Appendix G

Flora and Fauna Report

GHD

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Department of Agriculture and Food

Report for State Barrier Fence Esperance Extension: Scoping Study

Preliminary Flora and Fauna Assessment

July 2012

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Purpose

The Department of Agriculture and Food Western Australia (DAFWA) has proposed the construction of an extension to the State Barrier Fence (SBF). The proposed extension will extend from the current SBF's most southerly point at Jerdacuttup to the Indian Ocean east of Esperance.

GHD Pty Ltd (GHD) was commissioned to undertake a scoping study to compare and assess the various alignments in regards to their potential to provide optimum vermin control and minimal environmental and social impact. As part of this scoping study GHD conducted an initial flora and fauna assessment in order to provide information on ecological aspects for the scoping study. This assessment provides information to enable the comparison of the flora and fauna issues relevant to the various alignments. The information from this preliminary flora and fauna assessment will be assessed along with information on other environmental, social and technical components during the process of providing a recommended route(s).

The preliminary flora and fauna assessment will also assist DAFWA in the identification of any major ecological issues associated with the SBF and the requirements for further investigations. It is GHD's assumption that this project will require further approvals and that this document will provide a basis for further reports.

1.2 Project Background

The SBF has been established in Western Australia since 1901. For the last 111 years it has been a physical barrier designed to protect Western Australia's agricultural resources from vermin and predators. It was originally constructed to protect the state from invasive rabbits. This failed for various reasons and its most significant role today is the exclusion of emus and wild dogs.

The SBF originates at the Zuytdorp Cliffs north of Kalbarri and runs southwards along the perimeter of the agricultural region to Jerdacuttup in the Ravensthorpe Shire. The existing fence is currently over 1700km in length with the Yilgarn extension currently under renovation. The Zuytdorp Cliffs provide a strong geographical barrier preventing vermin and predators from entering at the most northern point of the SBF. At the present most southern point there is no physical barrier in place to stop the migration of vermin around the fence.

The proposed Esperance extension aims to complete the physical barrier from coast to coast and increase the resilience of the associated agricultural area's vermin control.

Its length will be between 500 km and 730 km depending on the route chosen. The proposed SBF will broadly run along the interface between agricultural and vacant crown lands in a broad arc from Jerdacutttup to the southern coast to the east of Esperance (the 'Project Area'). The SBF will mostly consist of a 1.3 m "ring lock" netted fence with an angled skirt. This design allows for movement of native fauna while excluding emus and wild dogs, which are of concern.

The SBF will be located in the centre of a 20 m wide cleared easement. This gives a possible maximum Project Area clearing size of between 1000 and 1460 ha depending on the length of the alignment chosen.

A large proportion of the SBF is expected to be constructed adjacent to existing cleared tracks/roads which may be used as the 10 m buffer on one side of the alignment. For the purpose of the scoping study the alignment options will be assessed for 100 m either side of the proposed route to ensure all significant factors affecting the fence are considered and to provide options for the detailed work required to establish a final alignment for the SBF that will be constructed.

1.3 State Barrier Fence Alignment Options

The proposed SBF extension commences at Jerdacuttup, approximately 150 km west of Esperance. The first section of the SBF extension follows Bandalup Rd and West Point Rd, whereafter it passes along the interface between agricultural and vacant crown lands in a general north-east direction. It crosses the Coolgardie-Esperance Highway approximately 35 km to the north of Salmon Gums, the most northerly point. The SBF extension then heads in an approximate south-east direction along the edge of the agricultural land until it turns directly south before Cape Arid National Park. There are a number of alternative end point options being discussed, including an off-coast endpoint just north of Fisheries Road and a coast endpoint at a granite outcrop at the western end of Cape Arid National Park.

The proposed SBF can be dissected into a series of sections and options. These options are not mutually exclusive and in some sections of the Project Area only one option for alignment exists. A section refers to a portion of the SBF where there is only one proposed route. An option refers to a portion of the alignment where there is more than one proposed route. The origin near Jerdacuttup and the southernmost endpoint are sections where no other proposed option exists.

The alignment options being considered in this study can be further classified according to their distance from the current agricultural border to the south and west of the proposed SBF. The options have been assigned a letter according to this classification under the following criteria:

- Option A – The outermost route
- Option B - The median route between A and C
- Option C – The innermost route
- Option BC – Where options B and C merge
- Section – where no other options exist

The proposed SBF alignments are mapped at Figure 1,Appendix A.

There are also a number of subsections where alternatives to the fence are provided. These primarily occur at creek crossings where building a fenceline can be technically difficult, costly and have environmental implications. In these areas there is the potential to use "wings" to divert the target fauna instead of building a connecting fenceline. These diversion wings curve the fence back towards itself in a large arc on either side of the obstacle to focus the target fauna backwards and divert them from the area being protected by the wing.

Generally the alignment runs along the boundary between the agricultural land and the remnant vegetation within the UCL. Where options exist, Option C, the innermost option, follows the boundary between the cleared private property and the UCL while Option A, the outermost option, generally follows the shortest route across the UCL.

1.4 Scope of Works

DAFWA contracted GHD to undertake this study to identify the expected primary flora and fauna impacts of the various alignments of the proposed Esperance extension of the SBF and to assess the alignment options based on the identified issues. This assessment includes:

- A relevant literature and database review; and
- A Level 1 site assessment conducted in May 2012 to assess key areas and identify the potential major flora and fauna constraints along the alignments.

For the purpose of the scoping study, an area of 100 m width along all the alignment options and sections was investigated (the 'Project Area'). However, as the Project Area is a very large area, and access to some sections of it was very difficult, the field survey only assessed key sites within the Project Area (see Section 2.2).

2. Methodology

2.1 Desktop Assessment

The desktop assessment was carried out to identify potential flora and fauna constraints which may be in, or adjoining, the SBF extension. This included a literature search to identify information pertaining to the Project Area and to provide information on any aspects of ecological significance. The following aspects were included:

- A review of the Department of Environment and Conservation's (DEC) Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) databases to determine the potential for TECs or PECs to be present within the Project Area. This included those communities listed under the *Environment Protection and Biodiversity Conservation* Act, *1999* (EPBC Act).
- A search of DEC's Threatened Flora Databases and Priority Flora List;
- A review of the Western Australian Museum's (WAM) and DEC's *NatureMap* – to determine terrestrial vertebrate fauna species and flora species lodged in the Museum and the State Herbarium from within or adjacent to the Project Area;
- A review of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters database, with a buffer distance of 10 km – to identify species listed under the EPBC Act potentially occurring within the Project Area;
- A discussion of broad vegetation types shown in existing mapping (e.g. Beard *et al.* 1973); and
- An assessment of DEC's information on scrub-rolled clearing corridors.
- A review of other pertinent literature including: *A Biodiversity Audit of Western Australia's 53 Biogeographical Subreregions in 2002* (Comer *et al.*, 2001 *and* Comer *et al.*, 2002); *A Biodiversity and Cultural Conservation Strategy for the Great Western* Woodlands (DEC, 2010); *Advice on the Ecological Effects of the Esperance Extensions on Native Wildlife Field Assessment* (DAFWA, 2012)

2.2 Field Survey

The field survey sought to confirm the desktop assessment and provide information on the existing environment in the Project Area. The survey included a preliminary examination of the physical environment, vegetation and flora and fauna within the Project Area.

The flora and vegetation survey was a Level 1 survey conducted with reference to the Environmental Protection Authority (EPA) Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a).

The fauna survey was undertaken in conjunction with the flora and vegetation survey and consisted of a Level 1 survey in regard of the requirements of the EPA's Guidance Statement No. 56 *Assessment of Environmental Factors for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004b) and the DEC and the EPA's Technical Guide *Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3* (EPA, 2002).

The survey targeted key areas and sites of concern (such as areas containing conservation significant communities or species). Representative sites were surveyed to allow the remainder of the mapping to be extrapolated based on aerial photography, landform and previous surveys.

The flora and fauna survey included:

- Opportunistic collection and identification of flora species present on the site. Any conservation significant species identified in the field were recorded with a GPS location and their sub-population size estimated;
- Ground truthing of key areas to verify the information gathered from the desktop survey;
- Assessment of the potential fauna habitat present;
- Determination of suitable habitat for significant fauna;
- Confirmation of species identification using resources at the WA Herbarium;
- Electronic mapping using aerial photography to delineate vegetation units, vegetation condition, water courses and conservation significant species observed;
- An inventory of the vertebrate fauna species in the Project Area through opportunistic recording of species; and
- Identification of potential impacts.

Experienced, qualified GHD ecologists undertook the survey of the Project Area between the 22 May and 29 May 2012. The site was traversed by vehicle using roads, firebreaks and other cleared areas adjacent to the SBF alignment options. Key sites were selected on the basis of previous mapping (Beard, 1973), geology and soils mapping, access and aerial photography.

Representative flora and vegetation sites were surveyed by using both non-permanent quadrat and Rapid Assessment sites (RAs) (Figure 2, Appendix A). The field survey aimed to place one quadrat (10 m x 10 m) in each broad vegetation type. Twenty-eight quadrats were assessed across the Project Area and at each quadrat a photo was taken and the following aspects were recorded (details provided in Appendix C):

- Landform;
- Soil;
- Slope;
- Ground cover (bare ground, logs, twigs, leaves);
- Vegetation condition and disturbance factors;
- Age since fire;
- Vegetation Type;
- Cover class of vegetation structural layers; and
- Flora species list.

The RAs were a less detailed assessment of areas, predominantly aimed at determining the dominant species and a search for any conservation significant species. One hundred RAs were undertaken across the Project Area and at each RA a photo was taken and the following aspects recorded (details provided in Appendix C):

- Vegetation type;
- Any significant landform or soil features;

- Vegetation condition and disturbance factors; and
- Flora species list for dominant species and conservation significant flora.

Nomenclature

Nomenclature used in this report follows that used by the DEC's online *FloraBase* program (http://florabase.dec.wa.gov.au/) for flora species and online *NatureMap* program (http://naturemap.dec.wa.gov.au/default.aspx) and Christidis and Boles (2008) for fauna species as these references are deemed to contain the most up to date species information for Western Australia.

2.3 Limitations

This assessment was a scoping study in order to determine the likely optimum alignment for the SBF extension; it was not a comprehensive impact assessment. Potential impacts from the SBF have been discussed to some extent but a full assessment of impacts has not been undertaken. Prior to further works and referral to gain environmental approvals, further studies and impact assessment will be required.

The desktop assessments used a variety of spatial and online resources where the responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The Project Area has been very poorly studied in the past with little systematic survey data available. Desktop studies were based on broad-scale information sources.

The field survey was a reconnaissance survey (Level 1) aimed at determining the major flora and fauna issues associated with the various alignments. A flora and fauna list was compiled during the field surveys but this was not a comprehensive list. Complete flora and fauna surveys can require multiple surveys, at different times of year, and over a period of a number of years, to enable observation of all species present. Some flora species, such as annuals, are only available for collection at certain times of the year and others are only identifiable at certain times (such as when they are flowering). Additionally, climatic and stochastic events (such as fire) may affect the presence of plant species. Species that have a very low abundance in the area are more difficult to locate, due to above factors.

This field survey was not conducted at the optimum time of year to record certain flora species, such as annuals, or to obtain the necessary flowering and fruiting material required to identify certain plants. Further surveys undertaken during optimal conditions, in Spring, would be required to record plants that could not be identified during this survey.

The fauna assessment was primarily aimed at determining the major fauna habitats associated with the various alignments. The assessment only addressed the broadscale issues associated with the various alignment options; more detailed investigations are required at the next stage of this project.

This assessment considered only vertebrate fauna species, impacts on invertebrate fauna species was not included in the scope of this assessment.

2.3.1 Dieback

Dieback is not discussed within this assessment, as a separate report on this issue has been prepared by Great Southern Bio Logic (Spencer, 2012).

3. Regional Context

3.1 Bioregion

The Western Australian Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into 85 bioregions based on biological and geographic/geological attributes. The southern section of the Proposal area is within the Recherche subregion (ESP2) of the Esperance bioregion, which is characterised by proteaceous scrub and mallee heaths on sandplain overlying Eocene sediments, rich in endemics (Comer *et al.*, 2001). Vegetation types in this area are diverse and include heath, coastal dune scrub, mallee, mallee-heath and granite heath (Comer *et al.*, 2001). Known ecosystem values within the Recherche subregion, which may occur within the Project Area, include:

- The scrub heath on deep sand with *Banksia* and *Lambertia,* and *Banksia* scrub heath of the Esperance sandplain;
- Threatened fauna, including the Western Ground Parrot, Malleefowl, Carnaby's Cockatoo, Peregrine Falcon, Australasian Bittern, Chuditch, Red-tailed Phascogale, Black-footed Rock-wallaby, Heath Rat; Dibbler, the reptiles *Parasuta spectabilis bushi, Phyllodctylus* sp. Cape Le Grand and Carpet Python;
- Threatened flora species;
- Granite hills and outcrops at Cape Arid; and
- Extensive salt lakes.

(Comer *et al.*, 2001)

The northern section of the Project Area is located within the Eastern Mallee subregion (MAL1) of the Mallee bioregion, which is gently undulating, predominantly mallee over myrtaceous-proteaceous heaths on duplex (sand over clay) soils (Comer *et al.*, 2002). This area includes mallee on sandplains, samphire around small salt lakes, mallee and patches of woodland on clay, and scrub-heath on sandstone (Comer *et al.*, 2002). Known ecosystem values within the Eastern Mallee subregion, which may occur within the Project Area, include:

- Rare fauna including, Western Whipbird, Western Ground Parrot, Malleefowl, Cape Barren Goose, Slender-billed Thornbill, Chuditch, *Parasuta spectabilis bushi;*
- Rare ecosystems and plant assemblages of the Russell Range;
- Granite outcrops, which are likely to be significant as refugia; and
- Salt lake systems which are likely to have a high level of species diversity.

(Comer *et al.*, 2002)

3.2 Vegetation

Broad-scale mapping of the vegetation of the area was undertaken by Beard (1973). This mapping is presented in Figure 2, Appendix A.

The Project Area sits across a gently undulating plain with protruding granite domes and lake systems. Beard (1973) discusses the relationship of soils, lakes and vegetation in the area.

3.2.1 Soils and Vegetation

Generally on the Esperance Plains, in the southern section of the Project Area, the soil has an upper horizon of coarse to fine sand of variable depth overlying clay. In the southern portion of the Plain the upper horizon of sand is bleached and often coarser than further inland and the vegetation is scrub-heath and mallee-heath.

In western sections the shallower profiles often contain a band of pea ironstone at the base of the sand layer. Mallee dominates in these areas.

Further inland the surface layer of sand is shallower, of irregular depth, laterite is absent and mallee is the dominant vegetation. Even further inland calcareous soils begin to appear, first in patches and then the mallee gives way to *Eucalyptus oleosa* woodlands. The surface soil here is pink, loamy with a fluffy or floury texture, and overlies calcareous nodules or limestone.

In the east, near the coast, the *Eucalyptus cooperana* mallee zone grows on a thin red soil over limestone.

On Mt Ragged and the adjoining hills in the east of the Project Area there is only a thin layer of sand and humus over rock. The hills are surrounded by a belt of sand possibly derived from disintegration of the quartzite and supporting heath vegetation. The granite domes throughout the area are often largely bare of soil but may have granite rubble, sand and humus in patches that support vegetation (Beard, 1973).

3.2.2 Lake Systems

Much of the Project Area contains lake systems and these systems support various vegetation complexes. The lakes on the Esperance plain occur in three zones of differing character. On the more southern portion they are ephemeral small rounded depressions. Few are open lakes; most are covered with vegetation, either Melaleuca scrub in sandy areas, or *Eucalyptus occidentalis* woodland or mallee if on clay (Beard, 1973).

Where the vegetation changes from heath to mallee, there is a change in the lakes from fresh to salt and from circular to elongated. Most are oriented in an east-west direction and in areas they become very thickly clustered, separated by well-vegetated ridges of sand. The lakes are dry for most of the year and carry sparse samphire vegetation.

