Main Roads WA

Report for Bunbury Outer Ring Road - Southern Section (South Western Highway To Bussell Highway) Environmental Impact Assessment

November 2012

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Executive summary

Main Roads Western Australia (Main Roads) proposes to construct the Bunbury Outer Ring Road (BORR) Southern Section (South Western Highway to Bussell Highway) (the Project) in Bunbury, Western Australia. Main Roads commissioned GHD Pty Ltd (GHD) to prepare an Environmental Impact Assessment (EIA) for the Project.

The BORR is a planned Controlled Access Highway linking the four major highways radiating around Bunbury, on the outer edge of the City, to the planned Bunbury Port Access Road (PAR). The BORR and PAR will provide a high standard route for access to the Bunbury Port and the developing industrial areas to the east of Bunbury. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic.

The Project includes the construction of 9 km of dual carriageway from the South Western Highway (south) to Bussell Highway, including intersections, a service road, overpass road link, services re-locations and associated road infrastructure. Construction is planned within the next five years.

Main Roads propose to submit this EIA to the Environmental Protection Authority (EPA) for a assessment under Section 38 of the *Environmental Protection Act 1986* (EP Actt. Should the Project not be formally assessed, all environmental impacts will be managed by way of a Construction Environmental Management Plan and associated clearing will be undertaken under Main Roads Statewide Purpose Clearing Permit (CPS 818/6), or seek a Purpose Clearing Permit under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Main Roads also propose to submit this EIA to the Commonwealth Minister for the Environment through the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) for a decision on the requirement for formal assessment under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999*. Discussions with DSEWPC have included the requirement for an offset for impacts on fauna species protected under the EPBC Act, notably Black Cockatoos and Western Ringtail Possum.

GHD has been commissioned to prepare an Environmental Impact Assessment (EIA) for the Project, which includes assessment of the existing environment, including physical, biological, social, aesthetic, heritage, noise and site contamination. The EIA will determine key environmental factors and if additional site investigations are required, include appropriate physical and biological field investigations and an assessment of the Project against the EP Act “Ten Clearing Principles”.

The EIA also aims to provide necessary information to assist the Main Roads Project Manager in applying for necessary clearances, permits and licences relevant to the Project and recommend whether the Project is likely to have a significant environmental impact which may trigger referral to either the EPA or DSEWPaC.

The results of the EIA indicate that:

- The Project Area occurs within an area mapped as having a moderate to high likelihood of ASS and PASS being present, and as such Main Roads should undertake site investigations to accurately assess the level of risk and determine appropriate management strategies.
- There are no listed contaminated sites within the Project Area.
- Much of the northern part of the Project Area traverses ‘Multiple Use’ wetland. The road also traverses the Five Mile Brook, which is identified as a Conservation Category Wetland and an

Environmentally Sensitive Area, but is not a proclaimed watercourse under the *Rights in Water and Irrigation Act 1914 .*

- Clearing at the crossing of Five Mile Brook is required for the construction of a culvert crossing, to maintain surface water flows and site stabilisation/rehabilitation. These works are not expected to have any significant long term impact on Five Mile Brook.
- More than 30% of the pre-European Beard Vegetation extent remains within the Shire of Capel and the Bioregion. The extent of Vegetation Associations 6 and 1000 within the State, Region and Bioregion are identified as *Vulnerable*, aside from Vegetation Association 6 within the Shire of Capel, which is listed as *Depleted*.
- Southern River, Bassendean (Central and South), and Karrakatta (Central and South) Vegetation Complexes occur within the Project Area, with Southern River and Bassendean (Central and South) Complexes listed as *Vulnerable* with 22% and 25% of their pre-European extent remaining respectively, while Karrakatta complex is considered *Least Concern* with 56% of the pre-European extent remaining.
- Seven native vegetation types were identified within the Project Area, with a total of 155 plant taxa from 43 families recorded during a 2011 site survey. Of these, 32 species are introduced or not endemic to the area.
- A total of 71 individuals of the Priority 4 flora species, Sandplain White Spider Orchid *(Caladenia speciosa)* were recorded, mostly in small populations, located in the southern section of the Road Disturbance footprint.
- Three Declared Plants under the *Agriculture and Related Resources Protection Act 1976 (WA)* were recorded within the road footprint during the 2011 survey.
- One PEC is mapped within the Project Area by DEC. The site vegetation survey did not confirm the presence of this or any of the other TEC or PEC identified by DEC mapping as occurring within the vicinity of the Project Area.
- Vegetation condition in the road footprint ranged from *Pristine* (1) to *Completely Degraded* (6), with the majority assessed as *Degraded* (5) to *Completely Degraded* (6) due to past clearing and agriculture.
- Based on the 2011 Concept Design, the expected clearing impact for the road is approximately 22 ha, excluding vegetation considered as *Degraded* (Condition 5) or *Completely Degraded* (Condition 6). Up to an additional 11 ha is required to be cleared for Subsidiary Infrastructure, including fencing, noise walls, services relocations and drainage works.
- An assessment of the proposed clearing against the Ten Clearing Principles has determined that the Project is at variance to Principle b), likely to be at variance with Principle f) and may be at variance with Principles a), e), and i).
- A dieback survey, conducted for the Project in 2011 (Glevan 2011), noted that, where vegetation was intact the Site was uninfested. Due to possible changes in dieback status over time it is recommended that dieback occurrence be re-assessed closer to road construction and that a Dieback Hygiene Plan be prepared and implemented for the Project.
- Eight reptiles, three amphibians, three native mammals, six non-native mammals, and 59 birds were recorded within the Project Area during the 2011 survey. Of these, five conservation significant fauna species were identified:
  - Carnaby's Black Cockatoo (*Calyptorhynchus latirostris);*
  - Baudin's Black Cockatoo (*Calyptorhynchus baudinii*);
  - Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso);*
  - Western Ringtail Possum (*Pseudocheirus occidentalis);* and
  - Southern Brown Bandicoot (*Isoodon obesulus fusciventer).*

- Approximately 28 ha of potential breeding habitat and 28 ha of foraging habitat for the Black Cockatoo species, is expected to be cleared for construction of the road and Subsidiary Infrastructure.
- No actual breeding events were observed, although clearing will include approximately 565 potential Black Cockatoo breeding trees for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure.
- Approximately 23 ha of known Western Ringtail Possum habitat (WRTP) is expected to be cleared for construction of the road and subsidiary infrastructure.
- Approximately 9041 ha of native vegetation occurs within 10 km of the Project Area. Although no assessment of this vegetation as to the suitability for foraging and breeding has been undertaken, this vegetation is likely to provide some habitat, potentially reducing the impact of the Project on fauna species, including conservation species.
- Based on the expected impact of clearing on conservation significant fauna, particularly Black Cockatoo species and the Western Ringtail Possum, the Project will require referral to the DSEWPC under the provisions of the EPBC Act.
- No conservation reserves or non-Indigenous heritage sites will be impacted by the Project.
- Aboriginal heritage surveys of the Project Area identified one Aboriginal heritage site that will be impacted by the Project. It is recommended that Main Roads seek approval to use the land at this site for the construction of the BORR Southern Section under Section 18 of the *Aboriginal Heritage Act 1972.*
- A traffic noise assessment and Preliminary Management Plan have been prepared for the Project, which includes management measures to ensure compliance with the Western Australian Planning Commission (WAPC) *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Landuse Planning* (WAPC, 2009).

Main Roads has consulted with a number of environmental stakeholders in respect to the Project including:

- Office of the Environmental Protection Authority;
- Department of Sustainability, Environment, Water, Population and Communities;
- Department of Environment and Conservation Bunbury office; and
- South West Environment Centre.

Acronyms

ACMC	Aboriginal Cultural Materials Committee
AHA	*Aboriginal Heritage Act 1972*
ARRP Act	*Agriculture and Related Resources Protection Act 1976* (WA)
ASS	Acid Sulphate Soil
BAP	Benzo(a)pyrene
BORR	Bunbury Outer Ring Road
BOM	Bureau of Meteorology
CAWS Act	*Country Areas Water Supply Act 1947*
CCW	Conservation Category Wetland
CEMP	Construction Environmental Management Plan
DAFWA	Department of Agriculture and Food Western Australia
DBH	Diameter at Breast Height
DEC	Department of Environment and Conservation
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
DIA	Department of Indigenous Affairs
DoW	Department of Water
EIA	Environmental Impact Assessment
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation 1999*
EPP	Environmental Protection Policy
ESA	Environmentally Sensitive Area
FMP	Flora / Fauna Management Plan
GBRS	Greater Bunbury Regional Scheme
IBRA	Interim Biogeographic Regionalisation of Australia
LRP	Landscape Remediation Plan
IUCN	International Union for Conservation of Nature MRWA
MRWA	Main Roads Western Australia
MUW	Multiple Use Wetland
MWSSD Act	*Metropolitan Water Supply, Sewerage, and Drainage Act 1909*
NEPM	National Environmental Protection Measure
NES	National Environmental Significance

NNTT	National Native Title Tribunal
NPBH	New Perth to Bunbury Highway
NRM	Natural Resource Management
PAR	Port Access Road
PATN	A software package designed to display patters in complex data
PDWSA	Public Drinking Water Source Area
PEC	Priority Ecological Community
PF	Priority Flora
RIWI Act	*Rights in Water and Irrigation Act 1914*
SLIP	Shared Land Information Platform
SWMP	Surface Water Management Plan
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
TFD	Threatened Flora Database
TMP	Traffic Management Plan
WAHERB	Herbarium of Western Australia
WAPC	Western Australian Planning Commission
WC Act	*Wildlife Conservation Act 1950*

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1. Introduction and Planning Background

1.1 Introduction

Main Roads Western Australia (Main Roads) commissioned GHD to prepare an Environmental Impact Assessment (EIA) for the proposed Bunbury Outer Ring Road Southern Section (South Western Highway to Bussell Highway) (the Project). The Project is located 10 km south of Bunbury (Figure 1) and forms the southern link of the Bunbury Outer Ring Road (BORR). This EIA considers the road as detailed in concept plans provided by Main Roads in late 2011.

The BORR is a planned Controlled Access Highway linking the four major highways radiating around Bunbury, on the outer edge of the City, to the planned Bunbury Port Access Road (PAR). The BORR and PAR will provide a high standard route for traffic wishing to access the Bunbury Port and the developing industrial areas to the east of Bunbury. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic.

The Project forms the southern section of the BORR connecting the South Western Highway to Bussell Highway. The central section of the BORR will be constructed as part of the Bunbury Port Access Project (Stage 2) in 2012/2013. The alignment of the northern section of the BORR from the Boyanup Picton Road to the Forrest Highway is currently being reviewed by Main Roads in consultation with the Western Australian Department for Planning and the Shire of Dardanup.

The BORR is planned with the capacity to be upgraded to freeway status over the long term, but will initially be constructed as a four lane dual carriageway and upgraded to freeway future standard, as traffic volumes increase with ongoing development in the Greater Bunbury and South West Regions. The Project includes the construction of 9 km of dual carriageway, from the South Western Highway, south to Bussell Highway, including intersections, a service road, overpass road link, services re-locations and associated road infrastructure.

There is no timeframe for construction of either the northern or southern section of the BORR, although construction of the southern section is likely to occur within the next five years.

Main Roads proposes to submit this EIA to the Environmental Protection Authority (EPA) for a determination under Section 38 of the *Environmental Protection Act 1986* (EP Act 1986). Should the Project not be formally assessed, Main Roads will seek to conduct required clearing under its Statewide Purpose Clearing Permit (CPS 818/6), or seek a Purpose Clearing Permit under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

Similarly, Main Roads propose to submit this EIA to the Commonwealth Minister for the Environment through the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) for a decision on the requirement for formal assessment under the provisions of the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

1.2 Planning Background

The BORR forms a major component of the planned regional road network for the Greater Bunbury Area. The concept for the road was originally developed by Main Roads in the early 1970's in consultation with other State Government departments and local authorities, and in conjunction with the preparation of the Bunbury Wellington Region Plan (Department of Planning and Urban Development 1993).

