oppo
Ptilotus manglesii		30	0.5
Stirlingia latifolia		40	2
Boronia ramosa subsp. *anethifolia*			Oppo
Tricoryne elatior		30	0.5
Ursinia anthemoides	*		Oppo
Vellereophyton dealbatum			Oppo
Xanthorrhoea preissii		70	1

Site No: HW15r	Type: Releve	Longitude: 116.008478	Latitude: -31.95808
Date: 11/29/2016		Soil Types:	
Topography: Flat		Soil Colour:	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina humilis		100	1
Banksia attenuata			Oppo
Banksia dallanneyi var. *dallanneyi*		20	5
Banksia menziesii			Oppo
Bossiaea eriocarpa		30	8
Burchardia congesta		60	0.1
Caustis dioica		30	1
Dasypogon obliquifolius		30	4
Desmocladus fasciculatus		20	0.2
Ehrharta calycina	*	80	1
Eucalyptus marginata subsp. *marginata*		800	25
Gastrolobium capitatum		40	0.2
Gladiolus caryophyllaceus	*	70	0.2
Gompholobium knightianum			Oppo
Hakea costata		220	0.5
Hibbertia hypericoides		30	0.5
Lambertia multiflora		160	1
Lepidosperma leptostachyum		60	2
Melaleuca trichophylla		40	2
Mesomelaena tetragona		50	10
Opercularia vaginata		30	0.3
Patersonia occidentalis		40	1
Petrophile macrostachya		100	1
Petrophile linearis			Oppo
Philotheca spicata		50	0.2
Schoenus brevisetis		30	1
Stirlingia latifolia		40	0.5
Tetraria octandra		30	1
Tricostularia exsul		60	1
Xanthorrhoea acanthostachya		100	1
Xanthorrhoea preissii		100	5

Site No: HW16	Type: Quadrat	Longitude: 116.004122	Latitude: -31.960853
Date: 11/29/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Alexgeorgea nitens		10	0.2
Allocasuarina fraseriana		600	10
Allocasuarina humilis		40	0.2
Banksia attenuata		600	5
Banksia dallanneyi var. *dallanneyi*		20	5
Banksia menziesii		300	10
Bossiaea eriocarpa		30	3
Burchardia congesta		40	0.2
Caesia micrantha		30	0.1
Conostephium pendulum		30	0.2
Cyathochaeta avenacea		70	1
Dampiera linearis		20	0.5
Dasypogon obliquifolius		50	4
Daviesia nudiflora subsp. *nudiflora*			Oppo
Daviesia preissii			Oppo
Eucalyptus marginata subsp. *marginata*		800	8
Gastrolobium capitatum		30	1
Haemodorum laxum		80	0.2
Hemiandra pungens		20	2
Hemiphora bartlingii		20	0.3
Hibbertia hypericoides		40	4
Hypolaena exsulca		40	1
Lambertia multiflora		160	6
Lechenaultia biloba		10	0.1
Lomandra preissii		30	0.2
Mesomelaena tetragona		40	10
Patersonia occidentalis		30	0.5
Persoonia elliptica		400	0.5
Petrophile linearis		20	0.1
Pimelea ciliata subsp. *ciliata*		30	0.2
Scaevola repens var. *repens*		10	0.2
Schoenus brevisetis		30	1
Stachystemon vermicularis		60	3
Stirlingia latifolia		50	3
Isopogon drummondii	P3	60	0.5
Synaphea sp.			Oppo

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria octandra		40	5
Thysanotus arbuscula		10	0.1
Tricostularia exsul		60	4
Xanthorrhoea preissii		100	8
Xylomelum occidentale		400	1.5

Site No: HW17	Type: Quadrat	Longitude: 116.001698	Latitude: -31.957207
Date: 11/29/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: VG. Weeds, edge effect			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		600	10
Anigozanthos manglesii		100	0.2
Babingtonia camphorosmae		40	0.5
Banksia dallanneyi var. *dallanneyi*		30	8
Bossiaea eriocarpa		20	1
Briza maxima	*	30	1
Conospermum undulatum		130	0.3
Dampiera alata		10	0.2
Dampiera linearis		10	0.2
Dasypogon obliquifolius			Oppo
Daviesia preissii			Oppo
Ehrharta calycina	*	120	1
Eucalyptus marginata subsp. *marginata*		2000	20
Gastrolobium capitatum		30	1
Gladiolus caryophyllaceus	*	70	0.5
Haemodorum laxum		120	0.5
Hibbertia hypericoides		40	3
Lambertia multiflora		110	0.3
Lepidosperma leptostachyum		40	3
Lomandra sericea		30	0.2
Mesomelaena tetragona		40	4
Monotaxis grandiflora var. *grandiflora*		15	1
Opercularia vaginata		30	0.2
Persoonia elliptica		300	2
Scaevola repens var. *repens*		10	0.2
Stirlingia latifolia		40	1
Boronia ramosa subsp. *anethifolia*		10	0.3
Tetraria octandra		30	5
Thysanotus arbuscula		20	0.1
Tricoryne elatior		20	0.2
Xanthorrhoea gracilis		60	3
Xanthosia huegelii		30	0.3

Site No: HW18r	Type: Releve	Longitude: 116.006067	Latitude: -31.958544
Date: 11/30/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Medium Brown	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: VG.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. cygnorum		300	1
Allocasuarina fraseriana		500	3
Banksia armata var. armata		50	1
Banksia dallanneyi var. *dallanneyi*		20	0.5
Banksia menziesii			Oppo
Bossiaea eriocarpa		20	0.5
Briza maxima	*	40	0.5
Caustis dioica		30	0.4
Conostylis aurea		30	0.1
Cyathochaeta avenacea		120	0.5
Dasypogon obliquifolius		30	1
Daviesia nudiflora subsp. *nudiflora*		40	0.5
Desmocladus fasciculatus		10	0.1
Ehrharta calycina	*	80	4
Eucalyptus gomphocephala		1500	1
Eucalyptus marginata subsp. *marginata*		800	25
Gastrolobium capitatum		30	0.5
Gladiolus caryophyllaceus	*	100	0.3
Gompholobium knightianum		30	0.2
Haemodorum laxum		160	0.2
Haemodorum sp.		30	0.1
Hemiandra linearis		10	0.01
Hibbertia hypericoides		50	1
Lambertia multiflora		120	0.5
Lepidosperma leptostachyum		50	0.1
Lomandra preissii		30	0.5
Lyginia barbata		50	0.2
Mesomelaena pseudostygia		40	4
Microtis media		20	0.01
Patersonia occidentalis		40	0.2
Petrophile linearis		40	0.2
Scaevola repens var. *repens*			Oppo
Isopogon drummondii	P3	100	0.3

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria octandra		40	5
Tricoryne elatior		30	0.1
Tricostularia exsul		80	8
Ursinia anthemoides	*	15	0.02
Verticordia densiflora var. *densiflora*		150	0.5
Xanthorrhoea preissii		100	4

Appendix C AECOM (2017b) Floristic Community Type Analysis

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Shire of Kalamunda
29-Sep-2017

DRAFT

Floristic Community Type Analysis

Forrestfield North Detailed Flora and Vegetation Assessment

D R A F T

Floristic Community Type Analysis

Forrestfield North Detailed Flora and Vegetation Assessment

Client: Shire of Kalamunda

ABN: 60 741 095 678

Prepared by

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Quality Information

Document Floristic Community Type Analysis

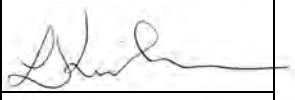
Ref 60527304

Date 29-Sep-2017

Prepared by F de Wit

Reviewed by L Kirchner

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	28-Sep-2017	Draft	Linda Kirchner Associate Director - Environment	
B	28-Sep-2017	Draft for Review	Linda Kirchner Associate Director - Environment	
C	29-Sep-2017	Draft for Client Review	Linda Kirchner Associate Director - Environment	

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Executive Summary

The Shire of Kalamunda required Floristic Community Type (FCT) analysis to determine the significance of native vegetation at the State level within a defined survey area in Forrestfield. Quadrat data from the 2016 Level 2 Flora and Fauna Assessment (AECOM, 2016) was assessed against the Keighery (2012) Swan Coastal Plain dataset to infer the relevant FCT.

Firstly a review of the desktop study and historical surveys was undertaken. This provided an overview of existing environment and potential State significant vegetation communities that may be present. Four communities listed as Threatened Ecological Communities (TECs) were considered to potentially occur within the survey area, including:

- FCT3a *Corymbia calophylla – Kingia australis* Woodlands on Heavy Soils
- FCT3c *Corymbia calophylla – Xanthorrhoea preissii* Woodlands and Shrublands
- FCT7 Herb-rich Saline Shrublands in Clay Pans
- FCT20a *Banksia attenuata* Woodlands over Species Rich Dense Shrublands.

Another two significant communities listed by Department of Biodiversity, Conservation and Communities (DBCA) were identified:

- FCT2 Southern Wet Shrublands
- Banksia Dominated Woodlands of the Swan Coastal Plain.

Within the survey area three Banksia/Jarrah Woodlands, one heath community, and one riparian community represented native vegetation. These were represented by 12 quadrats. These quadrats were individually compared to the SCP dataset. All quadrats showed the highest similarity to those in the SCP dataset representing FCT20a *Banksia attenuata* Woodlands over Species Rich Dense Shrublands. Similarities differed from 32-52%. The low similarity is likely to be a reflection of the single scoring event and limited time spent at each quadrat (<1 hr). This FCT represents an Endangered TEC at both the State and Federal level.

Verification of the Banksia Woodlands of the SCP was also undertaken. The native vegetation within the survey area was divided into five patches and each assessed against the key diagnostic criteria, condition assessment and minimum patch size. All patches met most of the diagnostic criteria with the exception of the overstorey dominance/co-dominance aspect. The vegetation within the survey area was dominated by *Eucalyptus marginata* and *Allocasuarina fraseriana* with less *Banksia attenuata/Banksia menziesii*, or sometimes these species were absent. Despite this, the desktop study found multiple known locations of the Banksia Woodland TEC within the survey area, indicating that all native vegetation in Good or better condition represents this Federally listed TEC. In this case, the lack of a dominant *Banksia* tree stratum appears to have no effect on the presence of this TEC.

This leads back to the FCT analysis. Perhaps the location of the survey area on the eastern SCP presents a unique composition of overstorey species which has led to the lower similarity of survey quadrats to SCP quadrats representing FCT20a. Furthermore, the desktop study found numerous locations of the Priority 3 Banksia Dominated Woodlands within the survey area. Despite this, all quadrats were aligned with FCT20a. Lacking key diagnostic characteristics for the Priority community, it is uncertain what the differentiating factor is between FCT20a and the Banksia Dominated Woodlands. Consultation with DBCA was undertaken however the response was inconclusive. Both represent the Federally listed Banksia Woodlands.

In conclusion, all native vegetation in Good or better condition within the survey area is considered to represent the Federally listed Banksia Woodlands of the SCP. FCT analysis indicates that this same extent represents the State listed TEC FCT20a.

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1.0 Introduction

1.1 Background

The Shire of Kalamunda is proposing to re-zone an area currently zoned as urban-deferred. Part of this process will require subdivision of properties and clearing of native vegetation for urban development. A detailed flora and vegetation assessment, and a level 1 fauna assessment (including Black Cockatoo survey) was undertaken in November 2016. At this time, the Federally listed Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (Banksia Woodland TEC) was identified and mapped, and a number of Floristic Community Types (FCTs) have been referenced as potentially occurring in the survey area.

To further support the Banksia Woodlands TEC mapping, and assess the local and regional significance of vegetation on the Swan Coastal Plain (SCP), FCT analysis is required. FCT analysis is undertaken using a statistical program to assess the similarity of quadrat data obtained from the 2016 survey to the comprehensive SCP dataset. This report includes an overview of the desktop study, the results of the FCT analysis and a more comprehensive Banksia Woodlands assessment. FCT analysis is important on the Swan Coastal Plain as it provides a comparable dataset to determine relative species richness and local and regional significance of the patch at State-level by determining the TEC/PEC status.

1.2 Location

The survey area is located between Maida Vale Road (north), Dundas Road (west), Sultana Road West (south) and Roe Highway (east) in the suburb of High Wycombe. It includes 144 ha of land, of which 116.2 ha is cleared and 27.80 ha is considered native vegetation. The location and extent of the survey area is shown in Figure 1.

1.3 Scope of work

The objective of the FCT analysis is to determine the significance of native vegetation within the survey area at the State level. Specifically:

- Vegetation quadrats from the 2016 Assessment were compared to the SCP dataset
- Analysis in accordance with the draft DPaW statistical analysis methods (2015) was undertaken to identify quadrats in the SCP dataset that are most similar to quadrats within the survey area
- The analysis outcomes were used to identify the FCT most representative of the vegetation types.

PROJECT ID	60507828
CREATED BY	RNM
APPROVED BY	FdeWit
LAST MODIFIED	20 JAN 2017

AECOM
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1:12,500 when printed at A4
DATUM GDA 1994, PERTH COASTAL GRID94
0 100 200 300 400
Meters

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).

LEGEND
- Survey Area
- Highway
- Minor Road

Survey Area

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure 1

Map Document: P:\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig1_SurveyArea_v2_A4.mxd (fotheringhamd)

A4 size

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2.0 Methods

2.1 Floristic Community Type Analysis

A detailed flora and vegetation survey was undertaken in November 2016 (Forrestfield North Level 2 Flora and Fauna Survey; AECOM, 2016). At this time floristic data was collected from 12 quadrats and six relevés. Floristic quadrat data is presented in Appendix A. Relevé data was not further considered as it is not suitable for statistical analysis at this level (DPaW, 2015). Quadrats within the survey area were subject to one scoring event. This deviates from the two events recommended in the DPaW FCT draft analysis methods (2015) and it may cause a low similarity and reduce compatibility of the datasets.

The Keighery (2012) SCP dataset was used for the FCT analysis. A sub-set of this data was defined using a 25 km radius from the survey area. This reduces 'noise' in the data analysis from quadrats located a considerable distance away. It also excludes FCTs that do not occur in the local area. The subset includes 261 SCP quadrats representing 43 FCTs.

The survey area data was reconciled with this dataset and all species coded using the three first letters of the genus and species, reducing infra-specific names. All nomenclature of species followed the WA Plant Census.

The program PC Ord was used to undertake the Bray Curtis distance measure. The Bray Curtis dissimilarity measure was used to quantify the compositional dissimilarity between the quadrats based on presence absence data. Subtracting the results from 1 gives the similarity index, also known as the Bray Curtis index. This method is easily interpretable and provides meaningful results. A sense check was completed incorporating appropriate geology, soils, landscape and the description provided in the Gibson *et al.* (1994) reference material and Bush Forever (Government of WA, 2000).

2.2 Banksia Woodlands of the Swan Coastal Plain verification

Within the survey area native vegetation was separated into five patches. Patches were based on areas that were, at least for the most part, isolated from other areas of native vegetation and in Good or better condition. This approach was used in order to further refine condition categories and potentially inform management actions. Another option would have been to assess the area as one patch. The defined patches comprise of multiple vegetation communities as mapped in the AECOM (2016) report.

The Threatened Species Scientific Committee (TSSC) developed a comprehensive conservation advice document (2016) which provides a detailed description, methods for identifying the community, current threats, research priorities and conservation actions required. Identifying this community is described in detail using four steps:

- Step 1: use key diagnostic characteristics to determine if TEC is present
- Step 2: determine condition of patch
- Step 3: consider if patch meets minimum size threshold
- Step 4: surrounding context of a patch must be taken into account when considering factors that add to the importance of a patch that meets the condition thresholds.

The key diagnostic characteristics summarise the main features that characterise the Banksia Woodland. The condition categories are applied to identify the varying quality of patches, usually as a result of degradation, and ensure that patches of high quality are considered a Matter of National Significance (MNES). The condition of the patch is informed by species richness of quadrat data compared to available datasets, most notably the Gibson *et al.* (1994) and Keighery *et al.* (2012) Swan Coastal Plain datasets, and weed cover. The condition of the patch and size thresholds are then used to determine whether the quality of the patch is suitable to meet MNES standards.

Floristic data collected from permanent quadrats should be used to inform the TEC assessment. This will not only support the condition category assessment, but also identify the associated Floristic Community Type (FCT) that is inferred for these quadrats.

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2.2.1 Key Diagnostic Features

Key diagnostic characteristics
Location and physical environment
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.
Soils and landform
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.
Structure: The structure of the ecological community is a low woodland to forest with the following features:
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of a layer of sclerophyllous shrubs of various heights and a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.
Composition
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: · *Banksia attenuata* · *Banksia menziesii* · *Banksia prionotes* · *Banksia ilicifolia.* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*.
Contra-indicators
Patches clearly dominated by *Banksia littoralis* are not part of the TEC
Patches clearly dominated by *Banksia burdettii* are not the TEC
FCT 20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.

2.2.2 Condition assessment

The condition of vegetation of each patch needs to be determined in accordance with the following:

- The condition assessment of a patch should be centred on the area of highest native floristic diversity and/or cover of the patch
- Timing of surveys and recent disturbance should be taken into account
- Surrounding context of a patch should be considered
- Certain vegetation components of Banksia Woodlands community merit consideration as critical elements to protect. Three components are recognised as threatened in their own right i.e. Priority Ecological Communities
- A relevant expert may be useful to help identify the ecological community and its condition
- Vegetation must be in 'Good' or better condition in accordance with Table 1.

Table 1 Condition Table

Keighery (1994) Vegetation Condition Scale	Indicative condition measures/thresholds	
	Typical native vegetation composition	Typical weed cover
Pristine No obvious signs of disturbance.	Native plant species diversity fully retained or almost so[1]	Zero or almost no weed cover/abundance
Excellent Vegetation structure intact, disturbance only affecting individual species, weeds are non-aggressive species.	High native plant species diversity[1]	Less than 10%
Very Good Vegetation structure altered, obvious signs of disturbance (e.g. repeated fires, dieback, logging, grazing). Aggressive weeds present.	Moderate native plant species diversity[1]	5 – 20%
Good Vegetation structure altered but retains basic vegetation structure or ability to regenerate it. Obvious signs of disturbance (from partial clearing, dieback, logging, grazing). Presence of very aggressive weeds.	Low native plant species diversity[1]	5 – 50%
Degraded Basic vegetation structure severely impacted by disturbance. Requires intensive management. Disturbance evident such as partial clearing, dieback, logging and grazing. Presence of very aggressive weeds at high density.	Very low native plant species diversity[1]	20 – 70%
Completely Degraded Vegetation structure is no longer intact and the area is completely or almost completely without native flora. Equivalent to 'Parkland Cleared'.	Very low to no native species diversity[1]	Greater than 70%

1. relative to expected natural range of diversity for that vegetation unit e.g. Floristic Community Type where comparative data exists.

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2.2.3 Patch size thresholds

Different minimum patch sizes apply to different levels of condition, as outlined below:

- Pristine – no minimum patch size
- Excellent – 0.5 ha or 5,000 m^2 (50 x 100 m)
- Very Good – 1 ha or 10,000 m^2 (100 x 100 m)
- Good – 2 ha or 20,000 m^2 (200 x 100 m).

2.2.4 Additional information

The following information should be taken into consideration when applying the key diagnostic criteria and condition thresholds:

- Land use history and landscape position of patch including position relative to surrounding vegetation
- A patch is a discreet and mostly continuous area of the ecological community and may include small-scale variations (<30 m), gaps and disturbances such as tracks paths or breaks that do not significantly alter the overall functionality of the ecological community.
- Variation in canopy cover, quality or condition of vegetation across a patch should not be considered evidence of multiple patches
- A buffer zone is a contiguous area immediately adjacent to a patch of the ecological community. The recommended minimum buffer zone is 20-50 m. Larger buffer zones should be considered for patches of particularly high conservation value, or if patches are down slope of drainage lines or a source of nutrient enrichment, or groundwater drawdown.
- Restored vegetation is not excluded provided it meets the key diagnostic criteria, condition threshold and patch size.
- Sampling protocols includes developing a quick map of the vegetation, landscape qualities and management history. Following this, a thorough sampling exercise must be undertaken to represent the range of variation. At least one hour per plot in early to mid-spring and a second survey in late spring may be required to detect the majority of species. plots to be at least 100 m^2 (10 x 10 m). Search effort (number of person hours per plot across entire patch) and surveyor's level of expertise can be useful for future reference.
- Timing of surveys should allow a reasonable interval after a disturbance. Surveys at least one year post fire may be required to assess a site against the key diagnostic characteristics and minimum condition thresholds.
- Surrounding environment, landscape context and other significance considerations:
  - patches that are more species rich and less disturbed are likely to provide greater biodiversity value
  - patches that provide corridors or linkages within a largely modified landscape are particularly important.

The Conservation Advice provides an additional ten indicators to be considered when assessing impacts of actions or proposed actions under the EPBC Act. These are not further listed here.

2.2.5 Protected in reserves

The level of protection in reserves has been published based on estimated extent of major and partially corresponding vegetation system associations. This is shown in Table 2.

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Table 2 Extent of Banksia Woodlands ecological community estimated to be protected in reserves

Subregion	Current extent (ha)	Extent in reserves (ha)	% Protected
Dandaragan (SWA01)	81,067.8	24,671.2	30.43
Perth (SWA02)	253,540.6	57,054.9	22.50
Jarrah Forests (JAF01/02)	1,881.4	105.9	5.63
TOTAL	**336,489.9**	**81,832.0**	**24.32**

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3.0 Summary of Historical Surveys

3.1 Threatened and Priority communities

A desktop review was undertaken as part of this report to provide a comprehensive overview of the potential threatened ecological communities that may occur within the survey area. The desktop study took into account the government database results undertaken as part of the detailed flora and vegetation assessment (AECOM, 2016), the Strategen (2012) Environmental Review document and the Keighery (2012) Floristic Community Type dataset. The Keighery (2012) dataset was consulted within 4km of the survey area to identify potential significant communities that occur in close proximity of the survey area. A summary of the results is presented in Table 3.

Table 3 Threatened communities identified in the desktop study informed by various sources

FCT	Community Name	Cons. Status		Source
		DBCA	EPBC Act	
2	Southern Wet Shrublands	Endangered	-	Keighery
3a	*Corymbia calophylla – Kingia australis* Woodlands on Heavy Soils	Critically Endangered	Endangered	Keighery Strategen
3c	*Corymbia calophylla – Xanthorrhoea preissii* Woodlands and Shrublands	Critically Endangered	Endangered	Strategen
7	Herb-rich Saline Shrublands in Clay Pans	Vulnerable	Critically Endangered	Keighery
20a	*Banksia attenuata* Woodlands over Species Rich Dense Shrublands	Endangered	Endangered	Database, Keighery
?	Banksia Dominated Woodlands of the Swan Coastal Plain.	Priority 3		Database

Southern wet shrublands is listed by DBCA as Endangered. It is known in the vicinity of the survey area from one location on the corner of Roe Highway and Tonkin Highway. This community is described by Gibson *et al.* (1994) as shrublands or open low woodlands occurring on seasonally inundated sandy clay soils.

The ***Corymbia calophylla – Kingia australis*** **Woodlands TEC** occurs on the eastern side of the Swan Coastal Plain. The floristic composition varies with water regime across its distribution (DotEE, 2017a). The community is associated with areas where groundwater is less than 3m from the natural ground surface, indicating a high level of dependence on groundwater. There are 41 occurrences of this community extending across 192.5 ha between Ruabon and Guildford. There is one occurrence of this community within 1.3km of the survey area, located east of Roe Highway associated with Bush Forever Site 319 Dundas Road Bushland. Due to its restricted distribution, no condition thresholds are applicable to this community, with all areas meeting the description are considered habitat critical to the survival of this community.

The ***C. calophylla – Xanthorrhoea preissii*** **Woodlands TEC** is not known to occur within 5km of the survey area. It is known to occur on heavy soils of the eastern side of the Swan Coastal Plain. Dominant species include *C. calophylla,* occasionally *Eucalyptus wandoo*. This community is currently known from 115 ha located between Bullsbrook and Capel. Similarity with this community, due to its restricted distribution, no condition thresholds are applicable to this community.

Herb-rich saline shrublands in claypans are listed under “Clay Pans of the Swan Coastal Plain” federally listed Critically Endangered community. This community is unique in its composition of geophytes and annual flora that germinates, grows and flowers sequentially as the areas dry over summer (TSSC, 2012). This community is located within the Perth Airport land tenement.

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The **Banksia Woodlands TEC**, described by the Threatened Species Scientific Committee (TSSC, 2016) incorporates Woodland of *Banksia* species with scattered eucalypts and other tree species over a species rich mix of sclerophyllous shrubs, graminoids, and forbs. The community shows high endemism and considerable local variation in species composition across its range. It is restricted to the southwest of WA on the Swan Coastal Plain. It occurs mainly on deep Bassendean and Spearwood sands or occasionally on Quindalup sands.

At the State level, this Banksia Woodlands community is represented by a number of FCTs as defined in Bush Forever (Government of WA, 2000) and Gibson *et al.* (1994). Within the survey area, the Banksia Woodlands TEC is represented by FCT20a *Banksia attenuata* woodlands over species rich dense shrublands. This community is listed as an Endangered TEC by Department of Biodiversity, Conservation and Attractions (DBCA). In addition, the TEC is also represented by a Priority 3 ecological community (PEC) listed as 'Banksia Dominated Woodlands of the Swan Coastal Plain'. This community is directly aligned with the EPBC Act listed TEC.

3.2 Vegetation communities

Five vegetation communities were described and mapped within the survey area (Table 4). These encompassed:

- Three *Banksia/E. marginata* Woodlands, AfHhMp, EmAcMt, EmToDo
- one Heath community VaCd
- one Riparian community ErApEh
- one significantly disturbed community, mapped as 'Trees'.

For the purpose of the FCT analysis, only the three Woodlands and one Heath community were included.

Table 4 Vegetation community descriptions recorded and mapped in the survey area including survey effort, species richness and total extent

Community Description	Additional Details
AfHhMp *Allocasuarina fraseriana*, *Banksia attenuata, Banksia menziesii* and occasional *Nuytsia floribunda* low woodland over *Xanthorrhoea preissii, Lambertia multiflora, Adenanthos cygnorum* subsp. *cygnorum* and *Xanthorrhoea acanthostachya* mid sparse shrubland over *Hibbertia hypericoides, Banksia dallanneyi* var. *dallanneyi, Bossiaea eriocarpa, Calothamnus torulosus* and *Petrophile macrostachya* low sparse shrubland with *Mesomelaena pseudostygia, Schoenus brevisetis, Lepidosperma leptostachyum*, *Caustis dioica* and *Tricostularia exsul* tall open sedgeland with *Dasypogon obliquifolius*, *Scaevola repens* var. *repens*, *Haemodorum laxum*, *Gladiolus caryophyllaceus**, *Burchardia congesta* and *Anigozanthos manglesii* low sparse forbland.	Survey effort: four quadrats (1, 4, 6, 9) Species richness: 92 native, seven weed species. Area: 5.5 ha
EmAcMt *Eucalyptus marginata* and *Banksia menziesii* low open woodland over *Adenanthos cygnorum* subsp. *cygnorum*, *Lambertia multiflora* and *Xanthorrhoea acanthostachya* mid open shrubland over *Melaleuca trichophylla*, *Hibbertia hypericoides, Eremaea pauciflora* var. *pauciflora, Allocasuarina humilis* and *Stirlingia latifolia* low shrubland with *Mesomelaena pseudostygia*, *Cyathochaeta avenacea, Tricostularia exsul* and *Lepidosperma leptostachyum* mid to low sedgeland over *Tricoryne elatior, Dasypogon obliquifolius, Lyginia barbata, Scaevola repens* var. *repens, Haemodorum laxum* and *Lomandra sericea* low sparse forbland.	Survey effort: three quadrats (2, 5, 10), one relevè (14). Species richness: 79 native, four weed species, Area: 3.51 ha

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Community Description	Additional Details
EmToDo *Eucalyptus marginata* and *Allocasuarina fraseriana* mid woodland over Banksia *attenuata, Banksia menziesii* and *Persoonia elliptica* low woodland over *Lambertia multiflora* and *Xanthorrhoea preissii* mid open shrubland over *Banksia dallanneyi* var. *dallanneyi, Hibbertia hypericoides, Bossiaea eriocarpa*, *Stirlingia latifolia*, and *Gastrolobium capitatum* low shrubland with *Tetraria octandra, Mesomelaena pseudostygia, Mesomelaena tetragona* and *Lepidosperma leptostachyum* low sedgeland over *Dasypogon obliquifolius*, *Patersonia occidentalis, Dampiera linearis, Haemodorum laxum, Scaevola repens* var. *repens* and *Lomandra preissii* low sparse forbland.	Survey effort: five quadrats (3, 11, 13, 16, 17), three relevès (12, 15 and 18). Species richness: 87 native, eight weed species. Area: 10.32 ha
ErApEh *Corymbia calophylla* and *Eucalyptus rudis* tall woodland over *Trymalium odoratissimum* thicket over *Acacia pulchella*, *Hibbertia hypericoides* and *Xanthorrhoea preissii* mid sparse shrubland over **Ehrharta calycina, *Cynodon dactylon, *Gladiolus caryophyllaceus* and *Tetraria octandra* grassland/herbland on clay soils within Poison Gully.	Area: 0.18 ha
VdCd *Eucalyptus marginata* subsp. *marginata* mid isolated trees over *Verticordia densiflora* var. *densiflora, Daviesia angulata, Hypocalymma angustifolium, Stirlingia latifolium* and *Banksia bipinnatifida* subsp. *bipinnatifida* low open shrubland with *Caustis dioica, Mesomelaena tetragona, Tetraria octandra* and *Schoenus brevisetis* tall open sedgeland over *Patersonia occidentalis, Lyginia barbata, Haemodorum spicatum*, *Tricoryne elatior* and *Anigozanthos manglesii* low open forbland.	Survey effort: two quadrats (7, 8) Species richness: 45 native, five weed species. Area: 2.65 ha

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4.0 Results

4.1 FCT Analysis

The FCT analysis results identified FCT20a Banksia Woodlands over Species-rich Dense Shrublands as the most representative FCT to survey area quadrats. This community is listed as Endangered by DBCA and represents the Banksia Woodlands of the Swan Coastal Plain Federally listed TEC.