Further inland the lakes are salty, more irregularly scattered and generally more circular. They are often associated with granite outcrops (Beard, 1973).

3.2.3 Vegetation Extent

A vegetation type is considered under-represented if there is less than 30% of its original distribution remaining. From a purely biodiversity perspective, and not taking into account any other land degradation issues, there are several key criteria now being applied to vegetation (EPA, 2000). These are detailed below:

- The "threshold level" below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at 30% of the pre-European/pre-1750 extent for the vegetation type;
- 10% of the pre-European/pre-1750 extent for the vegetation type is regarded as being a level representing *Endangered*; and

- Clearing which would put the threat level into the class below should be avoided.

Such status can be delineated into five (5) classes:

- *Presumed Extinct*: Probably no longer present in the bioregion
- *Endangered**: <10% of pre-European extent remains
- *Vulnerable**: 10-30% of pre-European extent exists
- *Depleted**: >30% and up to 50% of pre-European extent exists
- *Least Concern*: >50% pre-European extent exists and subject to little or no degradation over a majority of this area.

* Or a combination of depletion, loss of quality, current threats and rarity gives a comparable status

The extent of the vegetation types mapped by Beard (1973) within the Project Area has been determined by the Government of Western Australia (2011) (Table 1). This indicates that the majority of the mapped vegetation types that occur within the Project Area are described as *Least Concern*. Three vegetation types (47, 1516, 2048) are *Depleted* and two vegetation types (512, 4801) are *Vulnerable*. These are highlighted in the table below.

Table 1 Broad Vegetation Types and Extent (After: Government of Western Australia, 2011)

Vegetation Association	Vegetation Description	Pre-European extent statewide (ha)	Current extent statewide (ha)	% remaining	% Pre-European extent in IUCN Class I-IV Reserves
9	Medium woodland; coral gum (*E. torquata*) & goldfields blackbutt (*E. le soufii*)	240509.33	235161.94	97.78	1.26
10	Medium woodland; red mallee group	145676.38	144160.85	98.96	0.45
42	Shrublands; mallee & acacia scrub on south coastal dunes	310084.5	295859.61	95.41	44.79
47	Shrublands; tallerack mallee-heath	1033054.74	372046.82	36.01	17.57
125	Bare areas; salt lakes	3492381.05	3269266.1	93.61	7.2
128	Bare areas; rock outcrops	329836.18	283024.14	85.81	14.95
129	Bare areas; drift sand	95286.17	63838.18	67	43.65
482	Medium woodland; merrit & red mallee	1628465	1612407.2	99.01	8.83

Vegetation Association	Vegetation Description	Pre-European extent statewide (ha)	Current extent statewide (ha)	% remaining	% Pre-European extent in IUCN Class I-IV Reserves
486	Mosaic: Medium woodland; salmon gum & red mallee / Shrublands; mallee scrub *Eucalyptus eremophila*	436130.37	254277.54	58.3	4.86
512	Shrublands; mallee scrub, *Eucalyptus eremophila* & Forrest's marlock (*E. forrestianna*)	237886.07	61978.71	26.05	2.4
516	Shrublands; mallee scrub, black marlock	607434.26	332304.86	54.71	24.07
519	Shrublands; mallee scrub, *Eucalyptus eremophila*	2333413.58	1418019.52	60.77	10.49
552	Shrublands; *Casuarina acutivalvus* & *Calothamnus* (also *Melalueca*) thicket on greenstone hills	33908.73	31506.82	92.92	0.89
924	Shrublands; mallee scrub, *Eucalyptus eremophila* & red mallee	107608.05	59929.4	55.69	22.64
925	Shrublands; mallee scrub, red mallee	5152.66	3780.93	73.38	1.84
1047	Shrublands; *Eucalyptus incrassata* mallee-heath	220297.22	186621.59	84.71	54.85
1516	Shrublands; mallee scrub, black marlock & Forrest's marlock	126686.24	58191.45	45.93	19.87
1519	Shrublands; mallee scrub, *Eucalyptus eremophila* & *Banksia*	3290.12	3290.12	100	
2048	Shrublands; scrub-heath in the Mallee Region	322219.98	158398.71	49.16	7.6
3106	Medium woodland; salmon gum & Dundas blackbutt	52660.8	51574.58	97.94	5.93
4048	Shrublands; scrub-heath in the Esperance Plains including Mt Ragged	50400.59	30021.61	59.57	47.59

Vegetation Association	Vegetation Description	Pre-European extent statewide (ha)	Current extent statewide (ha)	% remaining	% Pre-European extent in IUCN Class I-IV Reserves
	scrub-heath				
4801	Shrublands; heath with scattered *Nuytsia floribunda* on sandplain	58196.27	6304.65	10.83	3.32

The vegetation types that were determined to be *Depleted* or *Vulnerable* were further assessed to determine which Options or Sections they occurred in, and the extent to which they may be impacted for each of these Options or Sections (Table 2). For all Options and Sections, excepting Section 38, the amount of clearing required for each of these *Depleted* or *Vulnerable* vegetation types was less than 0.1 % of the remaining vegetation extents. Section 38 contains approximately 0.3 % of the remaining "Shrublands; heath with scattered Nuytsia floribunda on sandplain". This vegetation type is of particular concern as there is only 10.83 % of the pre-European extent remaining across the State. If further clearing of this vegetation type occurs it may drop below 10 % and be considered *Endangered.*

All of these calculations would be overestimates of the potential impact on these vegetation types as it has been assumed that clearing will be required for the entire alignment, with no consideration given to existing cleared or disturbed areas.

Table 2 Amount of *Depleted* or *Vulnerable* Vegetation Types Within the Options: includes the percentage of current extent remaining within option

Vegetation Association	Vegetation Description	Section Number	% of Pre-European extent remaining	Current extent statewide (ha)	Area (ha) of vegetation within option (20m width)	% of current extent within option
47	Shrublands; tallerack mallee-heath	1	36.01	372046.82	44.528	0.012
		7			4.598	0.001
		2A			1.268	0.000
		2B			2.318	0.008
		8A			1.737	0.009
		8B			0.021	0.009
		8C			0.007	0.000
512	Shrublands;	1	26.05	61978.71	31.481	0.051

Vegetation Association	Vegetation Description	Section Number	% of Pre-European extent remaining	Current extent statewide (ha)	Area (ha) of vegetation within option (20m width)	% of current extent within option
	mallee scrub, Eucalyptus eremophila & Forrest's marlock (E. forrestianna)	2A			26.544	0.043
		2B			42.153	0.068
		4C			23.005	0.037
		6C			37.903	0.061
		8C			3.168	0.005
1516	Shrublands; mallee scrub, black marlock & Forrest's marlock	25	45.93	58191.45	1.356	0.002
		23A			12.416	0.021
		23B			21.521	0.037
		24A			31.067	0.053
		24B			35.767	0.061
2048	Shrublands; scrub-heath in the Mallee Region	1	49.16	158398.71	1.831	0.001
4801	Shrublands; heath with scattered Nuytsia floribunda on sandplain	38	10.83	6304.65	18.408	0.292
		35C			3.181	0.050

3.3 The Great Western Woodlands

The Great Western Woodlands is a continuous band of native vegetation that stretches north and east from the edge of the wheatbelt, covering almost 16 million hectares. The woodlands cover much of the Unallocated Crown Land (UCL) within the Project Area, and the SBF extension runs along the edge of the woodlands for much of its length.

The Great Western Woodlands is an internationally significant area of great biological richness. It is the largest remaining intact Mediterranean climate woodland on earth (DEC, 2010). The woodlands are still in excellent biological condition but are under increasing pressure from pest animals, weeds and bushfires. The conservation strategy (DEC, 2010) for the Great Western Woodlands includes priorities for retaining the composition, structure and function of native ecosystems and to minimise clearing within the woodlands.

The Great Western Woodlands is an ecologically significant area and impacts on the woodlands should be avoided where possible. The greatest impacts on the woodlands from the SBF extension would be expected where the innermost alignments cross large areas of remnant vegetation. Impacts could be avoided by utilising the outside extents of the UCL, adjacent to the agricultural land.

4. Vegetation and Flora Results and Discussion

4.1 Vegetation Associations

The broad vegetation associations have been extrapolated from Beard (1973) vegetation types, soils mapping, aerial photography and observations made during the Level 1 survey. Where sufficient information has been was gathered during the survey the broad associations have been further refined into sub-associations.

There are large sections within the Project area that are difficult to interpret due to fire and scrub-rolling. Also field verification of vegetation was restricted to those areas assessed during the field visit, and was not undertaken across the whole Project extent. The Project area is highly diverse in vegetation associations and species and the descriptions provided within this document are not exhaustive. Further vegetation mapping is recommended during the detailed site investigation.

A discussion on the vegetation associations in a broad context is discussed below and descriptions of the associations are detailed in Table 3 and mapped at Figure 3.

Western Mallee Low Woodland Associations (Ravensthorpe end to Cups Road)

The western extent of the Project area contains a mosaic of mallee vegetation associations on undulating sandy plains (VT1, VT2, VT5, VT7, VT9, VT11 and VT12). *Eucalyptus occcidentalis* occurs in freshwater winter wet depressions (VA3). The Young River contains samphire communities (VT6) and *Allocasuarina* woodlands occur on the slopes of the Oldfieldii River (VT4). There are scattered occurrences of Allo*casuarina* shrublands with *Eucalyptus grossa* (VA8) on rises.

Salt Lake System

A band of salt lake systems containing samphire communities bounded by *Eucalyptus salmonophloia, Melaleuca quadrifaria, M. thyoides, M. linguiformis* and *M. uncinata* (VT10) occurs east of Cascade Road and continues across most of the central area to Clare Road

These salt lakes and pans are irregular in shape, small or elongated.

Salmon Gums Mallees and Woodlands

The Salmon Gums area forms a transitional zone between the mallee associations to the south and the sclerophyll woodland further inland (Beard, 1973). In this area the vegetation mosaics and is dominated by mallee form associations with patchy woodlands (VT14 and VT15).

Eastern Mallee Low Woodland Associations

This area is similar to the western mallee associations. This section forms a gently undulating plain of mallee and woodland mosaics (VT16, VT17 and VT19) that are relieved by granite outcrops (VT18). The plain is intersected by many elongated salt lakes and pans (VT10).

This section of the Project was difficult to access and survey sites were limited. As such, the area has been assigned vegetation associations that are generally consistent with Beard (1973) mapping. The mallee and low woodlands

Coastal Section

The coastal section consists of a gently undulating sandy plain that is pockmarked with small rounded depressions which fill with water in winter to become freshwater lakes. These lakes support *Eucalyptus occidentalis* and *Melaleuca preissiana* woodland (VT3).

The sand plain consists of mallee heath associations (VT20, VT22, VT23 and VT24) that are high in diversity, particularly in proteaceae and myrtaceae species. In areas of deeper sand *Banksia speciosa* forms a dense shrubland.

Table 3 Broad Vegetation Associations in the Project Area

Vegetation Association	Photograph
VT 1. Mixed mallee heath over myrtaceous shrub on sandy plains This association occurs in the western portion of the Project. It consists of a mosaic of eucalypt mallees on an undulating sandy plain. The understorey contains a dense shrub layer dominated by myrtaceous species. Species that occur within this association include: Mallees (to 4m): *Eucalyptus eremophila, Eucalyptus flocktoniae, E. suggrandis, E. pleurocarpa, E. leptocalyx, E. incrassata* Shrubs 1-2 m: *Melaleuca subfalcata, M. calycina, M. uncinata, M. thymoides, M. sapientes, M. societalis, M. glaberrima* and *Banksia baueri.* Shrubs under 1 m: *Melaleuca suberosa, M. carrii, Calothamnus gibbosus, C. quadrifidus, Acacia bidenata, A. chrysocephala, A. ingrata, Leucopogon sp. Dragon Rocks (A.M Coates 2609), L. tamminensis var. australis, L. heterophyllus, L. sp.Coujinup (M.A. Burgman 1085), Hibbertia recurvifolia* and *H. acerosa.* Representative sites: Quadrat 1, Quadrat 2, Quadrat 25, RA1, RA2, RA9, RA10 and RA16. Beard Association: 519	 RA10  Quadrat 1

VT2. *Eucalyptus pleurocarpa* mallee over Proteaceous and Myrtaceous Heath on sandy plain

This association occurs in a mosaic with VT1. This vegetation type is distinguished by the dominance of *Eucalyptus pleurocarpa* in the mallee layer.

Species occurring in this association include:

Mallees (under 4 m): *Eucalyptus pleurocarpa, E. incrassata, E. flocktoniae* subsp. *flocktoniae, E. leptocalyx, E. dissimilata and E. dielsii.*

Shrubs (under 1.5 m): *Acacia maxwellii, Allocasuarina humilis, Banksia obovata, B. pulchella, Hakea laurina, H. cygna subsp. cygna, H. ilicifolia, Melaleuca subfalcata, M. cucullata, M. uncinata* and *Taxandria spathulata.*

Sub associations include:

2A*: E. pleurocarpa* over *Banksia spp.* heath.

2B- Scattered *E. pleurocarpa* over a shrubland of *Allocasuarina huegeliana, A. microstachya, Calothamnus quadrifidus, Hakea corymbosa, Melaleuca bromeliodes* on upper slope with coarse sand with quartz.

Representative sites: RA3, RA4, RA5, RA6,RA7, RA8, RA15, RA93 and RA94.

Beard Association: 47

RA5

RA3

VT3 – *Eucalyptus occidentalis* in a drainage depression and creeklines

This vegetation association occurs in depressions and creeklines throughout the Project area. These areas would fill with water during the winter months. These depressions support *Eucalyptus occidentalis* woodland with *Melaleuca preissiana* over sedges.

Sub-association

3A – *Eucalyptus occidentalis* in the coastal section along Merrivale Road and bordering Cape Arid National Park. In this section the landscape contains undulating low rises dissected by creeklines. *E. occidentalis* dominates the lower lying areas and transisions to other eucalypt species on higher slopes and hill crests.

Representative sites: Quadrat 10, Quadrat 18, RA11, RA12, RA32, RA35, RA36, RA37, RA38, RA39, RA40,

Beard Association: 3A is the same as Fany Cove 516

RA11

Quadrat 18

VT4 – *Allocasuarina* on slopes near drainage lines

This association was recorded at one location, near Oldfield River in the western portion of the study area.

Allocasuarina ?globosa forms a dense stand on the south facing hill slope.

Representative site: RA13.

Beard Association: 2048.

RA13

VT5 – Mixed mallee *Eucalyptus eremophila, E. flocktoniae, E. forrestiana* over myrtaceous shrubland on undulating plain

This association is similar in structure to VT1. It occurs in the sections east of West Point Road.

This section has been scrub rolled and contained regrowth vegetation.

Species recoded in this association include:

Mallees: *Eucalyptus. eremophila, E. flocktoniae, E. forrestiana, E. uncinata, E incrassata* and *E. perangusta.*

Shrubs: *Grevillea pectinata, Melaleuca coronicarpa, M. societalis, M. uncinata, M. coronicarpa, Acacia hadrophylla, A. crassuloides* and *A. nitidula.*

Sub – associations:

5A: Stand of *Eucalyptus kessellii.*

5B: Stand of *Eucalyptus dielsii* with *Melaleuca societalis, Acacia spp., Grevillea cf. concinna, Hakea laurina* in the shrub layer.

Representative sites: Quadrat 27, RA88, RA89, RA91 and RA92.

Beard Association 512

RA88

RA92

VT6 – *Eucalyptus platypus* over *Frankenia* and *Tecticornia* shrubs in in drainage lines

This association was recorded in in the Young River.

Mallee: *Eucalyptus platypus* subsp. *congreta*

Shrubs (1-2 m): *Melaleuca cuticularis, M. eleuterostachya, Acacia assimilis* subsp. *atroviridis* and *A. nitidula.*

Shrubs (under 1 m): *Frankenia tetrapetala, Tecticornia* sp.

Representative site: RA17 and RA95.