The land requirement for the BORR was subsequently identified in the draft Greater Bunbury Region Scheme (GBRS), with the route advertised to the broader community as part of the

GBRS assessment. The GBRS was effected in November 2007, after being passed through Parliament, and gazetted in January 2008.

The design for the Project has recently been modified to meet current design standards and provide for a future transit (rail) corridor in the median.

1.3 Environmental Assessment Background

The Western Australian Planning Commission (WAPC) prepared the GBRS which was referred to the EPA for assessment under Section 48 of the EP Act. The EPA provided specific recommendations in respect to the BORR in Bulletin 1108 (EPA 2003),. These recommendations and the current or proposed actions to address them are detailed in Table 1.

Table 1 EPA Recommendations and Status/Proposed Action

Issue	EPA Recommendation	Status / Proposed Action
1	Re-alignment of the road to avoid impacts on Dalyellup Reserve (Reserves 23 000, 28 835 and 28 836) and located west of the BORR / Bussell Highway intersection (Area 1)	Alignment amended
2	Re-alignment of the road reservation to avoid impacts on wetlands to the north of Lilydale Road (Area 3B)	Alignment amended
3	Re-alignment of the road reservation to avoid impacts on wetlands located on Lot 2, Miles property (Area 4)	Alignment amended
4	Re-alignment of the road within the road reservation to avoid impacting on a wetland adjacent to the Pioneer Quarry on Lilydale Road (Area 3A)	Alignment amended
5	Preparation of Environmental and Noise / Vibration Management Plans, and Vegetation Mitigation Plans	This EIA. Traffic noise management plan has been prepared. Vegetation mitigation to be addressed as part of Project development - detailed design, Construction Environmental Management Plan and Environmental Offset
6	Conduct flora and fauna surveys to clearly identify the specific impacts of the road	Flora and fauna surveys completed in Spring 2008 and Spring 2011 with results detailed in this report

The EPA deferred the assessment of a number of environmental factors of the GBRS so that it would have the opportunity to assess the Project in more detail at the appropriate stage in the planning process. Consequently this EIA defines Project impacts and will be referred to the EPA for assessment under Section 38 of the EP Act.

The WA Minister for the Environment released Statement No. 000697 prescribing conditions for the implementation of the GBRS in October 2005 (DEC 2005). Conditions prescribed and that are relevant to the current Project are detailed in Table 2 below:

Table 2 GBRS Ministerial Conditions Relevant to the BORR Project

Condition	Requirement	Status
Condition 2	Re-alignment of sections of Bunbury Outer Ring Road	Re-alignments have been implemented and incorporated into current concept design
Condition 3	Preparation of Management Plans: - Drainage, Nutrient and Water Management Plan - Acid Sulphate Soil Management Plan	To be prepared as part of Project development
Condition 4	Completion of a Biological Survey	Completed as part of EIA preparation
Condition 5	Preparation of an offset strategy prior to construction of the Bunbury Outer Ring Road	To be prepared as part of Project development

Main Roads has amended the Project to comply with the EPA's recommendations 1 to 4 listed above, with the planned alignment shown in Figure 1.

This EIA in Section 3 provides recommendations to address the outstanding requirements of Ministerial Statement 000697 to be followed during the implementation of the Project.

2. Description of the Proposal

2.1 Project Scope

The BORR is planned as a Controlled Access Highway linking the four major highways radiating around the outer edge of Bunbury. The BORR will provide a high standard route for traffic wishing to bypass Bunbury and access the Bunbury Port via the Bunbury Port Access Road (PAR) without the need to travel through the developed areas of Bunbury. The Project comprises the southern section of the BORR and will provide a highway link between South Western Highway and Bussell Highway, and combine with the BORR Northern Section and PAR.

The Project comprises the following elements:

- Construction of a 9 km dual carriageway highway between South Western Highway and Bussell Highway;
- Construction of at-grade intersections at:
  - South Western Highway;
  - Hastie Road;
  - Ducane Road; and
  - Bussell Highway;
- Construction of a road overpass and associated road works at Yalinda Drive;
- Construction of a 2.3 km long service road from Ducane Road to Jilley Road;
- Construction of drainage structures including basins and culverts;
- Installation of fencing, principle shared paths (paths) and noise walls;
- Services re-locations;
- Construction of a pedestrian / fauna underpass;
- Construction of approximately 7km of principal shared paths;
- Construction of access roads to severed properties;
- Pre-construction activities including geotechnical investigations and service utilities re-locations; and
- Landscaping and rehabilitation works.

There is currently no timing for the construction of the Project, however, construction is likely to occur within the next five years.

2.2 Project Area

The Project Area includes a nominal 50 – 100 m width either side of the proposed roadworks. Significant environmental aspects, including potential conservation significant fauna habitat outside of the Project Area, but relevant to the Project were also considered during preparation of this EIA.

3. Scope of EIA Report

This EIA has been prepared to identify the primary environmental and social impacts associated with the proposed construction of the Project. Based on the environmental assessment, recommendations are provided for additional work, and/or preparation and implementation of specific management plans to address relevant environmental factors through the development and construction of the Project.

This EIA has used the Preliminary designs (Aecom 2011) provided by Main Roads as the basis for this assessment in addition to information provided by Main Roads Project Manager (Mr G Zoetelief). Investigations and activities conducted for the preparation of this EIA include:

- Site specific Level 2 flora and vegetation surveys (Spring 2009 and 2011) (GHD 2009a; GHD 2012a);
- Site specific Level 1 fauna surveys (Spring 2009 and 2011) (GHD 2009b);
- Site specific Dieback Survey (Glevan 2011);
- Site specific Aboriginal heritage survey (January 2012) (Goode 2012);
- Traffic Noise Assessment (Lloyd George Acoustics 2012);
- Air Emissions Modelling (GHD 2012b);
- Consideration of Ministerial Statement 000697 in respect to the Project;
- An assessment of all environmental aspects likely to require referral of the Project to the WA EPA and/or the Commonwealth DSEWPC;
- A review of the Department of Environment and Conservation's (DEC) Rare and Threatened Flora database;
- A review of DEC's Threatened Fauna database;
- A review of local and regional significance of plant communities;
- A review of the Western Australian Museum database for threatened and endangered fauna;
- A review of DEC's Environmentally Sensitive Areas (ESA) database;
- A review of the DSEWPC's database for issues listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- A review of European and Aboriginal Heritage within Project Area and surrounding buffer, including information from:
  - The Western Australian Heritage Commission;
  - A review of the Australian Heritage Places Inventory; and
  - The Department of Indigenous Affairs.

The EIA also identifies (but does not apply for) additional clearances required under legislative requirements including those required under the following Acts:

- *Environment Protection and Biodiversity Conservation Act 1999 (Cth);*
- *Environmental Protection Act 1986 (WA);*
- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004 (WA);*
- *Rights in Water and Irrigation Act 1914 (WA);*
- *Conservation and Land Management Act 1984 (WA)*
- *Wildlife Conservation Act 1950 (WA);*

- *Heritage of Western Australia Act 1990 (WA); and*
- *Aboriginal Heritage Act 1972 (WA).*

Also included in this EIA is a summary of consultation conducted by Main Roads with relevant stakeholders in respect to the Project.

3.1 Previous Studies

A number of previously unpublished reports have been completed for the Project on behalf of Main Roads. The information contained in them was examined during the preparation of the EIA and included where relevant. These previous studies include:

- HGM Maunsell (2002). Bunbury Outer Ring Road – Environmental Assessment and Management Plan. Unpublished report prepared for Main Roads Western Australia.
- Bennett Environmental Consulting (2003). Vegetation and Flora of Selected Areas – Bunbury Outer Ring Road and Port Access Road. Unpublished report prepared for Main Roads Bunbury.
- Bennett Environmental Consulting (2008). Significant Flora Along Proposed Bunbury Ring Road. Unpublished report prepared for Main Roads Bunbury.
- GHD (2002). Bunbury Outer Ring Road and Port Access Road – Wetlands and Threatened Community Survey. Unpublished report prepared for Main Roads Western Australia.

3.2 Environmental Factors

Based on an assessment of the Project and a review of studies completed, relevant environmental factors that require consideration to define the impact of the Project, and/or require consideration throughout Project development and construction have been determined as follows:

- Air quality;
- Acid sulphate soils;
- Contaminated sites;
- Hydrology and hydrogeology – surface water, wetlands, drainage, groundwater and public drinking water sources;
- Environmentally Sensitive Areas;
- Terrestrial flora and vegetation – vegetation type, vegetation extent and status, vegetation condition, clearing, significant flora, Threatened Ecological Communities and Priority Ecological Communities;
- Dieback;
- Weeds and Declared Plants;
- Topsoil management;
- Revegetation and landscaping;
- Fauna – threatened fauna, habitat values, habitat linkages;
- Reserves and conservation areas;
- Landuse;
- Visual amenity;
- European heritage;

- Aboriginal heritage;
- Traffic noise, and
- Construction phase impacts.

The anticipated impacts as a result of these factors are discussed in the following sections of this report, and environmental management recommendations addressing the factors conclude this EIA.

4. Existing Environment

The environmental and social factors considered relevant to this Project are outlined in this section. For each factor, a baseline environmental description is included, and where appropriate, is followed by an assessment of potential environmental impacts. Where relevant, recommendations are provided for additional investigations and/or management measures to be conducted or implemented during the development of the Project.

4.1 Climate

The Project is located approximately 10 km south of the City of Bunbury, in the South West of Western Australia. The nearest Bureau of Meteorology weather station to the Project Area is located at Bunbury.

The area has a Mediterranean climate with a mean annual rainfall of 715 mm. The area experiences a wide range of temperatures, with mean maximum temperatures of approximately 30°C in summer and 18°C in winter (BOM 2012). The average monthly maximum temperature and rainfall for Bunbury are presented in Plate 1.

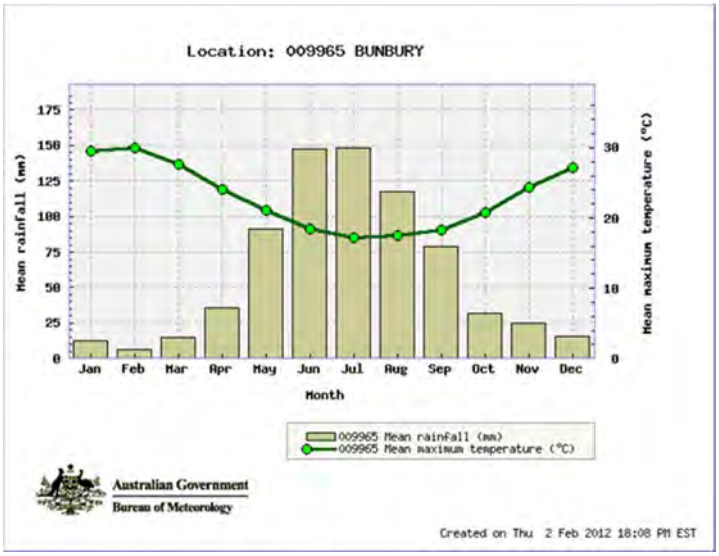

Plate 1 Mean Maximum Temperatur (°C) and Rainfall (mm) in Bunbury (Station 009965) (BOM 2012)

4.2 Air Quality

The requirements to conduct an Air Quality Impact Assessment for new road projects are detailed in Main Roads Environmental Guideline 6707/007 (Main Roads 2004). The need to conduct an assessment has been triggered for the Project as a consequence of private residences being located within 200 m of the planned road centreline. Consequently, Main Roads initiated an Air Quality Impact Assessment for the Project.

Traffic emissions were modelled for the Project by GHD using the AUSROADS Gaussian plume dispersion model. This model predicts ground level concentrations of pollutants typical of those produced from vehicles.

The model estimates the concentration of pollutants at identified receptors, with the receptors used in the noise modelling used as a basis for assessing air quality. Automatic receptors were also used, which involved estimating concentrations at 50 and 100 m from the alignment.