Communities AfHhMp and EmAcMr showed a 46-52% similarity to FCT20a, with the three top matches all representing quadrats assigned to FCT20a (Table 5). AfHhMp and EmAcMr have a high species richness (34-67 species/quadrat), low historical disturbance and are mapped in Excellent condition.

EmToDo also shows the highest similarity to quadrats representing FCT20a, however results were lower with 32-47% similarity. Survey quadrats had a species richness slightly lower than the other two Banksia communities at 32-50 species/quadrat. Condition was mapped as Very Good to Excellent.

Gibson *et al.* (1994) describes FCT20a as occurring in deep sands at the base of the Scarp in Forrestfield covering the Southern River unit and Karrakatta unit. This woodland is either represented by *B. attenuata* woodlands or *E. marginata-B. attenuata* woodlands and has an average species richness of 67.4 species/quadrat. The description of this FCT matches those of the three Woodland communities mapped in the survey area.

Some factors that should be considered regarding the moderate percentage similarity include:

- survey quadrats were scored once which is a reduced survey effort compared to the SCP dataset
- the survey was undertaken late in the season (November 2016) which may have affected presence of early-flowering annuals
- more time allowed for each quadrat (1 hour) may have allowed for additional species to be recorded, the survey was very time-restricted.

The inference of FCT20a being present at all patches of native vegetation (represented by a quadrat) in the survey area is contradictory to the desktop study. The database results show 26 locations of the Priority 3 “Banksia Dominated Woodlands” community. This P3 community is not associated with a particular FCT and is therefore difficult to identify. The FCT results therefore imply that the native vegetation represents an Endangered State and Federally listed TEC, however the desktop study implies that only one patch represents FCT20a.

DBCA was consulted to ascertain the difference between the Banksia Dominated Woodland to other FCTs however their response was inconclusive.

Community VcCa had cryptic results that varied between several FCTs, with FCT20a showing the closest resemblance. The other two inferred FCTs are associated with wetland communities and were therefore discounted. However, this community lacked any overstorey species and field observations indicate historical clearing followed by potential rehabilitation of native species? The community is very unique in its composition and implies human-disturbance/influence.

None of the quadrats showed any similarity to quadrats representing FCT2, 3a, 3c, 7, or 20c. For this reason, the other TECs can be excluded from being present in the survey area.

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Table 5 Inferred FCT for Forrestfield North including quadrat condition, species richness h the Project quadrat, the SCP FCT quadrat, and % similarity)

Quadrat	Condition	Sp. Richness	Quadrat (FCT; % similarity)	Review of Result	Final FCT
AfHhMp					
HW01	Excellent	67	Activ03 (20a; 52%) Activ01 (20a; 48%) Wire01 (28; 45%)	Consistent results for all quadrats in this community for FCT20a.	According to database records, this represents the P3 Banksia Woodlands.
HW04	Excellent	48	Activ03 (20a; 45%) APBF-1 (20a; 45%) Activ01 (20a; 43%)		According to database records, this represents the P3 Banksia Woodlands.
HW06	Excellent	34	Activ01 (20a; 41%) APBF-2 (20a; 38%)		According to database records, this represents the P3 Banksia Woodlands.
HW09	Excellent	54	Activ01 (20a; 46%) Activ03 (20a; 45%)		FCT20a *Banksia attenuata* woodlands over species rich dense shrublands.
EmAcMt					
HW02	Excellent	54	Activ01 (20a; 46%) M5303 (20a; 40%)	Consistent results for all quadrats in this community for FCT20a.	FCT20a *Banksia attenuata* woodlands over species rich dense shrublands.
HW10	Excellent	43	Activ01 (20a; 49%) APBF-2 (20a; 47%) APBF-1 (20a; 46%)		
EmToDo					
HW03	Excellent	34	Activ03 (20a; 32%) Hart01 (20a; 31%) APBF-1 (20a; 31%) KING-2 (28; 31%)	Consistent results for all quadrats in this community for FCT20a.	According to database records, this represents the P3 Banksia Woodlands.
HW13	Excellent	50	Activ03 (20a; 47%) M5303 (20a; 43%)		According to database records, this represents the P3 Banksia Woodlands.
HW16	Excellent	41	APBF-1 (20a; 44%) Activ03 (20a; 42%)		According to database records, this represents the P3 Banksia Woodlands.
HW17	Very Good	32	Active03 (20a; 38%) M5303 (20a; 35%)		

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Quadrat	Condition	Sp. Richness	Quadrat (FCT; % similarity)	Review of Result	Final FCT
VcCa					
HW07	Excellent	31	FL-1 (4; 37%) M5302 (20a; 37%) Cavs02 (21a; 31%)	Definitely not 4 *Melaleuca preissiana* damplands.	FCT20a *Banksia attenuata* woodlands over species rich dense shrublands – cryptic as this patch appears to represent historically cleared area.
HW08	Excellent	38	M5302 (S11; 46%) M5303 (20a; 42%)	Definitely not S11 Northern *Acacia rostellifera-Melaleuca acerosa* shrublands.	

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4.2 Banksia Woodlands Assessment

The three Woodland communities mapped within the survey area all appear to meet the Banksia Woodlands of the Swan Coastal Plain Assessment. It should be noted that in all communities, *Eucalyptus marginata* was the dominant tree species, along with dense patches of *Allocasuarina fraseriana*, often forming a top canopy stratum over *Banksia attenuata* and *Banksia menziesii* in lower percentages. This may reflect the location at the foothills.

4.2.1 Banksia Woodland Patch 1

Location	Patch 1 is located on the eastern border of the survey area, bounded by Roe Highway (east) and cleared paddock (west and north) and Conospermum Way (south).
Key diagnostic characteristics	Meets all key diagnostic characteristics.
Condition	Excellent, 92 species recorded in this patch and less than 2% weed cover. Mean species richness was 52 species/quadrat compared to FCT20a at 67.4 species/quadrat, the mean species richness represents 77% of anticipated species richness.
Patch size	2.33 ha
Additional features	The small size of the patch may imply higher risk of degradation from competing land uses. Patch supports population of Threatened *Conospermum undulatum* species.
Land use history	Unknown.
Any variations in patch	The patch comprises of variable condition native vegetation. The roadside vegetation along the south is in Good condition, comprising of a narrow strip of vegetation between cleared paddocks and the road. Several *C. undulatum* species occur in this corridor and therefore was considered important as a link between this patch and the adjacent patch. The remainder of the patch represents intact Excellent vegetation, dissected by one old track. Some weeds and rubbish was evident as a result of edge effects from Roe Highway and the paddocks adjacent. The northern tip is mapped as Degraded as a result of historical clearing and partial regrowth.
Buffer zone present	This patch has no buffer between adjacent conflicting land uses.
Sampling protocol	Assessed based on one scoring event of three quadrats in November, 2016.
Disturbance history	Unknown.
Surrounding environment	Paddock, minor road, and highway roadside. Paddock is proposed for further development.

Key diagnostic characteristics	**Response**
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Located on Forrestfield Complex in the foothills.

D R A F T

Key diagnostic characteristics	Response
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of a layer of sclerophyllous shrubs of various heights and a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.	The overstorey is patchy, varying from 2-20% and includes *E. marginata, A. fraseriana, B. attenuata* and *B. menziesii.* Understorey comprises 41 sclerophyllous shrubs and 35 herbaceous species (total), including 3 rushes and 11 sedges.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: · *Banksia attenuata* · *Banksia menziesii* · *Banksia prionotes* · *Banksia ilicifolia* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*.	Low trees comprising of *B. menziesii* and *B. attenuata* (4-6%) along with *E. marginata* (10-15%) and *A. fraseriana* (2%).
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

D R A F T

4.2.2 Banksia Woodland Patch 2

Location	Patch 2 includes 29, 31, and 37 Brand Road.
Key diagnostic characteristics	It meets all key diagnostic characteristics.
Condition	Very Good. Species richness is moderate with 66 species/3 quadrats, a mean species richness of 37 species/quadrat compared to FCT20a with 67.4 species/quadrat. Weed cover was less than 5%. Condition could potentially be Excellent if another quadrat scoring event was undertaken.
Patch size	2.13 ha
Additional features	Large population of *C. undulatum* present in patch.
Land use history	Unknown.
Any variations in patch	Varied from Very Good to Excellent with degradation caused by firebreak clearing and edge effects of adjacent conflicting land use. Patch represented by AfHhMp and EmAcMt which represents the variation in canopy cover of *E. marginata* and *A. fraseriana* and dominance of sedges and shrubs.
Buffer zone present	No buffer zone present, adjacent land predominantly cleared.
Sampling protocol	Represented by three quadrats (HW04, HW05 and HW06) that have been scored once in November 2016.
Disturbance history	Unknown.
Surrounding environment	Adjacent land represents private property and includes open paddock with scattered native trees, and private gardens comprising of introduced/planted species and housing.

Key diagnostic characteristics	**Response**
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Forrestfield complex on the foothills.

D R A F T

Key diagnostic characteristics	Response
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of a layer of sclerophyllous shrubs of various heights and a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.	Tree stratum varies in co-dominance between *E. marginata* (0-20% at two sample points), *A fraseriana* (0.5-8% at two sample points), *B. attenuata* (2-8% at two sample points), and *B. menziesii* (3% at one sample point). Understorey stratum includes 33 shrub species, 18 herbs and eight ruses and sedges.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: · *Banksia attenuata* · *Banksia menziesii* · *Banksia prionotes* · *Banksia ilicifolia* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*.	Canopy is dominated by *E. marginata* and *A. fraseriana* with variable cover of relevant Banksia species. Other tree species included *B. grandis*.
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

D R A F T

4.2.3 Banksia Woodland Patch 3

Location	63 & 67 Brae Road, and 62, 70 & 78 Brand Road.
Key diagnostic characteristics	Patch is dominated by *E. marginata* and *A. fraseriana* with some areas of *B. menziesii* and very low percent cover of *B. attenuata*.
Condition	Patch is considered in Very Good condition. Species richness was 83 plants/5 sample points. Using quadrat data only, mean species richness was 38 species/quadrat. This is moderate compared to FCT20a at 67.4 species/quadrat. Weeds predominantly below 1% with the exception of one degraded area where Veldt Grass was recorded at 20% cover.
Patch size	2.76 ha
Additional features	Supports population of Threatened *Conospermum undulatum*. Provides linkage from this patch to the adjacent patch (patch 4) separated by degraded vegetation.
Land use history	Unknown.
Any variations in patch	Edge effects have caused minor degradation on edge of Excellent condition vegetation. Patch is represented by all three Banksia woodland communities. Variation is evident in density of *E. marginata, A. fraseriana,* and *Banksia* trees and large variation in understorey dominance between sedges and shrubs.
Buffer zone present	No buffer zone present with the exception of planted road verge and adjacent private property gardens.
Sampling protocol	Patch 3 is represented by thee quadrats including HW9, HW10 and HW11, and two relevés HW14r and HW15r. The quadrats and relevés were scored/sampled once in November 2016.
Disturbance history	Unknown.
Surrounding environment	Patch of vegetation is adjacent to planted gardens, housing infrastructure and roads. In close proximity to Poison Gully riparian vegetation.

Key diagnostic characteristics	**Response**
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Forrestfield Complex, on the foothills.

D R A F T

Key diagnostic characteristics	Response
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of a layer of sclerophyllous shrubs of various heights and a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.	Dominated by *E. marginata* (8-40% at all sample points) and *A. fraseriana* (3-15% at all sample points) with *B. menziesii* (2-10% at two sample points) and some *B. attenuata* (5-8% at two sample points). Understorey is comprised of 38 sclerophyllous shrubs, ten rushes and sedges of variable dominance, and 28 herbs all less than 2% cover.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: · *Banksia attenuata* · *Banksia menziesii* · *Banksia prionotes* · *Banksia ilicifolia* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*; AND	Canopy is dominated by *E. marginata* and *A. fraseriana* at all four sample point locations with patches of relevant *Banksia* species in two of the four sample point locations.
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

D R A F T

4.2.4 Banksia Woodland Patch 4

Location	Patch 4 is nestled between Brae Road, Brand Road, and Sultana Road West.
Key diagnostic characteristics	Overstorey is dominated by *E. marginata* and *A. fraseriana* with 0-15% of *Banksia* species present.
Condition	Patch condition is Very Good to Excellent with low species richness accounting for the lower score. There are 80 species within the patch represented by four sample point locations. Mean species richness is 40 species/quadrat which is moderate compared to FCT20a with 67.4 species/quadrat. Species richness may be higher with another quadrat scoring event. Weed cover is less than 5%.
Patch size	7.00 ha
Additional features	Supports population of Threatened *Conospermum undulatum*. Provides linkage between patch 2, 3 and 5. Plays important habitat corridor role for Bush Forever block located nearby and Poison Gully riparian vegetation.
Land use history	Unknown. Semi-rural development in area has created isolated 'backyard' patches of native vegetation separated by firebreaks, fences, roads and backyards.
Any variations in patch	Highly variable condition reflecting landowner maintenance, historical clearing and low-level grazing from livestock. Firebreaks are prone to erosion as highly mobile sand is exposed, exacerbating degradation in some localised areas. Weed invasion is also significant in some areas.
Buffer zone present	No buffer zone is present.
Sampling protocol	Patch is represented by two quadrats (HW13, HW16) and two relevés (HW12r, HW18r). All sample point locations were subject to one scoring event in November 2016.
Disturbance history	Unknown.
Surrounding environment	The area is surrounded by private properties which include some areas of native vegetation and planted gardens as well as infrastructure.

Key diagnostic characteristics	**Response**
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Crosses from Southern River Complex onto Forrestfield Complex.

D R A F T

Key diagnostic characteristics	Response
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of a layer of sclerophyllous shrubs of various heights and a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.	Dominated by *E. marginata* (8-40%, all sample locations) and *A. fraseriana* (3-15%, all sample locations) with *B. menziesii* (0-10%, two sample locations) and some *B. attenuata* (0-8%, two sample locations). Understorey is comprised of 36 sclerophyllous shrubs, 11 rushes and sedges of variable dominance, and 24 herbs.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: · *Banksia attenuata* · *Banksia menziesii* · *Banksia prionotes* · *Banksia ilicifolia* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*.	Canopy is dominated by *E. marginata* and *A. fraseriana* with patches of relevant *Banksia* species at two of the four sample point locations.
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

D R A F T

4.2.5 Banksia Woodland Patch 5

Location	Patch 5 is located on the north side of Brae Road between Sultana Road West and Stewart Road.
Key diagnostic characteristics	Meets most key diagnostic criteria. As with all other patches in this area, the overstorey is dominated by *E. marginata* with minor areas of *Banksia* if present at all.
Condition	Condition is considered Very Good. Despite the low species richness, this is a direct reflection of sample effort rather than condition of the patch. Species richness is 32 species/quadrat, considered moderate to low compared to FCT20a with 67.4 species/quadrat. Additional quadrats in the patch in Excellent condition vegetation and more scoring events may influence this assessment. Weeds represent less than 3% of total foliage cover, taking into account the quadrat was located away from the edge of the patch.
Patch size	1.08 ha
Additional features	Represents extension of habitat corridor/area between Bush Forever Site, other patches of native vegetation, and Poison Gully.
Land use history	Unknown. Partial clearing for housing and associated infrastructure.
Any variations in patch	Significant variation in condition of native vegetation reflecting landowner use of area and land use history.
Buffer zone present	No buffer zone present.
Sampling protocol	Patch represented by one quadrat, HW17, sampled once in November 2016. Low representation of patch in suitable quadrats is likely to have affected the assessment.
Disturbance history	Unknown.
Surrounding environment	Surrounded by semi-rural urbanisation including gardens, paddocks with livestock, housing and a road.

Key diagnostic characteristics	**Response**
Location and physical environment	
Patch on Swan Coastal Plain or adjacent lower parts of the Darling and Whicher escarpments that lie within the Jarrah Forest bioregion to the immediate east and south of the Swan Coastal Plain.	Swan Coastal Plain
Soils and landform	
Typically occurs on: deep Bassendean, Spearwood sands, occasionally on Quindalup sands, sandy colluvium and Aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau. Sometimes on transitional substrates, sandflats.	Southern River Complex.

D R A F T

Key diagnostic characteristics	Response
Structure: The structure of the ecological community is a low woodland to forest with the following features:	
Distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated by one or more of the *Banksia* species identified below; AND Emergent trees *Eucalyptus* or *Allocasuarina* species may sometimes be present above the *Banksia* canopy; AND Highly species-rich understorey that consists of a layer of sclerophyllous shrubs of various heights and a herbaceous ground layer of cord rushes, sedges and perennial and ephemeral forbs that sometimes includes grasses.	Patch is dominated by *E. marginata* and *A. fraseriana* with occasional *Banksia* species. Undesrtorey includes 12 sclerophyllous shrubs, 12 herbs and three sedges. Additional survey effort is likely to increase these numbers.
Composition	
Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *Banksia menziesii.* Other *Banksia* species that dominate in some examples of the ecological community are *B. prionotes* or *B. ilicifolia*; AND Must include at least one of the following diagnostic species: · *Banksia attenuata* · *Banksia menziesii* · *Banksia prionotes* · *Banksia ilicifolia* Emergent tree layer often includes *Corymbia calophylla, E. marginata,* or less commonly *E. gomphocephala*; AND Other trees of a medium height may be present and may be co-dominant with the *Banksia* species across a patch, include *E. todtiana, Nuytsia floribunda, Allocasuarina fraseriana, Callitris arenaria, Callitris pyramidalis* and *Xylomelum occidentale*; AND	No, the canopy is dominated by *E. marginata* and *A. fraseriana.*
Contra-indicators	
Patches clearly dominated by *Banksia littoralis* are not part of the TEC	No
Patches clearly dominated by *Banksia burdettii* are not the TEC	No
FCT20c – Eastern shrublands and woodlands, corresponds with a separate EPBC ecological community listing, Shrublands and Woodlands of the eastern Swan Coastal Plain. Occurrences of this FCT should be considered under that separate listing.	No

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CREATED BY RNM
APPROVED BY FdeWit
LAST MODIFIED 28 SEP 2017

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LEGEND

Survey Area

Banksia Woodlands of the Swan Coastal Plain

Excellent Condition
Very Good Condition
Good Condition

Threatened Ecological Communities

SHIRE OF KALAMUNDA

FORRESTFIELD NORTH

Figure

2

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60527304\4. Tech Work Area\4.99 GIS\02_MXDs\Forrestfield_North_Jan2016\G60527304_Fig2_ThreatenedCommunities_v5_A4.mxd (fotheringhamd)

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D R A F T

5.0 Conclusion

The native vegetation mapped as Woodlands in Good or better condition within the Forrestfield North survey area represents the Federally listed Banksia Woodlands of the Swan Coastal Plain. This community extends for 15.30 ha and is considered in Very Good to Excellent condition in accordance with the Banksia Woodlands key diagnostic criteria.

This outcome is further supported by the FCT analysis which showed all quadrats within the survey area represent FCT20a Banksia Woodlands over Species-rich Dense Shrublands. This community is listed as Endangered by DBCA and under the EPBC Act. This is at odds with the desktop study which also showed a considerable presence of the Priority 3 community (as listed by DBCA) named Banksia Dominated Woodlands of the SCP. This community is not associated with a particular FCT and its diagnostic features are undefined.

The similarity of survey quadrats to the SCP dataset was moderate, at 32-52% similarity to SCP quadrats representing FCT20a. This low similarity is likely a factor of survey effort and timing. The description of FCT20a, its known location, and identifying features as published in Gibson *et al.* (1994) match the description of the three Woodlands mapped within the survey area.

D R A F T

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Appendix A

Quadrat Data

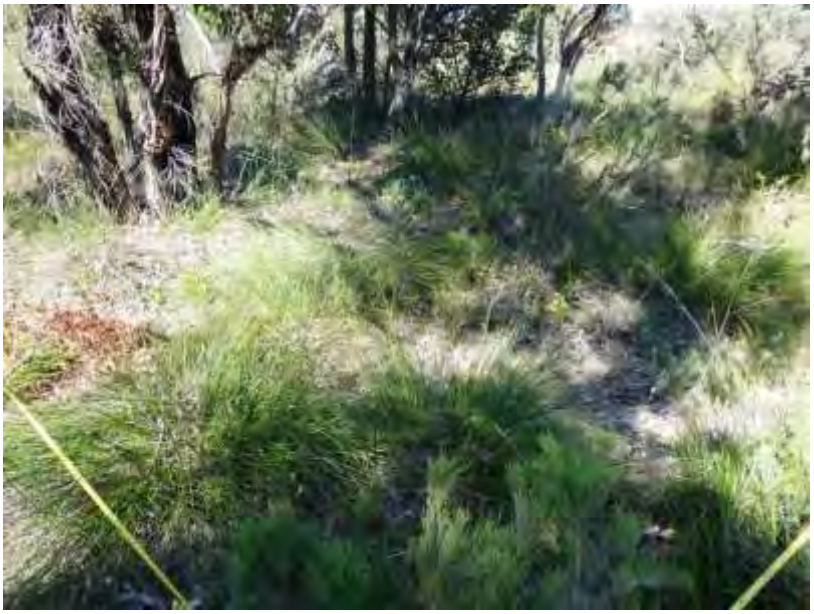
Plot Data

Site No: HW01	Type: Quadrat	Longitude: 116.009195	Latitude: -31.96267
Date: 11/22/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition: E. Edge Effect			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		250	2
Aira caryophyllea	*	10	0.1
Alexgeorgea nitens		5	2
Allocasuarina fraseriana		800	10 in landscape
Allocasuarina humilis			Oppo
Anigozanthos manglesii		60	0.3
Banksia attenuata			Oppo
Banksia dallanneyi var. *dallanneyi*		10	3
Banksia menziesii		500	2
Bossiaea eriocarpa		20	0.3
Briza maxima	*	30	0.5
Burchardia congesta		30	0.2
Caesia micrantha		70	0.1
Calothamnus torulosus			Oppo
Caustis dioica			Oppo
Conospermum undulatum			
Conostephium pendulum			Oppo
Dampiera linearis		15	0.1
Dasypogon obliquifolius		30	1
Daviesia divaricata			Oppo
Daviesia nudiflora subsp. *nudiflora*		50	0.3
Desmocladus fasciculatus		5	0.1
Ehrharta calycina	*	100	0.3
Eucalyptus marginata subsp. *marginata*		1200	8 in landscape
Gastrolobium capitatum		40	0.1
Gladiolus caryophyllaceus	*	50	0.5
Gompholobium knightianum		2	0.1
Gompholobium tomentosum			Oppo
Haemodorum laxum		120	0.5
Hakea conchifolia			Oppo
Hakea incrassata			Oppo
Hibbertia hypericoides		30	2
Hypochaeris glabra	*	30	0.1
Jacksonia floribunda			Oppo
Lambertia multiflora		100	2
Lepidosperma leptostachyum		80	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Levenhookia pusilla		5	0.1
Lomandra preissii		40	0.3
Lomandra sericea		30	0.1
Lomandra suaveolens		10	0.1
Melaleuca trichophylla		40	4
Mesomelaena pseudostygia		30	10
Mesomelaena tetragona		50	1
Nuytsia floribunda			Oppo
Opercularia vaginata		15	2
Patersonia occidentalis			Oppo
Petrophile macrostachya			Oppo
Petrophile linearis		40	0.5
Philotheca spicata			Oppo
Phyllanthus calycinus			Oppo
Pimelea ciliata subsp. *ciliata*			Oppo
Rhodanthe citrina		10	0.1
Scaevola canescens		3	0.2
Scaevola repens var. *repens*		15	3
Schoenus brevisetis		30	8
Stirlingia latifolia			Oppo
Stylidium diuroides subsp. *diuroides*		10	0.1
Isopogon drummondii	P3	100	0.5
Boronia ramosa subsp. *anethifolia*		30	0.2
Synaphea sp.			Oppo
Tetraria octandra		30	6
Trachymene pilosa		4	0.1
Tricoryne elatior		25	0.2
Tricostularia exsul		80	0.5
Ursinia anthemoides	*	20	0.1
Xanthorrhoea acanthostachya		100	8
Xanthorrhoea preissii			Oppo
Xanthosia huegelii		10	0.1

Site No: HW02	Type: Quadrat	Longitude: 116.009435	Latitude: -31.962045
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmAcMt		Fire History: 10+	
Vegetation Condition: E. Rubbish, Edge effect			



Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		350	6
Allocasuarina humilis		60	2
Astroloma stomarrhena		5	0.1
Banksia dallanneyi var. *dallanneyi*		30	2
Banksia menziesii		500	6
Bossiaea eriocarpa		15	0.2
Briza maxima	*	30	0.1
Burchardia congesta		30	0.1
Caesia micrantha			oppo
Caladenia sp.		5	0.1
Calothamnus torulosus		40	0.2
Conospermum undulatum		160	0.3
Conostylis aurea		20	0.1
Conostylis serrulata			oppo
Conostylis setigera		15	0.1
Conostylis setosa			oppo
Cyathochaeta avenacea		100	1
Dasypogon bromeliifolius			oppo
Dasypogon obliquifolius		20	1
Daviesia angulata		100	0.6
Daviesia nudiflora subsp. *nudiflora*		40	0.3
Desmocladus fasciculatus		10	0.1
Desmocladus flexuosus		30	0.6
Eucalyptus marginata subsp. *marginata*		600	10
Gastrolobium capitatum		20	0.1
Gastrolobium capitatum		40	0.1
Gladiolus caryophyllaceus	*	50	0.1
Gompholobium tomentosum			oppo
Haemodorum laxum		140	1
Hemiphora bartlingii		20	0.1
Hibbertia hypericoides		30	6
Jacksonia lehmannii		40	0.1
Kennedia prostrata			oppo
Lambertia multiflora		80	1
Lepidosperma leptostachyum		60	1
Lomandra sericea		30	0.2
Lyginia barbata			oppo

Taxon	Cons. Code	Height (cm)	% Alive
Melaleuca trichophylla		40	6
Mesomelaena pseudostygia		50	15
Patersonia occidentalis		30	0.4
Petropile linearis		30	0.2
Pimelea ciliata subsp. *ciliata*		20	0.1
Scaevola repens var. *repens*		10	1
Stirlingia latifolia		50	0.3
Stylidium piliferum		10	0.1
Boronia ramosa subsp. *anethifolia*		30	0.1
Synaphea sp.		40	0.1
Tetraria octandra		60	15
Thysanotus arbuscula		30	0.1
Tricoryne elatior		30	0.1
Tricoryne elatior		30	1
Tricostularia exsul		100	3
Ursinia anthemoides	*	10	0.1
Vellereophyton dealbatum		5	0.1
Xanthorrhoea acanthostachya		230	0.5
Xanthorrhoea gracilis		60	5