RA95

VT7: *Eucalyptus forrestiana* and *E. flocktoniae* Mallees on sand plains

This vegetation association is present in low lying plains near salt lakes in the western portion of the Project (near Rolland Road and Neds Corner Road).

Eucalyptus forrestiana and E. *flocktoniae* dominate the mallee layer with a dense shrubland of *Melaleuca coronicarpa, M. eleuterostachya, M. societalis* and *M. uncinata.*

Representative site: Q26.

Beard Association: 482.

Quadrat 26

VT8: *Eucalyptus grossa* mixed shrubs on coarse sand with quartz

Present in areas near rocky outcrops with coarse sand, some surface boulders and quartz.

Eucalyptus grossa is the key distinguishing mallee, with *E. dissimilata, E. forrestiana* and *E. pleurocarpa* also present.

The shrub layer includes *Allocasuarina huegeliana, Acacia glaucoptera, A. crassuloides, Callitris cf. columellaris, Hakea scoparia* subsp. *scoparia, Verticordia chrysantha, Grevillea anethifolia, Philotheca cf. gardneri subsp. globosa* (P1), *Melaleuca uncinata* and *Leucopogon* species.

Representative site: RA 22 and RA90.

Beard Association: 552

RA22

RA90

VT9: *Eucalyptus pleurocarpa* mixed mallee over myrtaceous and proteaceous heath

This association was recorded at the end of Field Road in the western portion of the study area. It is dominated by *E. pleurocarpa* over diverse shrub layer including *Banksia media, B. pulchella, Calothamnus gracilis, Grevillea anethifolia, Hakea corymbosa, Leucopogon sp. Bonnie Hill (K.R. Newbey 9831)* (P1), *Leucopogon sp.Bremer Bay (K.R. Newbey 4667), Callitris cf. columellaris, Melaleuca tuberculata* and *Melaleuca uncinata.*

There are affinities with VT2, however the shrub layer contains higher diversity and a different suite of species.

Representative site: Quadrat 5

Beard Association: 47

Quadrat 5

VT10: Salt lakes

A system of salt lakes and pans is present across the central extent of the Project. These consist of small round lakes or irregularly shaped elongated pans. They occur within lower lying depression in the undulating mallee plains.

Typically the lakes are dominated by samphire communities and bound by a mixture of salt tolerant *Melaleuca* species.

Species recorded within the salt lakes include: *Carpobrotus modestus, Atriplex sp., Tecticornia* species.

Fringing vegetation includes: *Eucalyptus salmonophloia, Melaleuca quadrifaria, M. thyoides, M. linguiformis, M. uncinata, Scaevola spinescens* and *Rhagodia cf. ulicina.*

Representative sites: Quadrat 3, RA19, RA27, RA47,RA52, RA64

Beard Association: 125

RA52

RA47

VT11 Mixed mallee and woodlands of *Eucalyptus leptocalyx*, *E. eremophila*, *E. redunca* over Myrtaceous heath

This mixed mallee mosaic occurs in association with the salt lakes communities in the western portion of the Project. It forms a mosaic of changing mallees form and woodlands.

Sub-associations include:

11A: *Eucalyptus flocktoniae* subsp. *flocktoniae* and *E. valens* low woodland.

11B. *Eucalyptus calycogona* subsp. *calycogona* and *E. extensa* woodland.

11C*: Eucalyptus gracilis* woodland bordering salt lakes.

Representative sites: Quadrat 4, Quadrat 6, Quadrat 24, Quadrat 23, RA18, RA20, RA21, RA23, RA25 and RA26.

Beard Associations: 924 and 482

Sub-association 11A: Quadrat 23

Sub-association 11B: Quadrat 6

VT12: Mallee *Eucalyptus eremophila* and *E. flocktoniae* over myrtaceous and proteaceous heath on grey sandy plain

Occurs near Field Road. This association is dominated by *Eucalyptus eremophila* and *E. flocktoniae over Banksia speciosa, Grevillea anethifolia, G. pectinata, Melaleuca coronicarpa and M. uncinata.* It forms a mosaic with VT9 and VT11.

Representative site: RA24

Beard Association: 925.

RA 24

VT13 Shrublands; acacia, casuarina & melaleuca thicket

This vegetation association was not observed during the field survey due to access constrains. However, Beard (1973) mapping and aerial photography have been used to extrapolate its location.

Beard Association: 1413

VT14 Salmon gums mallee and woodland mosaic

The Salmon Gums area contains a mosaic mallee and patchy woodlands. These area was divided into several sub-associations:

14A: *Eucalyptus urna, E. gracilis, E. decipiens* and *E. cf. platycorys.*

14B: *Eucalyptus salmonophloia* and *E. platycorys* woodland.

14C: *E. eremophila, E. terebra* and *E. urna.*

14D: *Eucalyptus extensa, E. gracilis* and *E. phenax* subsp. *phenax.*

14E: Mosaic of mixed mallees including *E. terebra* and *E. gracilis* with *Melaleuca thyoides* shrubland in areas surrounding salt lakes. *E. salmonophloia* occurs in patchy location bordering salt lakes.

Representative sites: Quadrat 12, Quadrat 13, Quadrat 14, Quadrat 15, Quadrat 28, RA42, RA43, RA44, RA45, RA46, RA48, RA49, RA50, RA51, RA53, RA56, RA57, RA96, RA98, RA99 and RA100.

Beard Association: 486

Sub-association 14A: Quadrat 12

Sub-association 14E: RA99

VT15 *Eucalyptus dundasii* woodland

A small area of *Eucalyptus dundasii* woodland and mallee complex occurs on the eastern side of Salmon Gums. This association has been divided into two sub-associations:

15A: *Eucalyptus dundasii* woodland with a sparse shrubland of *Melaleuca bromeliodes, Scaevola spinescens, Westringia rigida* and *Ricinocarpos stylosus.*

15B: Mixed mallee form community.

Representative sites: Quadrat 16, RA54 and RA55.

Beard Association: 3106.

Sub-association 15A: Quadrat 16

Sub-association 15B: RA54

VT16 – Shrublands mallee scrub

This vegetation association has been extrapolated from Beard (1973) mapping and aerial photography as access was limited during the survey. It forms a mosaic mallee and low woodlands associated with salt lakes.

Species include *Eucalyptus uncinata, E. eremophila, E. platypus,* and *E. suggrandis.* Shrubs include: *Grevillea plurijuga subsp. plurijuga, Melaleuca coronicarpa, M. societalis, M. bromeliodes* and *M. cucullata.*

Representative sites: RA74, RA73 and RA72

Beard Association: 519.

RA73

RA74

VT17 – Beard (1973) Association RIDLEY 10

This vegetation association was not observed during the field survey due to access constrains. However, Beard (1973) mapping and aerial photography have been used to extrapolate its location.

This association is described as: Medium woodland; red mallee group.

VT18 –Granite Outcrops

In the eastern portion of the Project the mallee associations are relieved by granite domes. These granite domes contain *Eucalyptus tetraptera* with shrubs including *Calothamnus tuberosus, C. quadrifidus, Allocasuarina huegeliana, Hakea commutata, Melaleuca elliptica, M. glena, Acacia merrallii, A. pinguiculosa* subsp. *teretifolia* and *Calytrix tetragona.*

Representative sites: Quadrat 20, RA71, RA86 and RA87.

Beard Association: 128.

RA71

Quadrat 20

VT19 – Eastern woodlands and mallees mosaic

This association occurs along the eastern extent of the Project. It contains a mosaic of mallees and woodlands (similar to VT1) with elongated salt lakes in lower lying depressions. This association would contain a number of sub-association and requires further mapping during the detailed study.

Species include: *Eucalyptus dielsii, E. diptera, E. oleosa* subsp. *oleosa, E. forrestiana, E. redunca, flocktoniae, E. suggrandis, E. uncinata, E. grossa* and *E. pleurocarpa.*

Shrubs: *Melaleuca thyoides, M. societalis, M. coronicarpa, M. quadrifaria, M. uncinata, M. cucullata, M. bromeliodes, Beaufortia schaueri, Grevillea plurijuga* subsp. *plurijuga, G. pectinata, Acacia pritzeliana, A. delphina, A. nitidula, Microcybe pauciflora* subsp. *pauciflora, Daviesia* cf. *benthamii* subsp. *acanthoclona, Leucopogon* sp.Mount Heywood (M.A. Burgman 1211) and *Eremophila dichroantha.*

Representative sites: Quadrat 19, Quadrat 21,Quadrat 22, RA63, RA65, RA66, RA67, RA68, RA69, RA70, RA75, RA76, RA77, RA78, RA79, RA81, RA82, RA83, RA84 and RA85.

Beard Association: 1516 and 516.

Quadrat 22

Quadrat 19

VT20 *Eucalyptus incrassata* and *E. angulosa* mallee heath

This association transitions with VT19 inland and VT22 in the coastal area. Typically *E. angulosa* replaces *E. incrassata* towards the coast.

Mallee form of *Eucalyptus angulosa* and *E. incrassata* (to 1.5 m) over a proteaceous and myrtaceous heath.

Shrub species include: *Adenanthos cuneatus, Banksia media, Grevillea baxteri, Hakea trifurcata, H. cinerea, H. nitida, Xanthorrhoea platyphylla, Allocasuarina humilis, A. thuyoides, Acacia latipes* subsp. *latipes* and *A. gonophylla.*

Nuytsia floribunda and *Banksia speciosa* occurs in mosaics within the broader association. *B. speciosa* forms a dense shrubland in areas of deeper soils.

Sub-association:

20A: *E. angulosa* heath in coastal plain.

20B: *Nuytsia floribunda* shrubland.

20c: *Banksia speciosa* shrubland.

Representative sites: RA59, RA61 and RA62.

Beard Association: 1047.

Sub-association 20A: RA58

Sub-association 20A: Quadrat 17

VT21 – Proteaceae Heath

This association occurred at the crest of hills within VT20. The two mallees *Eucalyptus incrassata* and *E. uncinata* have a scattered occurrence. The proteaceous and myrtaceous heath species dominate including *Banksia sp., Allocasuarina humilis, Melaleuca striata, M. pentagona subsp. pentagona, Calothamnus gracilis, Grevillea baxteri* and *Hakea corymbosa.*

Representative site: RA60

Beard Association 4048

RA60

VT22 – Mixed mallee heath

This mallee heath occurs near in the coastal end. It forms a dense heath (under 1 m) of with high species diversity.

Mallee species include: *Eucalyptus tumida, E. uncinata, E. incrassata* and *E. angulosa.*

Shrubs: *Banksia tenuis, B. media, B. obovata, B. repens, Hakea marginata, H. prostrata, H. ruscifolia, Adenanthos cuneatus, Lysinema ciliatum, Calothamnus gracilis, Melaleuca suberosa, M. scabra, M. globifera, M. calycina, M. striata, Beaufortia schaueri, B. micrantha, Acacia myrtifolia, A. mutabilis subsp. angustifolia, Daviesia lancifolia, D. incrassata, Jacksonia viscosa, Leucopogon fimbriatus, L. woodsii, Boronia crassifolia* and *Spyridium microcephalum.*

Representative sites: Quadrat 8, Quadrat 9, RA31, RA34 and RA33.

RA31

RA33

VT23 – Coastal Dune

The coastal end point could not be accessed during the field investigation. Areas nearby were surveyed to provide an indication of the vegetation and floristics that occur. This has been extrapolated based on a survey site completed nearby.

The species include: *Acacia nigricans, Banksia speciosa, Darwinia vestita, Ispopogon polycephalus, I. trilobus, Daviesia apiculata* and *Verticordia minutiflora.* The groundlayer includes: *Lepidopermum gladiatum, Meeboldina crebriculmis* and *Schoenus* cf. *subflavus.*

Representative site: RA 28

Beard Association: 129.

RA28

VT24 - Coastal Heath

This association was recorded on undulating sand plains adjacent to the coastal dunes.

As access was restricted surveying of this association was made from only one location, and comments are extrapolated from notes made within the same association near the Project.

The association includes scattered occurrences of *Eucalyptus angulosa* (to 1 m) and *Nuytsia floribunda*. A dense heath layer (under 1 m) dominated by proteaceous species forms the dominant vegetation. This includes shrubs: *Banksia media, B. pulchella, B. repens, B. petiolaris, B. cuneata, Melaleuca striata, Lecupogon striatus, Beaufortia micrantha, Daviesia* species and *Boronia* species.

Gullies comprise a taller shrubland (up to 2 m) and include *Acacia myrtifolia, A. nigricans, A. subcaerulea, Banksia speciosa, Ricinocarpos megalocarpus* and *Leucopogon woodsii*.

It is also expected that in lower lying areas between dunes *Melaleuca* swamps will be present. However, none were accessible for this survey.

Representative site: Quadrat 7, RA30

Beard Association: 42.

RA30

Quadrat 7

4.1.1 Threatened and Priority Ecological Communities

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English and Blythe, 1997). TECs are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. *Presumed Totally Destroyed, Critically Endangered, Endangered, Endangered and Vulnerable*.

The DEC maintains a list of TECs which have been endorsed by the Minister for the Environment (April 2012). DEC listed ecological communities are given special consideration in environmental impact assessments and have special status under the land clearing regulations of the *Environmental Protection Act 1986* (EP Act). The EPA's position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment. Some TECs are also protected under the EPBC Act.

Possible TECs that do not meet survey criteria are added to the DEC's PEC Lists under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, but do not meet criteria for *Near Threatened*. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. *Conservation Dependent* ecological communities are placed in Priority 5.

An EPBC Act Protected Matters Search was undertaken for the Project Area (DSEWPaC, 2012). No EPBC Act listed TECs were indicated to occur within the search area.

A DEC TEC database search indicated that the closest recorded TEC ("Russell Range mixed thicket complexes") occurs 18 km to the east of Section 32A of the alignment, and should not be impacted by this project.

The DEC search indicated a number of PECs that occur within the broader area, with the closest PEC approximately five km from the SBF alignment. Additionally, the DEC's list of PECs within the South Coast area was examined to determine any other PECs that have the potential to occur within the area Table 4. A number of the PECs within the general area are not likely to occur in the Project Area as they are endemic to specific landforms, such as the flora associations of individual mountains or ranges.

During the Level 1 survey the PECs that may occur within the general were examined to determine the likelihood of their occurrence in the Project Area (Table 4). However, many of the PECs are poorly described and further detailed survey work, including floristic analysis, is required to confirm these results.

Table 4 Potential PECs within the Project Area

PEC	Status	Likelihood of Occurrence
Heath on Komatiite of the Ravensthorpe area	Priority 3	Not identified during the field survey – unlikely to occur
Melaleuca sp. Kundip Heath - Very Open mallee	Priority 1	Not identified during the field survey – unlikely to occur

PEC	Status	Likelihood of Occurrence
over *Melaleuca* sp. Kundip		
Eucalyptus purpurata woodlands	Priority 1	Not identified during the field survey – unlikely to occur
Banksia laevigata – Banksia lemanniana proteaceous thicket	Priority 1	Not identified during the field survey – unlikely to occur
Tallerack (*Eucalyptus pleurocarpa*) mallee-heath on seasonally inundated soils	Priority 2	*Eucalyptus pleurocarpa* occurs within the Project Area, further detailed floristic work would be required to assess the presence of this PEC
Melaleuca spathulata/Melaleuca viminea Swamp heath	Priority 1	Not identified during the field survey – unlikely to occur
Swamp Yate (*Eucalyptus occidentalis*) woodlands in seasonally inundated clay basins (South Coast)	Priority 3	This PEC generally occurs to the west of the Project Area – however, a number of *Eucalyptus occidentalis* woodlands in drainage lines or damplands were recorded during the field survey and a detailed floristic examination of these areas would be required to determine whether there is a match to this PEC.
Scrub heath on deep sand with *Banksia* and *Lambertia*, and *Banksia* scrub heath on Esperance Sandplain	Priority 3	Potential to occur – a detailed floristic survey is required to assess the presence of this PEC
Taxandria spathulata Heath	Priority 4	Potential to occur – a detailed floristic survey is required to assess the presence of this PEC
Dense, obligate seeding Proteaceae dominate shrublands and kwongan of the Esperance Sandplains	Priority 3	Potential to occur – a detailed floristic survey is required to assess the presence of this PEC

4.2 Vegetation Condition

The vegetation condition of the Project Area was assessed using the vegetation condition rating scale developed by Keighery (1994), which consists of six rating levels as outlined in Table 7, Appendix B. This scale recognises the intactness of vegetation and is defined by the following:

- Completeness of structural levels;
- Extent of weed invasion;
- Historical disturbance from tracks and other clearing or dumping; and
- The potential for natural or assisted regeneration.