Three scenarios were modelled, based on existing traffic counts, projected 2021 and 2031 traffic counts. The model predicts that all emission concentrations, aside from Benzo(a)pyrene (BaP) in the current traffic count scenario, are below the National Environmental Protection Measure/World Health Organisation criterion. With conservatism built into the model, it is unlikely that BaP concentrations will exceed the relevant criteria (GHD 2012b).

The operation of BORR is expected to marginally reduce vehicle emissions in the local and regional airshed as a consequence of improved traffic flows and consequently vehicle efficiency.

Dust is likely to result from road construction and materials cartage operations, with impacts expected to be localised to the Project Area and transport routes. Dust management during construction will be addressed through the preparation and implementation of a Construction Environmental Management Plan (CEMP).

Recommendation 1

Main Roads to prepare and implement a Construction Environmental Management Plan (CEMP) to address construction issues including dust management.

4.3 Landform and Soils

The Project Area occurs on the Swan Coastal Plain and traverses the Bassendean and Spearwood dunes comprising three landform systems – Southern River, Bassendean and Karrakatta (Churchward and McArthur 1978) as described in Table 3.

Table 3 Landform Systems Traversed by the Project

Soil system	Description
Southern River	Sandplain with low dunes and many intervening swamps. Aeolian soils comprising iron and humus podzols, peats and clays.
Bassendean	Sandplain with low dunes and occasional swamps. Aeolian soils comprising leached pale sands on sandy alluvium.
Karrakatta	An undulating landscape of deep sands overlying limestone. Aeolian soils comprising yellow to grey sands.

4.4 Acid Sulphate Soils

The DEC (2009) describes Acid Sulphate Soils (ASS) as naturally occurring soils and sediments containing sulphide minerals, predominantly pyrite (an iron sulphide). In an undisturbed state below the water table these soils are benign. However, if the soils are drained, excavated or exposed by lowering of the water table, the sulphides will react with oxygen to form sulphuric acid. Disturbance of these soils can flush acidic leachate to groundwater and surface waters and cause off site environmental impacts.

Mapping of ASS is included on the WA Government's on-line Shared Land Information Platform (SLIP), which (DAFWA 2012) indicates that the majority of the Project Area (Ch. 10 642 – 17 800), from South Western Highway to Five Mile Brook, traverses land with a moderate to low risk of ASS within 3m of the soil surface. However, there are several small isolated areas that have been mapped as described below:

- Small isolated low lying seasonally inundated areas located at Lot 5 Centenary Road (Ch. 13 000), Lot 244 Lillydale Road (Ch. 13 400) and Lot 90- Marchetti Road (Ch. 16 700) have a moderate to high risk of ASS within 3m of the soil surface; and
- A 700m section (Ch 17 800 – 18 500) has no known risk of ASS occurring within 3m of the soil surface.

The mapped ASS risk over the Project Area is shown in Figure 2.

Recommendation 2

Main Roads conduct detailed ASS investigations where site excavations are required for road, culvert and overpass construction. An Acid Sulphate Soil Management Plan should also be developed and implemented for the construction works.

4.5 Contaminated Sites

A search of the DEC's Contaminated Sites Database (2011b) indicates that there are no listed contaminated sites within the Project Area.

The Project essentially traverses farmland and remnant vegetation through the southern Gelorup section. Based on a visual assessment of the Project Area, there are no visible indicators that current land uses will result in contaminated sites. A short section of the BORR Southern Section follows the existing Allenville Road alignment between two existing quarries, although quarries are not identified by DEC as a potentially contaminating activities, industries and landuses (DoE 2004).

4.6 Hydrology and Hydrogeology

4.6.1 Wetlands and Waterways

Wetlands on the Swan Coastal Plain have been classified using a geomorphic wetland classification system adapted from Semeniuk & Semeniuk (1995). These wetlands have also been evaluated and assigned an appropriate management category which provides guidance on the nature of wetland management and protection that the wetland should be afforded.

The Project Area traverses 12 seasonal wetlands, with most being Multiple Use, sumpland wetlands. These wetlands are listed in Table 4 and shown at Figure 3.

Table 4 Geomorphic Wetlands Within the Project Area

Geomorphic Wetland ID	Evaluation	Classification
7100	Multi Use	Sumpland
6984	Multi Use	Dampland
6534	Multi Use	Dampland
6981	Multi Use	Dampland
11176	Multi Use	Dampland
6017	Resource Enhancement	Sumpland
6022	Multi Use	Sumpland
6015	Multi Use	Sumpland
6011	Multi Use	Sumpland
6010	Multi Use	Palusplain
11173	Multi Use	Palusplain
6983	Multi Use / Conservation	Watercourse (Five Mile Brook)

'Multiple Use Wetlands' (MUW) are wetlands with few important ecological attributes and functions remaining. 'Resource Enhancement Wetlands' are wetlands that have been altered in some way and have no clear human uses (EPA 1993). These wetlands may present opportunities for future developments which could improve the conservation values of these wetlands.

A 'Conservation Category Wetland' (CCW) is a wetland that retains a high amount of naturalness (EPA 1993). CCW 4896 lies approximately 200 m north of the Project Area at the northern extent of the highway near South West Highway. This wetland will not be impacted by construction of the Project.

Five Mile Brook has also been mapped as both a MUW and CCW (Wetland 6983). Where the Project crosses the brook it is mapped as MUW, however, the CCW portion occurs approximately 65 m north (downstream) of the road reserve boundary and approximately 110 m downstream of the proposed road crossing. The CCW portion of the brook has also been recognised as an Environmentally Sensitive Area (Refer to Section 4.7). Road construction will require clearing at the crossing point, the construction of a culvert crossing to maintain surface water flows and site stabilisation/rehabilitation. These works are not expected to have any significant long term impact on Five Mile Brook.

The EPBC Act Protected Matters Search Tool did not indicate the presence of any Wetlands of National or International Significance (Ramsar Sites) within the Project Area.

Recommendation 3

It is recommended that Main Roads:

- Minimise the impact of the Project on Five Mile Brook through the preparation and implementation of a Foreshore Management Plan to manage any potential impacts which may occur through the construction process; and
- Prepare and implement a Drainage, Nutrient and Water Management Plan for the Project to minimise the impact of off-road drainage into the adjacent wetlands.

4.6.2 Groundwater

A search of the Department of Water (DoW) Geographic Data Atlas (DoW 2012) indicates that the Project Area is within the Bunbury West and Bunbury East sub-areas of the Bunbury Groundwater Area.

Proclaimed groundwater areas are protected under the *Rights in Water and Irrigation Act 1914* (WA) (RIWI Act). The RIWI Act gives the DoW the power to manage ground and surface areas and use of land that may impact upon these water sources.

Construction of the Project is unlikely to have a significant impact on existing groundwater resources.

4.6.3 Public Drinking Water Source Areas

Public Drinking Water Source Areas (PDWSAs) is a collective term used for the description of Water Reserves, Catchment Areas and Underground Pollution Control Areas declared (gazetted) under the provisions of the *Metropolitan Water Supply, Sewage and Drainage Act 1909* (WA) (MWSSD Act 1909) or the *Country Area Water Supply Act 1947* (WA) (CWAS Act 1947).

The DoW Geographic Data Atlas indicates that the Bunbury Water Reserve, a Public Drinking Water Source Area, Protection Area P3, occurs immediately north of the Project Area from Marchetti Road through to Bussell Highway.

The majority of the Project is unlikely to directly impact on the PDWSA, although the Project does involve disturbance within the PDWSA; in the southern extent at the Bussell Highway intersection and Yalinda Drive and along Hasties Road.

The Project extends approximately 150 m along Yalinda Drive into the Bunbury Water Reserve, and 200 m in the reserve at the Bussell Hwy intersection. The Project also extends approximately 650 m into the Bunbury Water Reserve, along the existing Hasties Road.

DoW, through the Water Quality Protection Notice; Land use compatibility in Public Drinking Water Source Areas (2004), provides advice on compatible land uses within PDWSA, with Major Transport Infrastructure, including roads, identified as acceptable in P3 Areas.

Consequently, the Project is a compatible land use within the Bunbury Water Reserve, but will be designed and constructed with reference to the DoW WQPN 44; Roads Near Sensitive Water Resources (DoW 2006).

4.7 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are subject to definition under Section 51B of the EP Act 1986 and include areas requiring special management attention to protect important scenic values, fish and wildlife resources, historical and cultural values, and other natural systems or processes.

A search of the DEC's Native Vegetation Map Viewer indicates six ESAs occur within 400 m of the Project Area (DEC 2011f) as described below:

- A large ESA (FID 12) is located at the far northern end of the alignment approximately 200 m north from the proposed alignment and is associated with Conservation Category Wetland 4896;
- A large ESA located at 5 Centenary Road and 262 Lillydale Road, North Boyanup, lies 30 m immediately south of the proposed alignment and is associated with the occurrence of geomorphic wetland 6011, which is a Multiple Use, sumpland wetland;
- The CCW (6983) portion of Five Mile Brook approximately 65 m downstream of the road crossing is also an ESA. This ESA is outside the proposed alignment;
- An ESA associated with a hard rock quarry is located adjacent to Allenville Road, north of Hastie Road. This ESA is 80 m west of the Project alignment; and
- Two small ESAs lie west and east of the alignment near Lillydale Road approximately 200 m and 250 m from the alignment respectively. These are associated with a multiple use dampland wetland.

None of these ESAs are directly impacted by the construction of the Project.

4.8 Terrestrial Flora and Vegetation

A Level 2 Flora Survey of the Road footprint was conducted by GHD in spring 2011. A copy of the Flora and Vegetation Assessment Report (GHD 2012a) is included at Appendix A. The area required to be cleared for the Subsidiary Infrastructure was not assessed during the 2011 survey, but was within the survey area of an earlier 2008 Survey (GHD 2009). The following section is a summary of the findings of this survey.

4.8.1 Vegetation Extent and Status

According to mapping by Heddle et al. (1980), Shepherd et al. (2002) and Shepherd (2005), the vegetation of the Project Area is considered to be representative of the Southern River

Vegetation Complex; the Bassendean Vegetation Complex (Central and South); and the Karrakatta Complex (Central and South).

Vegetation extents of the pre-European vegetation complex (Mattiske and Havel, 1998, Heddle et al. 1980 and Molloy et al. 2007) within the Project Area, are listed in Table 5.

Table 5 Vegetation complex, extent and status within the Project Area

Vegetation Complex	Pre-European Extent (Ha)	Remaining Extent (Ha)	Remaining Extent (%)	Protection (DEC CONS)	DEC SF (Ha)	Local Natural Areas (Ha)
Southern River Complex	9727	2102	22	180	63	1859
Bassendean Complex - Central and South	4947	1244	25	-	-	1244
Karrakatta Complex-Central And South	5584	3129	56	956	-	2173

Vegetation extents of the pre-European Beard Vegetation Associations within the Project Area, are listed in Table 6, with greater than 30% of the pre-European vegetation remaining within the Shire of Capel and the Bioregion. The extent of Vegetation Associations 6 and 1000 within the State, Region and Bioregion are identified as *Vulnerable*, aside from Vegetation Association 6 within the Shire of Capel, which is listed as *Depleted*.

Table 6 Vegetation association, extent and status within the Project Area

	Vegetation Association	Pre-European Extent (Ha)	Remaining Extent (Ha)	Remaining Extent (%)	% Current in DEC managed reserves
Total vegetation in IBRA Bioregion		1,501,209.20	587,832.98	39.16	34.79
Total vegetation in Shire of Capel		55,945.19	19,122.56	34.18	44.37
Statewide total of Beard vegetation association	6	56,343.00	14,018.91	24.88	35.63
	1000	99,835.86	28,426.03	28.47	16.34
Beard vegetation association in Shire of Capel	6	5,245.30	2,379.45	45.36	14.77
	1000	15,173.92	3,349.11	22.07	7.11
Beard Vegetation in IBRA Bioregion	6	56,343	14,018.91	24.88	35.63
	1000	94,175.31	25.172.12	26.73	16.76

According to the EPA (2006), the vegetation of the Southern River and Bassendean Complexes (Central and South) are considered to be *Vulnerable* in terms of their current extent of compared to their pre-European extents with 22% and 25% of their pre-European extent remaining respectively.