Site No: HW03	Type: Quadrat	Longitude: 116.010158	Latitude: -31.960788
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E. Weeds			

Taxon	Cons. Code	Height (cm)	% Alive
Alexgeorgea nitens		30	25
Allocasuarina fraseriana		250	2
Banksia attenuata		500	4
Banksia dallanneyi var. *dallanneyi*		20	2
Bossiaea eriocarpa		30	1.5
Briza maxima	*	30	0.2
Burchardia congesta		60	0.2
Calothamnus quadrifidus subsp. *quadrifidus*			oppo
Conospermum undulatum		50	0.2
Cyathochaeta avenacea		100	4
Dampiera alata		30	0.2
Dasypogon obliquifolius		30	0.2
Daviesia nudiflora subsp. *nudiflora*		40	0.5
Ehrharta calycina	*	100	0.4
Eragrostis curvula	*	130	1
Eucalyptus marginata subsp. *marginata*		1300	15
Gastrolobium capitatum		40	0.1
Gladiolus caryophyllaceus	*	80	0.1
Gompholobium confertum			oppo
Gompholobium knightianum		10	0.1
Haemodorum laxum		130	2
Hemiandra pungens		20	0.3
Jacksonia floribunda		40	0.2
Lepidosperma sp.		30	15
Lomandra sericea		30	0.2
Lomandra sericea		40	0.3
Melaleuca trichophylla		40	0.3
Petrophile linearis		50	0.1
Scaevola repens var. repens		10	4
Schoenus brevisetis		40	1
Stirlingia latifolia		50	0.6
Synaphea sp.		20	1
Thysanotus arbuscula		80	0.1
Tricoryne elatior		40	0.5
Xanthorrhoea preissii		100	5

Site No: HW04	Type: Quadrat	Longitude: 116.006648	Latitude: -31.962009
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		350	15
Allocasuarina fraseriana		300	0.5
Allocasuarina humilis		70	1
Banksia attenuata		500	2
Banksia dallanneyi		30	0.2
Banksia dallanneyi var. *dallanneyi*		20	4
Banksia grandis		500	5
Bossiaea eriocarpa		30	0.4
Burchardia congesta		40	0.2
Caesia micrantha		70	0.1
Calothamnus torulosus		20	0.1
Calytrix sp.			Oppo
Conospermum undulatum		20	0.1
Conostylis juncea		5	0.1
Cyathochaeta avenacea		110	0.2
Dampiera linearis		5	0.1
Dasypogon bromeliifolius		50	3
Dasypogon obliquifolius		20	0.5
Daviesia nudiflora subsp. *nudiflora*		30	0.2
Desmocladus fasciculatus		10	0.1
Eucalyptus marginata subsp. *marginata*		1400	20
Gastrolobium capitatum		30	0.1
Gompholobium confertum			Oppo
Haemodorum laxum		20	0.1
Haemodorum spicatum		100	0.1
Hakea lissocarpha		80	0.5
Hemiphora bartlingii			Oppo
Hibbertia huegelii		20	0.1
Hibbertia hypericoides		40	4
Lambertia multiflora		90	0.5
Lomandra hermaphrodita		20	0.1
Lomandra sericea		30	0.1
Lyginia barbata		60	1
Melaleuca trichophylla		40	0.5
Mesomelaena tetragona		50	10
Patersonia occidentalis		40	0.5
Petrophile linearis		30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Petrophile macrostachya		50	0.4
Philotheca spicata		100	0.2
Scaevola repens var. *repens*		15	1
Stachystemon vermicularis		40	1
Stirlingia latifolia		50	1.5
Isopogon drummondii	P3	80	1
Thysanotus affinis		20	0.1
Tricoryne elatior		30	0.1
Tricostularia exsul		80	15
Xanthorrhoea acanthostachya		80	4
Xylomelum occidentale		30	0.1

Site No: HW05	Type: Releve	Longitude: 116.007014	Latitude: -31.962401
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition:	
Community: EmAcMt		Fire History:	
Vegetation Condition: VG.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		400	25
Allocasuarina fraseriana		250	0.5
Allocasuarina humilis		80	0.5
Bossiaea eriocarpa		30	0.2
Conospermum undulatum			Oppo
Cyathochaeta avenacea		120	0.5
Dampiera linearis		10	0.1
Dasypogon obliquifolius		40	0.1
Daviesia nudiflora subsp. *nudiflora*			Oppo
Eremaea pauciflora var. *pauciflora*		50	0.5
Eucalyptus marginata subsp. *marginata*		300	1
Gompholobium confertum		20	0.1
Gompholobium tomentosum		40	0.3
Haemodorum laxum			Oppo
Hemiphora bartlingii		30	0.2
Hibbertia hypericoides		30	1
Johnsonia pubescens subsp. *pubescens*			Oppo
Kunzea glabrescens		250	1
Lambertia multiflora		100	0.5
Lyginia barbata		50	0.2
Lysinema pentapetalum			Oppo
Petrophile linearis			Oppo
Schoenus brevisetis			Oppo
Stirlingia latifolia		40	0.5
Isopogon drummondii	P3	60	0.4
Synaphea sp.			Oppo
Tricostularia exsul		100	20
Xanthorrhoea preissii		80	3

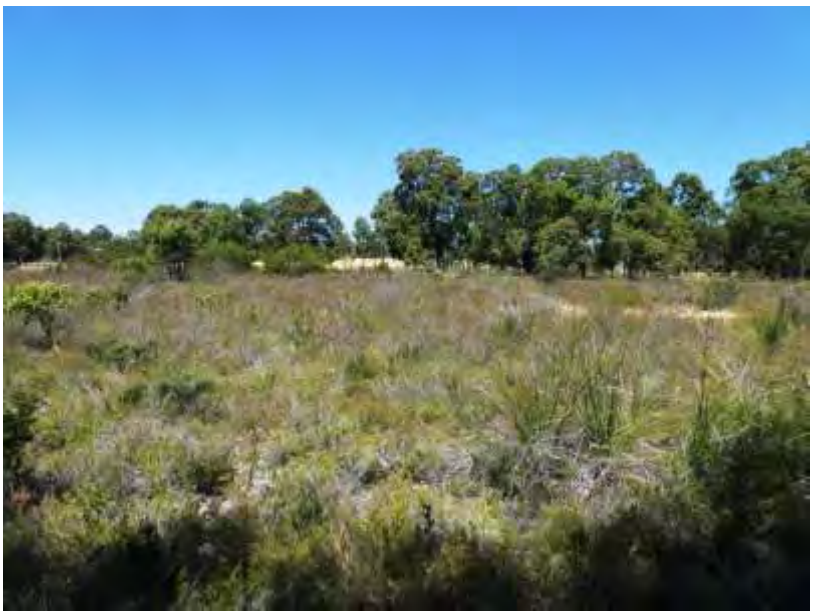
Site No: HW06	Type: Quadrat	Longitude: 116.007671	Latitude: -31.961865
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		700	8
Allocasuarina humilis		60	2
Banksia attenuata		500	8
Banksia dallanneyi var. *dallanneyi*		10	1
Banksia menziesii		400	3
Bossiaea eriocarpa		30	0.2
Briza maxima	*	30	0.1
Burchardia congesta		40	0.1
Calothamnus torulosus		30	1
Caustis dioica		40	0.3
Conostephium pendulum		40	0.1
Cyathochaeta avenacea		100	0.5
Dasypogon bromeliifolius		30	0.5
Dasypogon obliquifolius		30	2
Daviesia nudiflora subsp. *nudiflora*		50	0.2
Ehrharta calycina	*	100	4
Gastrolobium capitatum		20	0.1
Gladiolus caryophyllaceus	*	60	0.2
Gompholobium confertum		25	0.1
Gompholobium tomentosum		30	0.1
Haemodorum laxum		70	0.1
Hemiandra pungens		20	0.2
Hemiphora bartlingii		25	0.1
Hibbertia hypericoides		40	2
Lepidosperma leptostachyum		60	1
Mesomelaena pseudostygia		30	5
Petrophile macrostachya		40	0.3
Petrophile rigida		40	0.2
Scaevola repens var. *repens*		10	0.2
Schoenus brevisetis		40	1
Isopogon drummondii	P3	100	3
Tricoryne elatior		30	0.1
Tricostularia exsul		60	1
Xanthorrhoea preissii		100	6

Site No: HW07	Type: Quadrat	Longitude: 115.995246	Latitude: -31.952148
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: White	
Rocky Type:		Soil Condition: Dry	
Community: VdCd		Fire History: 10+	
Vegetation Condition: VG.			

Taxon	Cons. Code	Height (cm)	% Alive
Alexgeorgea nitens		15	0.2
Anigozanthos manglesii		30	0.3
Banksia dallanneyi var. *dallanneyi*		10	0.2
Briza maxima	*	30	0.1
Caesia micrantha		25	0.1
Caustis dioica		30	2
Conostylis juncea		20	0.1
Cyathochaeta avenacea		120	0.5
Dasypogon bromeliifolius			Oppo
Daviesia angulata		60	0.3
Ehrharta calycina	*	120	0.3
Eucalyptus marginata subsp. *marginata*		2000	2
Gladiolus caryophyllaceus	*	40	0.1
Grevillea bipinnatifida subsp. *bipinnatifida*		40	0.3
Haemodorum spicatum		100	1
Hypocalymma angustifolium			Oppo
Hypolaena exsulca		25	0.1
Jacksonia lehmannii		15	0.1
Lomandra micrantha		25	0.1
Lyginia barbata		50	1
Mesomelaena tetragona		60	0.5
Patersonia occidentalis		40	1
Pentameris airoides subsp. *airoides*	*	20	0.5
Scaevola canescens		10	0.1
Schoenus brevisetis		50	1
Stirlingia latifolia		60	2
Boronia ramosa subsp. *anethifolia*		20	0.1
Tricoryne elatior		30	0.2
Ursinia anthemoides	*	15	1
Verticordia densiflora var. *densiflora*		50	6
Xanthorrhoea preissii		70	0.5

Site No: HW08	Type: Quadrat	Longitude: 115.995632	Latitude: -31.953041
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: VdCd		Fire History: 10+	
Vegetation Condition: E.			



Taxon	Cons. Code	Height (cm)	% Alive
Agrostocrinum scabrum		30	0.1
Allocasuarina humilis		60	1
Anigozanthos manglesii		60	0.2
Babingtonia camphorosmae		30	0.2
Banksia dallanneyi var. *dallanneyi*		20	0.1
Bossiaea eriocarpa		30	0.2
Briza maxima	*	30	0.2
Burchardia congesta		40	0.2
Caustis dioica		50	10
Cheiranthera preissiana			0.1
Conostylis aurea		15	0.2
Dasypogon bromeliifolius		30	1
Daviesia angulata		90	8
Daviesia preissii			Oppo
Desmocladus fasciculatus		10	0.1
Eucalyptus marginata subsp. *marginata*		2500	5
Gastrolobium capitatum		20	0.2
Gladiolus caryophyllaceus	*	40	0.2
Goodenia caerulea		15	0.1
Grevillea bipinnatifida subsp. *bipinnatifida*		30	0.6
Haemodorum laxum		80	0.1
Hibbertia hypericoides		50	0.4
Hyalosperma cotula		10	0.1
Hypocalymma angustifolium		50	3
Hypolaena exsulca		20	0.4
Hypolaena exsulca		30	0.2
Lyginia barbata		40	1
Mesomelaena tetragona		70	3
Patersonia occidentalis		30	2
Philotheca spicata		60	0.3
Scaevola repens var. *repens*		10	0.2
Stirlingia latifolia		50	0.5
Boronia ramosa subsp. *anethifolia*		20	0.1

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria octandra		40	2
Thysanotus patersonii			0.1
Tricoryne elatior		20	0.6
Verticordia densiflora var. *densiflora*		50	1
Xanthorrhoea preissii		80	2
Xanthosia huegelii		15	0.2

Site No: HW09	Type: Quadrat	Longitude: 116.007428	Latitude: -31.956075
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: AfHhMp		Fire History: 10+	
Vegetation Condition:			

Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. pulchella		80	0.6
Adenanthos cygnorum subsp. *cygnorum*		200	
Alexgeorgea nitens		10	0.2
Allocasuarina fraseriana		600	10
Allocasuarina humilis			Oppo
Anigozanthos manglesii		60	0.2
Avena barbata	*		Oppo
Banksia armata var. *armata*			Oppo
Banksia attenuata		400	
Banksia dallanneyi var. *dallanneyi*		20	1
Bossiaea eriocarpa		40	2
Briza maxima	*	20	0.2
Burchardia congesta		50	0.2
Caesia micrantha			Oppo
Calothamnus torulosus		30	0.2
Caustis dioica		50	8
Conostephium pendulum			Oppo
Conostylis setigera		15	0.1
Cyathochaeta avenacea		110	0.4
Dampiera linearis		15	0.1
Dasypogon obliquifolius		30	0.5
Daviesia angulata		60	0.4
Daviesia nudiflora subsp. *nudiflora*			Oppo
Desmocladus fasciculatus		10	1
Ehrharta calycina	*		Oppo
Gastrolobium capitatum		30	0.5
Gladiolus caryophyllaceus	*	50	0.2
Haemodorum laxum		130	2
Haemodorum spicatum			Oppo
Hakea conchifolia		60	0.4
Hemiandra linearis			Oppo
Hemiphora bartlingii			Oppo
Hibbertia hypericoides		60	20
Jacksonia lehmannii		25	0.1
Lambertia multiflora		150	8
Lechenaultia biloba			Oppo
Lepidosperma leptostachyum		40	0.5

Taxon	Cons. Code	Height (cm)	% Alive
Lomandra sericea		30	0.4
Lyginia barbata		40	0.2
Mesomelaena pseudostygia		50	6
Mesomelaena tetragona		50	2
Monotaxis grandiflora var. *grandiflora*			Oppo
Nuytsia floribunda		700	2
Patersonia occidentalis			Oppo
Petrophile macrostachya		50	0.8
Philotheca spicata		60	0.2
Pimelea ciliata subsp. *ciliata*		50	0.1
Scaevola repens var. *repens*		10	0.2
Schoenus brevisetis		40	0.4
Stylidium piliferum		10	0.1
Isopogon drummondii	P3		Oppo
Synaphea sp.			Oppo
Thomasia macrocarpa			Oppo
Thysanotus arbuscula		20	0.2
Vellereophyton dealbatum		5	0.1
Xanthorrhoea preissii		120	1

Site No: HW10	Type: Quadrat	Longitude: 116.008553	Latitude: -31.957151
Date: 11/23/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmAcMt		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Acacia pulchella var. *pulchella*		100	1.5
Alexgeorgea nitens		10	0.2
Allocasuarina humilis		80	4
Banksia armata var. *armata*			Oppo
Banksia attenuata		400	1
Banksia dallanneyi var. *dallanneyi*		10	1
Banksia menziesii		500	15
Banksia sphaerocarpa		40	1
Bossiaea eriocarpa		30	0.5
Briza maxima	*	30	0.1
Burchardia congesta		40	0.1
Calothamnus torulosus			
Conospermum undulatum		80	0.2
Conostephium pendulum		50	0.2
Conostylis aurea			Oppo
Dasypogon obliquifolius		20	1
Daviesia nudiflora subsp. *nudiflora*		40	0.2
Desmocladus fasciculatus		10	0.1
Eremaea pauciflora var. *pauciflora*		40	2
Eucalyptus marginata subsp. *marginata*		2000	10
Gastrolobium capitatum			Oppo
Gladiolus caryophyllaceus	*	40	0.2
Haemodorum laxum			Oppo
Haemodorum sp.		10	0.1
Hemiandra pungens			Oppo
Hibbertia hypericoides		40	8
Jacksonia floribunda		50	0.2
Lambertia multiflora		100	2
Lepidosperma leptostachyum		40	2
Leucopogon sp.		40	0.1
Lomandra sericea		30	0.1
Lyginia barbata		40	1
Melaleuca trichophylla		40	3
Mesomelaena pseudostygia		40	1
Monotaxis grandiflora var. *grandiflora*		5	0.2
Patersonia occidentalis			Oppo
Petrophile macrostachya		50	1.5

Taxon	Cons. Code	Height (cm)	% Alive
Scaevola repens var. *repens*		15	0.3
Stirlingia latifolia		40	1
Isopogon drummondii	P3	80	3
Synaphea sp.		50	0.5
Tricoryne elatior		30	0.7
Tricostularia exsul		40	10
Xanthorrhoea preissii		90	1

Site No: HW11	Type: Releve	Longitude: 116.009061	Latitude: -31.957063
Date: 11/23/2016		Soil Types:	
Topography: Flat		Soil Colour:	
Rocky Type:		Soil Condition:	
Community: EmToDo		Fire History:	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		1300	15
Allocasuarina humilis		60	0.5
Banksia sphaerocarpa		50	0.5
Bossiaea eriocarpa		30	1
Burchardia congesta		40	0.3
Cheiranthera preissiana			0.1
Eucalyptus marginata subsp. *marginata*		1600	20
Gladiolus caryophyllaceus	*	40	0.1
Gompholobium knightianum		40	0.1
Hakea conchifolia		70	0.2
Hemiandra pungens			Oppo
Lyginia barbata			Oppo
Mesomelaena pseudostygia		40	10
Nuytsia floribunda		200	1
Patersonia occidentalis		30	1
Petrophile macrostachya		200	1
Scaevola repens var. *repens*		10	0.5
Tetraria octandra		30	20
Xanthorrhoea preissii		90	2

Site No: HW12r	Type: Releve	Longitude: 116.005128	Latitude: -31.960586
Date: 11/28/2016		Soil Types: Loam sand	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: VG.			

Taxon	Cons. Code	Height (cm)	% Alive
Acacia sp.	PI		Oppo
Adenanthos cygnorum subsp. *cygnorum*			Oppo
Allocasuarina fraseriana		400	10
Allocasuarina humilis			Oppo
Asteraceae (planted)	PI	60	2
Banksia attenuata		350	8
Banksia dallanneyi		30	4
Banksia grandis		60	0.1
Banksia menziesii		400	2
Banksia sessilis var. *sessilis*			Oppo
Briza maxima	*	40	2
Conostephium pendulum			Oppo
Dampiera linearis		20	0.2
Dasypogon bromeliifolius		30	0.2
Dasypogon obliquifolius			Oppo
Desmocladus fasciculatus			Oppo
Eucalyptus marginata subsp. *marginata*		700	40
Haemodorum laxum			Oppo
Hibbertia hypericoides			Oppo
Hypochaeris glabra	*		0.5
Lambertia multiflora			Oppo
Lepidosperma leptostachyum		40	2
Mesomelaena tetragona			Oppo
Patersonia occidentalis		40	0.2
Persoonia elliptica		400	3
Petrophile macrostachya			Oppo
Stirlingia latifolia		40	0.2
Isopogon drummondii	P3	80	0.2
Tetraria octandra		40	10
Tricostularia exsul			Oppo
Xanthorrhoea preissii		100	0.5

Site No: HW13	Type: Quadrat	Longitude: 116.006285	Latitude: -31.959895
Date: 11/28/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		400	15
Banksia dallanneyi var. *dallanneyi*		30	10
Banksia grandis			Oppo
Bossiaea eriocarpa		40	1
Briza maxima	*	30	3
Burchardia congesta		40	0.2
Conospermum undulatum		100	0.4
Conostephium pendulum		40	0.1
Cyathochaeta avenacea		70	0.2
Dampiera alata		20	0.1
Dampiera linearis		15	0.2
Dasypogon obliquifolius		40	2
Daviesia divaricata		20	0.1
Daviesia nudiflora subsp. *nudiflora*		50	0.3
Desmocladus fasciculatus		10	1
Ehrharta calycina	*	80	0.1
Eucalyptus marginata subsp. *marginata*		1800	10
Gladiolus caryophyllaceus	*	60	0.1
Gompholobium knightianum		20	0.2
Gompholobium tomentosum		40	0.2
Haemodorum laxum		100	0.2
Hakea conchifolia			Oppo
Hemiandra pungens		20	1
Hemiphora bartlingii			Oppo
Hibbertia hypericoides		20	0.5
Lambertia multiflora		160	8
Lechenaultia biloba		5	0.1
Lepidosperma leptostachyum		50	2
Leucopogon ?conostephioides		30	0.2
Lomandra preissii		20	0.1
Lyginia barbata		40	0.5
Melaleuca trichophylla		50	0.5
Mesomelaena pseudostygia		40	4
Mesomelaena tetragona		40	0.5
Monotaxis grandiflora var. *grandiflora*		20	0.1
Opercularia vaginata		30	0.1
Patersonia occidentalis		30	0.2

Taxon	Cons. Code	Height (cm)	% Alive
Persoonia elliptica			Oppo
Petrophile linearis		15	0.2
Pimelea ciliata subsp. *ciliata*		30	0.2
Scaevola repens var. *repens*		10	0.2
Stirlingia latifolia			Oppo
Boronia ramosa subsp. *anethifolia*		20	0.1
Synaphea sp.		30	0.3
Tetraria octandra		40	8
Tricoryne elatior		20	0.2
Tricostularia exsul		60	2
Vellereophyton dealbatum		5	0.1
Xanthorrhoea acanthostachya		70	0.3
Xanthorrhoea preissii		80	8

Site No: HW14r	Type: Releve	Longitude: 116.007548	Latitude: -31.958775
Date: 11/29/2016		Soil Types:	
Topography: Flat		Soil Colour:	
Rocky Type:		Soil Condition:	
Community: EmAcMt		Fire History:	
Vegetation Condition: G.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. *cygnorum*		350	15
Alexgeorgea nitens			Oppo
Allocasuarina fraseriana			Oppo
Allocasuarina humilis		40	0.2
Amphipogon strictus		20	0.5
Banksia attenuata			Oppo
Banksia dallanneyi var. *dallanneyi*		20	0.5
Banksia menziesii		400	5
Billardiera fraseri			0.2
Briza maxima	*	30	5
Cyathochaeta avenacea		130	0.3
Dasypogon obliquifolius			Oppo
Daviesia preissii		60	0.2
Desmocladus fasciculatus			Oppo
Ehrharta calycina	*	100	20
Eremaea pauciflora var. *pauciflora*		30	5
Eucalyptus marginata subsp. *marginata*		700	5
Gladiolus caryophyllaceus	*		Oppo
Haemodorum spicatum		100	0.1
Lambertia multiflora		220	0.5
Lyginia barbata		40	0.5
Melaleuca trichophylla		40	6
Mesomelaena pseudostygia		50	3
Nuytsia floribunda		400	Oppo
Petrophile linearis			Oppo
Ptilotus manglesii		30	0.5
Stirlingia latifolia		40	2
Boronia ramosa subsp. *anethifolia*			Oppo
Tricoryne elatior		30	0.5
Ursinia anthemoides	*		Oppo
Vellereophyton dealbatum			Oppo
Xanthorrhoea preissii		70	1

Site No: HW15r	Type: Releve	Longitude: 116.008478	Latitude: -31.95808
Date: 11/29/2016		Soil Types:	
Topography: Flat		Soil Colour:	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina humilis		100	1
Banksia attenuata			Oppo
Banksia dallanneyi var. *dallanneyi*		20	5
Banksia menziesii			Oppo
Bossiaea eriocarpa		30	8
Burchardia congesta		60	0.1
Caustis dioica		30	1
Dasypogon obliquifolius		30	4
Desmocladus fasciculatus		20	0.2
Ehrharta calycina	*	80	1
Eucalyptus marginata subsp. *marginata*		800	25
Gastrolobium capitatum		40	0.2
Gladiolus caryophyllaceus	*	70	0.2
Gompholobium knightianum			Oppo
Hakea costata		220	0.5
Hibbertia hypericoides		30	0.5
Lambertia multiflora		160	1
Lepidosperma leptostachyum		60	2
Melaleuca trichophylla		40	2
Mesomelaena tetragona		50	10
Opercularia vaginata		30	0.3
Patersonia occidentalis		40	1
Petrophile macrostachya		100	1
Petrophile linearis			Oppo
Philotheca spicata		50	0.2
Schoenus brevisetis		30	1
Stirlingia latifolia		40	0.5
Tetraria octandra		30	1
Tricostularia exsul		60	1
Xanthorrhoea acanthostachya		100	1
Xanthorrhoea preissii		100	5

Site No: HW16	Type: Quadrat	Longitude: 116.004122	Latitude: -31.960853
Date: 11/29/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Grey	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: E.			

Taxon	Cons. Code	Height (cm)	% Alive
Alexgeorgea nitens		10	0.2
Allocasuarina fraseriana		600	10
Allocasuarina humilis		40	0.2
Banksia attenuata		600	5
Banksia dallanneyi var. *dallanneyi*		20	5
Banksia menziesii		300	10
Bossiaea eriocarpa		30	3
Burchardia congesta		40	0.2
Caesia micrantha		30	0.1
Conostephium pendulum		30	0.2
Cyathochaeta avenacea		70	1
Dampiera linearis		20	0.5
Dasypogon obliquifolius		50	4
Daviesia nudiflora subsp. *nudiflora*			Oppo
Daviesia preissii			Oppo
Eucalyptus marginata subsp. *marginata*		800	8
Gastrolobium capitatum		30	1
Haemodorum laxum		80	0.2
Hemiandra pungens		20	2
Hemiphora bartlingii		20	0.3
Hibbertia hypericoides		40	4
Hypolaena exsulca		40	1
Lambertia multiflora		160	6
Lechenaultia biloba		10	0.1
Lomandra preissii		30	0.2
Mesomelaena tetragona		40	10
Patersonia occidentalis		30	0.5
Persoonia elliptica		400	0.5
Petrophile linearis		20	0.1
Pimelea ciliata subsp. *ciliata*		30	0.2
Scaevola repens var. *repens*		10	0.2
Schoenus brevisetis		30	1
Stachystemon vermicularis		60	3
Stirlingia latifolia		50	3
Isopogon drummondii	P3	60	0.5
Synaphea sp.			Oppo

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria octandra		40	5
Thysanotus arbuscula		10	0.1
Tricostularia exsul		60	4
Xanthorrhoea preissii		100	8
Xylomelum occidentale		400	1.5

Site No: HW17	Type: Quadrat	Longitude: 116.001698	Latitude: -31.957207
Date: 11/29/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Dark Brown	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: VG. Weeds, edge effect			

Taxon	Cons. Code	Height (cm)	% Alive
Allocasuarina fraseriana		600	10
Anigozanthos manglesii		100	0.2
Babingtonia camphorosmae		40	0.5
Banksia dallanneyi var. *dallanneyi*		30	8
Bossiaea eriocarpa		20	1
Briza maxima	*	30	1
Conospermum undulatum		130	0.3
Dampiera alata		10	0.2
Dampiera linearis		10	0.2
Dasypogon obliquifolius			Oppo
Daviesia preissii			Oppo
Ehrharta calycina	*	120	1
Eucalyptus marginata subsp. *marginata*		2000	20
Gastrolobium capitatum		30	1
Gladiolus caryophyllaceus	*	70	0.5
Haemodorum laxum		120	0.5
Hibbertia hypericoides		40	3
Lambertia multiflora		110	0.3
Lepidosperma leptostachyum		40	3
Lomandra sericea		30	0.2
Mesomelaena tetragona		40	4
Monotaxis grandiflora var. *grandiflora*		15	1
Opercularia vaginata		30	0.2
Persoonia elliptica		300	2
Scaevola repens var. *repens*		10	0.2
Stirlingia latifolia		40	1
Boronia ramosa subsp. *anethifolia*		10	0.3
Tetraria octandra		30	5
Thysanotus arbuscula		20	0.1
Tricoryne elatior		20	0.2
Xanthorrhoea gracilis		60	3
Xanthosia huegelii		30	0.3

Site No: HW18r	Type: Releve	Longitude: 116.006067	Latitude: -31.958544
Date: 11/30/2016		Soil Types: Sand	
Topography: Flat		Soil Colour: Medium Brown	
Rocky Type:		Soil Condition: Dry	
Community: EmToDo		Fire History: 10+	
Vegetation Condition: VG.			