The vegetation condition within the RA and quadrat sites was assessed during the field survey . The majority of the Project Area contained vegetation with a rating of Condition 3 (Very Good) or higher due to the location of the fence alignment within buffer strips. There was little evidence of weed invasion

across the Project Area and generally the structural levels remained intact. The areas of undisturbed vegetation were generally in Condition 1-2 (Excellent – Pristine or nearly so).

The vegetation within the older, low fuel modified buffer strips (discussed in more detail in Section 4.2.1, below) was generally in Condition 3 (Very Good) because, while they have been cleared in the past, the regeneration of species is very good and there is little weed invasion. The structural levels of these areas are not necessarily complete but the potential for regeneration is good. However, while these areas have the potential to regenerate it is assumed that regeneration will not be allowed as the process of scrub-rolling to maintain the buffer strip will continue.

4.2.1 Low Fuel Modified Buffer Strip

DEC currently maintains a low-fuel modified buffer strip, most recently installed in the 1990s by the then Bush Fires Board (now Fire and Emergency Services Authority of Western Australia), which runs along the majority of the UCL/agricultural land interface. At the edge of the buffer the DEC utilises existing roads (where possible) or a 10 m mineral earth access track. These roads or tracks are used as the base to subsequently maintain a low fuel zone varying in size, but averaging up to 50 m in width. This low fuel zone is scrub-rolled and then subject to a fuel reduction burn of any accumulative vegetation material, preferably within the same or following year. The buffer is generally re-treated approximately every 10 years, depending on factors such as risk to key infrastructure, private property assets, vegetation type, seed maturity cycles and viability and fuel loads. The access tracks innermost to the agricultural lands are maintained more frequently, either by grading or chemical application.

The low fuel modified buffer strip has been mapped at Figure 2 (Appendix A) from datasets provided by the DEC. The innermost option of the SBF alignment generally lies within the low fuel modified buffer strip, where possible. In the northern section of the alignment, from around Ainsworth Rd, west of Salmon Gums, to McCrea Rd, east of Salmon Gums the low fuel modified buffer strip does not occur. This means that the fence alignment in this area will require clearing of undisturbed vegetation along the UCL, which is currently in pristine – excellent condition. In some sections of this area a narrow cleared track runs along the interface between the UCL and the agricultural land which could be utilised as part of the clearing required for the fence. However, clearing of undisturbed vegetation along the edge of the UCL will still be required.

The buffer strip is, as expected, in lower condition than the undisturbed vegetation bordering this strip. However, while the vegetation within the buffer strip has been impacted by the scrub-rolling and burning, the older regrowth areas still show good diversity of species and low weed invasion (Plate 1). If these areas were allowed to regrow, it would be expected that the vegetation structure would be in good condition. The buffer strips that have been treated more recently, particularly in the north-east of the Project Area, are still dominated by the disturbance specialist species and the vegetation structure has been heavily impacted (Plate 2, below).

Plate 2 Regrowth scrub-rolled vegetation: shows undisturbed vegetation to the left of the photo, access track and scrub-rolled regrowth vegetation to the right.

Plate 1 Recently scrub-rolled and burnt vegetation: shows undisturbed vegetation to the left of the photo, access track and scrub-rolled vegetation to the right.

During the field survey the quadrats and RAs were generally done within the areas of undisturbed vegetation, in order to better assess the vegetation associations that would be present in the area without disturbance. However, RAs within the buffer strips were also conducted to provide information on the vegetation within these modified areas and to search for significant flora species, which can often be disturbance-response species.

Calculations on the extent to which each Option or Section is within the scrub-rolled vegetation or within undisturbed vegetation was conducted, based on the mapping (Table 13, Appendix C). Due to the scale at which the alignment was drawn there are areas where the alignment is shown outside of the scrub-rolled vegetation; however, it is possible to place the alignment within the scrub-rolled vegetation and thus minimise clearing of the vegetation in better condition. As such, the calculations of undisturbed vegetation clearing are sometimes over-estimated and can be reduced by refining the alignment to sit within the low fuel modified buffer strip.

4.2.2 Soil Health

Issues associated with soil health, in relation to flora and vegetation issues, include soil stability, erosion, and salinity. Within the Project Area soil health issues are generally relevant to the cleared areas around the edge of the farmland. Where clearing of areas of undisturbed vegetation will be required for the construction of the fenceline there is the risk that soil health would decline.

Issues associated with soil health can be minimised by using existing disturbed areas wherever possible. DAFWA have also indicated that after the initial construction of the fence, the methods for maintaining the cleared areas around the fence do not require scraping but may use low level methods for clearing, such as chemical application. This can help ensure the structural integrity of the soil by allowing some retention of plant material to help bind the soil.

4.3 Flora Diversity

4.3.1 Existing Flora Records

A *NatureMap* search (DEC, 2012) indicated more than 1500 flora taxa previously collected within a broad area with a buffer of 20 km around the SBF extension options. The diversity recorded within the *NatureMap* searches reflects the high diversity of the general area. The Esperance region is known for its high diversity of flora species and the SBF extension crosses a large variety of vegetation types, meaning a large number of flora species would be expected to occur across and near the Project Area.

During the Level 1 field survey the dominant species and any potential conservation significant species were recorded within each quadrat and RA site. Where identification was uncertain, species were confirmed using the resources of the Western Australian Herbarium.

The field survey recorded 395 taxa from 43 families for the Project Area. This number is considerably less than what would be expected from a full field survey. Additionally, the results were skewed by the season of the survey, as some species could not be identified due to lack of flowering and fruiting material, and due to annual species not being visible. This made identification of some of the dominant plants difficult, particularly for the Myrtaceae species. Other families that were underrepresented in the field survey, due to difficulties with identification, included the Chenopodiaceae, Asteraceae and the Poaceae.

The dominant families recorded within the Level 1 survey were:

- Myrtaceae 109 taxa
- Proteaceae 55 taxa
- Fabaceae 55 taxa
- Ericaceae 26 taxa
- Cyperaceae 22 taxa

Additionally, the dominant genera recorded were:

- Eucalyptus 39 taxa
- Melaleuca 37 taxa
- Acacia 31 taxa

- Hakea 19 taxa

A complete list of flora recorded within the Project Area is provided at Appendix C.

4.4 Conservation Significant Flora

Flora species considered to be significant are listed under the EPBC Act and the *Wildlife Conservation Act 1950* (WC Act). Any activities that are deemed to have a significant impact on species that are recognised by the WC Act and/or the EPBC Act can trigger referral to the EPA and/or the DSEWPaC (Table 8 and Table 9, Appendix B).

The DEC also maintains a list of Priority Listed Flora species which are species not currently protected under the WC Act (Table 9, Appendix B). Priority flora may be rare or threatened, but cannot be considered for declaration as rare flora until adequate surveys have been undertaken of known sites and the degree of threat to these populations have been clarified. Special consideration is often given to sites that contain Priority flora species, despite them not having formal legislatory protection.

Desktop searches of the EPBC Act Protected Matters database (DSEWPaC, 2012), DEC's rare flora databases and the *NatureMap* database with a very general 20 km buffer (DEC, 2012) indicate that there are 14 Threatened (Declared Rare) Plant Species and 145 Priority species recorded within the area intersected by the SBF alignment (Table 14). The DEC records indicate that 61 species occur within 1 km of the proposed alignments (Figure 3). However, these records should not be considered to indicate the only occurrence of significant species along the alignments. The Project Area is very large and contains a number of areas that have been very poorly studied. The majority of flora surveys would have occurred in areas with good access (such as along roads) or where surveys would have been required for previous projects (such as road developments). The lack of records of significant species in some sections of the alignment (particularly the areas that cut through the UCL) reflects a lack of surveys, not necessarily a lack of significant species along these areas.

The Level 1 field survey did not record any species listed as Threatened or Declared Rare under the EPBC Act or the WC Act. Eleven species on DEC's priority flora list were recorded during the Level 1 field survey. These species are included in Table 5 and mapped at Figure 2, Appendix A.

Identification of some potentially conservation significant species was limited due to lack of flowering and fruiting parts. Further detailed surveys for conservation significant species during Spring will be required at later stages of the Project.

Table 5 Priority Flora Species Recorded During the Field Survey

Species	Status	Location
Acacia diaphana	P1	Q18
Allocasuarina cf. *globosa*	P1	RA13;
Leucopogon sp. Bonnie Hill (K.R. Newbey 9831)	P1	Q5
Philotheca cf. gardneri subsp. *globosa*	P1	RA90; Q26
Acacia cf. *euthyphylla*	P3	RA76

Species	Status	Location
Hibbertia hamata	P3	RA32;
Micromyrtus elobata subsp. *scopula*	P3	RA63; RA67; RA78; Q19
Darwinia cf. *polycephala*	P4	RA75; RA76; RA77
Eremophila serpens (Snake Eremophila)	P4	RA89
Grevillea baxteri (Cape Arid Grevillea)	P4	RA58; RA60; RA62;
Melaleuca fissurata	P4	RA64

4.5 Introduced (Weed) Species

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. A Commonwealth initiative has led to the creation of a list of 20 Weeds of National Significance (WONS). The assessment used in determining the WONS was based on four major criteria:

- Invasiveness;
- Impacts;
- Potential for spread; and
- Socio-economic and environmental values.

Additionally, weeds that are, or may become a problem to agriculture or the environment can be formally classified as Declared Plants under the *Agriculture and Related Resources Protection Act, 1976* (ARRP Act). The Department of Agriculture and Food and the Agriculture Protection maintains a list of Declared Plants for Western Australia. If a plant is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to comply with the specific category of control. Declarations specify a category, or categories, for each plant according to the control strategies or objectives which the Agriculture Protection Board believes are appropriate in a particular place. These Declared Plants are divided into five classes, which are detailed in Table 10, Appendix B.

A desktop search of the EPBC Act Protected Matters database (DSEWPaC, 2012) indicated the presence or potential presence of four significant invasive flora species within the Project Area. These include:

- * *Asparagus asparagoides* Bridal Creeper
- **Carrichtera annua* Ward's Weed
- **Lycium ferocissimum* African Boxthorn
- **Tamarix aphylla* Athel Tree

While these species have the potential to occur in the Project Area not all are known from the Esperance area. **Tamarix aphylla* is not currently a significant issue in the area but its record relates to planted trees in the townsite and on farms.

During the field survey the Project Area was assessed for the presence of weed species. A full list of weeds was not recorded during the field survey, but this should be undertaken during later, detailed surveys. The field survey noted weed species of significance, such as those on the WONS list.

Generally the weed species within the Project Area were weeds of the agricultural areas, such as pasture grasses and weedy daises. The majority of the introduced species were located directly adjacent to the disturbed areas, such as roads and paddocks. Weed invasion of native vegetation is minimal in both the scrub-rolled vegetation and the undisturbed vegetation. The only recorded areas of significant weed invasion within the native vegetation were at Quadrat 10 and at RA38 where bridal creeper (**Asparagus asparagoides*) has invaded remnant vegetation. These areas are along the boundary of Cape Arid National Park which is a concern for its potential impacts on the conservation values of the National Park. Bridal creeper is a serious environmental weed and is on the list of WONS.

Weed invasion has the potential to be a serious issue associated with the construction of the SBF extension. Where the fence will be built through remnant vegetation that has not been previously disturbed there is the potential for the construction of the fence to lead to increased weed invasion. To reduce the risk of weed invasion it would be preferable to construct the SBF extension in areas of existing disturbance, such as along firebreaks. Particular consideration should be taken in areas with high environmental significance, such as Cape Arid National Park.

5. Fauna Results and Discussion

Previous assessment of the potential impacts of the SBF extension on fauna has been conducted by DAFWA, *Advice on the Ecological effects of the Esperance Extensions on Native Wildlife* (DAFWA, 2012). These overall impacts, that are applicable to all the fence options, are not covered in detail within this flora and fauna report. Rather, this report compares potential fauna impacts from the various alignment options, determines measures to minimise potential impacts and discusses further works required to assess the overall fauna impacts.

5.1 Fauna Habitats

The dominant fauna habitat types recorded along the alignment during the field survey include:

- Woodlands: This is the dominant habitat type within the Project Area, occurring across the northern areas. Of particular importance within the woodlands are the old, large hollow-bearing trees that offer shelter and breeding habitat for a number of species.
- Salt lakes: Salt lakes are scattered throughout the Project Area, particularly around Salmon Gums. These lakes are often dry but can be important habitat areas for species such as ducks when they are filled after rain events.
- Shrub/Heath-lands: Heath and Mallee-heath occur in the western and eastern sections of the Project Area, particularly around Cape Arid National Park. The Proteaceous heaths are feeding habitat for a number of species.
- Creeklines: Creeklines are often important as fauna habitat and can have significance as fauna corridors. There are a number of major creeklines within the west of the Project Area and one adjacent to Cape Arid National Park.
- Rocky outcrops: Rock outcrops are generally considered to have high value for fauna habitat and support a number of unique species, particularly reptile species.
- Coastal dunes: The SBF extension passes through secondary dunes at the coastal end-point; however, impacts on the primary dunes and coast are avoided, as it ends at a rocky outcrop.

Areas that have high value as fauna habitat include rocky outcrops and creeklines, as they provide shelter and resource availability.

5.2 Habitat Linkages and Fragmentation

Ecological linkage is defined as a series of patches of native vegetation which act as stepping stones of habitat to facilitate the maintenance of ecological processes and the movement of organisms within, and across, a landscape (EPA, 2009).

The SBF will be a barrier for large, flightless fauna species that will be too big to pass through the fence mesh and which cannot pass over the fence. The 10 metres of cleared area on either side of the fence may also be a barrier for those species that will not cross open ground.

None of the fauna species for which the fence will be a barrier are truly migratory. However, even for the non-migratory species the fence may prevent animals accessing resources, such as water and habitat.

This is especially relevant in the areas where the fence causes fragmentation within remnant habitat and where animals may be isolated from areas within their existing range.

Where the SBF extension fragments habitat and isolates fauna populations there is the risk that these small populations will be unviable into the future. If recolonisation is prevented due to the barrier effect of the fence, the species may become locally extinct. In the longer term, isolation of populations may also alter gene flow within the meta-population and consequently reduce long-term viability of the population. These issues are particularly pertinent to the small-medium species which are unable or unlikely to pass through the fence and which may be threatened by other factors (DAFWA, 2012). Potentially impacted significant species are discussed further in Section 5.3.1.

Climatic variation and long-term climatic changes will impact on the availability of fauna resources. The distribution of fauna species will change as resources contract and move (DAFWA, 2012). The SBF may have a significant impact on fauna populations in the future if it reduces the connectivity of habitat that would allow some species to adapt to climatic changes.

5.3 Fauna Diversity

A *NatureMap* search (DEC, 2012) indicated 219 vertebrate, terrestrial fauna taxa have been previously recorded within a rough 20 km of the Project Area (Table 15, Appendix D). The *NatureMap* records show that Scincidae (21 taxa), Meliphagidae (15 taxa) and Anatidae (11 taxa) are the most represented families that have been recorded within this area. Opportunistic fauna sightings from the field survey are also provided at Table 15. However it should be noted that this field survey was primarily a reconnaissance survey and was not conducted during optimum conditions for fauna spotting and thus observations were limited.

Given the large Project Area and the variety of landforms and habitats that the alignment crosses, the number of species expected to occur within the Project Area would be large.