The expected Project clearing footprint with respect to each of these vegetation complexes is presented in Table 7. The Project clearing footprint comprises clearing required for the road (Road Footprint clearing) and clearing for Subsidiary Infrastructure, including fencing, noise walls, services relocations and drainage works.

The Road Footprint clearing area excludes vegetation considered as *Degraded* (Vegetation 5) or *Completely Degraded* (Vegetation Condition 6) and is based on the 2011 Concept Design. Clearing for Subsidiary Infrastructure will be revised as detailed design progresses, with an estimate detailed in Table 7. While it is not expected that there will be a significant change during final design, the clearing areas required for the Subsidiary Infrastructure may differ slightly.

Table 7 Estimated Clearing Footprint – Vegetation Type

Vegetation Complex	Road Footprint Clearing Area (Ha)	Approximate Subsidiary Infrastructure Clearing Area (Ha)	Project clearing as a % of pre-European Extent Remaining	% of pre-European Extent after Project clearing
Southern River Complex	1.7	1.8	0.15	22
Bassendean Complex (Central and South)	3.9	3.5	0.56	25
Karrakatta Complex (Central And South)	16.4	5.7	0.67	57
Total	22	11		

Table 7 presents the extent of Project clearing of the *Vulnerable* vegetation complexes is 0.15% and 0.56% of the pre-European extent for the Southern River Complex and Bassendean Complex (Central and South), respectively.

On that basis, the Project will not alter the threat level class for the three vegetation complexes.

4.8.2 Site Vegetation

The vegetation within the Road footprint assessed in 2011 was classified into seven vegetation types excluding highly disturbed vegetation and water bodies. These vegetation types comprise:

1. Open forest Eucalyptus spp., Banksia attenuata and Agonis flexuosa;
2. Open forest Banksia attenuata and Agonis flexuosa;
3. Open heath Melaleuca lateritia and Viminaria juncea over sedgeland;
4. Closed tall scrub Astartea scoparia and Kunzea glabrescens over sedgeland;
5. Low open forest Melaleuca preissiana and Melaleuca viminea over sedgeland;
6. Low open forest Eucalyptus rudis and Melaleuca preissiana over sedgeland; and

7. Scattered remnant vegetation Eucalypts spp., Banksia attenuata and Agonis flexuosa.

The location and extent of these vegetation types is shown at Figure 4 and detailed at Appendix A.

4.8.3 Vegetation Condition

The vegetation condition of the road footprint was assessed using the vegetation condition rating scale developed by Keighery (1994) and Bush Forever (Department of Planning 2000) that recognises the intactness of vegetation. The condition of the vegetation required to be cleared for the Subsidiary Infrastructure was not assessed during the 2011 site survey, and has been estimated based on the condition of the road footprint and aerial photography.

The site vegetation condition assessment is shown at Figure 5 and discussed in detail at Appendix B. A summary of the assessment is discussed below.

The site vegetation ranged from *Pristine* (1) to *Completely Degraded* (6) with the majority of the Project Area assessed as *Degraded* (5) to *Completely Degraded* (6) as a result of past clearing and agriculture. Scattered Eucalypt, Banksia and *Agonis flexuosa* species with a degraded native understorey dominated the majority of the proposed alignment particularly the 6.6 km section from South Western Highway to Jilley Road.

The vegetation condition of the geomorphic wetland UFI 1106, which is associated with the ESA located at 5 Centenary Road, and 262 Lillydale Road, North Boyanup, was rated *Very Good* (3) to *Good* (4). Areas surrounding this wetland are *Completely Degraded* (6) pasture. The wetland vegetation type of Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland has been invaded by weeds and grazing presently occurs on its boundaries.

The Open forest of Eucalyptus spp., *Banksia attenuata* and *Agonis flexuosa* adjacent to and north of Marchetti Road rated *Pristine* (1) showing no evidence of disturbance during the 2011 survey.

Over the 2.3 km section from Jilley Road to Bussell Highway the vegetation condition predominantly rated between *Very Good* (3) to *Degraded* (5). Most of the native vegetation overstorey within this section remained; however it had been impacted by weed invasion and some partial clearing. A small section of open forest of Eucalyptus spp., *Banksia attenuata* and *Agonis flexuosa*, adjacent to Jilley Road, was rated *Excellent* (2) to *Very Good* (3).

4.8.4 Vegetation Clearing

The total footprint for the Project is 95 ha, comprising both native vegetation and currently cleared land, with clearing for the road footprint being 22 ha, as detailed in Table 8.

Additional clearing will be required for Subsidiary Infrastructure, including fencing, noise walls, services relocations and drainage works. This has been estimated at 11 ha, but is likely to be revised as detailed design is finalised. While it is not expected that there will be a significant change during final design, clearing areas may differ slightly due to unforeseen circumstances.

Regardless, clearing will only be undertaken where it is required for the road and related infrastructure (fencing, services etc). No clearing is proposed for temporary work areas such as site offices, storage areas or access tracks. The expected clearing area for the road is listed in Table 8, with the expected clearing area required for subsidiary infrastructure listed in Table 9.

Table 8 Road Footprint Clearing - Vegetation Type and Condition

Veg Cond	Road Area (ha)
Open forest of *Eucalyptus spp., Banksia attenuata and Agonis flexuosa*	
1	0.2
2-3	2.0
3	2.7
3-4	3.2
4-5	8.9
5	2.2*
5-6	5.5*
6	0.8*
Total	17.0
Open forest of *Banksia attenuata* and *Agonis flexuosa*	
3	0.5
3-4	1.7
Total	2.20
Open heath of *Melaleuca lateritia* and *Viminaria juncea* over sedgeland	
5-6	0.1*
Total	0.1*
Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland	
3	0.1
6	0.01*
Total	0.1
Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland	
3	0.10
4	1.4
5-6	3.0*
6	0.8*
Total	1.5
Low open forest of *Eucalyptus rudis* and *Melaleuca preissiana* over sedgeland	
4-5	0.4
5-6	
Total	0.4
Scattered remnant vegetation of *Eucalypts spp*., *Banksia attenuata* and *Agonis flexuosa*	
5-6	4.1*

Veg Cond	Road Area (ha)
6	9.5*
Total	13.6*
Clearing Area required	22

*NOTE: Vegetation with a condition rating of 5 (*Degraded*) and 6 (*Totally Degraded*) is not calculated in the clearing area for the road due to it not being representative of the original vegetation as a result of a high level of disturbance.

Table 9 Estimated Subsidiary Infrastructure Clearing– Vegetation Type and Condition

Veg Cond	Subsidiary Infrastructure (ha)
Open forest of *Eucalyptus spp., Banksia attenuata and Agonis flexuosa*	
1	0.1
2-3	0.6
3	0.8
3-4	0.6
4-5	2.6
5	0.4
5-6	0.2
6	0.5
Total	5.8
Open forest of *Banksia attenuata* and *Agonis flexuosa*	
3	0.2
3-4	0.2
Total	0.4
Open heath of *Melaleuca lateritia* and *Viminaria juncea* over sedgeland	
5-6	
Total	
Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland	
3	0.4
6	0.1
Total	0.5
Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland	
3	0.1
4	0.2

Veg Cond	Subsidiary Infrastructure (ha)
5-6	
6	0.2
Total	0.5
Low open forest of *Eucalyptus rudis* and *Melaleuca preissiana* over sedgeland	
4-5	
5-6	
Total	0
Scattered remnant vegetation of *Eucalypts spp*., *Banksia attenuata* and *Agonis flexuosa*	
5-6	0.3
6	1.5
Total	1.8
Highly disturbed	
6	1.6
Clearing Area required	11

Clearing of any native vegetation is regulated by the DEC and requires a permit under Part V of the EP Act 1986. Main Roads has been issued with a Statewide Purpose Clearing Permit (CPS 818/6) which provides for clearing for roadworks to occur under certain conditions and prescribes specific management and offset requirements.

CPS 818/6 requires an assessment to be conducted against the 'Ten Clearing Principles', with the clearing required for this Project having been assessed against the 'Ten Clearing Principles' as detailed at Section 5 of this report.

Recommendation 4

Main Roads finalise design and scope of works in order to determine the final clearing footprint and quantify the impacts.

4.8.5 Threatened Ecological Communities

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English & 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, and Vulnerable.

TECs are listed under both State and Federal legislation. Federally listed TECs are protected under the EPBC Act. DEC maintains a list of TECs for Western Australia, some of which are also protected under the EPBC Act.

DEC also maintains a Priority Ecological Community (PEC) List. PECs are not specifically listed under any formal Federal or State legislation but are considered by the DEC as important as whole ecosystems (including their processes and communities). Priorities 1, 2 and 3 PECs are ecological communities that are adequately known; are rare but not threatened, or 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.

A search of the DEC TEC database (DEC 2011d and 2011e) and the EPBC Protected Matters search tool (DSEWPC 2011a) indicates there are six TECs and two PECs within 10 km of the Project Area as shown at Figure 6 and further discussed at Appendix A:

- SCP19b, Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain (original description; Gibson et al. (1994) - listed as "*Critically Endangered*" under the State DEC listing;
- SCP3c, *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain - listed as "*Critically Endangered*" under the State DEC listing and as "*Endangered*" under the Commonwealth TEC listing (State and Commonwealth significance);
- SCP09, Dense shrublands on clay flats - listed as "*Vulnerable"* under the State DEC listing;
- SCP07, Herb rich saline shrublands in clay pans- listed as "*Vulnerable*" under the State DEC listing;
- SCP08, Herb rich shrublands in clay pans - listed as "*Vulnerable*" under the State DEC listing;
- SCP18, Shrublands on calcareous silts of the Swan Coastal Plain - listed as "*Vulnerable*" under the State DEC listing;
- SCP25: Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands - listed as "*Priority 3*" under the State DEC listing; and
- SCP21b: Southern *Banksia attenuata* woodlands - listed as "*Priority 3*" under the State DEC listing.

PEC SCP25 Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands is mapped by DEC as being located within the southern section of the Project Area north of Woods Road (Figure 6 and Appendix A). A statistical analysis of all GHD quadrat data collected from the vicinity of the mapped occurrence was undertaken using PATN. The results of the analysis indicated that the vegetation types mapped by GHD do not represent an occurrence of the PEC SCP25. Factors affecting PATN analysis are the timing of the survey, which can affect the level of species identification, and vegetation condition.

Based on the fact that the survey was conducted in spring when species identification was optimal and the vegetation condition was *Good* (Condition 4), the results indicate the PEC SCP 25 is unlikely to occur within the road footprint.

It should be noted that the DEC quadrat data used for the PEC SCP25 was collected in the early 1990's (Webb 2011) and the vegetation condition within the Project Area may have declined during the intervening period through weed invasion and clearing. This can affect the results of PATN analysis, as the species composition would be altered due to these two disturbance factors.

Further discussion with DEC's Andrew Webb on April 4, 2012 noted that SCP21b and SCP25: are very similar apart from several understorey species. SCP25 is poorly represented in the local area and is restricted to reserve areas, while SCP21b is common in the Bunbury area. Clearing impact is unavoidable due to the width of the road reserve limiting options to shift the Project footprint to avoid clearing effects.

The site vegetation survey did not identify the presence of any of the other TEC or PEC identified by DEC mapping as occurring within the vicinity of the Project Area.

4.8.6 Site Flora

Vegetation within the Project Area is considered to have a moderate degree of species diversity. A total of 155 plant taxa (including subspecies and varieties) representing 101 genera and 43 plant families was recorded in the road footprint, as detailed at Appendix A. This total is comprised of 122 native species and 32 introduced (exotic) species.