Taxon	Cons. Code	Height (cm)	% Alive
Adenanthos cygnorum subsp. cygnorum		300	1
Allocasuarina fraseriana		500	3
Banksia armata var. armata		50	1
Banksia dallanneyi var. *dallanneyi*		20	0.5
Banksia menziesii			Oppo
Bossiaea eriocarpa		20	0.5
Briza maxima	*	40	0.5
Caustis dioica		30	0.4
Conostylis aurea		30	0.1
Cyathochaeta avenacea		120	0.5
Dasypogon obliquifolius		30	1
Daviesia nudiflora subsp. *nudiflora*		40	0.5
Desmocladus fasciculatus		10	0.1
Ehrharta calycina	*	80	4
Eucalyptus gomphocephala		1500	1
Eucalyptus marginata subsp. *marginata*		800	25
Gastrolobium capitatum		30	0.5
Gladiolus caryophyllaceus	*	100	0.3
Gompholobium knightianum		30	0.2
Haemodorum laxum		160	0.2
Haemodorum sp.		30	0.1
Hemiandra linearis		10	0.01
Hibbertia hypericoides		50	1
Lambertia multiflora		120	0.5
Lepidosperma leptostachyum		50	0.1
Lomandra preissii		30	0.5
Lyginia barbata		50	0.2
Mesomelaena pseudostygia		40	4
Microtis media		20	0.01
Patersonia occidentalis		40	0.2
Petrophile linearis		40	0.2
Scaevola repens var. *repens*			Oppo
Isopogon drummondii	P3	100	0.3

Taxon	Cons. Code	Height (cm)	% Alive
Tetraria octandra		40	5
Tricoryne elatior		30	0.1
Tricostularia exsul		80	8
Ursinia anthemoides	*	15	0.02
Verticordia densiflora var. *densiflora*		150	0.5
Xanthorrhoea preissii		100	4

Appendix D Ethnosciences (2018) Report of an Ethnographic Assessment of the Forrestfield North DSP

Ethnosciences

ABN 47 065 099 228

Ethnography, Heritage & Cultural Interpretation

Report of an Ethnographic Assessment of the Forrestfield North DSP, Shire of Kalamunda, Western Australia

Prepared for Strategen

By Jan Turner, William Christensen and Edward M. McDonald

April 2018

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Ethnosciences

ABN 47 065 099 228

Ethnography, Heritage & Cultural Interpretation

Disclaimer

The results, conclusions and recommendations contained within this report are based on information available at the time of its preparation. Whilst every effort has been made to ensure that all relevant data has been collated, the authors can take no responsibility for omissions and/or inconsistencies that may result from information becoming available subsequent to the report's completion.

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Abbreviations

ACMC:	Aboriginal Cultural Material Committee
AHA:	*Aboriginal Heritage Act 1972*
AHIS:	Aboriginal Heritage Inquiry System
DAA:	Department of Aboriginal Affairs
DPLH:	Department of Planning, Lands & Heritage
DSP:	District Structure Plan
PDA:	Proposed Development Area
LSP:	Local Structure Plans
Strategen:	Strategen Environmental
SWALSC:	South West Aboriginal Land and Sea Council

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Kezia Jacobs-Smith

Marion Collard

Marion Kickett

Marlene Rose Warrell

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Summary & Recommendations

Ethnosciences was commissioned by Strategen to conduct an ethnographic assessment of the Forrestfield North District Structure Plan (DSP) area in the Shire of Kalamunda, with a particular focus on the Registered Aboriginal Site Poison Gully Creek (DPLH ID 25023). The assessment involved both desktop research and community consultation, the latter involving separate women's and men's on-site meetings in December 2017 with follow-up consultation. No archaeological research was undertaken as part of the assessment.

The search of the online AHIS and other archival sources confirmed that Poison Gully Creek (DPLH ID 25023) is the only Registered Aboriginal Site in the DSP study area. Two 'Other Heritage Places' (DPLH ID 3667 and DPLH ID 3637, both artefact scatters) are also listed. It is highly likely that additional archaeological sites (i.e., artefact scatters) could be found within the study area.

Poison Gully Creek (DPLH ID 25023) was the only place within the study area reported by the Aboriginal consultants that might reasonably be considered to be an Aboriginal Site within the meaning of s5 of the AHA. Both the women's and the men's consultations confirmed the cultural significance of Poison Gully Creek and highlighted its importance to Nyungar women in particular as a 'birthing place' with associated rituals and still seen as a place for teaching and learning about traditional cultural knowledge, both specific to the site and country more generally.

The women in particular strongly expressed a desire to protect the natural bush and creek between Dundas Road and Milner Road and in particular the open space adjacent to the Dundas Road crossing. They wish to have an area where they can continue to teach and support their children and grandchildren in an accessible and nurturing bush environment.

Water is a central aspect of the site which, together with its immediate surrounds, is conceptualised to be a single entity from its source in the high country of Kalamunda to where it joins with the waters of Munday Swamp. Both the surface and the subsurface

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waters are seen as integral to the site, which despite various historical impacts is conceptualised as following the path laid down by ancestral beings in the Dreaming. Concerns are expressed with regards to impacts on the creek that might also have flow-on effects on Munday Swamp.

Whereas Nyungars are typically concerned about negative impacts on waterways such as Poison Gully Creek, the community is generally supportive of endeavours to improve and restore water flow and quality to reflect the waterways' original state where these have been degraded through past land use practices.

Such work, however, would require either consent from the Minister of Aboriginal Affairs under s18 of the AHA or approval under Regulation 10 from the Registrar of Aboriginal Sites.

The Nyungar consultants' conceptualisation of Poison Gully Creek as a place and its extent is not two-dimensional, nor do they view the place in isolation from its broader geographical and cultural setting. This perspective was reflected in all the meetings with the Nyungar consultants, with a strong emphasis throughout on its relationship with other places. Of special significance to them in this regard were places, such as Munday Swamp and Allawah Grove, traditionally linked by the flow of water and the *bidi* or tracks and part of a meshwork in which place is to be understood as an outcome of movement, practice and event, which result in the experience of 'biographical entanglements'.

Recommendations

1. It is recommended that the Shire of Kalamunda and its agents continue their consultations with the Nyungar community in respect of the Forrestfield North DSP, particularly as this might impact on Poison Gully Creek (DPLH ID 25023).
2. It is also recommended that the Shire of Kalamunda seek advice from the DPLH as to whether any planned impacts on Poison Gully Creek (DPLH ID 25023) will require consent from the Minister of Aboriginal Affairs under s18 of the AHA or approval under Regulation 10 from the Registrar of Aboriginal Sites.

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3. It is further recommended that the Shire of Kalamunda, in conjunction with Nyungar women, examine ways in which the natural bush and creek between Dundas Road and Milner Road can be enhanced as a Nyungar women's place.
4. It is likewise recommended that the Shire of Kalamunda commemorate the Aboriginal heritage of the Forrestfield North DSP study area, giving particular emphasis to the meshwork of Nyungar places, including the high country in Kalamunda, Munday Swamp and Allawah Grove.
5. It is recommended that Nyungars are invited to engage in any works associated with Poison Gully Creek, including the rehabilitation of the creek and revegetation with native plants.
6. It is also recommended that the Shire of Kalamunda commission an archaeological survey of the Forrestfield North DSP study area prior to the commencement of development.

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Introduction

Ethnosciences was contracted by Strategen Environmental (Strategen) to conduct an ethnographic assessment of the Forrestfield North District Structure Plan (DSP) area in the Shire of Kalamunda, with a particular focus on Poison Gully Creek which is a Registered Aboriginal Site (DPLH ID 25023). An archaeological survey of the Forrestfield North DSP study area was not part of the current study brief.

In June 2014, the State Government announced the Forrestfield Airport Link, a $2 billion train line connecting with the Midland line near Bayswater Station, servicing the airport and finishing in the Forrestfield/High Wycombe area. The train line is scheduled to be commissioned by 2020. Following this announcement, the State Government requested the Shire of Kalamunda to explore the opportunities that a new train station could bring to the surrounding areas. This meant moving away from the industrial land uses previously proposed and focusing on residential and retail/commercial uses more suitable for a train station precinct.

The new focus resulted in the Forrestfield North District Structure Plan being prepared, which planned for the delivery of high-density residential, a new activity centre and a commercially-focused Transit Oriented Development precinct based around the new train station (Figure 1). The purpose of the DSP is to provide strategic guidance for the preparation of subsequent Local Structure Plans (LSPs) which will support the coordination and implementation of subdivision and development around and feeding into the Forrestfield Train Station.

Scope of Works

Ethnosciences provided the following professional services:

- A review of the Aboriginal Heritage Inquiry System (AHIS) and other relevant archival material;
- Ethnographic consultation, including site inspections with relevant Aboriginal stakeholders nominated by the South West Aboriginal Land and Sea Council (SWALSC);

- Documentation of the Aboriginal representatives' views and comments with regard to the DSP study area and the provision of an ethnographic assessment of any places identified in the study area and in particular Poison Gully Creek (DPLH ID 25023); and
- Preparation of a report which complies with the standards currently published by the Department of Planning, Lands and Heritage (DPLH) documenting the outcomes of the ethnographic assessment.

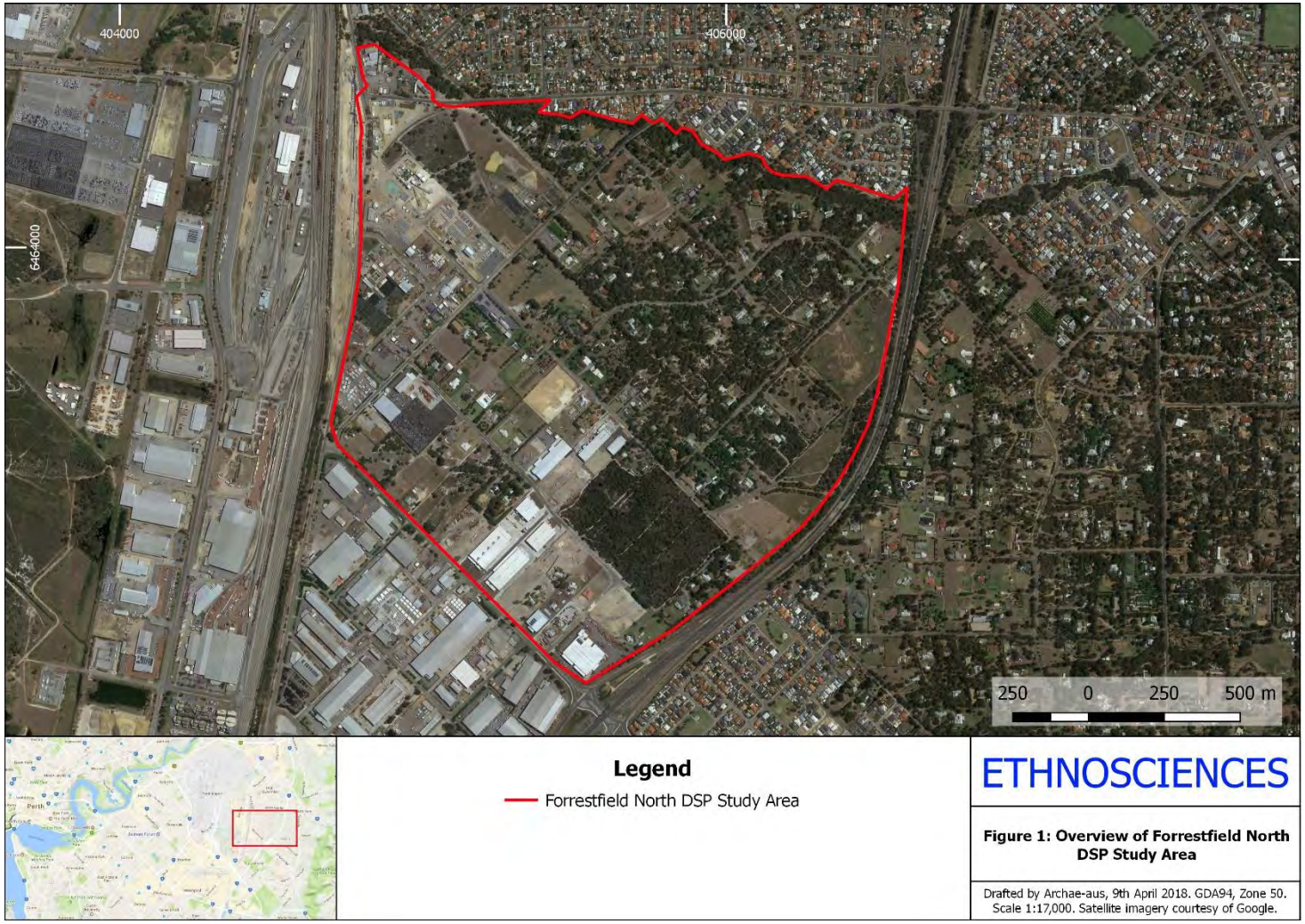

Figure 1: Forrestfield North DSP study area (Source: Strategen)

Ethnographic Survey/Consultation Methods

The ethnographic survey/consultation was conducted in the following stages:

- Desktop research;
- Preliminary consultation with SWALSC regarding the selection of the 'relevant Aboriginal people' to be consulted about the proposed development;
- Ethnographic consultations on site with female and male representatives of Aboriginal groups and families nominated by SWALSC as having interests in the area (December 2017);
- A second women's consultative meeting (March 2018); and,
- Report preparation.

Edward McDonald and Jan Turner undertook desktop research and Jan Turner and William Christensen conducted the on-site consultations with the female and male Nyungar representatives respectively. The report was jointly prepared by Jan Turner, William Christensen and Edward McDonald.

Desktop Research

The desktop research involved, in the first instance, an examination of the Register of Aboriginal Sites using the DPLH's online Aboriginal Heritage Inquiry System (AHIS). A range of relevant published and unpublished material relating to the ethnohistory and the Aboriginal heritage values of the study area and its environs was also reviewed. The latter included reports of previous heritage surveys conducted in the area. Of particular relevance to the current study is the ethnographic survey carried out by Nicolas Green (Green & Jackson 1995) and that by Jan Turner and her colleagues (Turner, de Gand & Mattner 2014).

Preliminary Consultation

As is required by the DPLH (formerly the DAA), SWALSC was consulted about the selection of a panel of 'relevant Aboriginal people' having associations with, and knowledge of, the Poison Gully site, which in broad terms forms the northern boundary of the DSP area, and its environs. Poison Gully Creek is listed on the Register of Aboriginal

Sites under the classifications "Birth Place" and "Water Source" (see below for further comment). The former classification, reflects the site's particular importance to Nyungar women. Consequently, SWALSC provided a list of eight women whom their internal research showed were of relevance to the consultation. To this list we added two additional women who are the daughters of two of the site's listed informants on the DPLH register and several men who also have reported associations with the Forrestfield area and who had been consulted in previous surveys.

Ethnographic Consultations

The ethnographic consultations were undertaken on site on December 7, 2017 and December 19, 2017, for the women's and men's group respectively. In the end, six of the ten women invited, or their proxies attended the consultative meeting. Three are members of the registered Native Title Claim over the Metropolitan Area (the Whadjuk People, which is a party to the South West Settlement) [1] and three are members of the unregistered claim, the Swan River People 2. In addition, a second women's consultation was held off-site in March 2018 which was attended by six women, most notably Gwen Corunna who had not been included in the original panel selected by SWALSC.

[1] The South West Settlement signed in June 2015 between the WA Government and SWLASC, which includes six identical Indigenous Land Use Agreements (ILUAs) in respect of the Yued, Whadjuk People, Gnaala Karla Booja, Ballardong People, South West Boojarah #2 and Wagyl Kaip and Southern Noongar groups and the passing of the Noongar (Koorah, Nitja, Boordahwan) (Past, Present, Future) Recognition Act 2016. [

Table 1: Aboriginal people attending the December 2017 consultations and their group affiliation

Aboriginal Group	December 7, 2017 Women's Consultative Meeting	December 19, 2017 Men's Consultative Meeting
Whadjuk People	Kezia Jacobs-Smith Myrtle Yarran Marion Collard	Ron Gidjup Cedric Jacobs
Swan River People	Bella Bropho Vanessa Corunna Marlene Rose Warrell	Albert Corunna Richard Wilkes

Women's Consultative Meetings

The first ethnographic consultation with female consultants was conducted by anthropologist Jan Turner on site on December 7, 2017 with follow-up phone calls made during December to confirm details. Jan Turner, having consulted with Nyungar women in 2014 at Poison Gully Creek, knew of or had met several of the participants previously. However, the selection of women attendees was determined by SWALSC and women's availability on the day.

Locking in a date when women were able to attend proved difficult and several dates were mooted. Unfortunately, the date agreed to subsequently coincided with the afternoon funeral of a Nyungar elder (a woman who had been deferred to by other women in the 2014 consultations). A minute's silence was requested to honour her memory. No photographs of the women were taken during the December 2017 consultations out of respect for the deceased. However, they gave their permission for prior photographs of Poison Gully Creek to be included in this report.

The on-site consultations were divided between a group discussion in the morning and two independent consultations with one woman attending each in the afternoon. There was no overlap in attendance. The morning consultation was held upstream at the Milner Road crossing and both afternoon interviews were held at the well-shaded Dundas Road

crossing. Consultation times were flexible to accommodate the maximum number of respondents. Keywords, concepts and observations were recorded at Poison Gully Creek. Photographs of Poison Gully Creek, its banks and nearby vegetation were taken in the lunchbreak between sessions. These photographs provide an environmental context for the discussion that follows. The contents of this report were elaborated and consented to in March 2018.

The follow-up meeting in March 2018 was held at a private home in Maddington and provided the opportunity for women to expand further on their cultural knowledge of Poison Gully Creek and Munday Swamp, reminisce about their residency at Allawah Grove, and give their consent as to what could be included in this report in the more general context of Nyungar women's cultural discussions. The women involved included among others: Vanessa Corunna, Gwen Corunna, Bella Bropho and Marion Kickett. Of these, Vanessa Corunna and Bella Bropho were participants in the December consultative process.

The women consulted ranged in age from a woman in her twenties through to a woman of eighty years, including an adult with young children to grandmothers and great-grandmothers, providing a range of women's knowledge and views. This breadth of the group consulted provided opportunities for observations of intra-group behaviours of respect, ritual and the public demonstration of cultural knowledge. These women currently reside locally in the Perth metropolitan area, Quairading and Wyalkatchem.

Men's Consultative Meeting

Anthropologist Dr Will Christensen consulted the male representatives on December 19, 2017. The consultation group comprised Mr Ron Gidjup and Mr Cedric Jacobs, both of the Whadjuk People Native Title Claim, together with Mr Albert Corunna and Mr Richard Wilkes from the unregistered Swan River People 2 Native Title Claim. Christensen also had the opportunity to consult with two of the men as he drove them from their residences in Rockingham and Pinjara to the meeting and back again in the afternoon.

Ethnographic Background

Bates (1985) was the first researcher to systematically collect information regarding the social organisation, language and customs of the Aboriginal people of the Southwest of Western Australia. She was engaged in anthropological research on behalf of the Western Australia Government from 1904-1911, undertaking pioneering ethnographic fieldwork in 1905 on the Maamba Reserve (see below) (McDonald, Coldrick & Christensen 2008b discuss her research within the context of the development of modern ethnographic practice).

Bates (1985: 39) referred to the Aboriginal people occupying this region as the 'Bibbulmun Nation'. She reports (1985, 1992) that the Bibbulmun comprised of a number of related 'tribal' groupings. She notes similar customs and beliefs among the groups, though she also reported that regional differences, including forms of descent and dialectic terms, applied to various local communities (Bates 1985: 46–54). The Bibbulmun were part of what Berndt (1979:19) would later refer to as part of the 'Old Australian Tradition' of Law and male initiatory practices including, among other practices, the piercing of the septum and the insertion of a 'nose-bone'. Unlike in other parts of Western Australia circumcision was not practiced.

Bates (1985: 48) identified the local group located in the country in which the Forrestfield North DSP area is located as the *Yabbaru Bibbulmun* [northern Bibbulmun]. She reports that they were also known by neighbouring groups as the *Illa kuri wongi* after the dialect which they spoke. Later researchers, however, provide a vastly different perspective to that of Bates. Berndt (1979), following Tindale (1974), suggests that, at the time of British colonisation, the Southwest was occupied by thirteen 'tribes' or socio-dialectal groups, to use Berndt's term, that formed a discrete socio-cultural bloc referred to as 'Nyungar'. Tindale (1974) recorded the socio-dialectal group who inhabited the region in which the DSP area is located as the *Whadjug* or *Whadjuk* (Figure 2).

More recently, Keen (1997:261) has suggested that anthropologists "get away from the idea of discrete Aboriginal 'societies' 'cultures', 'groups' or 'communities' as basic elements, and to substitute a more regional perspective." He (1997:261, 273) notes that

most ethnography is based on the assumption that Australia was divided into a number of discrete 'cultures', 'societies' or 'tribes' and that the 'tribe' model "has been found wanting". The works of Tindale and Berndt are clearly based on such a model, though the latter presents a different picture with respect to the Western Desert. Keen's (1997) concept of 'focused networks' and 'regional system(s)' in contrast focuses on:

> *A nexus of adjacencies, of chains of connection, and of a dynamic, open, and transforming systemic network, broken here and there by fissures and lesions. A 'local system' becomes defined in a relative way. It is possible that somewhat uniform and reproduced systems on interconnected practices might be detected, but on the other hand, what might be found is a pattern of continuous variations in one place, or a mosaic of overlapping differences in another. Whatever the pattern, any local system must be seen in its wider context.*

The differences between the 'tribal' system in the Southwest provided by Bates (1985) and Tindale (1974) has perplexed many researchers, including the present consultants. McDonald and Christensen (1999) have previously noted that these differences may be due to a number of reasons, such as:

- different data collection periods (Bates, 1905–12; Tindale 1930s–60s);
- a focus on different levels of social organisation;
- variations in use of anthropological terminology; and,
- common Aboriginal practice for groups to be known by several names.

The differences may reflect Bates' appreciation of the 'focused networks' which characterised Nyungar social organisation. While Bates (1985) uses the term 'tribe' to discuss the social organisation of the Southwest and other parts of the State, her actual description would seem to be broadly consistent with the model outlined by Keen with all its apparent contradictions of 'continuous variations' and 'mosaic of overlapping differences'.[2] Bates also had a particular interest in movement and interconnectivity, investigating individual's 'runs' (see below), country, roads and tracks (called *bidi* in

[2] McDonald & Christensen (1999) and Edwards & McDonald (1999) explore in more detail some of the possible reasons for the differences between Bates' and other researchers' findings.

Nyungar country), along which people, myth, ceremony and objects moved and were exchanged (McDonald, Coldrick and Christensen 2008b). [3]

Journals and records by early settlers describe various influential Aboriginal 'leaders' in the early days of the Swan River colony and the 'territories' in which they were principally located. According to Lyon (1833 cited in Green 1979: 176), the area in which the DSP is located was, at the time of colonisation, *Beeloo* territory whose leader was Munday or Monday. Lyon described Munday's territory as extending south from the Swan to the Canning River, north to the Upper Swan and Ellen's Brook and east into the mountains (i.e. the forested uplands east of the Darling Scarp). Hallam and Tilbrook (1990: 234) note that "Monday seems usually to be found south of Guildford on the Helena River, moving between west and east of the Swan" (Figure 3).

Other early commentators (e.g., Armstrong and Symmons) paint a somewhat different picture of land holdings and band composition shortly after colonisation (Hallam & Tilbrook 1990). Armstrong (1836, in Green 1979), for example, wrote of the "Canning Tribe" occupying the country Lyon allocates to Munday and Munday's group holding land north of the Swan River (see Brown 1983, his Figures 1, 2 & 3). These differences may have resulted from a lack of understanding of the complex nature and fluidity of Nyungar social organisation on the one hand and changes due to Aboriginal adjustments to the usurpation by colonists on the other. Hallam (1975) and Hallam & Tilbrook (1990) point out that this emerging picture of Aboriginal life contradicted European observers' focus on geographical areas and patrilineal relationships. A more accurate description, Hallam suggests, is that of a system of overlapping sets of ritual and social connections with land usage rights based on membership of both matrifilial and patrifilial groups. Individuals, families and bands moved between areas, generating a fluid local population size and

[3] Baines (1988) and Birdsall (1988) discuss the contemporary significance of 'runs' and 'lines'in Nyungar life and sociability. The word *bidi* in Nyungar also means 'vein' as well as 'track' (Bindon & Chadwick 1992: 13) metaphorically referring to the flow of people, ideas and objects, a similar metaphor is typically used in respect of the flow of water (McDonald, Coldrick and Christensen 2008a).

composition and suggesting that boundaries between territories were permeable (Hallam & Tilbrook 1990).

Bates (1985; nd(i) and nd(ii)) provides data which indicates that the present survey area was part of Joobaitch's (died 1907) run or country which he inherited from his father and uncles. The Swan, Helena and Canning Rivers, according to Bates, marked boundaries of his country. Bates (1985: 49) reports that Joobaitch*:*

> *[S]eemed to lay special claim to some springs in what is now the Canning district, where he was born, and was so eager to die upon his own special ground that he managed to evade the civilised comforts of the Public Hospital and died near one of his own springs while he was being brought into Perth for medical attention.*

Despite the massive disruptions to traditional activities caused by European settlement, Nyungars have continued to use areas in and around Forrestfield for camping, hunting and rural-based employment (see Baines 1988; Biskup 1973; Bourke 1987; and Green 1979 amongst others). Of particular interest is the old Welshpool Reserve or Maamba (DPLH ID 3773) located in Forrestfield to the south of the study area. The old reserve(s), which is a Registered Aboriginal Site, is depicted on the AHIS as continuous with the boundaries of the present-day Hartfield Park, Forrestfield/Wattle Grove, Kalamunda, though the exact boundaries of the place are problematic as there seems to have been at least two Aboriginal reserves in the area with different reserve numbers and which may have overlapped (Wall 1976).Ancestors of a number of key Nyungar families lived on the reserve in the late 1890s and early 1900s. One of the key Nyungar men involved with the 1995 survey in Forrestfield (see Green & Jackson 1995), Mr Corrie Bodney, reports that his mother was born at Maamba and that his grandmother, Berrigan, after whom Berrigan Drive is named, lived there for several years. Mr Bodney also reported that he had camped at what is now Fleming Reserve in High Wycombe to the north of the study area in the 1960s after he was evicted from Allawah Grove (Green & Jackson 1995: 16).

The former Allawah Grove Reserve (# 12720; partially captured by DPLH ID 3771), located at the Perth Airport to the west of the study area, is a place of major significance to Perth Nyungars (Plate 1). O'Connor (1997: 18) suggests, based on his assessment, "… that the

Allawah Grove site is, to Aboriginal people, one of the most important historic/human/mundane sites in the Perth Metropolitan area". Members of many of the key families who have been involved with heritage surveys in the Forrestfield area have at some stage resided at Allawah Grove, either before it was requisitioned for military use during World War II,[4] or in the 1950s and 1960s when it was re-established as an Aboriginal reserve (O'Connor, Bodney & Little 1985: 96; Carter 1986: 241–43; Delmege 2015; Lapham 2002; Smith Walley & Pushman 2005).

A brief glimpse of life at Allawah Grove is crucial to understanding the contemporary significance of Poison Gully Creek. A readily-available source of materials with good photographic evidence is in the 2005 University of Western Australia publication by Smith Walley and Pushman (2005). Many of the comments obtained during the current consultations are substantiated by reference to this publication, in particular the six o'clock curfew referred to by women informants with regard to the birthing associations of Poison Gully Creek (Smith Walley & Pushman 2005: 14), customary hunting and gathering practices and the inter-generational passing on of cultural knowledge. In 1959, according to official reports, there were 134 'residents' and 13 'authorised visitors' in Allawah Grove but it was also home for a large number of 'unofficial' residents and a number of fringe camps were located in the surrounding bush. Indeed, families evicted from Allawa Grove often ended up camping nearby (J. Wilson, 1958 and Makin 1970).

From its gazettal in 1910 as an Aboriginal Reserve until it was acquired by the Commonwealth during the Second World War, Allawah Grove families lived in lean-to shelters made of salvaged tin and timber cut and bark stripped from the paperbark trees growing in the nearby swamps (see Plate 2). This use of wetland resources was extensive and in 1962 the young mothers of Allawah Grove began using different barks to create layered artworks, or bark paintings, which became saleable, creative products enabling

[4] Ironically, the Reserve's requisitioning occurred shortly after Aboriginal families camping in various locations around Guildford and the Swan Valley were forced by authorities to move to the reserve. Several of the Aboriginal families removed the during WWII were relocated to a temporary reserve at Widgie Road, Beechboro, (1942–52). Others moved in with families in Eden Hill, some of whom owned their own blocks (for more on Widgie Road, see Robinson 1978 and Delmege 2015).

women to generate a reliable income. These artworks were sold domestically and overseas (Lapham 2002: 47–48; Smith Walley & Pushman 2005: 35, 41; Gare 1967). During the second consultative meeting in March 2018, two women were singled out in the presence of others as being bark artists, initially as residents of Allawah Grove. Interest was expressed in resuming this artwork style and the necessity of conserving stands of living paperbark trees such as those found at Munday Swamp and Poison Gully Creek as natural resource materials for future generations.