5.3.1 Conservation Significant Fauna

Statutory Framework

The conservation of fauna species and their significance status is currently assessed under both Commonwealth and State acts. The acts include the Commonwealth EPBC Act and State WC Act (*Wildlife Conservation (Specially Protected Fauna) Notice 2010).*

The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN). A description of Conservation Categories delineated under the EPBC Act are described in Table 8 and Appendix B.

The EPBC Act also protects migratory species that are listed under international agreements (see Appendix B) and marine species on Commonwealth lands and waters.

The WC Act uses a set of schedules, but also classifies species using some of the IUCN categories. These Schedules are described in Table 11, Appendix B.
In Western Australia the DEC also produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the Western Australian WC Act but for which the Government feels there is a cause for concern. These species have no special legislatory protection, but their presence would normally be considered. Such taxa need further survey and evaluation of conservation

status before consideration can be given to declaration as threatened fauna. Levels of Priority are described in Table 12, Appendix B.

Desktop and Field Assessment

From the searches of the *NatureMap* database (DEC, 2012) and the EPBC Act Protected Matters Search Tool (DSEWPaC, 2012) a number of protected fauna species were identified as potentially occurring within the survey area (Table 15, Appendix D). Additionally, some significant species have a distribution that may include the Project Area but were not recorded in the data searches. These species were determined from previous work by GHD ecologists. The protected species that have the potential to occur in the Project Area are presented in Table 6. This table provides information on the habitat of the species and discusses potential impacts from the SBF extension.

It should be noted that some species that appear in the EPBC Act Protected Matters Search Tool are often not likely to occur within the specified area, as the search provides a general guidance to matters of national significance that require further investigation. The records from the DEC searches of threatened fauna provide more accurate information for the general area; however some records of sightings or trappings can be dated and often misrepresent the current range of threatened species.

Table 6 Protected Fauna Species Potentially Occurring Within the Project Area (Source: DEC, 2012; DSEWPaC, 2012, Gaikhurst, G. *pers. comm.*)

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Pezoporus wallicus subsp. *flaviventrus* (Ground Parrot)	Endangered	Schedule 1 - Critically Endangered	The Western Ground Parrot once occurred to the north of Perth, as well as near Albany. They are now confined to the south coast at Waychinicup, Fitzgerald River and Cape Arid national parks. Ground Parrots live in low species-rich coastal kwongan (shrubby heath), no more than 50 cm high, particularly those containing low *Banksia* and *Hakea*. They are also attracted to *Daviesia pachyphylla* regenerating after fire. Nesting takes place on the ground in a shallow hollow under a bush (Burbidge, 2004).	Potential impacts would be spatially limited to the south western portion of the Project Area in the Cape Arid National park area as these species are unlikely to occur elsewhere though the alignment. The Ground Parrot is not currently known to occur within the Project Area (it occurs to the east of the Project Area, within the national park) and potential impacts are unlikely. However, the fence, once established, may limit future movement of this species through the landscape. The fence will potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Bettongia penicillata ogilbyi (Woylie)	Endangered	Schedule 1 – Endangered	The Woylie was once wide spread across the Australian continent is now restricted to a few geographically isolated populations, mainly in the South west of WA. Several of these populations have recently suffered precipitous declines. The species historically occurred in a wide variety of habits, however is now restricted to forests and areas where predation has been controlled (or excluded).	This species is unlikely to occur within the Project area though translocations of the species to conservation estate in the region has occurred (and may continue in the future). Consultation with DEC Wildlife branch would confirm the future translocation plans for the species and thus allow thorough assessment of impacts. The fence, once established, would limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Botaurus poiciloptilus (Australasian Bittern)	Endangered	Schedule 1 – Endangered	The Australasian Bittern inhabits shallow freshwater swamps with fairly dense low vegetation of reeds, sedges, rushes and grasses. In WA it is confined to the SW corner. It has disappeared from the Wheatbelt, and is now largely confined to coastal areas, especially along the south coast.	The clearing of vegetation may have some limited impact on this species. However there is very limited habitat for the bird within the Project Area and the fence, once established, will not limit movement.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Calyptohynchus latirostris (Carnaby's Black Cockatoo)	Endangered	Schedule 1 – Endangered	Carnaby's Cockatoo, also known as the Short-billed Black-Cockatoo, is distributed across the south-west of Western Australia in uncleared or remnant areas of *Eucalyptus* Woodland and Shrubland or Kwongan heath. Breeding usually occurs in the wheatbelt region of Western Australia, with flocks moving to the higher rainfall coastal areas to forage after the breeding season. These Cockatoos feed on the seeds of a variety of native plants, including *Allocasuarina, Banksia, Dryandra, Eucalyptus, Grevillea* and *Hakea,* and some introduced plants. They will also feed on the nectar from flowers of a number of species, and on insect larvae.	This species is known to occur in the area. Potential breeding trees were recorded within the northern section of the Project Area. Targeted survey would be required to determine all potential breeding trees within the final alignment and to inform the approvals processes. Clearing of breeding trees should be avoided. There is potential feeding habitat for this species within the western and eastern sections of the Project Area. During the field survey a large flock of Carnaby's Black Cockatoo was recorded roosting and feeding near Fisheries Rd in the east of the Project Area. This Project will likely require clearing of feeding habitat; this may be considered to be a significant impact and require approval at the Commonwealth and State levels.
Macronectes giganteus (Southern Giant Petrel)	Endangered	Schedule 1 – Endangered	The Southern Giant Petrel is a marine bird occurs in Antarctic to subtropical waters. They breed on Macquarie and Heard Islands and on other subantarctic islands. They are widespread in southern oceans, and have been recorded as far north as Shark Bay in WA.	Given the marine nature of these species the Project Area is not considered to contain significant habitat. Potential impacts on these species are negligible.
Halobaena caerulea (Blue Petrel)	Vulnerable		The Blue Petrel is a marine species of the Subantarctic and Antarctic seas. It has been recorded off the Australian coast between East Gippsland in Victoria to Perth area of WA. The Blue Petrel previously bred on Macquarie Island, but breeding is now restricted to offshore stacks near Macquarie Island (Garnett and Crowley, 2000).	
Macronectes halli (Northern Giant Petrel)	Vulnerable		The Northern Giant Petrel is a marine and oceanic species. It mainly occurs in sub-Antarctic waters, but regularly occurs in Antarctic waters of the southwestern Indian Ocean, the Drake passage and west of the Antarctic Peninsula (Marchant and Higgins, 1990). The range of the Petrel extends into subtropical waters mainly between winter and spring. It frequents both oceanic and inshore waters near breeding islands and in the non-breeding range.	
Pterodroma mollis (Soft-plumaged Petrel)	Vulnerable		The Soft-plumaged Petrel is a marine, oceanic species that is generally found over temperate and subantarctic waters in the South Atlantic, southern Indian and western South Pacific Oceans	

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Thalassarche chrysostoma (Grey-headed Albatross)	Endangered	Schedule 1 – Vulnerable	A number of albatrosses are listed as threatened in Western Australia. These species of Albatross are marine, pelagic and aerial. Albatrosses breed on subantarctic and other southern ocean islands and fly enormous distances in the southern oceans searching for food.	Given the marine nature of these species the Project Area is not considered to contain significant habitat. Potential impacts on these species are negligible.
Diomedea exulans (Wandering Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Thalassarche cauta (Shy Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Thalassarche chlororhynchos (Yellow-nosed Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Thalassarche melanophris (Black-browed Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Cereopsis novaehollandiae subsp. grisea (Cape Barren Goose)	Vulnerable	Schedule 1 – Vulnerable	The Cape Barren Goose breeds only on islands in the Archipelago of the Recherche, off Esperance, and other islands in the vicinity. It resides on islands but is occasionally seen on the mainland, near Esperance (Burbidge, 2004).	The clearing of vegetation is likely to have a limited impact on this species. This species has large homeranges and the fence, once established, will not limit movement. Potential impacts on these species are negligible.
Dasyurus geoffroii (Chuditch)	Vulnerable	Schedule 1 – Vulnerable	The Chuditch formerly ranged over nearly 70 % of Australia. Chuditch currently survives only in south-western WA, in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland. This reduction in range and decline in population numbers have been caused by habitat alteration, impacts from the introduction of foxes and cats, hunting and poisoning. The site contains some habitat that is suitable for Chuditch and they have been known to occur in the region, so there is the potential for this species to utilise parts of the Project Area.	The clearing of vegetation may have some impact on this species. The fence, once established, may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Leipoa ocellata (Malleefowl)	Vulnerable	Schedule 1 - Vulnerable	The Malleefowl generally occurs in semi-arid areas of Western Australia, from Carnarvon to south east of the Eyre Bird Observatory (south-east Western Australia). It occupies shrublands and low woodlands dominated by mallee vegetation (DSEWPaC, 2012b). The Malleefowl uses areas of eucalypt or native pine, *Callitris* woodlands, acacia shrublands, Broombush *Melaleuca uncinata* vegetation or coastal heathlands.	The clearing of vegetation may have some impact on this species. Malleefowl, while general ground-dwelling, can fly and may be able to cross the fence; however, it is unknown whether this species may see the fence as a barrier. The fence, once established, may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Falco peregrinus (Peregrine Falcon)	-	Schedule 4.	The Peregrine Falcon is uncommon but wide-ranging across Australia. Habitat is extremely diverse, from rainforest to arid scrub, from coastal heath to alpine. The Peregrine Falcon nests primarily on ledges of cliffs, shallow tree hollows, and ledges of building in cities.	The clearing of vegetation may have some impact on this species. However, this species has large homeranges and the fence, once established, will not limit movement.
Platycercus icterotis xanthogenys (Western Rosella – inland subspecies)		Schedule 1 – Vulnerable	The inland sub- species of the Western Rosella is found in open and partly cleared eucalypt woodland and forest, riverine forest, farmland, orchards, wooded savannah and shrubland. The inland populations have been affected by massive, large scale deforestation. The bird feeds on grass seeds, herbs, insects, fruits, berries, flowers, nectar and buds. The Rosella is generally seen in pairs or small groups which are known to be quiet and fairly tame, the species often f forms larger flocks where food is abundant and breeds in August to September in nests in tree-hollows.	The clearing of vegetation, particularly where there are potential nesting trees (such as around the Salmon Gums area) may impact this species. However, the fence, once established, will not limit movement.
Lerista viduata (Ravensthorpe Range Slider)		Priority 1	The Ravensthorpe Range Slider is known only from the Ravensthorpe area at the eastern extent of the Project Area. The small skink shelters in leaf litter at the base of trees and shrubs in Eucalyptus woodlands within its restricted range.	The clearing of vegetation may have some impact on this species. However, the fence, once established, will not limit movement on a micro scale. However the track associated with the fence may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat and population linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Acanthophis antarcticus (Southern Death Adder)		Priority 3	The Southern Death Adder habitat ranges from rainforest to shrublands and heaths. This species is declining in many areas, probably due to habitat destruction and altered fire regimes (Wilson and Swan, 2008).	The clearing of vegetation may have some impact on this species. Snakes are known to get tangled in fences, though the level of movement restriction is unknown. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Paroplocephalus atriceps (Lake Cronin Snake)		Priority 3	The Lake Cronin Snake is a poorly known species, known from only five specimens, all collected from the vicinity of Lake Cronin. Whilst there is limited information on the biology of the moderately large snake, it is known that the diet includes lizards, it is active during the night and day, and is possibly arboreal. Taxonomic information requires further review and the conservation status of the species is related to data insufficiency.	Further studies to assess the level of impact would be required as it is unknown whether this species occurs within the Project Area; however, clearing of vegetation may have some impact on this species. Snakes are known to get tangled in fences, though the level of movement restriction is unknown. The fence, once established, may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Ardeotis australis (Australian Bustard):		Priority 4;	The Australian Bustard occurs across much of Australia, including across most of Western Australian, except in heavily wooded areas in the south. The Australian Bustard occurs mainly in open country, such as grasslands, low heath or lightly wooded grassland. This species is typically widespread and nomadic, but locally scarce.	The clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Burhinus grallarius (Bush Stonecurlew)		Priority 4	The Bush-stone Curlew inhabits dry open woodlands, lightly timbered country, mallee and mulga; anywhere with groundcover of small sparse shrubs, grass or litter of twigs (Morcombe, 2000). It avoids dense forest and closed canopy habitats.	The clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Macropus irma (Western Brush Wallaby)		Priority 4	The Western Brush Wallaby, a medium sized macropod, is a grazer found primarily in open forest and woodland. This species was once very common in the south-west of Western Australia but has undergone a reduction in range and a significant decline in abundance in its current habitat. The decline in populations of this species has resulted from extensive clearing within its original distribution and from predation of juvenile Western Brush Wallabies by foxes.	The clearing of vegetation may have some impact on this species. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Morelia spilota subsp. imbricata (South-west Carpet Python)	-	Schedule 4 - Priority 4;	The Carpet Python occurs in a large range of habitats including woodlands, forests and dense coastal scrub, on granite and limestone outcrops and along watercourses. The distribution of the species is from Geraldton and Yalgoo in the North east to Pinjin, Kalgoorlie, Fraser Range and most of the remaining south west (Storr *et al.* 2002). It is often arboreal and preys on birds, other reptiles and small to medium size mammals.	The clearing of vegetation may have some impact on this species. Snakes are known to get tangled in fences, though the level of movement restriction is unknown. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Oreoica gutturalis gutturalis (Crested Bellbird – southern)		Priority 4	The Crested Bellbird occurs along semi-arid coastlines and the arid inland. The occur in acacia shrublands, euclayptu woodlands, spinifex and chenopod plains.	The clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Thinornis rubricollis (Hooded Plover):	-	Priority 4;	The Hooded Plover is a wader that is endemic to Australia with most of the remaining birds occurring in southern Western Australia. Hooded Plovers live on ocean beaches and on coastal and inland salt lakes. This species is known to occur on coastal areas and inland lakes in the Esperance region. They are mainly found on the coast during the dry season, but some birds move inland during the wet season. They feed on invertebrates such as worms, shellfish, crustaceans, insects and seeds. Hooded Plovers are particularly vulnerable in the first stages of their lives. They take approximately four weeks to hatch and are flightless for five to six weeks after that. The eggs and flightless chicks can easily be hunted and eaten by foxes, dogs and cats. Being highly camouflaged they are also accidentally crushed by pedestrians, 4WD vehicles and trail bikes.	Impacts to this species would be limited to the coastal areas and salt lake areas of the Project area. However, the clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species. Potential impacts on nesting birds may result if the access tracks along the fenceline lead to an increase in 4WD access in nesting areas.
Isoodon obesulus subsp. fusciventer (Quenda)	-	Priority 5	The Quenda or Southern Brown Bandicoot is an omnivorous marsupial that occurs in the southwest of Western Australia. This species prefers areas with dense understorey vegetation, particularly around swamps and along watercourses. However, it also occurs in woodlands, and may use less ideal habitat where this habitat occurs adjacent to the thicker, more desirable vegetation. This species is relatively common in parts of the greater Perth and south west region.	The clearing of vegetation may have some impact on this species. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Macropus eugenii subsp. derbianus (Tammar Wallaby, WA subsp.)	-	Priority 5	The Tammar Wallaby is a small grey-brown, nocturnal wallaby occurring in the south-west of Australia. The species inhabits dense, low vegetation, such as coastal scrub, heath, dry sclerophyll forest and thickets of Mallee and woodland during the day and open grassy areas for feeding at night. Males and females live to 11 and 14 years, respectively and occupy their own home range with no social grouping. The Tammar Wallaby is herbivorous and eats mostly grasses (such as *Austrodanthonia setacea*) as well as *Gastrolobium bilobum* and *Corymbia calophylla*. Research has suggested that the species needs to drink water to survive, with some evidence it can drink sea water when fresh water is unavailable. The breeding habits are not known for this subspecies. Tammar Wallaby populations are thought to be threatened by fox predation, loss of suitable habitat due to inappropriate fire regimes and land clearing.	The clearing of vegetation may have some impact on this species. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Migratory Fauna

From the searches of the *NatureMap* database (DEC, 2012) and the EPBC Act Protected Matters Search Tool (DSEWPaC, 2012) a number of migratory fauna species were identified as potentially occurring within the survey area

- *Haliaeetus leucogaster* (White-bellied Sea-Eagle)
- *Apus pacificus* (Fork-tailed Swift)
- *Ardea ibis* (Cattle Egret)
- *Pluvialis fulva* (Pacific Golden Plover)
- *Diomedea exulans* (Wandering Albatross)
- *Thalassarche chrysostoma* (Grey-headed Albatross)
- *Thalassarche cauta* (Shy Albatross)
- *Thalassarche chlororhynchos* (Yellow-nosed Albatross)
- *Thalassarche melanophris* (Black-browed Albatross)
- *Hydroprogne caspia* (Caspian Tern)
- *Merops ornatus* (Rainbow Bee-eater)
- *Ardenna carneipes* (Fleshy-footed Shearwater)
- *Ardenna tenuirostris* (Short-tailed Shearwater)
- *Macronectes halli* (Northern Giant Petrel)
- *Macronectes giganteus* (Southern Giant Petrel)
- *Pterodroma macroptera* (Great-winged Petrel)
- *Pterodroma mollis* (Soft-plumaged Petrel)
- *Pezoporus wallicus subsp. flaviventrus* (Ground Parrot)
- *Arenaria interpres* (Ruddy Turnstone)
- *Calidris acuminata* (Sharp-tailed Sandpiper)
- *Calidris alba* (Sanderling)
- *Gallinago megala* (Swinhoe's Snipe)
- *Gallinago stenura* (Pin-tailed Snipe)
- *Numenius minutus* (Little Curlew)
- *Tringa nebularia* (Common Greenshank)

5.3.2 Feral Animals

The *NatureMap* search (DEC, 2012) and the EPBC Act Protected Matters Search Tool (DSEWPaC, 2012) indicated that a number of feral animals may occur within 20 km of the Project Area. These include:

- **Capra hircus* (Goat);
- **Felis catus* (Feral Cat);
- **Oryctolagus cuniculus* (European Rabbit);
- **Rattus rattus* (Black Rat)
- *Streptopelia senegalensis* (Laughing Turtle-Dove)
- **Sus scrofa* (Pig); and
- **Vulpes vulpes* (Red Fox);

This desktop search indicates all the potential species, however, it is likely that the species of concern in the area be limited to the Feral Cat, European Rabbit, Red Fox and Wild Dog.