The dominant families represented in the flora surveys included Myrtaceae (17 native species), Fabaceae (16 native species and six introduced species) and Asteraceae (four native species and nine introduced species).

4.8.7 Conservation Significant Flora

Species of significant flora are protected under both State and Federal Acts. Any activities that are deemed to have a significant impact on species that are recognised by the State *Wildlife Conservation Act 1950* (WC Act) and EPBC Act can trigger referral to the EPA and/or DSEWPC.

In Western Australia, the DEC produces a supplementary list of Priority Flora, these being species that are not considered Threatened under the WC Act but for which the Department feels there is a cause for concern. These species have no special legislative protection, but their presence would normally be considered relevant to an assessment of the conservation status of an area. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened flora.

Desktop queries of the EPBC Protected Matters Search (DSEWPC 2011a), NatureMap Database (DEC 2011a) and the DEC Rare Flora Database (DEC 2011c) were undertaken for the Project Area. These searches identified the occurrence of 28 DEC Priority species and five Threatened species within 5 km of the Project Area and the possible occurrence of five EPBC listed species within 5 km of the Project Area. These species are shown in Figure 6 and are listed at Appendix A.

No threatened flora or Priority species were recorded during the 2008 site survey (GHD 2009). Similarly, no Threatened (previously called Declared Rare) flora as listed by the DEC (2011a) or species of national conservation significance listed under the EPBC Act 1999 (DSEWPC 2011a) were recorded from the road footprint during the 2011 survey (GHD 2012

Sandplain White Spider Orchid (*Caladenia speciosa*), a Priority 4 flora was recorded within the Project Area during the 2011 survey, mostly in small populations throughout the southern section of the alignment between Yalinda Drive and Bussell Highway. A total of 71 individual *Caladenia speciosa* plants were recorded within the Project road reserve.

4.9 Dieback

Phytophthora cinnamomi threatens over 2300 (40%) different plant species in Western Australia. Once the pathogen infects the roots, the plant may begin to show symptoms of 'dying back', hence the common name used for the pathogen: Dieback. Dieback has a widespread but discontinuous range in areas of the south west with an annual rainfall above 400 mm (Dieback Working Group 2010).

A site dieback assessment of the Project Area was conducted by Gleven Consulting (Glevan 2011) on behalf of GHD in October 2011. A copy of the survey is included at Appendix B. This survey noted that:

- The section of the Project east of Jilley Road was considered to be unmappable for Dieback due to the lack of indicator species and past disturbance;
- The sections west of Jilley Road are considered to be uninfested with Dieback;

- Lot 1 Ducane Road located east of the alignment is dieback uninfested, and that hygiene measures should be implemented to access the Project through this property; and
- A Dieback Management Plan should be prepared and implemented for the construction of the Project.

Recommendation 5

Main Roads update the Dieback mapping of the Project Area during the final design stages of the Project and prepare a Dieback Management Plan, based on this map, to be implemented during road construction.

4.10 Weeds and Declared Plants

A total of 32 weed species were recorded within during the Spring 2011 survey, as listed at Appendix A. The most common weed species recorded were Veldt Grass (*Ehrharta* spp.), Freesia (*Freesia alba x leichtlinii*) and *Hypochaeris* sp.

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* (WA) (ARRP Act). The Department of Agriculture and Food Western Australia (DAFWA 2011) maintain 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 control that plant on their properties.

Three Declared Plant species were identified, with the location of these weeds, management status and number of plants detailed in Table 8 and shown at Figure 5:

Table 10 Details of Declared Plants Identified

Weed	Management Status	Location and Number of Plants
Bridal Creeper (*Asparagus asparagoides*)	P1 for the whole state and is regarded as a Weed of National Significance (WONs) (DSEWPC 2011b)	6 302 166 N, 375 293 E (1) 6 302 289 N, 375 293 E (10) 6 302 227 N, 375 312 E (1) 6 302 038 N, 375 302 E (1) 6 300 335 N, 372 989 E (1)
One-leaf cape Tulip (*Moraea flaccida*)	P1 for the whole state and P4 for the Shire of Capel	6 304 382 N, 376 128 E (1)
Arum lily (*Zantedeschia aethiopica)*	P1 and P4 for the entire State	6 304 380 N, 376 099 E (1) 6 304 335 N, 376 097 E (3) 6 304 840 N, 377 592 E (1) 6 304 934 N, 377 594 E (1) 6 304 930 N, 377 536 E (1) 6 300 008 N, 371 989 E (15)

Recommendation 6

Main Roads manage the Declared Weed populations within the Project Area prior to and during road construction and on-going road reserve management.

4.11 Topsoil Management

The site topsoil is representative of the vegetation condition which varies considerably throughout the site. The management of topsoil during roadworks is important to optimise the

use of the resource by its regeneration potential, and to minimise the risk of transporting weeds and dieback within the site.

Poor topsoil management can result in the spread of weeds and Dieback. The movement of topsoil and weed seeds can result in new weed populations and increased weed density at existing weedy sites.

Recommendation 7

Main Roads prepare and implement a Topsoil Management Plan (TMP) for the Project to identify the use and management of in-situ topsoil during road works.

4.12 Revegetation and Landscaping

Opportunities to enhance the areas visual amenity, floral diversity and potential for fauna habitat exist along the entire Project length. This could be achieved through appropriate topsoil management and revegetating currently degraded sections within the corridor with local "provenance" native seed and / or seedlings.

Main Roads Project Manager has advised that there is scope for revegetation during construction of the highway and proposes to develop and implement a Revegetation and Landscape Plan for the Project.

Recommendation 8

Main Roads prepare and implement a Revegetation and Landscape Plan for the Project.

4.13 Fauna

4.13.1 Fauna Survey

A Level 1 fauna survey was conducted by GHD's qualified zoologist Glen Gaikhorst in conjunction with the flora investigation in September 2011. The fauna survey included desktop investigations and field surveys and was conducted in accordance with Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia – Guidance Statement No. 56 (EPA 2004b) and Technical Guide- Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2010).

The 2011 survey supplemented a Level 1 fauna survey conducted over four days and three nights between the period of 17th February and the 5th March 2009 and over four days and two nights between the 4th and 7th of August 2009.

The survey report is included at Appendix C with the outcomes of the survey summarised below.

In total 59 birds, three native mammals (five introduced), eight reptiles and three amphibians were observed during the field surveys. Introduced species observed included the Black Rat (*Rattus rattus*); Rabbit (*Oryctolagus cuniculus*); Cat (*Felis catus*); Dog (*Canis lupus*); Pig (*Sus scrofa*); Red Fox (*Vulpes vulpes*); Eastern Long-billed Corella (*Cacatua tenuirostris*); and Laughing Kookaburra (*Dacelo novaeguineae*).

4.13.2 Conservation Significant Fauna

Fauna potentially within the Project Area that are protected under state or Commonwealth environmental legislation, are:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*);
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*);
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*);

- Western Ringtail Possum (*Pseudocheirus occidentalis*)*;* and
- Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)*.*

A summary of the 2011 survey observations relevant to these species is detailed below.

Forest Red-tailed Black Cockatoo

During the 2009 survey, GHD observed and heard Forest Red-tailed Black Cockatoos at multiple locations along the alignment, most of which, were in the southern section in the Gelorup area (Woods Road and Bussell Highway). Feeding was observed along the alignment primarily on Marri.

Forest Red-tailed Black Cockatoo were sighted twice during the 2011 field survey (GHD): a flock of four birds were observed on Marchetti Road feeding in *Eucalyptus marginata*. A flock of six birds were sighted in the same area also feeding *Eucalyptus marginata*, with a juvenile heard begging for food.

This species is known to occur in the area which supports good habitat for Forest Red-tailed Black Cockatoo for both feeding and breeding. Feeding habitat is present throughout the Project in remnant habitat areas, primarily on Marri (*Corymbia calophylla*) and Jarrah nuts.

No breeding observations were recorded, although several trees (Jarrah, Marri and Tuart) which had hollows that showed signs of chewing and could be used by the Forest Red-tailed Black Cockatoo were observed and a juvenile was observed at Marchetti Road, suggesting breeding may occur in the area. 565 trees within the road footprint are of a size suitable for the development of nesting hollows in the future as they have a (Diameter at Breast Height) DBH >500 mm.

A survey of the area required for subsidiary infrastructure has not been completed, with the number of trees requiring removal estimated from aerial photography (Landgate 2010). Approximately 192 trees are within the area identified for noise walls, fencing or paths, with this likely to be revised down once the finalised design is complete.

Baudin's Cockatoo

This species is known to occur in the area and was observed by GHD in 2009. The Project Area contains significant habitat for the Baudin's Cockatoo feeding and breeding. Feeding habitat is present throughout the alignment in remnant habitat areas.

No actual breeding observations were recorded in the Project Area. Several trees (Jarrah, Marri and Tuart) were observed in the alignment which had hollows that show signs of chewing and could be used by the Baudin's Cockatoo. A large number of other trees have a size suitable for the development of nesting hollows in the future as they have a >500 mm DBH.

Carnaby's Cockatoo

The Carnaby's Cockatoo was sighted twice during the 2011 field assessment: flock of six birds close to the intersection of Woods and Banksia Roads in Gelorup, and 26 birds in *Eucalyptus spp./Banksia* woodland near Ducane Road. The Project Area also contains habitat for the Carnaby's Cockatoo for both feeding and breeding. *Banksia attenuata* trees within the Project Area showed evidence of feeding at numerous locations.

In 2009, no Carnaby's Cockatoos were observed, but multiple sites of feeding evidence on Marri, and Banksia were recorded.

In total, 565 potential Black Cockatoo nesting trees occur within the road footprint, being Marri, Jarrah, Flooded Gum (*Eucalyptus rudis*) and Tuart (*Eucalyptus gomphocephala*) with a DBH >500 mm. Approximately 192 trees have been identified, through aerial photography, within the

area determined as likely to require clearing for subsidiary infrastructure. The actual number of trees is likely to be refined down as detailed design of this infrastructure is finalised.

Western Ringtail Possum

During the field survey several Western Ringtail Possum individuals were observed as being active during the day after being disturbed in dreys. A number of dreys (resting platforms in trees) were recorded throughout the Project Area. Most dreys were present in *Banksia attenuata,* Peppermint (*Agonis flexuosa*)*, Melaleuca spp.* and low Marri*.* Dropping were recorded in most areas, particularly where the canopy had some connectivity and logs were present on the ground or perched against trees.

The Western Ringtail Possum was also observed within the current Project Area during the 2009 survey.

Southern Brown Bandicoot

The Project Area has limited understorey and ground cover plants to support a long term population of Southern Brown Bandicoot. However some diggings were observed in the median strip of the Bussell Highway and determined as being likely to have been caused by the Southern Brown Bandicoot. This area is next to a large bushland reserve (Reserves 23000, 28835 and 28836) located west of the highway which is likely to maintain a Southern Brown Bandicoot population with dispersal into the Project Area.

Additional conservation significant fauna species that may potentially occur, but were not observed within the Project Area are discussed at Appendix C and include:

- Southern Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*)
- Rainbow Bee-eater (*Meriops ornatus*)
- Chuditch (*Dasyurus geoffroii*)
- Quokka (*Setonix brachyurus*)
- Western Brush Wallaby (*Macropus irma*)
- Fairy Tern (*Sternula nereis nereis*)
- Australasian Bittern (*Botaurus poiciloptilus*),

4.13.3 Habitat Value

Five important fauna habitat types were identified within the Project Area based on species observations or evidence of conservation listed species in the form of scats, dreys, feathers, signs of feeding and other activity. Other areas are known habitats of listed species or have greater biodiversity. These habitat types are listed below:

- Damplands and Wetlands, dominated by Melaleuca spp. and sedges often in grazed paddocks.
- Riverine and riparian zones on Five Mile Brook.
- Jarrah/Banksia spp. mixed woodland which comprise a Jarrah dominated overstorey, over mixed herb shrub layer on sandy soils.
- Marri/Banksia spp. mixed woodland which comprise a Marri (Corymbia calophylla) dominated overstorey, often with an equal density of Banksia attenuata, and scattered Banksia grandis and Peppermint on well drained slopes over mixed herb and shrub layer.
- Peppermint/Mixed Banksia spp. woodland which comprise a Peppermint (*Agonis flexuosa*) dominated woodland, with low mixed understorey of shrubs and annuals. Generally

adjacent wetlands, Peppermint were observed in the Project Area as being often co-dominant with Melaleuca spp. or inhabiting low lying areas.