In 2014, women told Turner of being children at Allawah Grove and assisting in the gathering of bark materials for artworks whilst hunting turtle at nearby Munday Swamp (Turner 2014). A similar conversation between Vicky Bandry and Donna Kickett details hunting techniques and the gathering of edible seed pods, tubers, roots, tree sap and bardie grubs (Turner 2014: 36–37) and also details strict cultural protocols that applied to the hunting, cooking, dismemberment and sharing of turtle (Turner 2014:43; see also Lapham 2002: 42). What becomes apparent from listening to oral recollections of life at Allawah Grove is that it functioned as a community of Indigenous interest where opportunities abounded for the transmission of cultural knowledge both within and between resident families and visiting family members, and provided one of the last opportunities in the metropolitan area for Nyungar people to live as a community to an extent that challenged the mainstream policies of Assimilation.

The ethnohistorical evidence shows that rivers, creeks and wetlands in the Perth metropolitan region and beyond were most intensively occupied by Aborigines, given the availability of fresh water and food resources (see, for example, Hammond 1980/1933; Hallam 1975; see also O'Connor, Quartermaine & Bodney 1989; McDonald, Coldrick & Christensen 2008). This conclusion is supported by the archaeological data. In particular, the alluvial plains and the associated *warran* or native yam grounds were of crucial subsistence importance (Hallam 1975).

A number of wetlands located in the vicinity of the Allawah Grove Reserve are recorded as focal points of Nyungar activity from pre-colonial to recent times as food resource areas (see, for example, O'Connor, Bodney & Little 1985; O'Connor, Quartermaine & Bodney

1989; McDonald, Hales & Associates 1988; Smith, McDonald & Machin 1990). Several of these are listed on the AHIS as registered sites or 'Other Heritage Places', including Munday Swamp (DPLH ID 3719), Soldier Swamp (DPLH ID 3718), Airport: Tonkin Highway, Wullemarra Spring (ID 3495) and the Hazelmere Lakes (DPLH ID 17501, known as 'Leghorn Lakes' to Nyungars). Ongoing heritage investigations in and around the airport indicate that Munday Swamp is still being used for hunting and foraging (e.g., Terra Rosa 2015; Turner 2014).

Langton (2006) notes that in Aboriginal Australia waterscapes are construed not only as physical domains, but also as spiritual, social and jural spaces, according to the same fundamental principles as places in the landscape. She also suggests that "the dialogic relationship in Indigenous thought between the ancestral past and its effect on human existence derives from the Aboriginal understanding of the transformative powers of the spiritual beings that inhabit those places". For this reason, waterscapes are frequently associated with ancestral beings, in particular in the South West with the *Waugal*. Many major waterscapes in the Perth Metropolitan region are listed as mythological sites, including the Swan River (DPLH ID 3536), the Helena River DPLH ID 3758, the Ellen Brook (DPLH ID 3525), the Canning River (DPLH ID 3538), the Southern River (DPLH ID 3511), the Wungong River (DPLH ID 3512) and so on. These have been reported to be associated with the creative activities of the Waugal.

Bates (1985:221) notes in respect of the 'woggal' [Waugal]: "It made all the big rivers of the Southwest" and "wherever it travelled it made a river". She also reports that the Waugal travelled through "certain districts" and "left traces of its journeys at certain places" in the Southwest; for example, "certain hills and other features [are] sacred through their being the homes of these fabulous snakes" (Bates 1985:219). The Waugal, therefore, is associated with other topographical features besides waterscapes including hills, rocks, trees, caves, sand dunes, ridges, etc. These places are the "traces of its journeys". [5] Bates (1985:221) adds

[5] In broaching the notions of the "traces of its journeys" and the Waugal's "home", Bates (1985) is referring to the process where the mythic being metamorphoses into the topographic feature which forever contains its spiritual essence (see Berndt & Berndt 1988).

that "The places where it camped in these travels were always sacred." Indeed, the Waugal is reported to be associated with Poison Gully Creek (DPLH ID 25023).

Modern Nyungar cosmological writings place *Waakarl* [Waugal], the creation being, as belonging to the *Nyetting,* the cold or dark time (i.e., the Dreamtime), 'Era 1' which is associated with the single continent Pangea in the Earth's formation 300 million years ago (Robertson, Nannup, et. al 2017: 10–12). "The Waakarl of the Nyoongar [Nyungar] narrative is described as the rhythm of the earth. It can be understood to be an embodiment of the energy generated by persistent friction between ice and land." Robertson, Nannup, et. al (2017) view the *Waakarl* as the primary spiritual being, forced down onto and into the earth by the crushing sky, emerging again and again, and in so doing creating the waterways and swamps and forging the environment where other spiritual beings would settle. "[M]any of the spiritual ancestors followed the trail left by the Waakarl and selected the places where they would one day flourish" (ibid: 10).

As with other groups in Aboriginal Australia, the notion that 'water is life' underpins Nyungar conceptualisations of surface and subsurface hydrological systems (see McDonald, Coldrick & Villiers 2005 and McDonald, Coldrick & Christensen 2008 for discussions of Nyungar concerns; for more general discussions of Aboriginal views, see Rose 2004 and Strang 2002 and 2008). The key ancestral being associated with water is the Waugal or water serpent, described in various parts of Australia as the 'rainbow serpent', whose actions highlight the interconnectedness of water with the wider environment, including earth and the sky and human beings. As Rose (2004:39) remarks:

> *One set of connectivities articulated by the Rainbow Serpent is thus the flow of water from inside the earth, across the surfaces, into the sky and back to earth. On the face of it, Rainbow Serpent connectivities parallel ecological analysis of water dynamics and energy flow. However, the internal forces and sources of water that the Rainbow Serpent is, and accesses, are deep matters in Indigenous metaphysics.*

Water and water sources are immensely important to Nyungar identity and social being. As Strang (2002) notes in another context, water metaphorically frames social and environmental relationships and is an important source of cultural identity. Metaphors of

blood figure centrally in Aboriginal, including Nyungar, conceptualisations of water and its flow (Strang 2002; McDonald, Coldrick & Christensen 2008).

Munday Swamp (DPLH ID 3719) and other wetlands generally have also been reported to be associated with the creative activities of the Waugal (Terra Rosa 2015, for example). O'Connor, Bodney & Little (1985: 98–100) report that the late Mrs Ollie Worrell was probably the last Nyungar to know "the ritual invocation specific to the area" [Munday Swamp]. O'Connor (1997: 18) concludes that "to Nyungars the Munday Swamp site is one of the most important mythological/sacred sites in the same [airport] region". This statement might be somewhat hyperbolic; however, it does draw attention to the potential significance of this wetland, and by extension to others in the area, to Nyungars (see below for further comment).

Wetlands and rivers were connected by a series of pads (*bidi*) for example, *bidi* extended from the present-day Perth area south to Mandurah and Pinjarra on the Murray River and north to Cockleshell Gully and beyond (Bates 1985; McDonald & Venz 2002). A number of major roads in the South West generally follow the alignment of these original Aboriginal pads. For example, Popham (1980:17) notes that Albany Highway follows a route surveyed by Hillman in 1836 which "followed the worn pathways of the Aboriginals (sic) and the course of the Neerigen Brook". Coy (1984:4) reports that "[t]he South Western Highway, known originally as the Foothills Track, vaguely follows a major Nyungar walking pad, which ran from the Perth Causeway to Pinjarra, then southwards to the Blackwood."

Ethnohistorical data suggest that local groups undertook a great deal of movement along these pads (Bates 1992). Individuals, families and bands moved between areas, generating a fluid local population in terms of size, location and composition, suggesting that boundaries between territories were permeable. Hallam (1975) points out that this emerging picture of Aboriginal life contradicted European observers' focus on geographic areas and patrilineal relationships. A more accurate description is that of a system of overlapping sets of ritual and social connections with land usage rights based on membership of both matrilineal and patrilineal groups.

European colonisation heralded the destruction of traditional Aboriginal social organisation, beginning in the Perth area and expanding steadily across the South West. Epidemics, shootings by Europeans, and draconian policies introduced by the colonial administration (e.g., forced exclusion from urban areas, concentration on reserves, and restrictions on movement and labour) resulted in the decimation of the Nyungar population as well as the attenuation of traditional ties with the land and sites (Berndt 1979; Hammond 1933). As a result of this dislocation, there has been a loss of traditional mythological and ceremonial associations with the land along with the knowledge underpinning these connections. However, there is still some mythological knowledge available in the Nyungar community.

While there is a paucity of information regarding Aboriginal occupation in the area post European contact, information gleaned from local histories and other sources indicates that Aboriginal people continued to play a significant, albeit marginal, role in local social and economic life. Nyungars were employed seasonally on farms or in local industry or were engaged in marginal economic activities such as bean stick cutting (for clothes line props and crayfish pots). Popham (1980:120) reports that Aborigines in the Armadale area exchanged "the scraped-off wood of zamia palms, which were used as pillow filling in exchange for tea and flour" at the turn of the twentieth century. Aboriginal involvement in the local economy also meant that Aboriginal people lived in or on the fringes of the local community. In the 1950s men were walking from Allawah Grove to Bentley for work and to the Swan Valley for extended periods of seasonal vine cutting (Lapham 2002).

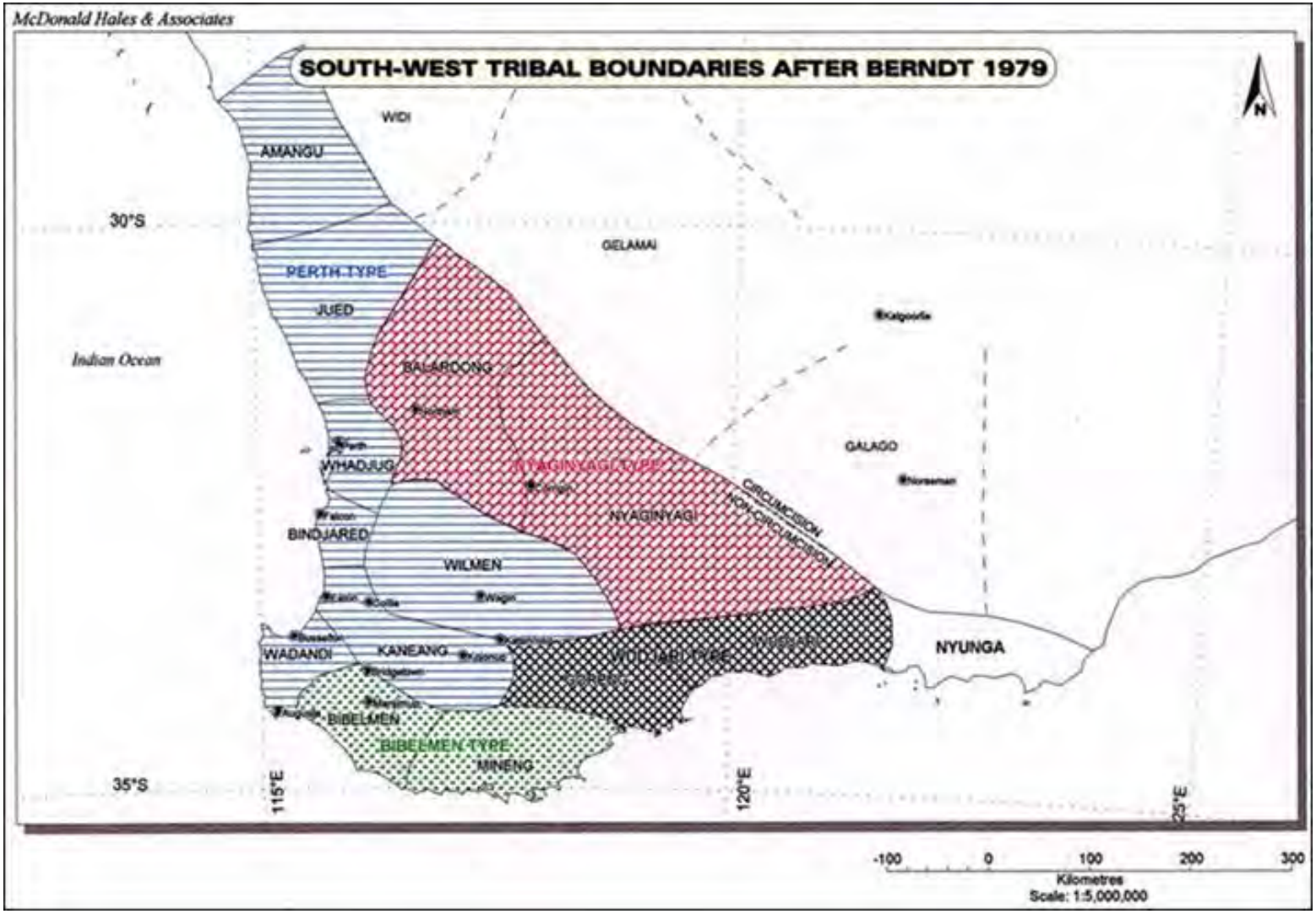

Figure 2: South-West tribal boundaries and social types (after Berndt 1979)

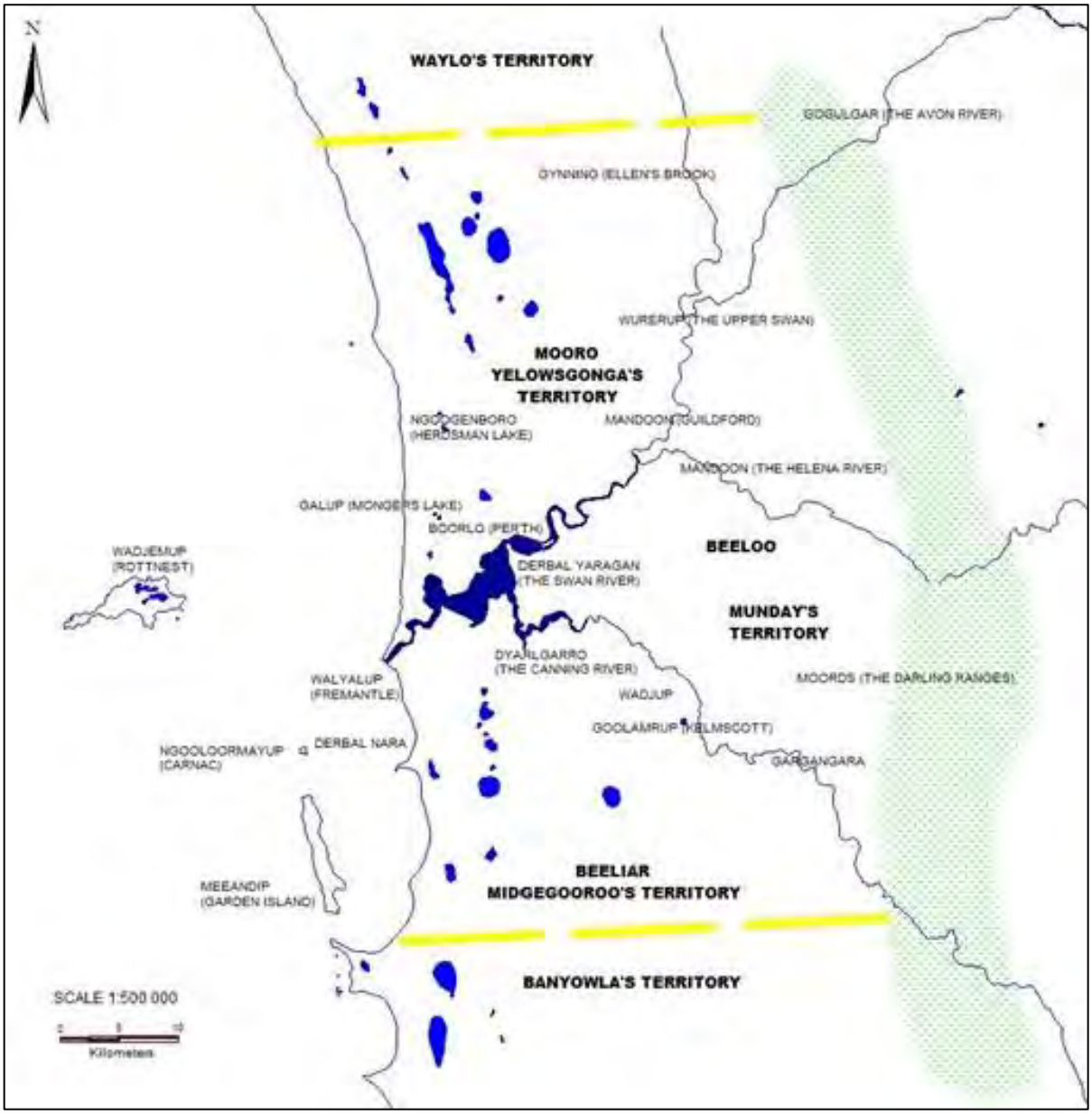

Figure 3: Place names and territories recorded by Robert Lyon after Green 1979

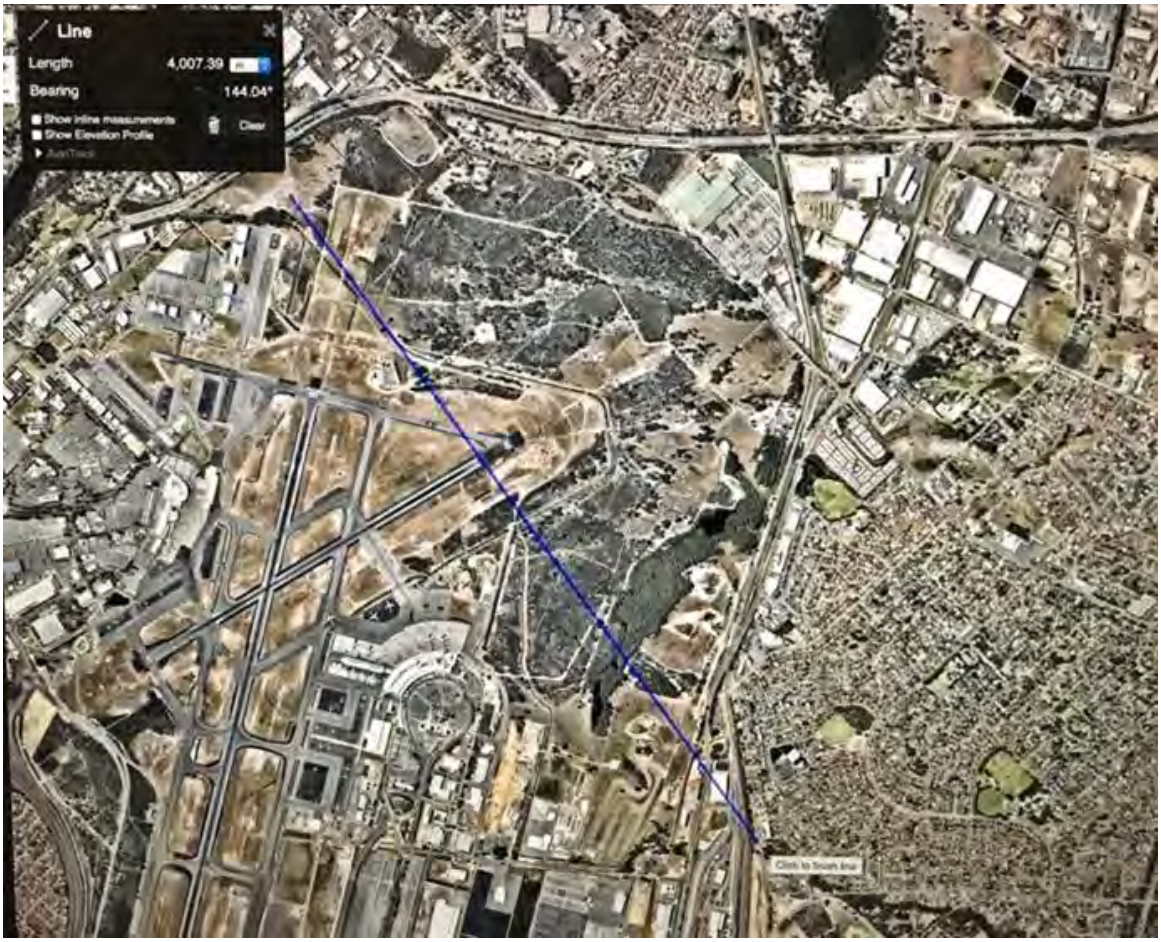

Figure 4: Aerial photograph showing distance between Allawah Grove and Poison Gully Creek as being 4km (courtesy T. Bergin).

Plate 1: Allawah Grove settlement (Source: Smith Walley & Pushman 2005)

Plate 2: Typical fringe camp at Allawah Grove (Source: Smith Walley & Pushman 2005)

Plate 3: Poison Gully Creek, Dundas Rd Crossing, summer 2017 (Photo: J. Turner)

Plate 4: Ducks on Poison Gully Creek, Dundas Rd Crossing, winter 2014 (Photo: J. Turner)

Plate 5: Poison Gully Creek, Dundas Rd Crossing, winter 2014 (Photo: J. Turner)

Plate 6: 'Soap Bush', plant associated with human bathing in general and Nyungar women's post birth practices in particular (Photo: J. Turner)

Ethnographic Survey Results

Desktop Research Findings

Registered Aboriginal Sites

The search of the Register of Aboriginal Sites confirmed that Poison Gully Creek (DPLH ID 25023), which is currently listed on the DPLH Register of Aboriginal Sites under the classifications "Birth Place" and "Water Source", is located within the study area. The following summary comes from Turner (2014: 4–5).

Poison Gully Creek was not formally reported as an ethnographic site in its own right until specific ethnographic research was undertaken by Nicolas Green in 1995 associated with the installation of a sewerage system (Green & Jackson 1995). Subsequent heritage research by Chown et. al. was undertaken in 2008 in response to a proposal by Western Power to install cables across Poison Gully Creek. Background research at this time revealed that although the Green and Jackson report of 1995 had been lodged with the Department of Indigenous Affairs, Poison Gully Creek had not been registered as an Aboriginal site.

The initial research of May 2008 undertaken by Bob Chown reinforced the earlier findings that not only was Poison Gully Creek a significant cultural site, it was associated specifically with "women's business" and secondly that Nyungar women, with the support of men, requested a female anthropologist be engaged to consult with them (Chown et al. 2008: 1). Their request was recognised and three weeks later a female anthropologist, Jeanne Hohnen, was engaged to undertake site documentation research for Poison Gully Creek, now also referred to by its Site Register identifier, DPLH ID 25023. Ms Hohnen met with 16 Nyungar women over two on-site consultations at Poison Gully Creek and in one home visit. She was able to include a considerable amount of cultural information in the subsequent report (Hohnen & Bergin 2008).

The site was assessed by the Aboriginal Cultural Material Committee (ACMC) during deliberations of a Section 18 Notice on August 6, 2008 (Resolution Number 2008/093) and

was determined to be a place to which Section 5(b) of the AHA applies (i.e., a sacred site) on the basis of Sections 39(2)(b): "any former or reputed use or significance which may be attributed upon the basis of tradition, historical association, or Aboriginal sentiment" and 39(2)(c): "any potential anthropological, archaeological or ethnographical interest".

Access to the site file is restricted and only available to females. Ironically, though a 'female only' site, two of the place's listed informants or knowledge holders are men, the late Ken Colbung and Corrie Bodney. The other informant is the now defunct organisation, the Nyungar Circle of Elders. Another layer of irony is added when it is noted that both the late Ken Colbung and Corrie Bodney reported to Green (Green & Jackson 1995: 16 & 19) that Poison Gully Greek was not in their opinion an Aboriginal Site (that is, they were unaware of any mythological or ritual significance).

As the site file is 'Closed', the boundaries on the AHIS are 'restricted' and therefore 'dithered'; i.e., the spatial representation published on the AHIS website is broader than the actual boundary, because of the site's reported significance and hence confidentiality regarding the place's precise boundaries. [6]

In 2014, the specific services of a female anthropologist were deemed necessary by Waru Consulting as part of their Section 18 consultations for the Public Transport Authority's proposed rail link. Jan Turner was engaged to do this work. Her gender-specific report to Waru was then incorporated into a final report which included reporting on both women's and men's consultations (Turner et al 2014).

Turner has noted a consistency in the nuanced gendered knowledge and the right to speak publicly about Poison Gully Creek across her consultations from 2014, 2017 and 2018. Women are standing up as spokespersons but also deferring to the wishes of senior men

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[6] The DPLH website notes in respect of restricted boundaries: "To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km^2) provides a general indication of where the place is located."

as to what information can be divulged publicly. These nuances are further illuminated in the Women's section of this report.

Munday Swamp (DPLH ID 3719), into which Poison Gully Creek (DPLH ID 25023) originally flowed, is located on Perth Airport land to the west of the study area. Nyungars previously have expressed concerns about impacts on Poison Gully Creek having downstream negative impacts on Munday Swamp. DPLH ID 3719 is a Registered Aboriginal Site under the categories of ceremonial and mythological significance (Waugal associations) as well as being a camp, an artefact scatter and a place associated with hunting and plant resources. The site file is 'Closed' and therefore the site is depicted on the AHIS with a dithered 2km x 2km boundary. However, information on the site file would indicate that its actual boundary follows the fringe of riparian vegetation around the swamp (see Bergin & Mattner 2009: 34).

The notion of ceremonial/mythological has to be read with caution. Although clear, albeit quite generalised, mythological associations have been reported for the wetland, no 'ceremonial' activities per se seem to have been recorded. The AHA s5(b) recognises sacred, ritual and ceremonial sites ("any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent") and s39(3) gives primacy to sacred beliefs and ritual or ceremonial usage in the evaluation of places and objects. In practice, however, the DPLH conflate 'ritual' and 'ceremonial' sites and 'ritual' or 'ceremonial usage'. The term 'ritual' for example, in our experience does not appear on the AHIS or other DPLH documentation. However, though 'ritual' and 'ceremony' are two closely related concepts, they do need to be distinguished. What O'Connor, Bodney & Little (1985: 98–100) originally described was a 'ritual' observance: "the ritual invocation specific to the area". Similarly, Turner observed ritual behaviour at Poison Gully Creek in 2014. The term "specific" would suggest that it is in some way different from the general (though probably similar) invocation of the Waugal described by Baines (1988) and others which involve the sprinkling of sand in the water and calling out to the Waugal (see below for further comment). Possibly specific wording was used at Munday Swamp. Regardless, such rituals need to be distinguished from larger 'ceremonies' involving large groups of

people, such as those typically associated with initiation ceremonies or *mulyapin*, which refers to both initiation process and an initiation or corroboree ground. These are the sort ceremonies that Bates (1985) records having occurred at *Wardawardong* (DPLH ID 3796) on the eastern bank of the Swan River near its original junction with Blackadder Creek. Mr Bodney, who is one of the listed informants for Munday Swamp reports that his maternal grandmother, Berrigan, participated in the last corroboree at *Wardawardong* around 1907.

Munday Swamp was a place that Nyungars gathered in both prehistoric and historical times (Bropho n.d.). It was the location for evidence being heard by the Federal Court in the first Nyungar Native Title Claim where customary activities such as the cooking and eating of swamp turtles and other bush foods were demonstrated to the Court. Unfortunately, it would seem that the notation of 'ceremonial' on the AHIS and site file has given rise to the perception that large-scale religious ceremonies took place at Munday Swamp:

> *Munday Swamp, in particular, is a known ceremonial and mythological site which would have regularly drawn large numbers and/or groups of people to the area* (Terra Rosa 2015: 44).

This notion of Munday Swamp being the location of large scale 'ceremonies' then gets fed into the interpretation of the area's archaeology:

> *As no raw material sources suitable for tool making exist in the immediate Munday Swamp area, past people would have had to bring with them all the lithic items they would require in preparation for a potentially extended visit to this important ceremonial and mythological site* (Terra Rosa 2015: 45).

Nevertheless, regardless of the apparent misinterpretation of the term 'ceremonial' in relation to the place, Munday Swamp is a place of importance and significance to Nyungars and in a sense its significance frames the attribution of significance to other heritage places within the Forrestfield North DSP study area's environs and is directly linked to Poison Gully Greek and its status as an Aboriginal Site.

Other Heritage Places

Two 'Other Heritage Places', both artefact scatters, are listed in the Forrestfield North DSP study area: DPLH ID 3667 Crumpet Creek, Forrestfield and DPLH ID 3637 High Wycombe: Brooklands Estate. The former has been deemed not to be an Aboriginal Site within the meaning of Section 5 of the AHA and information regarding the place is archived in 'Stored Data'. The latter is a 'Lodged' place which has not as yet been assessed by the ACMC.