The SBF extension is aimed at preventing the movement of dogs but may also impact on the movement of other large feral animals. Additionally, there is the potential for the exclusion of dogs from the agricultural area to change the predator-prey relationships within the farmland, leading to increases in populations of cats and foxes. However, little information is available on the population dynamics of these species and impacts are hard to predict without detailed, ongoing studies.

5.3.3 Impacts on species

The clearing required for the SBF will reduce the amount of habitat and resources available for fauna species. This is particularly relevant for the areas of restricted and high value fauna habitat and for habitat of the significant species. The south-eastern area of the alignment contains large tracts of potential Carnaby's Black Cockatoo feeding habitat and potential breeding habitat for this species also occurs in the north of the Project Area. Impact on these areas should be minimised and clearing of this habitat avoided.

The SBF also has the potential to create a barrier and cause habitat fragmentation. Some of the significant species that may occur in the area, such as the Western Brush Wallaby and Tammar Wallaby, are unlikely to pass over or through the fence. If small populations of these species are isolated by the fence these populations may become unviable or susceptible to predation by cats and foxes. It is recommended that habitat fragmentation be minimised wherever possible.

Further surveys will be required to determine the presence of significant species along the alignment, or within areas of habitat that will be fragmented.

Risk from Fauna Interactions with the Fence

The potential risks to wildlife from the SBF extension were assessed by the Vertebrate Pest Research Section of DAFWA (2012). The risk for large mammals and emus, but also for other birds (particularly nocturnal species), bats, reptiles and smaller mammals, includes potential collisions and entrapment with fences, which can lead to mortality. Entanglements with fences for smaller wildlife can include getting caught in

upper wires (especially barbed wires for birds and bats), ensnarement under fences and lower wires and entanglement against electrified wires (DAFWA, 2012).

While fences are a permanent collision and entanglement risk to wildlife the risk is greatest immediately after construction of a new fence (DAFWA, 2012). Thus, risks will be minimised where the SBF extension can be constructed along existing fencelines or through disturbed vegetation.

6. Conclusions and Recommendations

6.1 Conclusions

The preliminary flora and fauna assessment involved a desktop investigation and a Level 1 Flora and Fauna Assessment of key areas and sites of concern. This assessment determined the following:

- The Project Area lies along and within the southern section of the Great Western Woodlands, which is an internationally significant area of great biological richness.
- The extent of the vegetation types mapped by Beard (1973) and determined by the Government of Western Australia (2011) indicates that the majority of the mapped vegetation types that occur within the Project Area are described as *Least Concern*. Three Beard (1973) vegetation types are *Depleted* and two vegetation types are *Vulnerable*. For all Options and Sections, excepting Section 38, the amount of clearing required for each of these *Depleted* or *Vulnerable* vegetation types was less than 0.1 % of the remaining vegetation extents. Section 38 contains approximately 0.3 % of the remaining "Shrublands; heath with scattered *Nuytsia floribunda* on sandplain".
- This assessment described 24 broad vegetation associations. These associations were extrapolated from Beard (1973) vegetation types, soils mapping, aerial photography and observations made during the Level 1 survey. These broad associations are partly desktop based and will need to be refined further by detailed investigations. These vegetation associations can be grouped to describe the broad sections of the Project Arae:
  - **Western Mallee Low Woodland Associations (Ravensthorpe to Cups Road):** The western extent of the Project area contains a mosaic of mallee vegetation associations on undulating sandy plains. *Eucalyptus occcidentalis* occurs in freshwater winter wet depressions. The Young River contains samphire communities and *Allocasuarina* woodlands occur on the slopes of the Oldfieldii River. There are scattered occurrences of Allo*casuarina* shrublands with *Eucalyptus grossa* on rises.
  - **Salt Lake System:** A band of salt lake systems containing samphire communities bounded by *Eucalyptus salmonophloia, Melaleuca quadrifaria, M. thyoides, M. linguiformis* and *M. uncinata* occurs east of Cascade Road and continues across most of the central area to Clare Road. These salt lakes and pans are irregular in shape, small or elongated.
  - **Salmon Gums Mallees and Woodlands:** The Salmon Gums area forms a transitional zone between the mallee associations to the south and the sclerophyll woodland further inland (Beard, 1973). In this area the vegetation mosaics and is dominated by mallee form associations with patchy woodlands.
  - **Eastern Mallee Low Woodland Associations:** This area is similar to the western mallee associations. This section forms a gently undulating plain of mallee and woodland mosaics that are relieved by granite outcrops. The plain

is intersected by many elongated salt lakes and pans. This section of the Project was difficult to access and survey sites were limited. As such, the area has been assigned vegetation associations that are generally consistent with Beard (1973) mapping.

- **Coastal Section:** The coastal section consists of a gently undulating sandy plain that is pockmarked with small rounded depressions which fill with water in winter to become freshwater lakes. These lakes support *Eucalyptus occidentalis* and *Melaleuca preissiana* woodland. The sand plain consists of mallee heath that is high in diversity, particularly in proteaceae and myrtaceae species. In areas of deeper sand *Banksia speciosa* forms a dense shrubland.

- The database searches did not indicate the presence of any TECs within the Project Area. A number of PECs are known to occur in the general area, but no recorded PECs are intersected by the alignments. The field survey did not record any PECs but further floristic examination of the vegetation types would be required to confirm their presence or absence.
- The majority of the Project Area contains vegetation in excellent condition and there is little evidence of disturbance or weed invasion across the Project Area. However, DEC currently maintains a low-fuel modified buffer strip, which runs along the majority of the UCL/agricultural land interface. The vegetation within this strip has been previously disturbed and cleared. These areas could potentially regenerate, however, it is assumed that this will not occur as scrub-rolling to maintain the buffer strip is expected to continue.
- The Project Area crosses through an area with high diversity, and passes through numerous vegetation types. During the Level 1 field survey 395 flora species were recorded in a limited number of sites. A greater number of species would be expected to be identified during the flowering period.
- A number of conservation significant flora species have been recorded within the Project Area. Eleven flora species on the DEC's priority list were recorded within the Project Area during the field survey.
- Within the Project Area weed invasion was generally restricted to the disturbed areas along the edges of roads and paddocks. However, Bridal Creeper, an invasive environmental weed was recorded in native vegetation at a number of sites. The introduction of weeds into undisturbed vegetation could be a significant issue associated with the SBF extension.
- The alignment passes through a number of fauna habitats along the alignment, including shrublands, woodlands and coastal dunes. Areas that have high value as fauna habitat include rocky outcrops and creeklines, as they provide shelter and resource availability.
- The SBF extension has the potential to fragment fauna habitat. The SBF will be a barrier for large, flightless fauna species that will be too big to pass through the fence mesh and which cannot pass over the fence. The 10 metres of cleared area on either side of the fence may also be a barrier for those species that will not cross open ground. The options which will have the greatest impact are those that

pass through undisturbed vegetation. The options that have less impact are those that follow the edge of farmland.

- Given the large Project Area and the variety of landforms and habitats that the alignment crosses the number of species expected to occur within the Project Area would be very large.
- A number of conservation significant fauna species occur or potentially occur within the Project Area. The SBF extension has the potential to impact on fauna species through clearing of habitat, due to its barrier effect or to to direct impacts through fauna interactions with the fence or during construction. Impacts will be greatest in areas of undisturbed vegetation.
- Potential breeding trees for Carnaby's Black Cockatoo occur within the northern section of the Project Area, impacts on the trees should be avoided. Large areas of feeding habitat for black cockatoos occur in the eastern section of the Project Area.

6.2 Recommendations

It is recommended that the least constrained option identified in the scoping study be utilised where possible, in order to minimise impacts on flora and fauna. The least constrained alignment generally follows the innermost option, along the edge of the UCL, at the interface with the agricultural land. This means that the proposed alignment is usually within the scrub-rolled vegetation, which will require less clearing of native vegetation and will reduce the impacts on undisturbed vegetation, along with the associated indirect impacts, such as the introduction of weed species, dieback and increase in erosion and soil degradation. The innermost option also reduces habitat fragmentation by avoiding transecting large tracts of native vegetation, which reduces the impact on wildlife corridor connectivity.

Further detailed flora and fauna surveys and impact assessment are required once the final alignment has been determined.

The flora surveys should include mapping of significant flora locations along the preferred alignment and consideration of whether the location of the alignment can be refined within the 100 m buffer to avoid impacts on these species.

Where significant impacts on flora are determined, consideration should be given to mitigation measures, such as the creation of habitat corridors and moving the SBF into existing cleared areas (i.e. closing Rollond Rd). Where impacts are significant environmental offsets may be required.

The fauna surveys should include assessment of habitat, targeted searches for conservation significant species and determination of potential fragmentation of populations.

Animal ethic issues associated with the entire fenceline will need to be considered in more detail by DAFWA. The following issues should be taken into consideration:

- Choice of construction materials and physical structure of the fence: The fence needs to be designed to reduce wildlife impacts, for example, avoiding use of barbed wire, and low electrical wires, and choosing high visibility construction materials.
- Management implications, including humane dispersal or destruction, in the case of any build-up of numbers of animals against the fence.

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Appendix A
Figures

Figure 1 **Alignment Options**

Figure 2 **Vegetation Aspects**

Figure 3 **Vegetation Associations**

Figure 4 **Conservation Significant Aspects**

1:750,000 (at A3)

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

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LEGEND

DAFWA Provided Alignment Options

No Alternative Option Provided

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2A Section Number with Option letter

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Alignment Options

Figure 1

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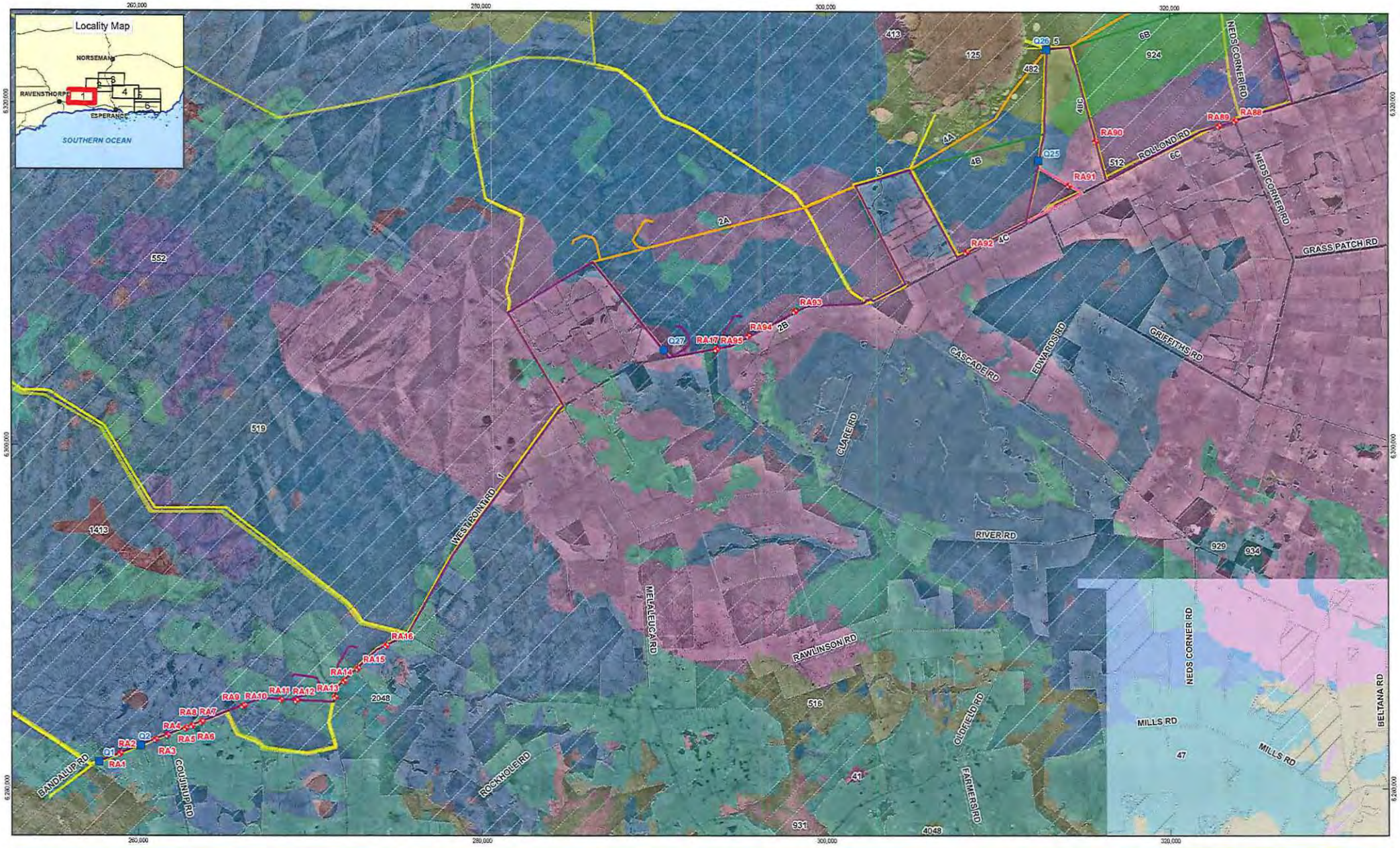
Data source: GA: NatMap 250.ecw - 2007; NatMap Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509. Created by: erice

239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au



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Vegetation Aspects

Figure 2

G:\61\28161\GIS\Maps\MXD\6128161_G002_Fig2_Rev0.mxd

Data source: GA: NatMap Geodata Topo Series 3 - 2006; DAFWA: Alignment Options - 20120508, Current Native Vegetation - 20120508, Pre-European Vegetation - 20120510, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: DEC Chainages - 20120508; GHD: GHD Survey - 20120705, Created by: erice

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Pre-European Vegetation Association