Eleven fauna habitat trees were identified within the Project Area that showed evidence of chewing by Black Cockatoos or had hollows suitable for Black Cockatoo breeding. One of these habitat trees had a large Wedge-tailed Eagle nest, and would not be used by Black Cockatoos while eagles are present. The location of these trees is detailed at Appendix C.

565 trees were identified within the road footprint as having potential for use in Black Cockatoo breeding. These consisted of Marri, Jarrah, Flooded Gum and Tuart that had a DBH >500 mm. Approximately 192 trees have been identified within the areas determined as representative for fencing and other Subsidiary Infrastructure. This is expected to be refined down as design of this infrastructure is finalised.

An assessment of the native vegetation within the vicinity of the Project Area indicates that there are approximately 9041 ha of native vegetation within the surrounding 10 km. No assessment of the habitat value of this vegetation has been undertaken for the WRTP or Black Cockatoo species, although this vegetation is likely to provide some habitat for these and other native fauna species.

4.13.4 Habitat Linkages

At the northern end of the Project Area, near South West Highway, a patch of Peppermint woodland is loosely connected to the roadside vegetation. This patch showed signs of a Western Ringtail Possum population based on the presence of dreys and droppings.

North of Gelorup the remnant vegetation within the Project Area is patchy with little connectivity to other areas. Some areas of road side vegetation do provide a thin linear corridor. These areas are along South West Highway, Ducane Road and Lillydale Road but are small and often degraded.

In the southern section of the Project Area (Gelorup section), road reservation acquired for the BORR has provided a vegetated linkage between privately owned remnant vegetation in the area and the reserves adjoining the western side of Bussell Highway. This linkage is presently used by the Western Ringtail Possum and Black Cockatoos as well as a number of native birds, reptiles and amphibians.

4.13.5 Fauna Impact

Clearing for construction of the Project may have an impact on a number of the conservation significant fauna species identified by site survey and desktop assessment. Table 11 identifies the likelihood of occurrence and the impacts that Project clearing is expected to have on each species. The three Black Cockatoo species are discussed together as their impacts are the same as identified in DSEWPC (2012b). Black Cockatoo 'Known Impact' areas are inclusive, therefore there is overlap in area between feeding and potential breeding areas.

The clearing areas detailed in Table 11 are based on the road concept design provided by Main Roads in 2011 (Drawing Numbers 201102 – 0103 to 201102 – 0012 Rev B apart from 201102 – 0110 Rev C).

These areas include an estimated clearing area for Subsidiary Infrastructure including service relocations, fences, noise walls and/or noise bunds. Approximately 192 trees have been identified through aerial photography within the area determined as representative for Subsidiary Infrastructure. These areas and trees required to be cleared are expected to be refined down as design of this infrastructure is finalised, with this clearing expected to be refined as the design progresses.

Table 11 Likelihood of Occurrence and Known Impacts

Species	Likelihood of Occurrence	Known Impacts (Areas are Approximate in size)
Forest Red-tailed Black Cockatoo	Known	Feeding 19 hectares of feeding habitat was recorded with a further 9 ha required for subsidiary infrastructure Potential Breeding 23 hectares of potential breeding habitat was recorded, with a further 5 ha required for subsidiary infrastructure **Actual Breeding** No actual breeding events were observed, although clearing will include approximately 565 potential Black Cockatoo breeding trees for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure. **Roosting** No roosting areas were recorded
Baudin's Cockatoo	Known	
Carnaby's Cockatoo	Known	
Australasian Bittern	Unlikely	No known impacts
Fairy Tern	Unlikely	No known impacts
Chuditch	Unlikely	No known impacts
Quokka	Unlikely	No known impacts
Western Ringtail Possum	Known	Known impact is loss of habitat, habitat connectivity, fragmentation and loss of individuals. The possum habitat identified during surveys comprises 17 hectares. This area of possum habitat is based on use from records of actual possums, dreys, droppings and other signs. A further 6 ha is required for Subsidiary Infrastructure
Southern Brown Bandicoot	Known	Loss of habitat, by including good management practices such as the installation of underpasses and rehabilitating of areas, impacts to the species would be minimal
Western Brush Wallaby	Unlikely	No known impacts
Southern Brush-tailed Phascogale	Possible	Loss of habitat. However, by including good management practices such as the installation of underpasses, overpasses and rehabilitating of areas, impacts to the species would be minimal
White-bellied Sea-Eagle	Unlikely	No known impacts
Fork-tailed Swift	Possible	An aerial species which rarely utilises a terrestrial environment, no known impacts
Rainbow Bee-eater	Possible	Loss of habitat, however as the species is migratory the impacts to the species would be minimal
Great Egret	Possible	Limited available habitat, no known impacts
Cattle Egret	Possible	Limited available habitat, no known impacts

In respect to recent requirements from DSEWPC regarding the Western Ringtail Possum, and the possible level of public interest in the Project, it is suggested that an additional population

assessment be undertaken to further quantify the impact of the roadworks clearing. In order to more accurately estimate population size and habitat use, distance sampling is suggested to quantify the impacts on existing local and regional populations and allow environmental regulators to better assess the Project.

DSEWPaC (2012b) provide a risk referral table which provides guidance to both proponents and regulators for where impacts on Black Cockatoos are likely to trigger referral under the EPBC Act. This risk referral table has been completed for the Project, are the results presented in Table 12.

Table 12 Black Cockatoo risk referral (to DSEWPaC) table

High risk of significant impacts: referral to DSEWPaC recommended	
Clearing of any known nesting tree.	**Referral is not triggered** There are no known breeding trees within the Project Area.
Clearing of any part or degradation of breeding habitat in a woodland or forest within a species' known breeding range.	**Referral is triggered.** There is potential breeding habitat present within the Project Area (approximately 23 ha for the road and 5 ha for subsidiary infrastructure). No actual breeding events were observed. Clearing will include approximately 565 potential Black Cockatoo breeding trees for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure.
Clearing of more than 1 ha of quality foraging habitat.	**Referral is triggered.** Clearing of up to 28 ha of potential Black Cockatoo feeding habitat is required for the Project.
Creating a gap or greater than 4 km between patches of Black Cockatoo habitat (breeding, foraging or roosting).	**Referral is not triggered.**
Clearing or degradation (including pruning of top canopy) of a known roosting site.	**Referral is not triggered.**
Uncertainty: referral recommended or contact the DSEWPaC	
Degradation (such as through altered hydrology or fire regimes) of more than 1 ha of foraging habitat. Significance will depend on the level and extent of degradation and the quality of the habitat.	**Referral may be triggered.** Clearing of up to 28 ha of potential Black Cockatoo feeding habitat associated with the Project
Clearing or disturbance in areas surrounding Black Cockatoo habitat that has the potential to degrade habitat through introduction of invasive species, edge effect, hydrological changes, increase human visitation or fire.	**Referral is not triggered**
Actions that do not directly affect the listed species but that have the potential for indirect impacts such as increasing competitors for nest hollows	**Referral may be triggered** Up to 565 trees identified as possible breeding trees will require clearing for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure.
Actions with the potential to introduce known plant diseases such as *Phytophthora* spp.	**Referral may be triggered.** The site is considered to be susceptible to Dieback

Low risk of significant impacts: referral may not be required but may refer to DSEWPaC for legal certainty	
Actions that do not affect Black Cockatoo habitat or individuals.	**Not applicable**
Actions whose impacts occur outside the modelled distribution of the three Black Cockatoos.	**Not applicable**

DEWSPaC also produce the Significant Impact Guidelines 1.1 (2009) which provide advice on where an impact on a MNES may be determined as significant. An assessment against the Significant Impact Criteria for the Black Cockatoo Species and the applicability to the Project has been listed in Table 13

Table 13 Assessment against the Significant Impact Criteria

Significant Impact Criteria	Applicability to Project
Lead to a long-term decrease in the size of a population or habitat	Unable to determine if the Project will lead to a long-term decrease in the size of the population. Clearing will include approximately 565 potential Black Cockatoo breeding trees for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure. Approximately 28 ha (23 ha for the road and 5 ha for subsidiary infrastructure) of foraging habitat will be cleared. No assessment has been undertaken of habitat or trees within a 10 km radius, although approximately 9041 ha of native vegetation occurs within 10 km of the Project. Further, total vegetation within the Shire of Capel remains above 30% of the pre-European extent.
Reduce the area of occupancy of the species	The area of potential foraging habitat is 28 ha (19 hectares of feeding habitat with a further 9 ha required for subsidiary infrastructure) and approximately 28 ha of potential breeding habitat (23 ha for the road and a further 5 ha required for subsidiary infrastructure). Approximately 9041 ha of native vegetation occurs within 10 km of the Project, some of which is likely to provide similar habitat. However, the area of proposed breeding (28 ha) and foraging (28 ha) habitat within the alignment equates to approximately 0.3% of the native vegetation within the surrounding 10 km
Fragment an existing population into two or more populations	According to the Black Cockatoo Referral Guidelines, creation of a 4 km gap between habitat areas triggers referral. In this case, the study area is surrounded by intact vegetation in the southern extent, which is likely to contain suitable habitat, and as such would be unlikely to fragment existing populations.
Adversely affect habitat critical to the survival of a species	28 ha of foraging/breeding habitat is proposed to be cleared. The southern section of the Project is surrounded by vegetation, likely to contain similar habitat to that proposed to be cleared. No assessment has been undertaken of habitat or trees within a 10 km radius, although approximately 9041 ha of native vegetation occurs within 10 km of the Project.
Disrupt the breeding cycle of a population	No actual breeding was observed during the survey, however, the identification of numerous potential breeding trees within Project Area, suggests breeding may occur. This is further supported by observations of Juveniles of both Forrest Red-tailed Black Cockatoo and Baudin's Black Cockatoo along the alignment, suggesting breeding in the area. The loss of potential breeding trees may impact on localised breeding.

Modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline	Clearing will include approximately 565 potential Black Cockatoo breeding trees for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure . Approximately 28 ha (25 ha for the road and 5 ha for subsidiary infrastructure) of foraging habitat will be cleared. No assessment has been undertaken of habitat or trees within a 10 km radius, although approximately 9041 ha of native vegetation occurs within 10 km of the Project. However, the area of proposed breeding (28 ha) and foraging (28 ha) habitat within the alignment equates to approximately 0.3% of the native vegetation within the surrounding 10 km
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species'' habitat	Unlikely that Project will result in introduction of invasive species harmful to any species in question and established on site.
Introduce disease that may cause the species to decline, or	Appropriate hygiene management is proposed to be implemented through a dieback Management Plan.
Interfere with the recovery of the species	Localised impacts may include car strikes, loss of habitat (feeding and breeding). Clearing of 565 potential Black Cockatoo breeding trees for the road, plus up to approximately 192 trees identified through aerial photography for Subsidiary Infrastructure. Approximately 28 ha (25 ha for the road and 5 ha for subsidiary infrastructure) of foraging habitat to be cleared. These impacts may result in a potential reduction in breeding area. However, the area of proposed breeding (28 ha) and foraging (28 ha) habitat within the alignment equates to approximately 0.6% of the native vegetation within the surrounding 10 km, although not all is expected to offer significant habit.

Based on the expected impact of clearing on conservation significant fauna, particularly Black Cockatoo species and the Western Ringtail Possum, the Project will require referral to the DSEWPC under the provisions of the EPBC Act 1999.