As noted, an archaeological survey of the Forrestfield North DSP study area was not part of the current brief. Areas around the present study area, such as the Perth Airport land and the Newburn Marshalling Yards, have been intensively surveyed and as a result dozens of archaeological sites, typically artefact scatters, have been recorded (see Archae-aus 2016, for example). It is reasonable to assume, therefore, that an archaeological survey of the Forrestfield North DSP study area would without doubt result in the recording of archaeological sites in addition to DPLH ID 3667 and DPLH ID 3637. This prediction is also supported by previous regional-scale research (see, for example, Hallam 1986; see also Figure 5 below

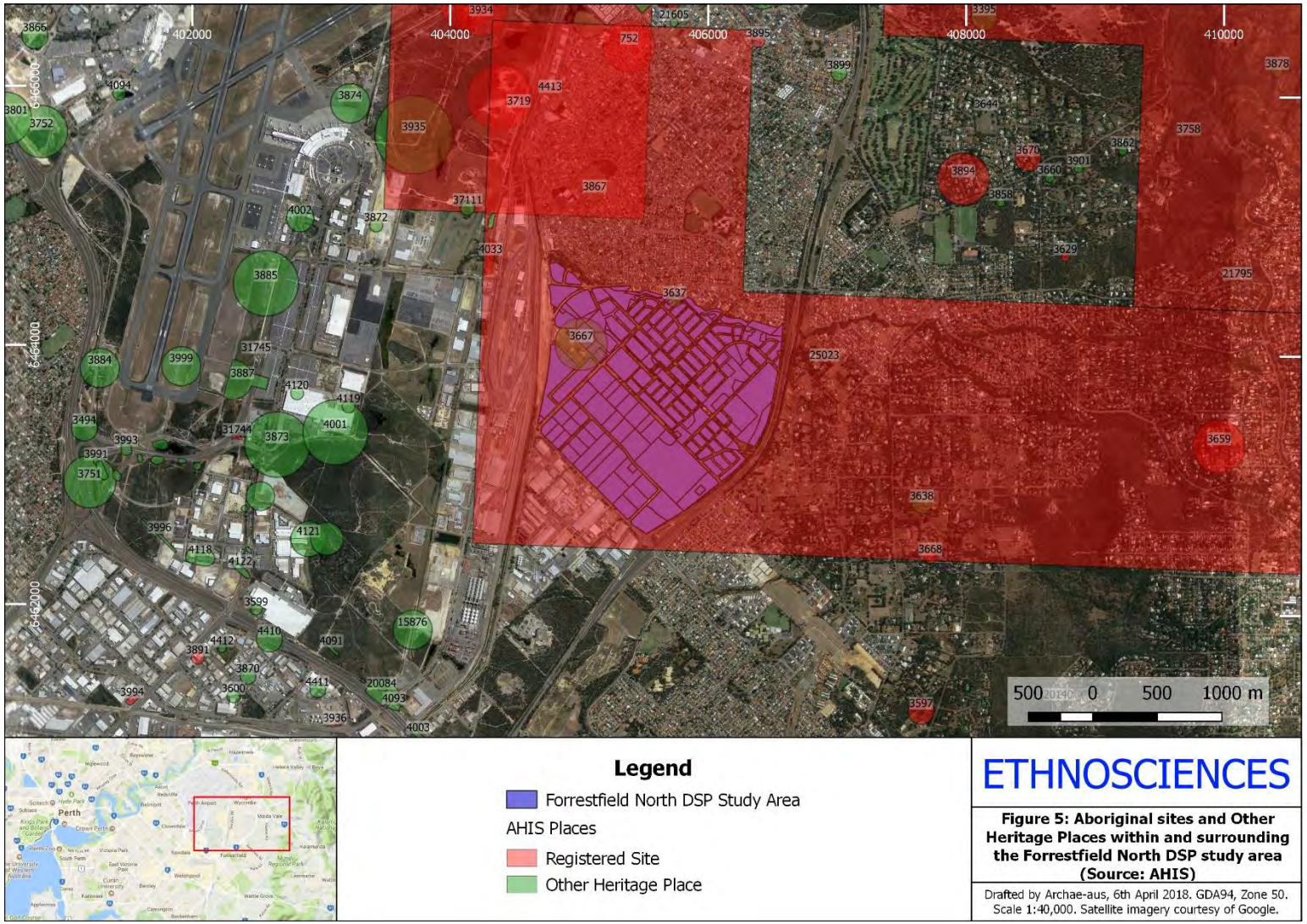

Figure 5: Aboriginal sites and Other Heritage Places within and surrounding the Forrestfield North DSP study area (Source: AHIS)

Outcomes of the Ethnographic Consultation

Both the women's and men's consultative meetings confirmed the presence and the importance and significance of Poison Gully Creek (DPLH ID 25023) in the Forrestfield DSP study area. No other places that might reasonably be considered to be Aboriginal Sites were identified by the Aboriginal consultants in the study area.

Results of the Women's Consultative Meetings

Nature and Extent of the Poison Gully Creek Site

The December 2017 consultations were consistent with those of 2014 with regard to the women's understanding of the nature and extent of the Poison Gully Creek site (DPLH ID 25023) (Turner 2014: 11–12). These can be summarised as follows:

The Nyungar women regard Poison Gully Creek and the immediate surrounds to be a single site from its source in the high country of Kalamunda to where it joins with the waters of Munday Swamp. They speak of the site as if it still follows its original path prior to European disturbance, insisting that water flows as a 'life force' both above and below ground. Above ground the creek rises and falls in depth, narrows and widens in breadth and flows, remains in still water pools or dries out according to the six Nyungar seasons.[7] Below ground the water is in continuous motion, following the path laid down by ancestral beings, the flow occurring irrespective of the seasonal conditions experienced above ground. The ever-present underground water is said to sustain life for the turtles, frogs and micro-aquatic life in the dry seasons and be simultaneously available for the root systems of even the tallest trees. It is also home to spiritual beings and is, in itself, direct proof of their existence.

[7] The Nyungar seasons are *Birak* (December - January), *Bunuru* (February – March), *Djeran* (April – May), *Makuru* (June – July), *Djilba* (August – September) and *Kambarang* (October – November) (see, for example, Australian Bureau of Metrology http://www.bom.gov.au/iwk/nyoongar/index.shtml [Accessed March 2018]).

At the time of the consultation for the Forrestfield North DSP, it was difficult to determine the land area included within the Poison Gully Creek site (DPLH ID 25023) but it appeared to vary for a distance of between 30 to 50 metres from the creek banks where they are clearly defined. In 2014, Nyungar consultant Rebecca Hume stated that a greater land area should be included where the waters broadened out in the vicinity of Munday Swamp and the differences between high and low watermarks were more pronounced (Turner 2014), which accords with Hohnen's findings (Hohnen & Bergin 2008: 10).

The Nyungar women's construction of the extent of the Poison Gully Creek site is challenging to Western perceptions of sites, which underlie the AHA, as stationary and two dimensional, i.e., having a defined area. In the case of DPLH ID 25023, these aspects are augmented by concepts of vertical depth and volume. The women defined the site as including the water below ground, the natural surface of the land and the airspace above the creek and its banks up to and including the tallest vegetation. Additionally, the Noongar women forcefully stated a cultural notion of water movement both east–west and in descending altitude from Kalamunda to Monday Swamp (see also Turner 2014: 11–12).[8]

Whilst the women consulted state that the entire length of Poison Gully Creek should be considered a site — from Kalamunda to Munday Swamp, consistent with the findings contained within heritage consultation reports from 1995 to 2017 (e.g., Green & Jackson 1995; Hohnen & Bergin 2008: 10; Turner 2014: 17) — there is a strong emphasis on the need to protect the natural bush and creek between Dundas Road and Milner Road and in particular the open space adjacent to the Dundas Road crossing. The women cite the aesthetic value of this area as being integral to their own, and indeed Nyungar, wellbeing in general. [9] They wish to have this area given full 'legal protection' to enable them to

[8] During Aboriginal heritage consultations, Nyungars frequently articulate four principles in respect of impacts on waterways: 'Do not interfere with (a) the riverbed, (b) the watercourse, (c) the quality of the water and (d) the foreshore areas' and are concerned that riverine sites ought to be left in their 'natural state' (McDonald 2017 and McDonald, Coldrick & Christensen n.d.).

[9] Aesthetic values are one of the evaluative criteria of the AHA (s39(2)(d)) that have to be addressed in respect of the assessment of the importance and significance of places and objects.

activate the spiritual wellbeing and nurturing forces of this women's place in the future. They wish to use this site as a place where Nyungar women can bring younger women to talk about sexual health, respect for their developing bodies, child rearing practices and the naming of children. Quietly, they express their opinions that it is only in these remnant pockets of bushland that older people can assist younger ones to turn away from drugs, despair, depression and thoughts of suicide. This desire is expressed in the following quotation:

> *… these sites where there is natural bush and where we can feel our spiritual connections need to be protected. It gives us a place to get away from the violence, sickness and sadness in our lives. Too many young people in trouble.*

The aesthetic qualities of the bush were noted many times over during the current consultations. This accords with the 2014 consultations:

> *The importance of the remaining bushland associated with the Poison Gully Creek site was endorsed by Gwen Corunna who spoke of the peacefulness of the natural environment and Poison Gully Creek in particular and its importance for women's wellbeing, particularly female youth, in direct contrast to youth problems of suicide and despair, the issuing of 'Move On' notices and the high imprisonment rates of Noongar youth.*

These sentiments were endorsed by those present in December 2017 and March 2018.

In the December 2017 consultation, an extra dimension was raised by reference to the inclusion of archaeological materials. One of the women, Kezia Jacobs-Smith, had participated in the Terra Rosa survey (2015) and was able to speak knowledgeably to others of the numbers of artefacts found during archaeological surveys in the adjacent Airport land area, including contemporary archaeological theories of land usage over prehistoric time. Of particular note was the introduction of lithic material such as quartz artefacts from the Darling Range and fossiliferous chert from what is now off the coast to the swampy coastal plain, reinforcing Indigenous oral histories of movement between the hinterland and the coast via *bidi* (tracks) that typically followed the waterways. The other women present acknowledged and concurred with Kezia's statements. As noted above, the Forrestfield North DSP study area has not been specifically surveyed archaeologically.

This archaeological dimension requires ethnographic attention.[10] It reflects not only recent Nyungar participation in archaeological surveys at the nearby Airport lands, but the development and deployment of a research method used in modern Nyungar collaborative writings associated with scientific research called "Koodjal jinnung" (looking both ways). This method has allowed Nyungar writers to integrate different concepts of time, deep geological history, pre-colonisation, post-colonisation and contemporary oral memories with Nyungar cultural concepts of time (see Robertson, Nannup et. al. 2017 and Robertson, Barrow et. al. 2017). It has allowed for the synchronisation of Western and Nyungar science perspectives and is integral to an understanding of the contemporary importance of Poison Gully Creek to the women.

Customary Behaviour

During the December 2017 consultation, one of the women was observed to speak quietly to a perceived spiritual force (possibly the Waugal) after she alighted from her vehicle and before we began discussions. Wandering to the banks of the creek bed, she paused, her gaze including the tree canopy before directing her words in the direction of a small patch of damp earth surrounded by reeds. This accords with the actions of two different women in the 2014 consultations observed by Turner and with those reported by Green (1995). Such behaviour forms part of what Rose (1996) refers to as 'rituals of wellbeing'. These, she notes, may occur in a formal ritual or ceremonial context or may involve such things as 'talking to', 'singing out' or 'calling out' to country, to Dreamtime beings, to other living things, or to the 'Old People' [ancestors] on visits to country. [11]

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[10] Archaeological sites are typically of concern to contemporary Aboriginal people and the AHA requires that such sites are evaluated with respect to 'relevant Aboriginal custom' (s39(2)(a)); Aboriginal tradition, historical association and sentiment (s39(2)(b)), and potential anthropological and ethnographical interest in addition to potential archaeological interest (s39(2)(c). For a discussion of the contemporary significance of archaeological sites see, McDonald & Coldrick (forthcoming).

[11] As noted above, the typical ritual associated with waterways is the throwing or sprinkling of sand/dirt in the water and invoking the Waugal to propitiate the spirit (see, for example, Baines 1988:247–48). This ritual has its correspondence in the Pilbara and other parts of the Northwest, where Aboriginal people squirt water from their mouths into the pool or other 'living waters' occupied by the mythic water snake or Rainbow Serpent and call out telling him that they are

The oldest woman consulted, Myrtle Yarran, was heard to speak to her female driver and asked that freshly fallen gumnuts be collected from beneath the trees, to be taken back to their home in Quairading, patterned with paint and distributed among family members as part of Christmas gift giving. Mrs Yarran attributed gifts created from this site as having positive family influences because they originated from a women's site.

Significance to Women

There is now a significant number of Nyungar women who speak of Poison Gully Creek, more particularly the vegetated shaded flat with pool access near Dundas Road, as a site where women came in the past to give birth. They speak of the conducive features: the shallow depth of the pool, privacy afforded by vegetation, easily obtainable small-sized firewood and slow-burning bark for practical and ritual purposes, the presence of the white flowering 'soap bush' that produces a sudsy cleansing substance when rubbed in the hands and specific plants known for their medicinal values such as red gum sap.

Women are aware of the knowledge of previous women spokespersons for the site and endorse their words. Of particular relevance are the oft-referred to words of deceased elder Dorothy Winmar as quoted in the Hohnen and Bergin report (2008: 12):

> *… [birthing places] could be close to Banksia trees, as these when burnt, gave the softest ash for babies. [She] explained that babies were covered in a layer of goanna fat and then Banksia ash to provide an insulating layer to keep them warm in the same way as a blanket.*

Winmar's words were selected and brought by Rebecca Hume to be read aloud to a women's consultative group in 2014 (Turner 2014: 13). They were also referred to in the 2017 consultation.

The proximity of Poison Gully Creek to the residential community of Allawah Grove and the resource-rich Munday Swamp was noted by the women. Marion Collard spoke of extended stays with her mother's family at the Allawah community and the opportunities that this provided for the transmission of cultural knowledge between named families.

countrymen; otherwise there is a danger, they believe, that the snake might harm those approaching the water source.

Marlene Warrell continues to eat 'long neck turtle' and actively transmits cultural knowledge to younger people. She is one of a group of sisters whose grandmother Ollie Warrell lived for many years at Allawah Grove and was so closely identified with this area that 2.5km from the Dundas Road crossing of Poison Gully Creek there is gazetted public open space named the 'Ollie Warrell Reserve'. Ollie Warrell was known to walk the *bidi,* the network of Nyungar walking trails that connected Aboriginal residential reserves and camps with the natural resource-rich swamps and watercourses of the coastal plain. At times, she was accompanied by her granddaughters (Turner 2014: 14).

It is clear from the preceding discussions that Poison Gully Creek is of contemporary significance to women and is held to be a woman's place. In the 2017 consultations there was much discussion about the role of women and which women in particular had responsibility for teaching/transmitting cultural knowledge, learning/receiving and capacity to speak for the site in the face of continuing development issues and their associated threats to the physical and spiritual integrity of the site. In the morning session, Bella Bropho was encouraged to take on this knowledge and "speak for this place". Rather than speak as a small group or as individuals about the specifics of women's cultural knowledge in December, all women consulted endorsed the idea of a specially convened women's meeting to be held at Matagarrup (Heirisson Island) in 2018. At the core of the discussion was dissatisfaction with the current heritage process. In the words of Vanessa Corunna: "What do we women want from heritage talks? How can we do this? How can we embrace our culture and overcome the [heritage] system of oppression?" The proposed Matagarup meeting was endorsed as an initiative of the women themselves rather than triggered by heritage processes of site identification and the associated process of obtaining consents to alter and too often impact or destroy the identified sites, referred to frequently by the women consulted as "section 18s". At the proposed Matagarup meeting, women intend to discuss establishing a women's cultural project to both gather and transmit knowledge to younger women — to raise, discuss and incorporate the words of now-deceased women elders or those too frail to attend on-site consultations.

The proposed project would document famous Nyungar midwives, ante and post-natal ritual practices and women's spiritual health and responsibilities. Gwen Corunna and her daughter Vanessa wished to have noted in this report that they have documentary evidence of six generations of their family being born in the metropolitan area from Adeline Wilkes' birth in 1898 beside the river at Success Hill, to the youngest of the "grannies" (i.e., grandchildren). It was also proposed that named "bush babies" (that is, living persons born in the bush or on community reserves in the Perth area rather than in a hospital) be approached to have their stories documented. This is in keeping with Nyungar-based community artwork honouring Bush Babies elsewhere in the Southwest and Pilbara regions of Western Australia. One Nyungar art exhibition on Bush Babies, installed in the WA Museum in Perth in 2014, was visited by over 72,000 people before it toured regional WA. This exhibition will have been continuously viewed until September 2018.[12]

Of particular relevance to this report were statements made relating specifically to gender and the transmission of gendered knowledge. In the morning session, women discussed previous practices whereby Nyungar men "spoke up" for Poison Gully Creek. It was posited that the men may have been protecting women and women's knowledge by allowing women to remain supportively in the background. However, it was also noted that many heritage surveys in Nyungar country are undertaken by male anthropologists with whom women do not easily wish to discuss women's sites. Two of the women present for the December 2017 consultation, Vanessa Corunna and Kezia Jacobs Smith, have studied the subjects of anthropology and archaeology at university level. However, they observe that they are not asked by heritage consultancy companies to participate as anthropologists. The paucity of female anthropologists working with Nyungar women on heritage surveys was noted, as was the inability of any single female anthropologist to gain familiarity and knowledge due to the multiplicity of heritage companies operating

[12] See, for example: , https://www.waitoc.com/fast-find/latest-news/bush-babies-exhibition-coming-perth; https://www.cacwa.org.au/advocacy-policy/stories/can---goomalling-ush-babies.

in the metropolitan area each with their preferred staff or consultants. In the March 2018 consultation/discussions, specific known birthing practices were referred to that involved natural births beside water sources such as Poison Gully Creek. However, it was requested that this knowledge not be made public as it was believed to be held by specific families and specific family members and was not open for general discussion in either the Nyungar or mainstream Western Australian communities.

Request for Documentation

There was general agreement that funds be sought to document from a Nyungar perspective the entirety of the Poison Gully Creek site from Kalamunda to Munday Swamp. Bella Bropho raised filming as an option that has been deployed on other cultural recording projects.

Results of the Men's Consultative Meeting

All four Nyungar men involved with the consultation spoke knowledgeably about the present survey area, drawing in this respect upon long and continuing individual and family associations with the survey area itself and with its broader social, cultural and geographic context.

One man, for example, spoke of early childhood experiences walking with his parents along a well-defined traditionally-important track (*bidi*) from the foothills to the Poison Creek Gully site, where they camped before progressing further along that track to other places of special significance to them on the coastal plain. He recounted how, in the context of these experiences, he had learned from both his parents about his "country", its resources, its special places and their relationship to each other, and about the responsibilities its owners had toward its upkeep and renewal. He further recounted how, growing toward adulthood, he acquired more and more knowledge about his country, including Poison Creek Gully, allowing him in later years to speak authoritatively about his country and to instruct younger generations about it, just as his parents and other relatives had done in earlier times.

The other three consultants had not had the same width of early childhood experience in regard to Poison Creek Gully per se, but all were able to point to similar experiences as youths and young adults learning first-hand from their parents and older relatives about Poison Gully Creek and its associations with surrounding "country". They too have subsequently taken on responsibilities in speaking and caring for "country" and for imparting the required knowledge to the younger generations.

In all essential respects, the men spoke with a single voice as it were in relation to the issues of concern to them raised by the proposed Forrestfield DSP.

The men acknowledged that Poison Gully Creek (DPLH ID 25023), a Registered Aboriginal Site with which all are familiar, is the only place lying within the present survey area which is currently recognised as an Aboriginal Site under the terms of the AHA. They reported that they were not aware of any other place within the survey area for which similar recognition had been sought, nor of any other place for which such recognition could or should now be sought.

They pointed out that in Nyungar culture, the senior women in their families were the holders of special knowledge and cultural responsibilities in relation to Poison Gully Creek, including speaking up for the site in relation to any potential disturbance or degradation. They noted approvingly in this regard that a prior Women's Meeting had been held in relation to the Project Area and that consultation had been led by Jan Turner, a female anthropologist with extensive research and consultation experience, including earlier work in relation to Poison Creek Gully itself (Turner 2014). Envisaging that further consultation would be necessary as the Forrestfield DSP proceeds, the men nominated two other women they want included in any follow-up meetings.

The Nyungar male consultants provided further information that they believed would complement and extend that provided by the women at the earlier consultation meeting. The key points made concern:

(i) their continuing access to and control of the land as its traditional owners and custodians;

(ii) cultural precepts and practices seen as sustaining both "country" and community;

(iii) complementary male and female knowledge and responsibilities; and,

(iv) linkages between the Forrestfield North DSP study area and the surrounding landscape.

The viewpoints expressed in each of these regards are summarised below.

The men reported that they were traditional owners and custodians of the broader area embracing Poison Gully Creek (DPLH ID 25023). As such, they carry broad responsibilities for the upkeep of the land based upon their unbroken inheritance of that land as its traditional owners. They acknowledged ruefully that the traditional ownership they assert in relation to this particular place is not recognised in current governmental legislation, administrative arrangements or formal agreements, other than to the limited extent allowed by current heritage legislation (i.e., the AHA). Extending this theme, they expressed their frustration at continually being asked to approve developments that 'chip away' at their inheritance. "It's death by a thousand cuts" is how one of the consultants expressed their shared sentiment in this regard. Putting aside that sense of inevitability, the consultants expressed their desire to explore whatever avenues might still be available to them to gain formal recognition of their customary rights via existing Native Title processes. [13]

As discussion turned more toward the specifics of the Forrestfield North DSP area, the consultants spoke in terms of both custodianship and ownership. One consultant expressed his annoyance at "whitefellas" who use "custodian" as an alternative to "owner" when discussing traditional relationships to land, especially when they think they are being more culturally sensitive by doing so. The two terms, he asserted, need to go together, to encompass the complementary dimensions of their relationship to land—the inextinguishable rights that have come to them from time immemorial, including

[13] These concerns were raised despite the signing of the South West Settlement between the WA Government and SWLASC, which includes the Whadjuk People, and the passing of the *Noongar (Koorah, Nitja, Boordahwan) (Past, Present, Future) Recognition Act 2016*.

rights to control what others might do on their territory; and their culturally-defined responsibilities to care for and renew the land. "We look after the land and the land looks after us." Another consultant added that the health of their people depended upon them continuing to look after their country.

Without in any way retreating from their recognition of the primacy of senior women in sustaining specific cultural belief and practice in relation to Poison Gully Creek, the consultants pointed out that men also have an essential role to play in its protection and care, and more generally in sustaining their links to country. Special rights and responsibilities are not sole rights and responsibilities, they said. Men, they reported, must protect and "back up" women's special rights and responsibilities without intruding upon them, just as women are expected to do in relation to men's corresponding activities in other places. "We work together" is how one consultant described the underlying relationship.

The consultants also spoke of how specific sites exist within a broader geographic and cultural context, and, therefore, should not be viewed in isolation either from other sites in the area, especially those along particular "tracks" (*bidi*), or from traditional "country" generally. Each site, they emphasised, constitutes one part of a much bigger picture shaped and defined by beliefs about how the land and its features were initially shaped in the distant past (as often conveyed in conceptions of the Dreaming as a transformative era in the remote past); and sustained in the eons since by successive generations playing their vital part in renewing the life and order instituted and ordained during that original heroic era, invoking the wider sense of the Dreaming as an "everywhen", to use Stanner's (1979) now familiar term, unifying past, present and future.

Against this background, the men expressed the desire to know more about the possible consequences for other areas outside the present Forrestfield North DSP study area of the plans now being prepared for the wider Forrestfield redevelopment. Possible downstream consequences for Munday Swamp (DPLH ID 3719) were cited as of particular concern in this respect.

Discussion

The women's and men's conceptualisation of Poison Gully Creek as a place and its dimensions are not easily shoehorned into the two-dimensional provisions of the AHA. The focus is on the dynamics of the place. In this regard, Poison Gully Creek was not discussed by either the women or men as an isolated place. Rather, the focus of discussions was on its relationship with other places, traditionally linked by the flow of water and by *bidi* or tracks. The creek and its *bidi* form part of a 'meshwork' (Ingold 2007 and 2011) in which place is to be understood as an outcome of movement, practice and event, which result in the experience of 'biographical entanglements'. As Pink (2012: 27) notes: "movement is integral to the constitution of place". Ingold (2007: 81) observes: "the lines of a meshwork are the trails along which life is lived …. It is the entanglement of lines, not in the connecting of points, that the mesh is constituted." Discussing the Walbiri of Central Australia, Ingold (2007: 79, 100) suggests that their life is laid out on the ground as the sum of their trails. Low (2017: 102) drawing on Munn's ethnography of the Walbiri notes that place and its significance can be defined out of "transient but repeatable boundaries out of the moving body". A similar point could be made regarding Nyungars.

Ingold's observations regarding 'meshwork' has a resonance is Baines (1988) and Birdsall's (1988) ethnographies which highlight the importance of movement along 'runs' and 'lines' and the resulting 'biographical entanglements' to Nyungar identity and sociability. As Sansom (1983: 120-121) remarks on Baines Nyungar ethnography on family stories: "the ancestral figures who move across country progress on the site-and-track pattern of the mythical ancestors of traditional Dreaming stories. … Nyungar stories ae stories of arrivals and departures, of human travels that cover country to take it into walkabout embrace." The sort of meshwork described by Ingold (2007) is evident in the present Aboriginal consultants' discussion of the place and its connections with Munday Swamp and Allawah Grove. The point here is that Poison Gully Creek has to be understood not as an isolated place but part of a meshwork that connects Nyungar lives with places in an ongoing and emergent fashion.

Conclusions and Recommendations

This report has presented the process and findings of ethnographic assessment in respect of the Forrestfield North District Structure Plan (DSP) area in the Shire of Kalamunda, with a particular focus on Poison Gully Creek, a Registered Aboriginal Site (DPLH ID 25023). The assessment involved desktop research and community consultation, the latter involving separate women's and men's meetings in December 2017. Because of the reported importance of Poison Gully Creek (DPLH ID 25023) to Nyungar women, the on-site consultation was followed up with telephone calls and an additional consultation with several Perth-based women in March 2018 in order to review the results of the research and to confirm the contents of the report.

The search of the online AHIS and other archival sources confirmed that Poison Gully Creek (DPLH ID 25023) is the only Registered Aboriginal Site in the DSP study area. Two 'Other Heritage Places' (DPLH ID 3667 and DPLH ID 3637, both artefact scatters) are also listed in the study area. The desktop research indicates that is highly likely that additional archaeological sites in the form of artefact scatters would be located within the Forrestfield North DSP study area.

With the exception of Poison Gully Creek (DPLH ID 25023), no other places were reported within the study area that might reasonably be considered to be an Aboriginal Site within the meaning of Section 5 of the AHA. Both the women's and the men's consultative meetings confirmed the cultural significance of Poison Gully Creek and highlighted its importance to Nyungar women in particular. Indeed, the site is a focal point in Nyungar women's assertion of their rights with respect to country and heritage practices. Discussions regarding the importance and significance of Poison Gully Creek are part of a broader concern among Nyungar women to document and support traditional birthing practices.

The site is confirmed by the women consultants to have been a 'birthing place' with associated rituals and is still seen as a place for teaching/transmitting cultural knowledge, learning/receiving. The women in particular strongly expressed a desire to protect the

natural bush and creek between Dundas Road and Milner Road and in particular the open space adjacent to the Dundas Road crossing. The women cite the aesthetic value of this area as being integral to their own, and indeed Nyungar, wellbeing in general. They wish to have an area where they can continue to teach and support their children and grandchildren in an accessible nurturing bush environment.

Water is a central aspect of the site which, together with its immediate surrounds, is conceptualised to be a single site from its source in the high country of Kalamunda to where it joins with the waters of Munday Swamp. Both the surface and the subsurface waters are seen as integral to the site, which despite various historical impacts is conceptualised as following the path laid down by ancestral beings in the Dreaming. In keeping with the Nyungar worldview, the creek's water is seen as a 'life force' that requires protection and ongoing attention. Concerns were expressed with regards to impacts on the creek that might also have flow-on effects on Munday Swamp.