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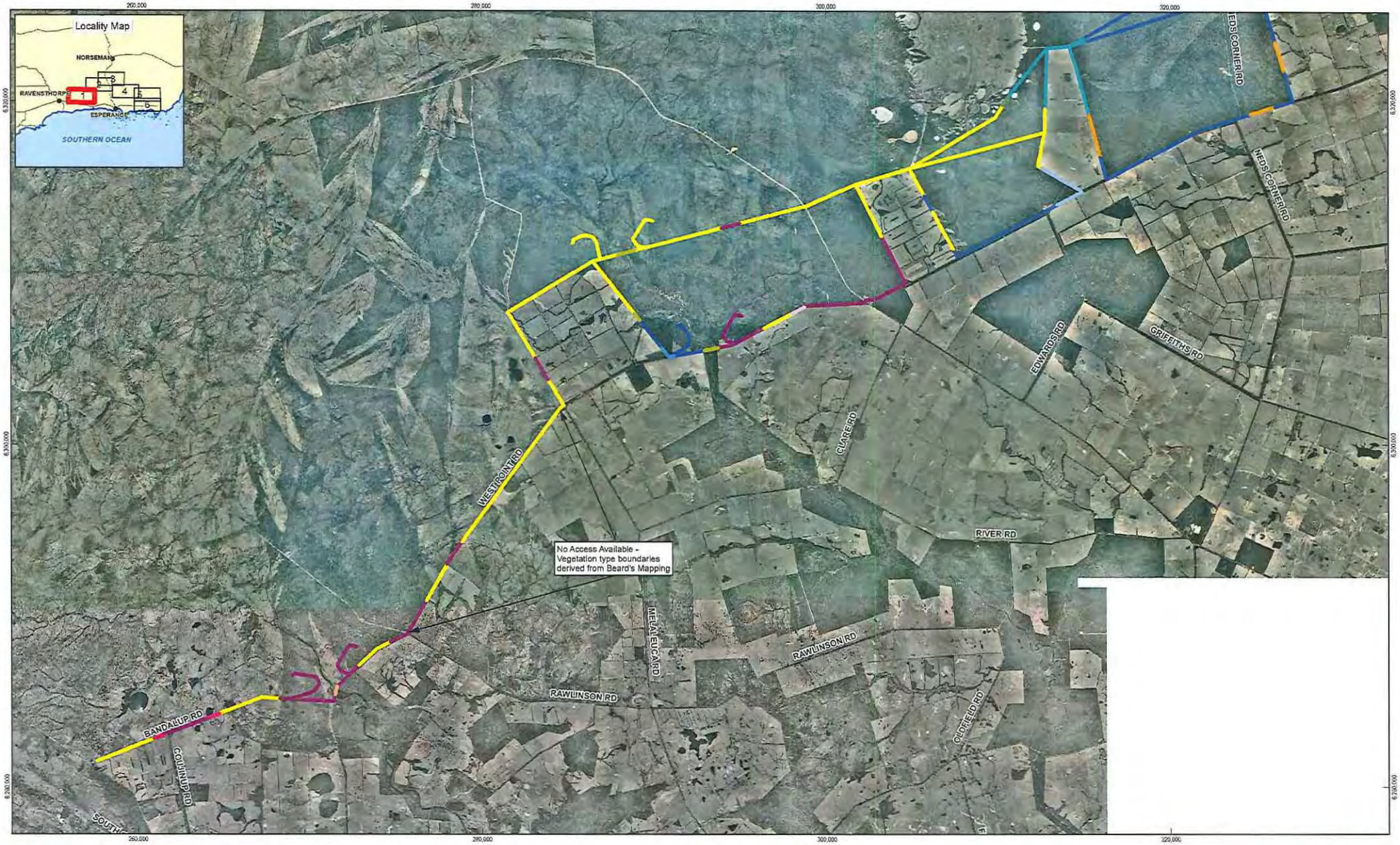
Data source: DAFWA Pre-European Vegetation Association - 20120905 Created by: sjice



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

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LEGEND

See attached Legend for the Vegetation Association Description

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Vegetation Association

Figure 3

Data source: GA: NatMap Geodata Topo Series 3 - 2006; GHD: Vegetation Association Description - 20120705; Landgate: Road Names - 20120509; DAFWA: Imagery - 2007-2009. Created by: erice, radelson

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Vegetation Association Description

Code	Description
VT1	Mixed mallee heath over myrtaceous shrub on sandy plains
VT2	*Eucalyptus pleurocarpa* mallee over Proteaceous and Myrtaceous Heath on sandy plain
VT2A	*E. pleurocarpa* over *Banksia cirsioides* heath
VT2B	Scattered *E. pleurocarpa* over a Allocasuarina shrubland
VT3	*Eucalyptus occidentalis* in a drainage depression and creeklines
VT3A	Eucalyptus occidentalis in the coastal section along Merrivale Road
VT4	*Allocasuarina* on slopes near drainage lines
VT5	Mixed mallee *Eucalyptus eremophila*, *E. flockiana*, *E. forrestiana* over myrtaceous shrubland on undulating plain
VT5A	Stand of *Eucalyptus kessellii*.
VT5B	Stand of *Eucalyptus dielsii*
VT6	Eucalyptus platypus over Frankenia and Tecticornia shrubs in in drainage lines
VT7	*Eucalyptus forrestiana* and *E. flocktoniae* Mallees on sand plains
VT8	*Eucalyptus grossa* mixed shrubs on coarse sand with quartz
VT9	*Eucalyptus pleurocarpa* mixed malle of myrtaceous and proteaceous heath
VT10	Salt lakes
VT11	Mixed mallee and woodlands of *Eucalyptus leptocalyx*, *E. eremophila*, *E. redunca* over Myrtaceous heath
VT11A	*Eucalyptus flocktoniae* subsp. *flocktoniae* and *E. valens* low woodland.
VT11B	*Eucalyptus calycogona* subsp. *calycogona* and *E. extensa* woodland.
VT11C	*Eucalyptus gracilis* woodland bordering salt lakes
VT12	Mallee *Eucalyptus eremophila* and *E. flockoniae* over myrtaceous and proteaceous heath on grey sandy plain
VT13	Shrublands; acacia, casuarina & melaleuca thicket
VT14	Salmon gums mallee and woodland mosaic
VT14A	*Eucalyptus urna*, *E. gracilis*, *E. decipiens* and *E. cf. platycorys*.
VT14B	*Eucalyptus salmoniphloia* and *E. platycorys* woodland.
VT14C	*Eucalyptus torquata* subsp. *conglobata*, *E. eremophila*, *E. terebra* and *E. urna*
VT14D	*Eucalyptus extensa*, *E. gracilis* and *E. phenax* subsp. *phenax*.
VT14E	Mosaic of mixed mallees including *E. terebra* and *E. gracilis* with *Melaleuca thyoides* shrubland in areas surrounding salt lakes. *E. salmoniphloia* occurs in patchy location bordering salt lakes.
VT15	*Eucalyptus dundasii* woodland
VT15A	*Eucalyptus dundasii* woodland with a sparse shrubland of *Melaleuca bromelioides*, *Scaevola spinescens*, *Westringia rigida* and *Ricinocarpos stylosus*.
VT15B	Mixed mallee form community.
VT16	Shrublands mallee scrub
VT17	Beard (1973) Association RIDLEY 10
VT18	Granite Outcrops
VT19	Eastern woodlands and mallees mosaic
VT20	*Eucalyptus incrassata* and *E. angulosa* mallee heath
VT20A	*E. angulosa* heath in coastal plain.
VT20B	*Nuytsia floribunda* shrubland.
VT20C	Banksia speciosa shrubland.
VT21	Proteaceae Heath
VT22	Mixed mallee heath
VT23	Coastal Dune
VT24	Coastal Heath

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Vegetation Association Legend

Figure 3

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Data source: GHD: Vegetation Association

1:200,000 (at A3)

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

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Figure 4

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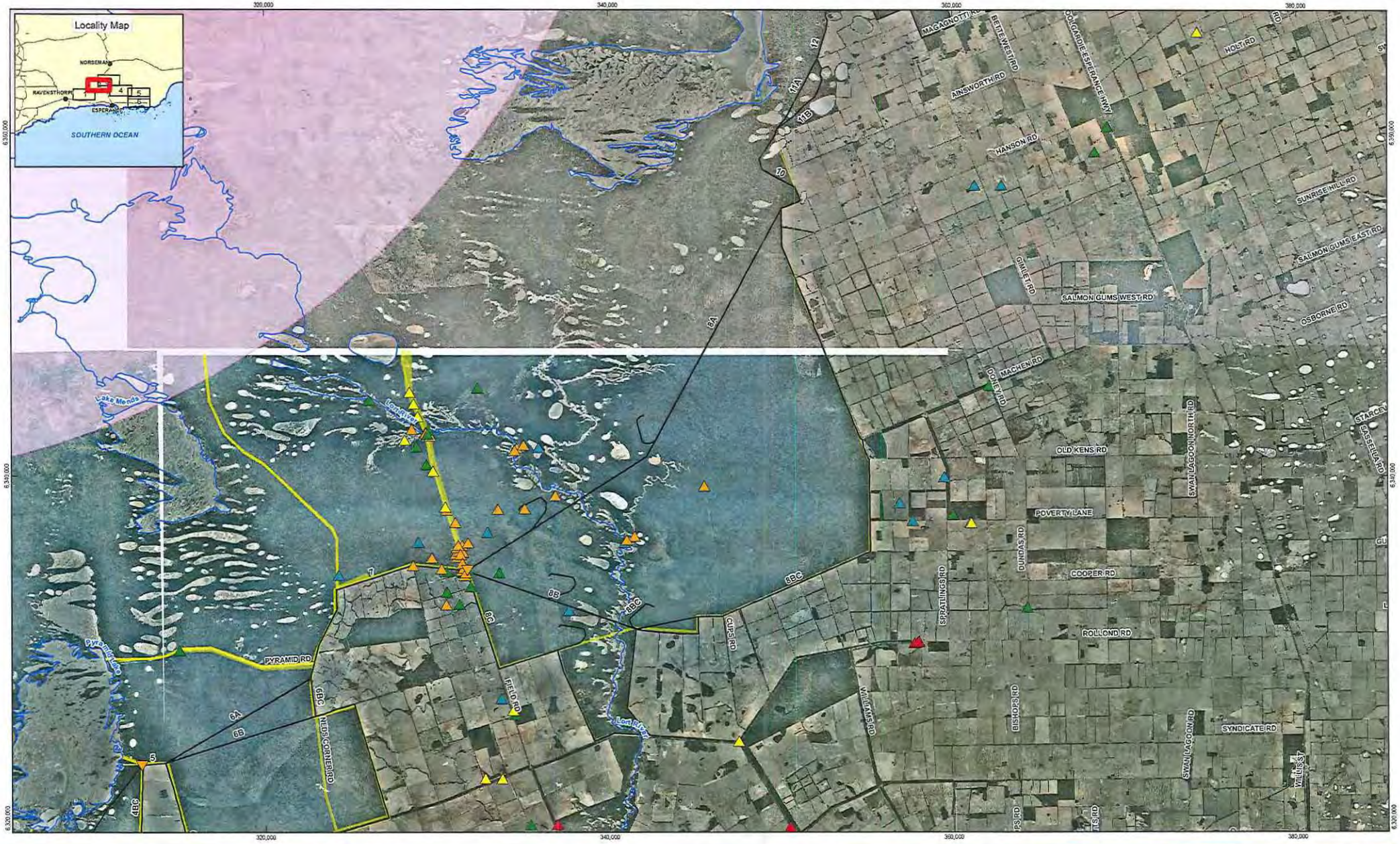

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0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa, T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

Figure 4

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Data source: GA: Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: Threatened (Declared Rare) & Priority Flora - 20120522, DEC Chainage - 201208, Priority Ecological Community - 20120523; GHD: GHD Survey June 2012 - 20120609, GHD Priority Flora - 20120705; DOW: Hydrography - 20120508. Created by: once

1:200,000 (at A3)

0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

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Figure 4

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Data source: GA: Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: Threatened (Declared Rare) & Priority Flora - 20120522, DEC Chainage - 201206, Priority Ecological Community - 20120523; GHD: GHD Survey June 2012 - 20120609, GHD Priority Flora - 20120705; DOW: Hydrography - 20120508. Created by: erico

1:200,000 (at A3)

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

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Figure 4

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Data source: GA: Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509, Imagery - 2007-2009, Landgate: Roads - 20120509; DEC: Threatened (Declared Rare) & Priority Flora - 20120522, DEC Chainage - 201206, Priority Ecological Community - 20120523; GHD: GHD Survey June 2012 - 20120609, GHD Priority Flora - 20120705; DOW: Hydrography - 20120508. Created by: erice

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1:200,000 (at A3)

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

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Figure 4

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Data source: GA: Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: Threatened (Declared Rare) & Priority Flora - 20120522, DEC Chainage - 201206, Priority Ecological Community - 20120523; GHD: GHD Survey June 2012 - 20120809, GHD Priority Flora - 20120705; DOW: Hydrography - 20120505. Created by: erico

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1:200,000 (at A3)

0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

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Figure 4

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Data source: GA: Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: Threatened (Declared Rare) & Priority Flora - 20120522, DEC Chainage - 201206, Priority Ecological Community - 20120523; GHD: GHD Survey June 2012 - 20120609, GHD Priority Flora - 20120705; DOW: Hydrography - 20120508. Created by: erice

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0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

See attached Legend for the Vegetation Association Description

Department of Food and Agriculture of Western Australia
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Vegetation Association

Figure 3

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Data source: GA: NatMap Geodata Topo Series 3 - 2006; GHD: Vegetation Association Description - 20120705; Landgate: Road Names - 20120509, DAFWA: Imagery - 2007-2009. Created by: erice, radelson

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0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

See attached Legend for the Vegetation Association Description

Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

Job Number	61-28161
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Vegetation Association

Figure 3

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Data source: GA: NatMap Geodata Topo Series 3 - 2006; GHD: Vegetation Association Description - 20120705; Landgate: Road Names - 20120509; DAFWA: Imagery - 2007-2009. Created by: erice, radeleon

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

See attached Legend for the Vegetation Association Description

Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

Job Number	61-28161
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Vegetation Association

Figure 3

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

See attached Legend for the Vegetation Association Description

Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

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Map Sheet 5 of 6

Vegetation Association

Figure 3

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0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

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Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

Job Number	61-28161
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Vegetation Association

Figure 3

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1:200,000 (at A3)

0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Survey
- Quadrats
- Rapid Assessment