9041 ha of native vegetation occurs within 10 km of the Project Area. This vegetation has not been assessed to determine the habitat value or number of habitat trees, although this may reduce the potential impact of the proposed clearing of 28 ha of potential breeding and 28 ha of potential foraging habitat.

In addition to impacts on conservation significant fauna species, Project clearing of approximately 33 ha will also result in the loss of habitat and habitat linkages for more common species.

In order to address the loss of fauna habitat, severance of fauna linkages and manage fauna impacts as a result of the highway Main Roads is proposing to implement the following fauna management measures:

- Construct a fauna underpass in the vicinity of Jilley Road;
- Provide for fauna movement at the Five Mile Brook crossing;
- Construct a fauna overpass as part of the Yalinda Drive overpass; and
- Install fauna fencing along sections of the Project

These management measures, combined with proposed environmental offsets, will mitigate the likely loss of individuals by ensuring fauna species populations remain at sustainable levels.

Recommendation 9

Main Roads undertake a significant tree survey of the subsidiary infrastructure disturbance footprint, as part of the detailed design process.

Recommendation 10

Main Roads conduct a Western Ringtail Possum distance sampling survey of the Jilley Road to Bussell Highway section of the Project Area to better quantify the clearing impacts on this species.

Recommendation 11

Main Roads implement fauna management measures as detailed in the CEMP during the design and construction of the Project.

4.14 Reserve and Conservation Areas

The Project will not have any direct impact on any conservation reserves or conservation areas. One reserve area occurs at the southern extent of the Project at the tie-in to Bussell Highway (Reserve 23 000) on the western side of the highway, while part of Five Mile Brook occurs within a reserve (Reserve 10 616). These reserves are detailed in Table 14.

Table 14 Reserve Adjacent to the Project

Reserve Number	Reserve Status (Class)	Purpose	Location	Responsible Agency	Reserve Area
23 000	A	Travellers stopping place and caravan park	Lot 305 Bussell Highway	Department for Planning and Infrastructure	125.4 ha
10 616	C	Drainage	Five Mile Brook (Woods Road)	Water and Rivers Commission	9.29 ha

Reserve 23 000 is identified as Regional Open Space under the GBRS. During development of the Project the Project Concept Design has been modified, as requested by the EPA in their assessment of the GBRS, to avoid impact on Reserve 23 000.

No other reserves or formal conservation area will be directly impact by the development of the Project.

4.15 Landuse

The Project essentially occurs within the Shire of Capel on land set aside as Primary Regional Road under the GBRS. Apart from the Five Mile Brook Reserve, the Project traverses freehold land.

The northern 6.6 km of the Project from South Western Highway to Jilley Road traverses sparsely populated rural land. One house located on Lot 239 South Western Highway will require demolition as it occurs within the road reservation.

From Jilley Road to Bussell Highway the BORR traverses the special rural area of Gelorup comprising lot sizes approximately 2 ha in size. Reservation for the BORR was set aside at the time of development and is currently in the ownership of the Commissioner of Main Roads.

Approximately 35 private houses occur within 200 m of the centre of the Project.

4.16 Amenity

Construction and operation of the Project will have a significant impact on the amenity of the local area particularly through Gelorup as a consequence of:

- Vegetation clearing;
- Traffic noise exposure;
- Changes to the local road system;
- Visual amenity;
- Visibility of the highway; and
- Changes to some property access where the BORR will sever existing access.

Measures such as traffic noise management, service roads, the Yalinda Drive overpass and site landscaping will reduce this impact to some extent but residual amenity impacts can be expected in the long term.

There will also be additional disruption during construction of BORR through dust, noise and vibration issues although these will be short term. These impacts can be minimised through the preparation and implementation of a CEMP as presented at Recommendation 1.

4.17 Non-Indigenous Heritage

A search of the EPBC Protected Matters Search Tool (DSEWPC 2011a) and Commonwealth Heritage List (DSEWPC 2012) did not identify any Commonwealth listed heritage sites within, or within 5km of the Project Area.

Similarly, a search of the Western Australian Heritage Council's Heritage Places Database did not identify any heritage places in the Project Area. Sites located within 2 km of the Project Area are listed in Table 15.

Table 15 European Heritage Sites within a 2 km radius of the Study Area

No.	Name	Location	Const. Date	Regn. Dates
LGA: Bunbury				
00382	Picton Inn Hotel	Kaeshagen St off Vittoria Rd Picton - now Wollaston	1850	11/03/1997 05/11/1996
00344	Leschenault Homestead	9 Estuary Drive Bunbury	1846 1874	19/05/1992
00381	Forrest Homestead	South Western Hwy, nr Vittoria Rd Intersect Picton - now Wollaston	1849 1960	29/09/1998 02/06/1998

No non-Indigenous heritage sites will be impacted by the construction of the Project.

4.18 Indigenous Heritage

Aboriginal heritage surveys of BORR were conducted in 1995 (McDonald Hales and Associates, 1995) and updated in 2002. These earlier surveys were again updated in 2009 (Goode, 2009).

More recently an Aboriginal Heritage Survey of the Project Area was conducted in early 2012 to determine the presence of any Aboriginal heritage sites as defined under the *Aboriginal Heritage Act 1972* (AH Act).

This survey included both archaeological and ethnographic components which are described below. The Aboriginal Heritage Survey report is provided in Appendix F.

Archaeological Survey

An archaeological field survey was conducted in January 2012 by Tom O'Reilly (Archaeologist), accompanied by Stuart Johnston (Archaeologist) and two representatives of the Gnaala Karla Booja WC 98/58 Native Title Claim Group. The survey comprised two persons walking abreast in transects, spaced 30 m apart in the wider sections or a single person walking transects in the narrow sections. In addition, predictive intensive transects were conducted at firebreaks, cleared patches, along the river bank where the route crosses on two occasions and any other area of site potential. The overall sampling percentage of the Project Area is estimated to be around 40% with the addition of predictive sampling (Goode 2012).

The survey included verifying the position of previously registered archaeological sites that were located within the Project area.

Ethnographic Survey

Ethnographic consultations focused upon providing significance assessments of affected sites for any necessary Section 18 consents were conducted on the 21st of February Mr Brad Goode (Anthropologist) and Mr Colin (Floyd) Irvine (Ethnographer) in company with representatives from Main Roads; Mr Gerry Zoetelief (Senior Project Manager), Mr Alan Grist (Project Manager SW Region), Mr Daniel Voery (Graduate Engineer), and Mr Neil Mc McCarthy (Senior Environmental Scientist –GHD) met nine representatives from Gnaala Karla Booja WC 98/058 Native Title Claim Group(Goode 2012).

Outcome of the Aboriginal Heritage Surveys

No previously recorded ethnographic sites or places were recorded within the survey corridor. The survey did identify one registered Aboriginal heritage site that will be impacted by the Project ('ID 18884 Bunbury Bypass Archaeological Site 1') at the BORR intersection with Hastie Road.

With regard to the potential impact upon ID 18884 Bunbury Bypass Archaeological Site 1', all consulted advised that as the area was disturbed, any material left had limited cultural significance and agreed that avoidance would be their preference but if this is not possible, a section 18 consent notice followed by salvage and relocation would be the next best course of action. Additionally all consulted agreed;

- That recognition of the cultural significance of the area to Nyungar people through the naming of bridges and roads with Nyungar names be considered;
- That dunes near the southern end of the road should be monitored as the group considers that there is some potential for burials in coastal sands;
- That Main Roads replant areas being cleared with local native species and protect all waterways and riparian areas; and
- That Main Roads consider creating employment opportunities for Nyungar people during the construction stage of the Project.

A DIA polygon predominately overlays the ramp connection of the BORR with Hastie Road (Goode 2012), with this site and the recommended management measures are detailed in Table 16.

Table 16 Aboriginal Heritage Sites Impacted by the Project

Site	Name	Site Type	Extent of Impact	Proposed management

ID				
18884	Bunbury Bypass Archaeological Site 1	Artefact Scatter	Whole	Salvage & Relocation to the offset repository used for material collected during BORR stage 1

m

Recommendation 12

It is likely that previously recorded archaeological heritage place ID 18884 Bunbury Bypass Archaeological Site 1 will be affected by the construction of the BORR and Hastie Road connection (Goode 2012).

As such it is recommended that Main Roads make application under Section 18 the AH Act for consent to use the land that may contain an Aboriginal site.

Recommendation 13

Main Roads comply with any conditions prescribed with the Section 18 approval for the Project.

Should ministerial consent be given, it is recommended that prior to any work commencing that Main Roads in consultation with the above claim group develop a cultural heritage management plan whereby the salvage and relocation of the material can occur prior to construction.

In terms of all salvaged archaeological material it is recommended that Main Roads provide suitable land as a repository site. Ideally this site would be close by to where the artefacts have come from. However Nyungar community monitors should be able to determine where to place material during the salvage operation. The repository should then be registered and protected under the AH Act.

It is recommended that Main Roads give due recognition of the Nyungar community as prior owners of the land and as a community willing to accommodate development that affects cultural values. This could be achieved by the naming of roads and bridges with Nyungar names.

It is finally recommended that Main Roads give due consideration to the use of local native species for rehabilitation and the creation of employment opportunities are considered.

4.19 Traffic Noise

State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (WAPC, 2009) prescribes noise level objectives for Main Roads to manage traffic noise on road new projects.

A traffic noise assessment was undertaken by Lloyd George Acoustics (Appendix F), to assess the potential impact and management action in accordance with the noise criteria outlined in the WAPC policy (WAPC, 2009). The study identified that should no management be implemented, noise at 22 residences will exceed the WAPC noise Limit by 2031.

By adopting the use of open graded asphalt, the number of residences expected to exceed the WAPC limit in 2031 reduces to three. Main Roads will implement management actions to ensure compliance with the WAPC Policy, including the use of open graded asphalt and bunds or walls as required.

A Preliminary Noise Management plan which details the type and location of treatment to be implemented is provided in Appendix G.

Recommendation 14

Main Roads to manage traffic related noise impacts in accordance with WAPC State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Landuse Planning (WAPC, 2009).

Recommendation 15

Main Roads to develop and implement a Noise Management Plan to mitigate noise levels at the residences to meet the noise criteria.

4.20 Construction Phase Impacts

Additional minor potential impacts requiring consideration and management during the Project's construction phase include the following:

- Aboriginal heritage salvage and monitoring;
- Construction noise and vibration;
- Dust;
- Materials transport to site;
- Traffic access and safety;
- Fire management;
- Hazardous chemicals storage and handling;
- Supply of construction materials;
- Use of water in construction;
- Gravel and limestone aggregates; and
- Waste disposal.

These impacts are expected to be short term (approximately 12 – 18 months) and are likely to be limited to the construction site and its near environs, including the local road system. Management of these issues should be clearly defined through the preparation and implementation of a CEMP for the Project.

Recommendation 16

Main Roads prepare and implement a CEMP for the construction of the Project. The conditions of the CEMP should be followed during any pre-construction works.

5. Vegetation Clearing

The clearing of any native vegetation is regulated by the DEC and requires a permit under Part V of the EP Act. Main Roads has been issued with a Statewide Purpose Clearing Permit (CPS 818/6) which allows for roadworks clearing and prescribes specific management and offset requirements.

CPS 818/6 requires an assessment of vegetation clearing against the "Ten Clearing Principles". The clearing required for this Project has been assessed against the "Ten Clearing Principles" as detailed at Appendix D. This assessment has identified that the:

- Proposal is at variance with Principle (b);
- Proposal is likely to be variance with Principle (f); and
- Proposal may be at variance with Principle (a), (e) and (i).

These principles relate to:

a) Native vegetation should not be cleared if it comprises a high level of biological diversity.

b) The vegetation comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

c) The vegetation is significant as a remnant of native vegetation in an area that has been extensively cleared.

d) The vegetation is growing in, or in association with, an environment associated with a watercourse or wetland.

e) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

If the Environmental Protection Authority do not formally assess the Project under the provisions of the EP Act 1986 then the Project clearing may be conducted under the provisions of Main Roads Clearing Permit CPS 818/6. These requirements include stakeholder consultation, environmental offsets, landscaping and environmental management plans.