Though Nyungars are typically concerned about negative impacts on waterways such as Poison Gully Creek, the community is generally supportive of endeavours to improve and restore water flow and quality to mirror the waterways' original state where these have been degraded through past land use practices. This support typically extends to endeavours to rehabilitate waterways through the removal of introduced floral species and revegetation with native plants. Such work, however, would require either consent from the Minister of Aboriginal Affairs under Section 18 of the AHA or approval under Regulation 10 from the Registrar of Aboriginal Sites.

The Nyungar consultants' conceptualisation of Poison Gully Creek as a place and its extent is not two-dimensional, nor do they view the place in isolation from its broader geographical and cultural setting. This perspective was reflected in all the meetings with the Nyungar consultants, with a strong emphasis throughout on its relationship with other places. Of special significance to them in this regard were places, such as Munday Swamp and Allawah Grove, traditionally linked by the flow of water and the bidi or tracks and part of a meshwork in which place is to be understood as an outcome of movement, practice and event, which result in the experience of 'biographical entanglements'.

Recommendations

1. It is recommended that the Shire of Kalamunda and its agents continue their consultations with the Nyungar community in respect of the Forrestfield North DSP, particularly as this might impact on Poison Gully Creek (DPLH ID 25023).
2. It is also recommended that the Shire of Kalamunda seek advice from the DPLH as to whether any planned impacts on Poison Gully Creek (DPLH ID 25023) will require consent from the Minister of Aboriginal Affairs under s18 of the AHA or approval under Regulation 10 from the Registrar of Aboriginal Sites.
3. It is further recommended that the Shire of Kalamunda, in conjunction with Nyungar women, examine ways in which the natural bush and creek between Dundas Road and Milner Road can be enhanced as a Nyungar women's place.
4. It is likewise recommended that the Shire of Kalamunda commemorate the Aboriginal heritage of the Forrestfield North DSP study area, giving particular emphasis to the meshwork of Nyungar places, including the high country in Kalamunda, Munday Swamp and Allawah Grove.
5. It is recommended that Nyungars are invited to engage in any works associated with Poison Gully Creek, including the rehabilitation of the creek and revegetation with native plants.
6. It is also recommended that the Shire of Kalamunda commission an archaeological survey of the Forrestfield North DSP study area prior to the commencement of development.

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3	R Mason	J Blitz	J Blitz		14/10/2021
4	R Mason	J Blitz	J Blitz		17/11/2021

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Addendum - EAMS

As required by the Western Australian Planning Commission the following reference documents are hereby included:

- DWER Notice of Classification August 2021 - Brand Road - 39 Smokebush and Road Reserves
- DWER Notice of Classification July 2021 - Brand Road - 65 Brand, 101 Brae, 29 Smokebush
- DWER Notice of Classification June 2021 - 51 Brand Road Landfill
- DWER Summary Report - 39 Smokebush Brand Landfill March 22 DMO 12039
- DWER Summary Report - 51 Brand Road March 22 DMO 12023
- DWER Summary Report - 65 Brand Road March 22 DMO 1568
- Map DMO 12039 - 39 Smokebush Lot 50 and Surrounding Road reserves sites
- Map DMO 12023 - 51 Brand Rd Lot 15
- Map DMO 1568 - main Brand site map Lot 13, 14, 18

The following documents are publicly available upon application to Department of Water and Environmental Regulation (Contaminated Sites Branch) or via https://www.der.wa.gov.au/your-environment/contaminated-sites/57-forms.

- Detailed Site Investigation – Lot 15 Brand Road, High Wycombe, WA (360 Environmental, October 2019)
- Stage 2 Detailed Site Investigation – Former Brand Road Landfill Lots 13, 14 and 18 Brand Road, High Wycombe, WA (360 Environmental, November 2020)
- Stage 2 DSI – Landfill Gas Addendum - Former Brand Road Landfill Lots 13, 14 and 18 Brand Road, High Wycombe, WA (260 Environmental, November 2020)
- Mandatory Auditor's Report – Former Landfill, Brand Road, High Wycombe, WA (Strategen JBS&G, 7 May 2021)

The Evaluation & Assessment of Contaminated Sites Risk (Including Ecological) is conducted in accordance with the Contaminated Sites Act 2003; Relevant Regulations; Codes; Standards & Guidelines. The addition of the Mandatory Auditors Report and Detailed Site Investigations represents a continuation and update of this Statutory Process.

Government of Western Australia
Department of Water and Environmental Regulation

Your ref:
Our ref: DMO 12039
Enquiries: Justin Ritchie
Phone: 1300 762 982
Fax: (08) 6364 7001
Email: info@dwer.wa.gov.au

Chief Executive Officer
City of Kalamunda
PO Box 42
Kalamunda WA 6926

Dear Sir/Madam

NOTICE OF A CLASSIFICATION OF A KNOWN OR SUSPECTED CONTAMINATED SITE GIVEN UNDER SECTION 15 OF THE *CONTAMINATED SITES ACT 2003*

The site detailed below **(the site),** consisting of 5 parcel(s) of land, was classified by the Department of Water and Environmental Regulation (the department) under the *Contaminated Sites Act 2003* (the Act) on 29 June 2021 as *'possibly contaminated – investigation required'*:

- LOT 50 ON DIAGRAM 33847 as shown on certificate of title 2140/245 known as 39 Smokebush Pl, High Wycombe WA 6057
- Parcel 79137 = Road reserve (Land ID: 3601786, Landgate PIN: 11573005), High Wycombe WA 6057
- Parcel 79139 = Approximate spatial representation of section of Smokebush Place road reserve (Land ID: 3151706, Landgate PIN: 1255890), High Wycombe WA 6057
- Parcel 79140 = Approximate spatial representation of section of Brand Rd road reserve (Land ID: 3581379, Landgate PIN: 11551672), High Wycombe WA 6057
- Parcel 79141 = Approximate spatial representation of section of Brae Rd road reserve (Land ID: 3581376, Landgate PIN: 11551669), High Wycombe WA 6057

Following the submission of further information, the site has been re-classified.

This notification is being sent to you in accordance with section 15(1) of the Act on the grounds that you, as the recipient, are one or more of the following:

(a) owner of the site (contact details sourced from the current certificate of title);
(b) occupier of the site;
(c) relevant public authority;
(d) person who, in the CEO's opinion, there is particular reason to notify;
(e) person who made the report under section 11 or 12; and
(f) person who, in the CEO's opinion, may be responsible for remediation of a site classified as *contaminated – remediation required.*

Site Re-Classification

Category of site classification: Possibly contaminated - investigation required

Date of site classification: 10/08/2021

Reasons for classification: This site comprises Lot 50 Smokebush Place, road reserve (Land ID 3601786) and portions of Brand Road, Brae Road and Smokebush Place Road reserves. The site was reported to the Department of Water and Environmental Regulation (the department) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site has been classified under section 13 of the Act based on information submitted to the department by May 2021.

The site comprises land parcels adjacent to the former landfill at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe. The former landfill site has been used for multiple land uses including as a sand mine, a landfill and for landfill gas abstraction. Landfilling is a land use that has the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (Department of Environment Regulation [DER], 2014).

The site was reported to the department as it was suspected that contaminated groundwater had migrated as a plume from the former landfill site beneath this site.

Groundwater investigations were conducted at the site and immediately up-hydraulic gradient of the site between April 2014 and March 2020. The most recent groundwater investigations identified per-and poly-fluoroalkyl substances (PFAS), ammonia and dichlorobenzene in groundwater. PFAS (such as from PFAS-containing waste) was identified in groundwater at concentrations exceeding health-based guidance values for drinking water, as published in the 'PFAS National Environmental Management Plan' (Heads of EPAs Australia and New Zealand, January 2020). Ammonia and dichlorobenzene were present in groundwater at concentrations exceeding assessment levels for non-potable use of groundwater, as published in the guideline 'Assessment and management of contaminated sites' (DER, 2014). These criteria are relevant as there are nearby domestic bores used for irrigation. Further groundwater investigations are required to determine the quality of groundwater migrating beneath the site from the adjacent former landfill.

Limited ground gas investigations were conducted at the former landfill site immediately adjacent to the site between February and September 2020. Carbon dioxide and methane were identified at the former landfill site and immediately adjacent to the site at an elevated concentration equivalent to a characteristic gas situation of 2 (low risk) as published in 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007) and NSW-EPA 2019 requiring gas management measures. Elevated concentrations of carbon monoxide and hydrogen sulfide were identified within the north-eastern and south-western portions of the former landfill site.

Further landfill gas monitoring is required to determine whether gas is migrating into the site from the former landfill site and to assess the gas risk to current and future land users of Lot 50 and the adjacent road reserves.

No soil investigations have been undertaken at the site, with the exception of a limited investigation within the Brand Road road reserve in February 2018 which included analysis of soil samples taken from 0.5 metres and 5 metres below ground level. No soil contamination was found to be present at these depths. Soil investigations may be required within Lot 50 to determine the contamination status of soil across the site prior to the proposed construction and use of amenities associated with the proposed adjacent sporting area.

A screening risk assessment indicates that further investigation is required to determine the risk to human health, the environment and environmental values.

The investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor. The auditor's review is documented in a mandatory auditor's report (MAR) dated 7 May 2021. The auditor recommended that further soil gas and groundwater investigations are undertaken to assess the potential risk to current and future site users. The department and the Department of Health accept the findings and recommendations of the auditor.

As the site has only been partially investigated, a comment cannot be made on the suitability of the site for the proposed development and use of a sports facility on Lot 50.

There are grounds to indicate possible contamination of the site. Groundwater and soil gas have not been fully investigated and a risk assessment to determine the risk to human health, the environment, and environmental values has not been carried out. Therefore, the site is classified as 'possibly contaminated - investigation required'.

When the results of further soil gas and groundwater investigations are submitted to the department, these will be reviewed, and the site may be reclassified.

The department, in consultation with the Department of Health, has classified this site based on the information available to the department at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to the department, and as such, the usefulness of this information may be limited.

Other Relevant Information:

Additional information included herein is relevant to the contamination status of the site and includes the department's expectations for action that should be taken to address potential or actual contamination described in the Reasons for Classification.

Due to the nature and extent of groundwater contamination identified to date, the abstraction of groundwater for any purpose is not recommended.

Based on the available information, contamination present on this site has originated from the adjacent land at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe, which have been classified separately under the Act. Therefore, this site is consistent with the definition of an "affected site" as specified in Part 1, Section 3 of the Act. Under the Act, the person responsible for the remediation of a source site is also responsible for remediation of any related affected sites.

Action Required:

Further soil, groundwater and landfill gas investigations are required to determine the contamination status of the site and assess the suitability of the proposed construction and use of amenities on Lot 50. A report documenting the results of these investigations should be submitted to an accredited contaminated sites auditor by 1 June 2022.

General Information

The nature and extent of contamination and any restrictions on the use of the land, if applicable, are listed in Attachment A.

Information relating to the classification of the site is also available by submitting a request for a summary of records (using Form 2) to: Department of Water and Environmental Regulation, Locked Bag 10, Joondalup DC, WA 6919. A fee of $30 currently applies for a Basic Summary of Records. Forms are available from www.der.wa.gov.au/contaminatedsites.

In some instances the department has had to classify sites based on historical information. A site may be re-classified at any stage when additional information becomes available, for example where a new investigation or remediation report completed in accordance with the department's 'Contaminated Sites Guidelines' and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*, is submitted to the department. The current site classification is the classification most recently conferred on the site.

Memorials

In accordance with section 58(1) of the Act, the department will lodge a memorial with the Registrar of Landgate, recording the classification against the site's Certificate(s) of Title. Parcel(s) without a registration number or certificate of title will not have a memorial lodged against them until a certificate of title has been created. Once complete, confirmation of the lodgement of the memorial(s) will be forwarded to the following people:

(a) each owner,
(b) Western Australian Planning Commission;
(c) CEO of the Department of Health;
(d) Local Government Authority;
(e) relevant scheme authority.

Given that memorial(s) will be lodged against the site, the Western Australian Planning Commission (WAPC) may not approve the subdivision of the land under Section 135 of the *Planning and Development Act 2005*, or the amalgamation of that land with any other land without seeking, and taking into account, the advice of the department as to the suitability of the land for subdivision or amalgamation. Furthermore, a responsible authority (e.g. Local Government Authorities) may not grant approval under a scheme for any proposed development of the land without seeking, and taking into account, advice from the department as to the suitability of the proposed development.

Appealing the Site Classification

All site classifications given by the department are appealable. However, only certain people can lodge a valid appeal. The people who can lodge a valid appeal varies, depending on the classification category, as detailed in Fact Sheet 4: *Site classifications and appeals*. Appeals need to be lodged in writing with the Contaminated Sites Committee at Forrest Centre, Level 22, 221 St Georges Terrace, Perth WA 6000, within **45 days** of being given this notification. The appeal should set out the appellant's relationship to the site, and must include the grounds and facts upon which it is based. An appeal fee (currently $45) applies.

To find out more about the appeal process, see the Contaminated Sites Committee website at www.csc.wa.gov.au or contact the office of the Committee on (08) 6364 7264.

For further information on all aspects of site classification, please refer to Fact Sheet 4 and the 'Contaminated Sites Guidelines', which are available from the department's website at www.der.wa.gov.au/contaminatedsites or by contacting the Contaminated Sites Information Line on 1300 762 982.

Yours sincerely

Michelle Brierley, A/Manager

CONTAMINATED SITES REGULATION
Delegated Officer under section 91
of the *Contaminated Sites Act 2003*

12/08/2021

Enc. Attachment A – Nature and Extent and Restrictions on Use.

Fact Sheet 4: *Site classifications and appeals*
Fact Sheet 5: *Buyer beware – buying and selling contaminated land*

- **LOT 50 ON DIAGRAM 33847**

Nature and Extent: Chlorinated hydrocarbons (such as from landfill waste) are present in groundwater beneath the adjacent former landfill and are likely to be present in groundwater beneath this site.

Ammonia and per-and poly-fluoroalkyl substances (PFAS) are present in groundwater down-hydraulic gradient of this site and are likely to have migrated from the adjacent former landfill.

Landfill gases (such as methane and carbon dioxide) are present beneath the adjacent former landfill and are likely to extend beneath this site.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

- **Road reserve (Land ID: 3601786, Landgate PIN: 11573005)**

Nature and Extent: Ammonia, 1,4-dichlorobenzene and per-and poly-fluoroalkyl substances (PFAS) are present in groundwater beneath the adjacent former landfill and are likely to be present in groundwater beneath this site.

Landfill gases (such as methane and carbon dioxide) are present beneath the adjacent former landfill and are likely to extend beneath this site.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

- **Approximate spatial representation of section of Smokebush Place road reserve (Land ID: 3151706, Landgate PIN: 1255890)**

Nature and Extent: Ammonia and per-and poly-fluoroalkyl substances (PFAS) are present in groundwater beneath this site and are likely to have migrated from the adjacent former landfill.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

- **Approximate spatial representation of section of Brand Rd road reserve (Land ID: 3581379, Landgate PIN: 11551672)**

Nature and Extent: Ammonia and 1,4-dichlorobenzene are present in groundwater beneath the adjacent former landfill (the source site) and are likely to be present in groundwater beneath this site.

Landfill gases (such as methane and carbon dioxide) are present beneath the adjacent former landfill and are likely to extend beneath this site.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

- **Approximate spatial representation of section of Brae Rd road reserve (Land ID: 3581376, Landgate PIN: 11551669)**

Nature and Extent: Landfill gases (such as methane and carbon dioxide) are present beneath this site and are likely to have migrated from the adjacent former landfill.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

Government of Western Australia
Department of Water and Environmental Regulation

Your ref:
Our ref: DMO 1568
Enquiries: Justin Ritchie
Phone: 1300 762 982
Fax: (08) 6364 7001
Email: info@dwer.wa.gov.au

Chief Executive Officer
City of Kalamunda
PO Box 42
Kalamunda WA 6926

Dear Sir/Madam

NOTICE OF A CLASSIFICATION OF A KNOWN OR SUSPECTED CONTAMINATED SITE GIVEN UNDER SECTION 15 OF THE *CONTAMINATED SITES ACT 2003*

The site detailed below (the site), was classified by the Department of Water and Environmental Regulation (the department) under the *Contaminated Sites Act 2003* (the Act) on 30 October 2018 as '*possibly contaminated - investigation required'*:

- LOT 14 ON DIAGRAM 24292 as shown on certificate of title 1551/323 known as 65 Brand Rd, High Wycombe WA 6057
- LOT 13 ON DIAGRAM 24292 as shown on certificate of title 1667/878 known as 101 Brae Rd, High Wycombe WA 6057
- LOT 18 ON DIAGRAM 24292 as shown on certificate of title 1582/348 known as 29 Smokebush Pl, High Wycombe WA 6057

Following the submission of a mandatory auditor's report, the site has been re-classified.

This notification is being sent to you in accordance with section 15(1) of the Act on the grounds that you, as the recipient, are one or more of the following:

(a) owner of the site (contact details sourced from the current certificate of title);
(b) occupier of the site;
(c) relevant public authority;
(d) person who, in the CEO's opinion, there is particular reason to notify;
(e) person who made the report under section 11 or 12; and
(f) person who, in the CEO's opinion, may be responsible for remediation of a site classified as *contaminated – remediation required.*

Site Re-Classification

Category of site classification: Possibly contaminated - investigation required

Date of site classification: 29/06/2021

Reasons for classification: This site was reported to the Department of Water and Environmental Regulation (the department) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site was first classified under section 13 of the Act based on information submitted to the department by May 2007. The site has been classified again under section 13 of the Act to reflect additional technical information submitted to the department by May 2021.

The site was reported to the department as it was used for multiple land uses including as a sand mine between 1978 and 1998, a landfill between 1989 and 1996 and for landfill gas abstraction between 1996 and 2010. Landfilling is a land use that has the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (Department of Environment Regulation [DER], 2014). The site is proposed for future use as a sporting area including an oval, club rooms and ancillary infrastructure.

Waste accepted at the landfill included commercial, domestic, demolition, and industrial wastes (e.g. wood, food scraps, building rubble and shredded rubber), asbestos, sewage sludge, and non-toxic liquid waste (e.g. oil and water mixture). Following closure, the landfill was compacted, levelled and partially capped with clay to a maximum thickness of 3 metres in the centre of the site. Where present, the capping material generally comprises a sandy layer underlain by clayey sand / sandy clay and grass cover in most areas. Uncapped landfill material (comprising bricks and rubble) was observed during site inspections, particularly on Lot 18.

A soil investigation was conducted at the site in February 2018 which included soil samples taken from above and below the landfill mass. No soil contamination was found to be present.

Groundwater investigations were conducted at the site between July 1990 and March 2020. The most recent groundwater investigations identified per-and poly-fluoroalkyl substances (PFAS), ammonia, vinyl chloride, dichlorobenzene and E.coli in groundwater, indicating that landfill leachate has impacted groundwater quality. PFAS (such as from PFAS-containing waste) was identified in groundwater at concentrations exceeding health-based guidance values for drinking water, as published in the 'PFAS National Environmental Management Plan' (Heads of EPAs Australia and New Zealand, January 2020). Ammonia, vinyl chloride, dichlorobenzene and E.coli were present in groundwater at concentrations exceeding assessment levels for non-potable use of groundwater, as published in the guideline 'Assessment and management of contaminated sites' (DER, 2014). Further groundwater investigations are required both on-site and off-site to determine the quality of groundwater beneath the site and adjacent parcels of land.

Landfill gas extraction was undertaken at the site between 1996 and 2010. Extracted gas was combined with gas from the Dawson Avenue landfill and was used as fuel at the Dawson Avenue Gas Power Station, prior to the power station being decommissioned in 2010 due to low methane volumes. Following decommissioning of the power station, the remaining gas from the Dawson Avenue and Brand Road landfills was burned in a flare at the Dawson Avenue site. Gas flow to the flare from the Brand Road site was reduced in 2012 since the methane content was too low and was impeding the operation of the flare.

Passive gas vents were installed at this site in 2014 to prevent landfill gas from accumulating beneath the clay-based landfill cap and potentially migrating laterally. A leachate collection and recirculation system is present on site, encompassing leachate pumps, leach drains and leachate injection points across Lots 13 and 14. However, it is understood that the system is now in disrepair and the system is no longer maintained.

Limited ground gas investigations were conducted at the site between February and September 2020. Methane and carbon dioxide were identified across the site at an elevated concentration equivalent to a characteristic gas situation of 2 (low risk), as published in 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007) and NSW EPA 2019, requiring gas management measures. Elevated concentrations of carbon monoxide and hydrogen sulfide were identified within the north-eastern and south-western portions of the site.

Concentrations of contaminants exceed adopted assessment levels for residential use and future primary school use. Therefore, a screening risk assessment indicates that further investigations are required to determine the risk to human health, the environment and environmental values.

The investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor. The auditor's review is documented in a mandatory auditor's report (MAR) dated 7 May 2021. The auditor recommended that further soil gas and groundwater

investigations are undertaken to assess the potential risk to future use of the site as a primary school. The department and the Department of Health accept the findings and recommendations of the auditor.

As the site has only been partially investigated, a comment cannot be made on the suitability of the site as a whole for any land use.

There are grounds to indicate possible contamination of the site. Groundwater and soil gas have not been fully investigated and a detailed risk assessment to determine the risk to human health, the environment, and environmental values has not been carried out. Therefore, the site is classified as 'possibly contaminated - investigation required'.

When the results of further soil gas and groundwater investigations are submitted to the department, these will be reviewed, and the site may be reclassified.

The department, in consultation with the Department of Health, has classified this site based on the information available to the department at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to the department, and as such, the usefulness of this information may be limited.

Other Relevant Information:

Additional information included herein is relevant to the contamination status of the site and includes the department's expectations for action that should be taken to address potential or actual contamination described in the Reasons for Classification.

Other than for analytical testing or remediation, groundwater abstraction is not recommended at this site because of the nature and extent of groundwater contamination.

Based on the available information, contamination present beneath this site has also been identified beyond the site boundary beneath the adjacent land, consistent with the definition of a "source site" specified in Part 1, Section 3 of the Act. In accordance with Regulation 31(1)(b) of the 'Contaminated Sites Regulations 2006', reports or information submitted to the department that are relevant to the investigation, assessment, monitoring or remediation of a source site are required to be accompanied by a mandatory auditor's report (MAR) prepared by an accredited contaminated sites auditor.

Action Required:

Further soil, groundwater and landfill gas investigations are required to determine the contamination status of the site and assess the suitability of the site for the proposed reuse of the site as a sporting area including an oval, club rooms and ancillary infrastructure. A report documenting the results of these investigations should be submitted to an accredited contaminated sites auditor by 1 June 2022.

General Information

The nature and extent of contamination and any restrictions on the use of the land, if applicable, are listed in Attachment A.

Information relating to the classification of the site is also available by submitting a request for a summary of records (using Form 2) to: Department of Water and Environmental Regulation, Locked Bag 10, Joondalup DC, WA 6919. A fee of $30 currently applies for a Basic Summary of Records. Forms are available from www.der.wa.gov.au/contaminatedsites.

In some instances the department has had to classify sites based on historical information. A site may be re-classified at any stage when additional information becomes available, for example where a new investigation or remediation report completed in accordance with the department’s

'Contaminated Sites Guidelines' and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*, is submitted to the department. The current site classification is the classification most recently conferred on the site.

Memorials

In accordance with section 58 (1), the department has already lodged memorial(s) against the Certificate(s) of Title relating to the site.

Given that the memorial(s) lodged against the site will remain, the Western Australian Planning Commission (WAPC) may not approve the subdivision of the land under Section 135 of the *Planning and Development Act 2005*, or the amalgamation of that land with any other land without seeking, and taking into account, the advice of the department as to the suitability of the land for subdivision or amalgamation. Furthermore, a responsible authority (e.g. Local Government Authorities) may not grant approval under a scheme for any proposed development of the land without seeking, and taking into account, advice from the department as to the suitability of the proposed development.

Appealing the Site Classification

All site classifications given by the department are appealable. However, only certain people can lodge a valid appeal. The people who can lodge a valid appeal varies, depending on the classification category, as detailed in Fact Sheet 4: *Site classifications and appeals*. Appeals need to be lodged in writing with the Contaminated Sites Committee at Forrest Centre, Level 22, 221 St Georges Terrace, Perth WA 6000, within **45 days** of being given this notification. The appeal should set out the appellant's relationship to the site, and must include the grounds and facts upon which it is based. An appeal fee (currently $45) applies.

To find out more about the appeal process, see the Contaminated Sites Committee website at www.csc.wa.gov.au or contact the office of the Committee on (08) 6364 7264.

For further information on all aspects of site classification, please refer to Fact Sheet 4 and the 'Contaminated Sites Guidelines', which are available from the department's website at www.der.wa.gov.au/contaminatedsites or by contacting the Contaminated Sites Information Line on 1300 762 982.

Yours sincerely

……..
Lomas Capelli, A/Manager

CONTAMINATED SITES REGULATION
Delegated Officer under section 91
of the *Contaminated Sites Act 2003*

01/07/2021

Enc. Attachment A – Nature and Extent and Restrictions on Use.

Fact Sheet 4: *Site classifications and appeals*
Fact Sheet 5: *Buyer beware – buying and selling contaminated land*

ATTACHMENT A – Nature and Extent and Restrictions on Use

- LOT 14 ON DIAGRAM 24292
- LOT 13 ON DIAGRAM 24292
- LOT 18 ON DIAGRAM 24292

Nature and Extent: The site has been used as an unlined landfill for the disposal of degradable household wastes and inert waste (such as building rubble). The landfill wastes are capped with up to 3 metres fill and in some areas the waste mass is exposed (e.g. Lot 18).

Landfill gases (such as carbon dioxide, hydrogen sulfide and methane) have been identified across the site and may be migrating radially from the site.

Per-and poly-fluoroalkyl substances, ammonia, vinyl chloride, dichlorobenzene and E.coli have been identified in groundwater beneath the site and may be migrating in a south-west direction from the site.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

Government of Western Australia
Department of Water and Environmental Regulation

Your ref:
Our ref: DMO 12023
Enquiries: Justin Ritchie
Phone: 1300 762 982
Fax: (08) 6364 7001
Email: info@dwer.wa.gov.au

Chief Executive Officer
City of Kalamunda
PO Box 42
Kalamunda WA 6926

Dear Sir/Madam

This letter is the formal notice of classification of a known or suspected contaminated site in which you have an interest. This constitutes the notice the Department of Water and Environmental Regulation (the department) is legally obliged to give under the *Contaminated Sites Act 2003* (the Act), which came into effect on 1 December 2006.

The Act was set up to record and manage contaminated sites in Western Australia, in order to protect people's health and the environment. Please note that contamination does not necessarily mean that an area is unsafe to live or work in – for example, it may be limited to groundwater, and only becomes an issue to be managed if a groundwater bore was being considered.

This notice explains why the site has been classified, what restrictions, if any, have been placed on the use of the site and how you can appeal the classification. In some cases, this notice may include other lots which also form part of the classified site, in addition to the lot in which you have an interest.

If, after reading this letter, you have any further queries, please contact the department on 1300 762 982 (Contaminated Sites Information Line).

NOTICE OF A CLASSIFICATION OF A KNOWN OR SUSPECTED CONTAMINATED SITE GIVEN UNDER SECTION 15 OF THE *CONTAMINATED SITES ACT 2003*

The site detailed below **(the site),** consisting of 1 parcel(s) of land, was reported to the CEO of the department as a known or suspected contaminated site and has been classified under the Act:

- LOT 15 ON DIAGRAM 24292 as shown on certificate of title 1605/949 known as 51 Brand Rd, High Wycombe WA 6057

This notification is being sent to you in accordance with section 15(1) of the Act on the grounds that you, as the recipient, are one or more of the following:

(a) owner of the site (contact details sourced from the current certificate of title);
(b) occupier of the site;
(c) relevant public authority;
(d) person who, in the CEO's opinion, there is particular reason to notify;
(e) person who made the report under section 11 or 12; and
(f) person who, in the CEO's opinion, may be responsible for remediation of a site classified as *contaminated – remediation required.*

Site Classification

Category of site classification: Possibly contaminated - investigation required

Date of site classification: 29/06/2021

Reasons for classification: This site was reported to the Department of Water and Environmental Regulation (the department) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site has been classified under section 13 of the Act based on information submitted to the department by May 2021.

The site is located immediately south-west of a former landfill site at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe which has been used for multiple land uses including as a sand mine, a landfill and for landfill gas abstraction. Landfilling is a land use that has the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (Department of Environment Regulation [DER], 2014).