Alignment Options
- No Alternative Option Provided
- A
- B
- BC
- C

Current Native Vegetation
DEC Chainage
2A Section Number with Option letter

519 DAFWA Pre-European Vegetation Association Number, See attached Pre-European Vegetation Association Legend

Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

Job Number	61-28161
Revision	0
Date	04 Sep 2012

Map Sheet 2 of 6

Vegetation Aspects

Figure 2

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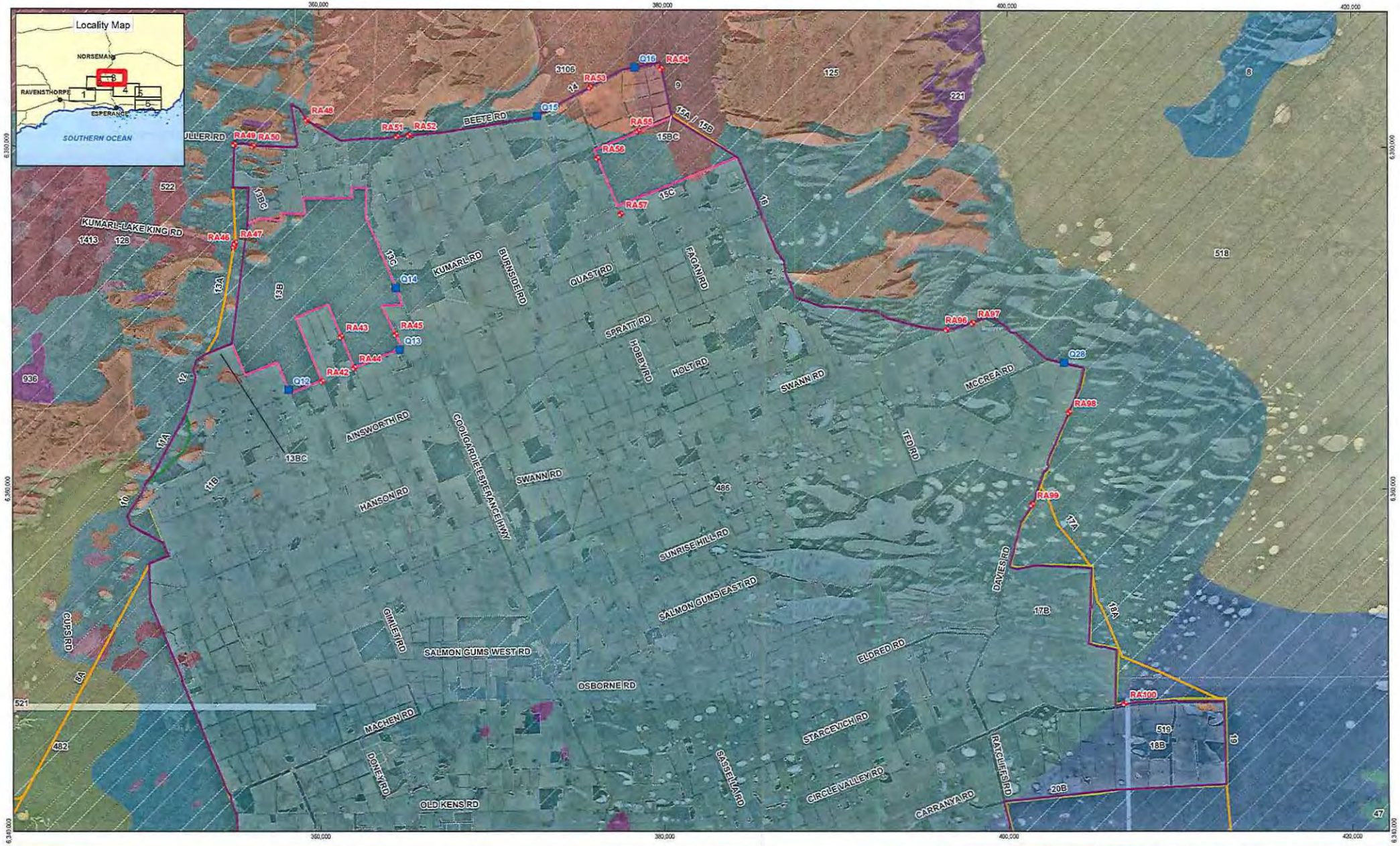

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0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Survey
- Quadrats
- Rapid Assessment

Alignment Options
- No Alternative Option Provided
- A
- B
- BC
- C

Current Native Vegetation
DEC Chainage
2A Section Number with Option letter

519 DAFWA Pre-European Vegetation Association Number, See attached Pre-European Vegetation Association Legend

Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

Job Number 61-28161
Revision 0
Date 04 Sep 2012

Map Sheet 3 of 6

Vegetation Aspects

Figure 2

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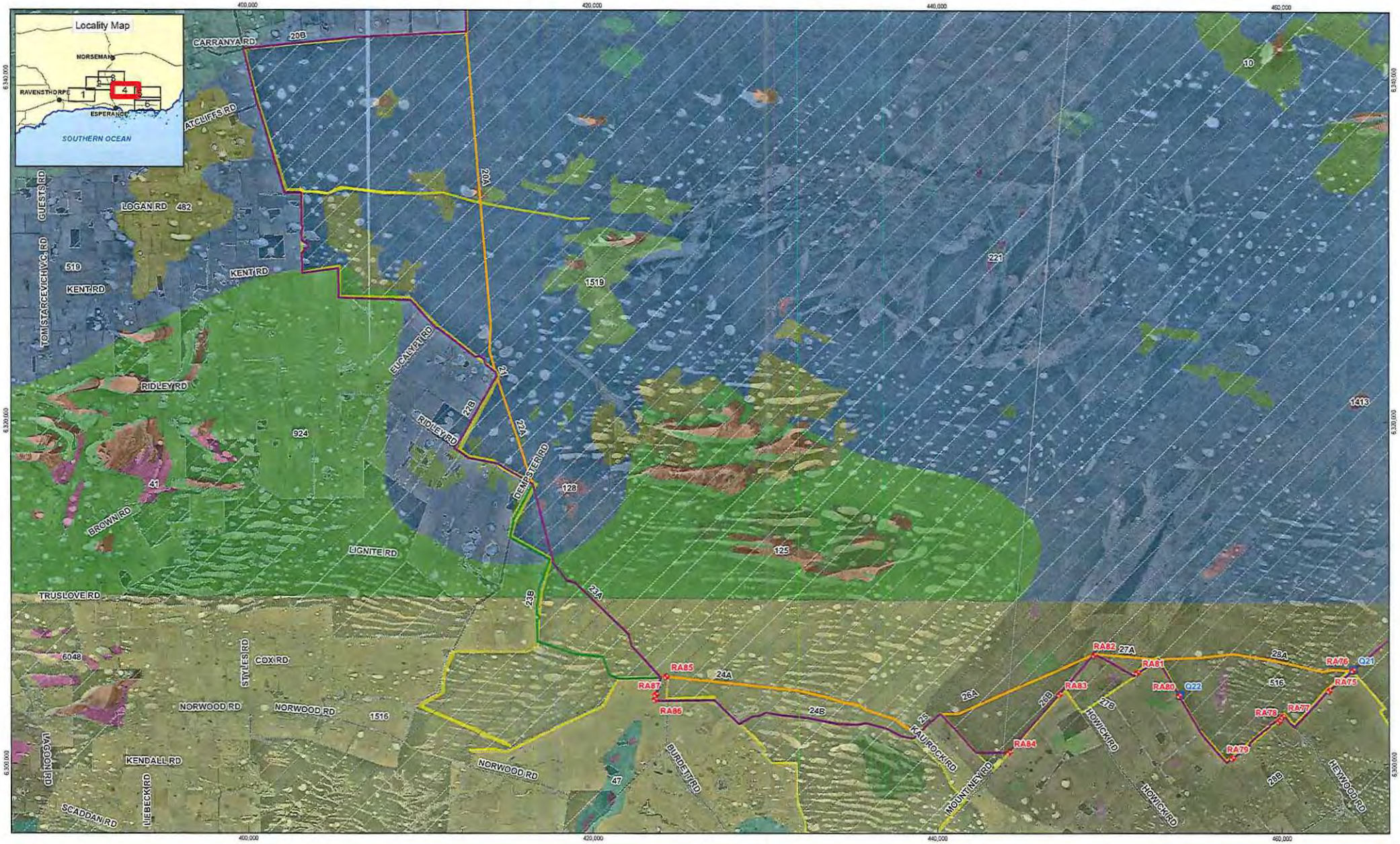

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0 1 2 4 6 8 10

Kilometres

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N

LEGEND

GHD Survey
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- Rapid Assessment

Alignment Options
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Current Native Vegetation
DEC Chainage
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Vegetation Aspects

Figure 2

Data source: GA: NatMap Geodata Topo Series 3 - 2006; DAFWA: Alignment Options - 20120509, Current Native Vegetation - 20120508, Pre-European Vegetation - 20120510, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: DEC Chainages - 20120508; GHD: GHD Survey - 20120705, Created by: erice

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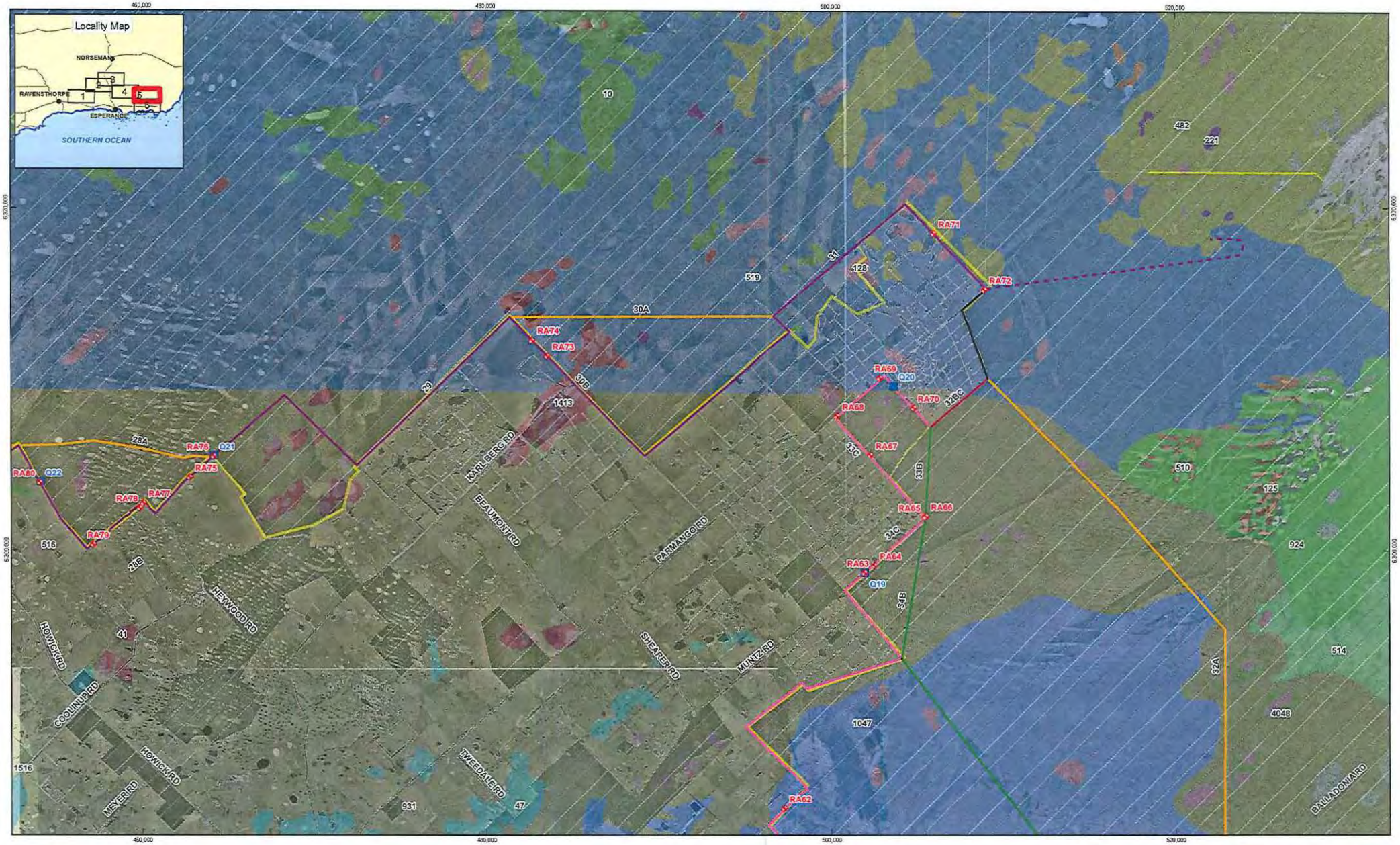

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Kilometres

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Horizontal Datum: Geocentric Datum of Australia
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LEGEND

GHD Survey
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Current Native Vegetation
DEC Chainage
2A Section Number with Option letter

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Department of Food and Agriculture of Western Australia
State Barrier Fence Scoping Study

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Map Sheet 5 of 6

Vegetation Aspects

Figure 2

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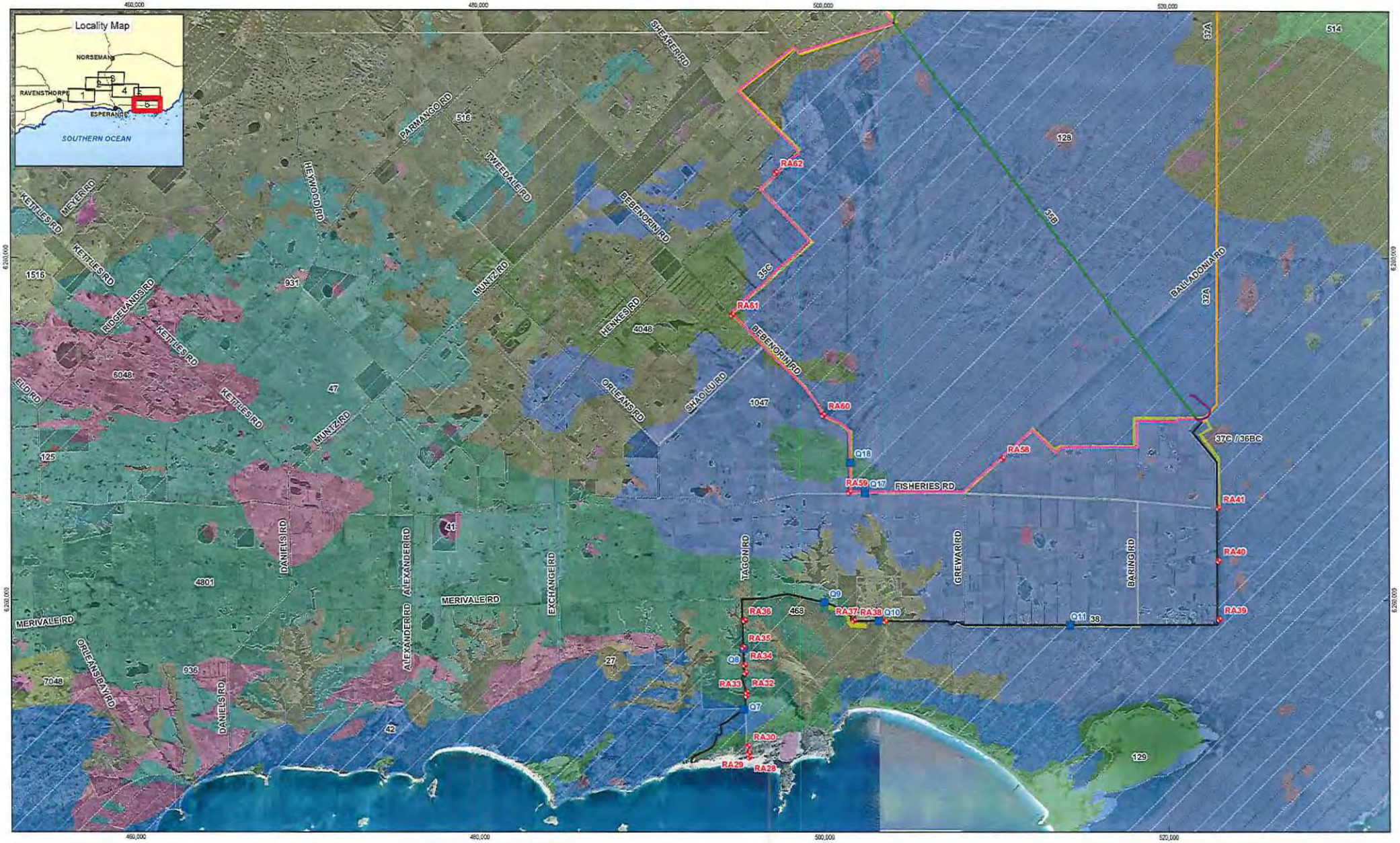

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0 1 2 4 6 8 10

Kilometres

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Map Sheet 6 of 6

Vegetation Aspects

Figure 2

Data source: GA: NatMap Geodata Topo Series 3 - 2006; DAFWA: Alignment Options - 20120509, Current Native Vegetation - 20120508, Pre-European Vegetation - 20120510, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: DEC Chainages - 20120508; GHD: GHD Survey - 20120705. Created by: ence

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Appendix B

Conservation Categories

Vegetation Condition Rating Scale

EPBC Act Flora and Fauna Conservation Categories

WC Act and DEC Flora Conservation Categories

Declared Plant Control Classes

WC Act Fauna Conservation Codes

DEC Priority Fauna Conservation Codes