The site is proposed for future use as a primary school. This site was reported to the department as it was suspected that contaminated groundwater had migrated as a plume from the former landfill site to affect groundwater beneath this site.

A groundwater investigation was conducted at the site in March 2020. A range of chlorinated hydrocarbons were detected in groundwater beneath the south-western portion of the site which may indicate the presence of migrating leachate-impacted groundwater from the adjacent former landfill. 1,4 dichlorobenzene, a chlorinated hydrocarbon compound, was present in groundwater at this site at concentrations exceeding assessment levels for non-potable use of groundwater, as published in the guideline 'Assessment and management of contaminated sites' (DER, 2014).

Further groundwater investigations are required across the site and particularly along the northern boundary of the site to determine the quality of groundwater migrating beneath the site from the adjacent former landfill site.

Limited ground gas investigations were conducted between February and September 2020. Carbon dioxide was identified adjacent to the site's north-eastern boundary at an elevated concentration equivalent to a characteristic gas situation of 2 (low risk) but due to the gas flow rate the calculated 'Gas Screening Value' was consistent with a characteristic gas situation of 1 (very low risk), as published in 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007) and NSW-EPA 2019, requiring gas management measures. Landfill gases (such as methane and hydrogen sulfide) were also identified within the former landfill within soil gas monitoring wells located immediately adjacent to the northern-eastern boundary of this site.

Further landfill gas monitoring is required to determine whether ground gas is migrating into the site from the former landfill site and to assess gas risk to current and future users of the site as a primary school.

No soil investigations have been undertaken to determine the quality of soil at the site. Soil investigations may be required to determine the contamination status of soil across the site prior to the proposed use as a primary school.

Concentrations of contaminants exceed adopted assessment levels for residential use and future primary school use. Therefore, a screening risk assessment indicates that further investigation is required to determine the risk to human health, the environment and environmental values.

The investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor. The auditor's review is documented in a mandatory auditor's report (MAR) dated 7 May 2021. The auditor recommended that further soil gas and

groundwater investigations are undertaken to assess the potential risk to future use of the site as a primary school. The department and the Department of Health accept the findings and recommendations of the auditor.

As the site has only been partially investigated, a comment cannot be made on the suitability of the site as a whole for any land use.

There are grounds to indicate possible contamination of the site. Groundwater and soil gas have not been fully investigated and a risk assessment to determine the risk to human health, the environment, and environmental values has not been carried out. Therefore, the site is classified as 'possibly contaminated - investigation required'.

When the results of further soil gas and groundwater investigations are submitted to the department, these will be reviewed, and the site may be reclassified.

The department, in consultation with the Department of Health, has classified this site based on the information available to the department at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to the department, and as such, the usefulness of this information may be limited.

Other Relevant Information:

Additional information included herein is relevant to the contamination status of the site and includes the department's expectations for action that should be taken to address potential or actual contamination described in the Reasons for Classification.

Due to the nature and extent of groundwater contamination identified to date, the abstraction of groundwater for any purpose is not recommended.

Based on the available information, contamination present on this site has originated from the adjacent land at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe, which have been classified separately under the Act. Therefore, this site is consistent with the definition of an "affected site" as specified in Part 1, Section 3 of the Act. Under the Act, the person responsible for the remediation of a source site is also responsible for remediation of any related affected sites.

Action Required:

Further soil, groundwater and landfill gas investigations are required to determine the contamination status of the site and assess the suitability of the site for the proposed redevelopment of the site as a primary school. A report documenting the results of these investigations should be submitted to an accredited contaminated sites auditor by 1 June 2022.

General Information

The nature and extent of contamination and any restrictions on the use of the land, if applicable, are listed in Attachment A.

Information relating to the classification of the site is also available by submitting a request for a summary of records (using Form 2) to: Department of Water and Environmental Regulation, Locked Bag 10, Joondalup DC, WA 6919. A fee of $30 currently applies for a Basic Summary of Records. Forms are available from www.der.wa.gov.au/contaminatedsites.

In some instances the department has had to classify sites based on historical information. A site may be re-classified at any stage when additional information becomes available, for example where a new investigation or remediation report completed in accordance with the department’s

'Contaminated Sites Guidelines' and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*, is submitted to the department. The current site classification is the classification most recently conferred on the site.

Memorials

In accordance with section 58(1) of the Act, the department will lodge a memorial with the Registrar of Landgate, recording the classification against the site's Certificate(s) of Title. Parcel(s) without a registration number or certificate of title will not have a memorial lodged against them until a certificate of title has been created. Once complete, confirmation of the lodgement of the memorial(s) will be forwarded to the following people:

(a) each owner,
(b) Western Australian Planning Commission;
(c) CEO of the Department of Health;
(d) Local Government Authority;
(e) relevant scheme authority.

Given that memorial(s) will be lodged against the site, the Western Australian Planning Commission (WAPC) may not approve the subdivision of the land under Section 135 of the *Planning and Development Act 2005*, or the amalgamation of that land with any other land without seeking, and taking into account, the advice of the department as to the suitability of the land for subdivision or amalgamation. Furthermore, a responsible authority (e.g. Local Government Authorities) may not grant approval under a scheme for any proposed development of the land without seeking, and taking into account, advice from the department as to the suitability of the proposed development.

Appealing the Site Classification

All site classifications given by the department are appealable. However, only certain people can lodge a valid appeal. The people who can lodge a valid appeal varies, depending on the classification category, as detailed in Fact Sheet 4: *Site classifications and appeals*. Appeals need to be lodged in writing with the Contaminated Sites Committee at Forrest Centre, Level 22, 221 St Georges Terrace, Perth WA 6000, within **45 days** of being given this notification. The appeal should set out the appellant's relationship to the site, and must include the grounds and facts upon which it is based. An appeal fee (currently $45) applies.

To find out more about the appeal process, see the Contaminated Sites Committee website at www.csc.wa.gov.au or contact the office of the Committee on (08) 6364 7264.

For further information on all aspects of site classification, please refer to Fact Sheet 4 and the 'Contaminated Sites Guidelines', which are available from the department's website at www.der.wa.gov.au/contaminatedsites or by contacting the Contaminated Sites Information Line on 1300 762 982.

Yours sincerely

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Lomas Capelli, A/Manager

CONTAMINATED SITES REGULATION
Delegated Officer under section 91
of the *Contaminated Sites Act 2003*

30/06/2021

Enc. Attachment A – Nature and Extent and Restrictions on Use.

Fact Sheet 4: *Site classifications and appeals*
Fact Sheet 5: *Buyer beware – buying and selling contaminated land*

ATTACHMENT A – Nature and Extent and Restrictions on Use

- LOT 15 ON DIAGRAM 24292

Nature and Extent: Chlorinated hydrocarbons, suspected to be associated with landfill leachate, have been detected in groundwater along the site's north-eastern boundary.

Landfill gases (such as carbon dioxide, hydrogen sulfide and methane) have been identified at the adjacent former landfill which may be migrating beneath this site.

Restriction on Use: Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site.

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:51:10AM, 17/03/2022

Receipt No: RR026383

ID No: 76557

Search Results

This response relates to a search request received for:

39 Smokebush Pl
High Wycombe, WA, 6057

This parcel belongs to a site that contains 5 parcel(s).

According to Department of Water and Environmental Regulation records, this land has been reported as a known or suspected contaminated site.

Address	39 Smokebush Pl High Wycombe, WA, 6057
Lot on Plan Address	Lot 50 On Diagram 33847
Parcel Status	**Classification:** 10/08/2021 - *Possibly contaminated - investigation required* **Nature and Extent of Contamination:** Chlorinated hydrocarbons (such as from landfill waste) are present in groundwater beneath the adjacent former landfill and are likely to be present in groundwater beneath this site. Ammonia and per-and poly-fluoroalkyl substances (PFAS) are present in groundwater down-hydraulic gradient of this site and are likely to have migrated from the adjacent former landfill. Landfill gases (such as methane and carbon dioxide) are present beneath the adjacent former landfill and are likely to extend beneath this site. **Restrictions on Use:** Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site. **Reason for Classification:** This site comprises Lot 50 Smokebush Place, road reserve (Land ID 3601786) and portions of Brand Road, Brae Road and Smokebush Place Road reserves. The site was reported to the Department of Water and Environmental Regulation (the department) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site has been classified under section 13 of the Act based on information submitted to the department by May 2021. The site comprises land parcels adjacent to the former landfill at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe. The former landfill site has been used for multiple land uses including as a sand mine, a landfill and for landfill gas abstraction. Landfilling is a land use that has the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (Department of Environment Regulation [DER], 2014).

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:51:11AM, 17/03/2022

The site was reported to the department as it was suspected that contaminated groundwater had migrated as a plume from the former landfill site beneath this site.

Groundwater investigations were conducted at the site and immediately up-hydraulic gradient of the site between April 2014 and March 2020. The most recent groundwater investigations identified per- and poly-fluoroalkyl substances (PFAS), ammonia and dichlorobenzene in groundwater. PFAS (such as from PFAS-containing waste) was identified in groundwater at concentrations exceeding health-based guidance values for drinking water, as published in the 'PFAS National Environmental Management Plan' (Heads of EPAs Australia and New Zealand, January 2020). Ammonia and dichlorobenzene were present in groundwater at concentrations exceeding assessment levels for non-potable use of groundwater, as published in the guideline 'Assessment and management of contaminated sites' (DER, 2014). These criteria are relevant as there are nearby domestic bores used for irrigation. Further groundwater investigations are required to determine the quality of groundwater migrating beneath the site from the adjacent former landfill.

Limited ground gas investigations were conducted at the former landfill site immediately adjacent to the site between February and September 2020. Carbon dioxide and methane were identified at the former landfill site and immediately adjacent to the site at an elevated concentration equivalent to a characteristic gas situation of 2 (low risk) as published in 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007) and NSW-EPA 2019 requiring gas management measures. Elevated concentrations of carbon monoxide and hydrogen sulfide were identified within the north-eastern and south-western portions of the former landfill site.

Further landfill gas monitoring is required to determine whether gas is migrating into the site from the former landfill site and to assess the gas risk to current and future land users of Lot 50 and the adjacent road reserves.

No soil investigations have been undertaken at the site, with the exception of a limited investigation within the Brand Road road reserve in February 2018 which included analysis of soil samples taken from 0.5 metres and 5 metres below ground level. No soil contamination was found to be present at these depths. Soil investigations may be required within Lot 50 to determine the contamination status of soil across the site prior to the proposed construction and use of amenities associated with the proposed adjacent sporting area.

A screening risk assessment indicates that further investigation is required to determine the risk to human health, the environment and environmental values.

The investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor. The auditor's review is documented in a mandatory auditor's report (MAR) dated 7 May 2021. The auditor recommended that further soil gas and groundwater investigations are undertaken to assess the potential risk to current and future site users. The department and the Department of Health accept the findings and recommendations of the auditor.

As the site has only been partially investigated, a comment cannot be made on the suitability of the site for the proposed development and use of a sports facility on Lot 50.

There are grounds to indicate possible contamination of the site. Groundwater and soil gas have not been fully investigated and a risk assessment to determine the risk to human health, the environment, and environmental values has not been carried out. Therefore, the site is classified as 'possibly contaminated - investigation required'.

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:51:11AM, 17/03/2022

	When the results of further soil gas and groundwater investigations are submitted to the department, these will be reviewed, and the site may be reclassified. The department, in consultation with the Department of Health, has classified this site based on the information available to the department at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to the department, and as such, the usefulness of this information may be limited. **Other Relevant Information:** Additional information included herein is relevant to the contamination status of the site and includes the department's expectations for action that should be taken to address potential or actual contamination described in the Reasons for Classification. Due to the nature and extent of groundwater contamination identified to date, the abstraction of groundwater for any purpose is not recommended. Based on the available information, contamination present on this site has originated from the adjacent land at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe, which have been classified separately under the Act. Therefore, this site is consistent with the definition of an "affected site" as specified in Part 1, Section 3 of the Act. Under the Act, the person responsible for the remediation of a source site is also responsible for remediation of any related affected sites. **Action Required:** Further soil, groundwater and landfill gas investigations are required to determine the contamination status of the site and assess the suitability of the proposed construction and use of amenities on Lot 50. A report documenting the results of these investigations should be submitted to an accredited contaminated sites auditor by 1 June 2022.
Certificate of Title Memorial	Under the Contaminated Sites Act 2003, this site has been classified as "possibly contaminated - investigation required". For further information on the contamination status of this site, please contact Contaminated Sites at the Department of Water and Environmental Regulation.
Current Regulatory Notice Issued	**Type of Regulatory Notice:** *Nil* **Date Issued:** *Nil*
General	No other information relating to this parcel.

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:17:42AM, 17/03/2022

Receipt No: RR026382

ID No: 76552

Search Results

This response relates to a search request received for:

51 Brand Rd
High Wycombe, WA, 6057

This parcel belongs to a site that contains 1 parcel(s).

According to Department of Water and Environmental Regulation records, this land has been reported as a known or suspected contaminated site.

Address	51 Brand Rd High Wycombe, WA, 6057
Lot on Plan Address	Lot 15 On Diagram 24292
Parcel Status	**Classification:** 01/09/2021 - *Possibly contaminated - investigation required* **Nature and Extent of Contamination:** Chlorinated hydrocarbons, suspected to be associated with landfill leachate, have been detected in groundwater along the site's north-eastern boundary. Landfill gas (such as carbon dioxide) was identified beneath the northern portion of the site. **Restrictions on Use:** Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site. **Reason for Classification:** This site was reported to the Department of Water and Environmental Regulation (the department) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site was first classified under section 13 of the Act based on information submitted to the department by May 2021. The site has been classified again under section 13 of the Act to reflect additional technical information submitted to the department by July 2021. The site is located immediately south-west of a former landfill. The former landfill occupied parts of Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe and was used for multiple land uses including as a sand mine, a landfill and for landfill gas abstraction. Landfilling is a land use that has the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (Department of Environment Regulation [DER], 2014). At the time of this classification the site is vacant; however, the department understands that the site is proposed for future use as a primary school. This site was reported to the department as it was suspected that contaminated groundwater had

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:17:43AM, 17/03/2022

migrated as a plume from the former landfill to affect groundwater beneath this site.

A groundwater investigation was conducted at the site in March 2020. A range of chlorinated hydrocarbons were detected in groundwater beneath the south-western portion of the site which may indicate the presence of migrating leachate-impacted groundwater from the adjacent former landfill. 1,4 dichlorobenzene, a chlorinated hydrocarbon compound, was present in groundwater at this site at concentrations exceeding assessment levels for non-potable use of groundwater, as published in the guideline 'Assessment and management of contaminated sites' (DER, 2014).

Further groundwater investigations are required across the site and particularly along the northern boundary of the site to determine the quality of groundwater migrating beneath the site from the adjacent former landfill.

Landfill gas investigations were conducted in 2019 and 2020.

The 2019 landfill gas investigations were conducted fortnightly between February and April 2019 utilising monitoring wells located along two transects within the northern and central portions of the site. No landfill gas was identified at concentration exceeding the equivalent of a characteristic gas situation of 1 (very low risk), as published in NSW EPA (2020) and 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007).

The 2020 landfill gas investigations were conducted monthly between April and September 2020 using a single landfill gas monitoring well located within the northern corner of the site. Carbon dioxide was identified within this well at a concentration equivalent to a characteristic gas situation of 2 (low risk), as published in NSW EPA (2020) and 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007).

Landfill gases (such as methane and hydrogen sulfide) were identified immediately adjacent to the site within the former landfill. Further landfill gas investigations are required across the site to determine whether landfill gas is migrating beneath the site from the former landfill site. The investigation should include a risk assessment to assess risks based on the current land use and the potential future use as a primary school. These investigations should be undertaken during weather conditions that would present the worst-case scenario of landfill gas flow beneath the site, and should consider the potential gas impacts resulting from any proposals to remediate or redevelop the adjacent landfill site.

Soil investigations were conducted in February 2019. These investigations included the excavation of test pits along the north-eastern portion of the site and a grid-based site walkover to visually identify stockpiled soil and potential asbestos-containing material (pACM).

Fly-tipped material was identified along the north-eastern boundary of the site. The fly-tipped materials included soil, scrap metal, tyres, glass, plastic, metal drums and pACM. The fly-tipped material has not been removed from the site. It is recommended the fly tipped material is removed from the site and the impacted area validated prior to any site development.

No landfill materials were identified in any test pit. However, minor quantities of asphalt and blue metal were identified at the surface of some test pits along the sites north-eastern boundary. No potential contaminants were identified within soil samples taken from the test tips at concentrations exceeding relevant ecological or health-based assessment levels.

Remedial works included hand collection of pACM across a majority of the site and offsite disposal of

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:17:43AM, 17/03/2022

the collected fragments to a licenced waste facility. The identified pACM was in good condition with no presence of asbestos fines or fibrous asbestos. As three areas along the north-eastern and south-eastern boundaries of the site were not accessible and the top 10cm of soil across the site was not raked, it is not known whether these areas are impacted by pACM. However, based on the low level of PACM identified at the site, it is recommended that a construction environmental management plan (CEMP) is developed and implemented to address unexpected asbestos finds during future site redevelopment.

With the exception of the 2019 landfill gas and asbestos investigations, the investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor. The auditor's review is documented in a mandatory auditor's report (MAR) dated 7 May 2021. The auditor recommended that further landfill gas and groundwater investigations are undertaken to assess the potential risk to future use of the site as a primary school. The department and the Department of Health accept the findings and recommendations of the auditor, but recommends that the suitability of this site for development as a primary school should only be considered once the adjacent landfill site has been successfully remediated and resultant offsite impacts have been understood and effectively managed.

As the site has only been partially investigated, a comment cannot be made on the suitability of the site for any land use.

There are grounds to indicate possible contamination of the site. Groundwater and landfill gas have not been fully investigated and an adequate risk assessment to determine the risk to human health, the environment, and environmental values has not been carried out. Therefore, the site is classified as 'possibly contaminated - investigation required'.

When the results of further soil, landfill gas and groundwater investigations are submitted to the department, these will be reviewed, and the site may be reclassified.

The department, in consultation with the Department of Health, has classified this site based on the information available to the department at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to the department, and as such, the usefulness of this information may be limited.

Other Relevant Information:

Additional information included herein is relevant to the contamination status of the site and includes the department's expectations for action that should be taken to address potential or actual contamination described in the Reasons for Classification.

Due to the nature and extent of groundwater contamination identified to date, the abstraction of groundwater for any purpose is not recommended.

Based on the available information, contamination present on this site has originated from the adjacent land at Lot 13 Brae Road, Lot 14 Brand Road and Lot 18 Smokebush Place, High Wycombe, which have been classified separately under the Act. Therefore, this site is consistent with the definition of an "affected site" as specified in Part 1, Section 3 of the Act. Under the Act, the person responsible for the remediation of a source site is also responsible for remediation of any related affected sites.

Action Required:

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:17:43AM, 17/03/2022

	Further soil, groundwater and landfill gas investigations are required to determine the contamination status of the site and assess the suitability of the site for the proposed redevelopment of the site as a primary school. A report documenting the results of these investigations should be submitted to an accredited contaminated sites auditor by 1 June 2022. A construction environmental management plan (CEMP) should be developed and implemented prior to any site development works or significant ground-disturbing works.
Certificate of Title Memorial	Under the Contaminated Sites Act 2003, this site has been classified as "possibly contaminated - investigation required". For further information on the contamination status of this site, please contact Contaminated Sites at the Department of Water and Environmental Regulation.
Current Regulatory Notice Issued	**Type of Regulatory Notice:** *Nil* **Date Issued:** *Nil*
General	No other information relating to this parcel.

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:42:29AM, 17/03/2022

Receipt No: RR026382

ID No: 13392

Search Results

This response relates to a search request received for:

65 Brand Rd
High Wycombe, WA, 6057

This parcel belongs to a site that contains 3 parcel(s).

According to Department of Water and Environmental Regulation records, this land has been reported as a known or suspected contaminated site.

Address	65 Brand Rd High Wycombe, WA, 6057
Lot on Plan Address	Lot 14 On Diagram 24292
Parcel Status	**Classification:** 10/08/2021 - *Possibly contaminated - investigation required* **Nature and Extent of Contamination:** The site has been used as a landfill for the disposal of degradable household wastes and inert waste (such as building rubble). The landfill wastes are capped with up to 3 metres fill and in some areas the waste mass is exposed (e.g. Lot 18). Landfill gases (such as carbon dioxide, hydrogen sulfide and methane) have been identified across the site and may be migrating radially from the site. Per-and poly-fluoroalkyl substances, ammonia, vinyl chloride, dichlorobenzene and E.coli have been identified in groundwater beneath the site and may be migrating in a south-west direction from the site. **Restrictions on Use:** Please refer to Reasons for Classification and Other Relevant Information for further information on the contamination present at the site. **Reason for Classification:** This site was reported to the Department of Water and Environmental Regulation (the department) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003' (the Act), which commenced on 1 December 2006. The site was first classified under section 13 of the Act based on information submitted to the department by May 2007. The site has been classified again under section 13 of the Act to reflect additional technical information submitted to the department by May 2021. The site was reported to the department as it was used for multiple land uses including as a sand mine between 1978 and 1998, a landfill between 1989 and 1996 and for landfill gas abstraction between 1996 and 2010. Landfilling is a land use that has the potential to cause contamination, as specified in the guideline 'Assessment and management of contaminated sites' (Department of

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:42:29AM, 17/03/2022

Environment Regulation [DER], 2014). The site is proposed for future use as a sporting area including an oval, club rooms and ancillary infrastructure.

Waste accepted at the landfill included commercial, domestic, demolition, and industrial wastes (e.g. wood, food scraps, building rubble and shredded rubber), asbestos, sewage sludge, and non-toxic liquid waste (e.g. oil and water mixture). Following closure, the landfill was compacted, levelled and partially capped with clay to a maximum thickness of 3 metres in the centre of the site. Where present, the capping material generally comprises a sandy layer underlain by clayey sand / sandy clay and grass cover in most areas. Uncapped landfill material (comprising bricks and rubble) was observed during site inspections, particularly on Lot 18.

A soil investigation was conducted at the site in February 2018 which included soil samples taken from above and below the landfill mass. No soil contamination was found to be present.

Groundwater investigations were conducted at the site between July 1990 and March 2020. The most recent groundwater investigations identified per-and poly-fluoroalkyl substances (PFAS), ammonia, vinyl chloride, dichlorobenzene and E.coli in groundwater, indicating that landfill leachate has impacted groundwater quality. PFAS (such as from PFAS-containing waste) was identified in groundwater at concentrations exceeding health-based guidance values for drinking water, as published in the 'PFAS National Environmental Management Plan' (Heads of EPAs Australia and New Zealand, January 2020). Ammonia, vinyl chloride, dichlorobenzene and E.coli were present in groundwater at concentrations exceeding assessment levels for non-potable use of groundwater, as published in the guideline 'Assessment and management of contaminated sites' (DER, 2014). Further groundwater investigations are required both on-site and off-site to determine the quality of groundwater beneath the site and adjacent parcels of land.

Landfill gas extraction was undertaken at the site between 1996 and 2010. Extracted gas was combined with gas from the Dawson Avenue landfill and was used as fuel at the Dawson Avenue Gas Power Station, prior to the power station being decommissioned in 2010 due to low methane volumes. Following decommissioning of the power station, the remaining gas from the Dawson Avenue and Brand Road landfills was burned in a flare at the Dawson Avenue site. Gas flow to the flare from the Brand Road site was reduced in 2012 since the methane content was too low and was impeding the operation of the flare.

Passive gas vents were installed at this site in 2014 to prevent landfill gas from accumulating beneath the clay-based landfill cap and potentially migrating laterally. A leachate collection and recirculation system is present on site, encompassing leachate pumps, leach drains and leachate injection points across Lots 13 and 14. However, it is understood that the system is now in disrepair and the system is no longer maintained.

Limited ground gas investigations were conducted at the site between February and September 2020. Methane and carbon dioxide were identified across the site at an elevated concentration equivalent to a characteristic gas situation of 2 (low risk), as published in 'Assessing risks posed by hazardous ground gases to buildings' (CIRIA 2007) and NSW EPA 2019, requiring gas management measures. Elevated concentrations of carbon monoxide and hydrogen sulfide were identified within the north-eastern and south-western portions of the site.

Concentrations of contaminants exceed adopted assessment levels for residential use and future primary school use. Therefore, a screening risk assessment indicates that further investigations are required to determine the risk to human health, the environment and environmental values.

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Basic Summary of Records Search Response

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The investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor. The auditor's review is documented in a mandatory auditor's report (MAR) dated 7 May 2021. The auditor recommended that further soil gas and groundwater investigations are undertaken to assess the potential risk to future use of the site as a primary school. The department and the Department of Health accept the findings and recommendations of the auditor.

As the site has only been partially investigated, a comment cannot be made on the suitability of the site as a whole for any land use.

There are grounds to indicate possible contamination of the site. Groundwater and soil gas have not been fully investigated and a detailed risk assessment to determine the risk to human health, the environment, and environmental values has not been carried out. Therefore, the site is classified as 'possibly contaminated - investigation required'.

When the results of further soil gas and groundwater investigations are submitted to the department, these will be reviewed, and the site may be reclassified.

The department, in consultation with the Department of Health, has classified this site based on the information available to the department at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to the department, and as such, the usefulness of this information may be limited.

Other Relevant Information:

Additional information included herein is relevant to the contamination status of the site and includes the department's expectations for action that should be taken to address potential or actual contamination described in the Reasons for Classification.

Other than for analytical testing or remediation, groundwater abstraction is not recommended at this site because of the nature and extent of groundwater contamination.

Based on the available information, contamination present beneath this site has also been identified beyond the site boundary beneath the adjacent land, consistent with the definition of a "source site" specified in Part 1, Section 3 of the Act. In accordance with Regulation 31(1)(b) of the 'Contaminated Sites Regulations 2006', reports or information submitted to the department that are relevant to the investigation, assessment, monitoring or remediation of a source site are required to be accompanied by a mandatory auditor's report (MAR) prepared by an accredited contaminated sites auditor.

Action Required:

Further soil, groundwater and landfill gas investigations are required to determine the contamination status of the site and assess the suitability of the site for the proposed reuse of the site as a sporting area including an oval, club rooms and ancillary infrastructure. A report documenting the results of these investigations should be submitted to an accredited contaminated sites auditor by 1 June 2022.

Certificate of Title Memorial

Under the Contaminated Sites Act 2003, this site has been classified as "Possibly contaminated - investigation required". For further information on the contamination status of this site, please contact the Contaminated Sites section of the Department of Environment & Conservation.

Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report generated at 10:42:29AM, 17/03/2022

Current Regulatory Notice Issued	**Type of Regulatory Notice:** *Nil* **Date Issued:** *Nil*
General	No other information relating to this parcel.

DMO 1568 - Brand Road landfill, High Wycombe

LEGEND

- Mining Tenements
- Road Centrelines
- Cadastre
- ICMS Points - DEC Current

N

0 ~100 m

Scale 1:3802
(Approximate when reproduced at A4)

Geocentric Datum Australia 1994

Note: the data in this map have not been projected. This may result in geometric distortion or measurement inaccuracies.

Prepared by: capelll
Prepared for:
Date: 14/06/2021 2:53:54 PM

Information derived from this map should be confirmed with the data custodian acknowleged by the agency acronym in the legend.

Government of Western Australia
Department of Water and Environmental Regulation

DMO 12023 51 Brand Road, High Wycombe

LEGEND

Cadastre for labelling

Road Centrelines

N

0 ~100 m

Scale 1:4150

(Approximate when reproduced at A4)

Geocentric Datum Australia 1994

Note: the data in this map have not been projected. This may result in geometric distortion or measurement inaccuracies.

Prepared by:
Prepared for:
Date: 2/06/2021 7:35:13 AM

Information derived from this map should be confirmed with the data custodian acknowledged by the agency acronym in the legend.

Government of Western Australia
Department of Water and Environmental Regulation

DMO 12039 City of Kalamunda parcels surrounding landfill

LEGEND

- Cadastre for labelling
- WIN Groundwater Sites
- Road Centrelines

N

0 ~300 m

Scale 1:10119
(Approximate when reproduced at A4)

Geocentric Datum Australia 1994

Note: the data in this map have not been projected. This may result in geometric distortion or measurement inaccuracies.

Prepared by:
Prepared for:
Date: 3/06/2021 2:19:26 PM

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Government of Western Australia
Department of Water and Environmental Regulation