Recommendation 17

If the Project is not formally assessed by the EPA, Main Roads should comply with the requirements detailed in CPS 818/6.

6. Stakeholder Consultation

Main Roads has consulted with a range of stakeholders during the development of the BORR Southern Section over the past 12 months regarding the environmental and cultural impacts of this Project. Stakeholders that have been consulted to date are detailed in Table 17.

Table 17 Environmental Stakeholder Consultation

	Agency	Date	Attendees
1	Office of the Environmental Protection Authority	15 February 2012	Murray Hogarth & Hans Jacob
2	Department of Environment and Conservation Bunbury office	22 December 2011	Peter Hanley, Andrew Webb and Kim Williams
		14 February, 2012	Peter Hanley, Kim Williams, Andrew Webb and Grant Lamb
3	DSEWPC	March 28, 2012	E-mail advice on Project to M Welsh
4	South West Environment Centre	November 16, 2011	Members of the SWEC

It is understood that Main Roads will continue to consult with these, and other relevant stakeholders through the development of the Project.

There was landowner opposition to the route through Gelorup in the late 1990's, with no recent wider community liaison regarding the Project having been conducted.

Due to the expected high level of community interest in the Project, particularly in the Gelorup area, Main Roads should develop and implement a Community Consultation Program for the Project at the earliest opportunity.

Recommendation 18

Main Roads continue to consult with relevant stakeholders during the development and implementation of the Project.

Recommendation 19

Main Roads develop and implement a Community Consultation Program for the Project at the earliest opportunity.

7. Impact Management and Mitigation

Construction and operation of the Project will result in a number of long term primary environmental impacts as detailed in Section 4. These include:

- Changes in the release of vehicle emissions in the local and regional airshed;
- Drainage impacts;
- Clearing of vegetation;
- Loss of fauna habitat;
- Loss of/severance of fauna migration pathway;
- Traffic noise exposure;
- Loss of visual amenity; and
- Visual amenity in the Gelorup section.

The recommendations detailed in this report will provide for the management and minimisation of these impacts but some residual environmental impacts are anticipated.

7.1 Environmental Offset

Main Roads is proposing to implement an Environmental Offset to provide a regional benefit to the conservation estate of the local area. This offset also fulfils requirements under both State and Commonwealth policies and legislation which ensure clearing and fauna habitat loss resulting from the Project are addressed.

Main Road has engaged in preliminary discussions with officers from the EPA, DSEWPC and DEC in respect to the preparation and implementation of an Environmental Offset Strategy for the Project. This strategy will address matters such as the purchase of offset land and rehabilitation of degraded areas of offset land purchased as part of the Project. The environmental offset would place into secure tenure areas of privately owned remnant vegetation and incorporate these areas into the conservation estate.

Environmental offsets will be in line with areas identified for conservation by the EPA (2008) in their advice to the Minister for the Environment on areas of conservation significance in the Preston Industrial Park.

The Offset Strategy will also be prepared in line with Condition 5 issued by the WA Minister for the Environment in Statement 000697.

Fauna linkages will be constructed to enable fauna to safely cross the BORR. An overpass will be constructed at Yalinda drive, with underpasses constructed at Five Mile Brook and Jilley Road, with opportunities to install culverts at other locations.

Traffic noise will be managed through detailed design of the Project, with visual amenity managed through landscaping.

Recommendation 20

Main Roads prepare and implement an Environmental Offset Strategy for the Project in consultation with DEC and DSEWPC.

Recommendation 21

Main Roads prepare and implement a Landscaping plan with consideration made to managing the noise and visual amenity impacts.

8. Summary of Recommendations

The following section lists the recommendations proposed throughout the EIA for additional work to be conducted during the development and implementation of the Project.

Recommendation 1

Main Roads prepare and implement a Construction Environmental Management Plan (CEMP) to address construction issues including dust management.

Recommendation 2

Main Roads conduct detailed ASS investigations where site excavations are required for road, culvert and overpass construction; and that an Acid Sulphate Soil Management Plan be developed and implemented for the construction works.

Recommendation 3

Main Roads:

- Minimise the impact of the Project on Five Mile Brook through the preparation and implementation of a Foreshore Management Plan to minimise the impact and manage the impact through the construction process, and
- Prepare and implement a Drainage, Nutrient and Water Management Plan for the Project to minimise the impact of off-road drainage on the environment.

Recommendation 4

Main Roads finalise design and scope of works to allow determination of final clearing impacts.

Recommendation 5

Main Roads undertake a Level 1 Flora survey of the subsidiary infrastructure disturbance footprint, once detailed design is complete.

Recommendation 6

Main Roads update the Dieback mapping of the Project Area during the final design stages of the Project and use the updated mapping to prepare a Dieback Management Plan to be implemented during road construction.

Recommendation 7

Main Roads manage the Declared Weed populations with the Project Area prior to and during road construction and on-going road reserve management.

Recommendation 8

Main Roads prepare and implement a Topsoil Management Plan (TMP) for the Project to identify the use and management of in-situ topsoil during road works.

Recommendation 9

Main Roads prepare and implement a Revegetation and Landscape Plan for the Project.

Recommendation 10

Main Roads undertake a significant tree survey of the subsidiary infrastructure disturbance footprint, as part of the detailed design process.

Recommendation 11

Main Roads conduct a Western Ringtail Possum distance sampling survey of the Jilley Road to Bussell Highway section of the Project Area to better quantify the clearing impacts on this species.

Recommendation 12

Main Roads implement fauna management measures as detailed in the CEMP during the design and construction of the Project.

Recommendation 13

As a result of the survey it is likely that previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site 1 will be affected by the construction of the ramp connection of the BORR with Hastie Road.

As such Main Roads make application under Section 18 the Western Australian Aboriginal Heritage Act (1972) for consent to use the land that may contain an Aboriginal site.

Recommendation 14

Main Roads comply with any conditions prescribed with the Section 18 approval for the Project.

Recommendation 15

Main Roads to manage traffic related noise impacts in accordance with WAPC State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Landuse Planning (WAPC, 2009).

Recommendation 16

Main Roads to develop and implement a Noise Management Plan to mitigate noise levels at the residences to meet the noise criteria.

Recommendation 17

Main Roads prepare and implement a CEMP for the construction of the Project. Alternatively, the construction contractor should prepare a CEMP for Main Roads approval prior to implementation as part of the Project delivery. The conditions of the CEMP should be followed during any pre-construction works.

Recommendation 18

If the Project is not formally assessed by the EPA, Main Roads should comply with the requirements detailed in CPS 818/6.

Recommendation 19

Main Roads continue to consult with relevant stakeholders during the development and implementation of the Project.

Recommendation 20

Main Roads develop and implement a Community Consultation Program for the Project at the earliest opportunity.

Recommendation 21

Main Roads prepare and implement an Environmental Offset Strategy for the Project in consultation with DEC and DSEWPC.

Recommendation 22

Traffic noise and visual amenity will be managed through landscaping. Main Roads should prepare and implement a Landscaping plan with consideration made to managing the noise and visual amenity impacts.

9. References

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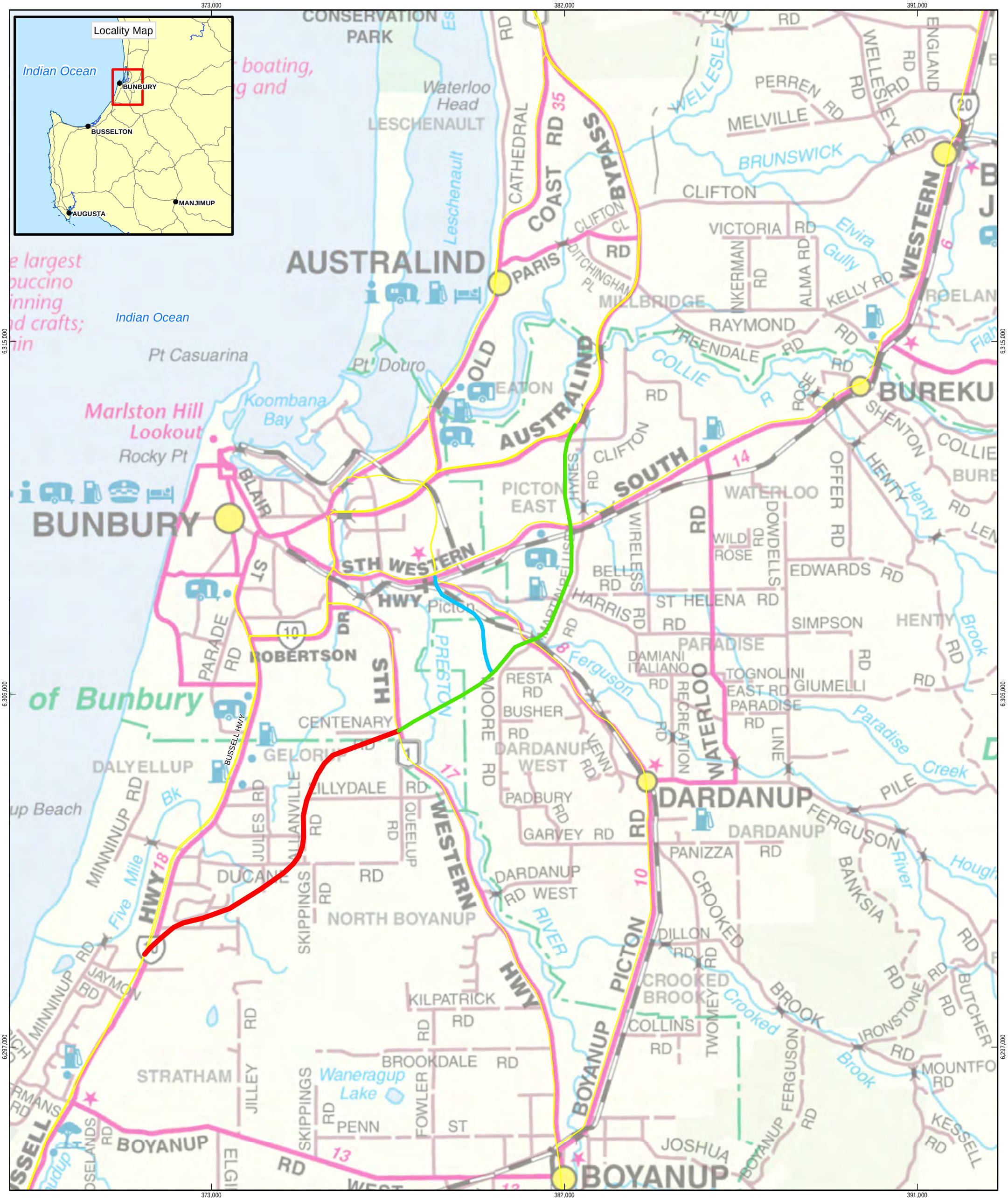
Appendices

Appendix A - Figures



LEGEND

Roads

- BORR Southern Section proposed alignment
- BORR Northern Section alignment (not yet built)
- Bunbury Port Access Road alignment (not yet built)
- Main arterial road for region

1: 90,000 (at A3)

0 450 900 1,800 2,700 3,600 4,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

BORR Southern Section proposed alignment

Job Number	61-27467
Revision	2
Date	20 Nov 2012

Figure 1

G:\61\27467\GIS\Maps\MXD\6127467_G015_Rev1_Fig2.mxd

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

Data source: Landgate: Bunbury 2010 Mosaic - 20120815; MRWA: Roads - 20111027; GA: 250K Australian Topographic Series - 2006. Created by: mczekaj, erice

370,000 373,000 376,000 379,000

6,303,000

CENTENARY RD

Bunbury Outer Ring Rd

HAREWOODS RD

BUSSELL HWY

KEN BELLS RD

6,300,000

Locality Map

INDIAN OCEAN

BUNBURY

CAPEL

BUSSELTON

370,000 373,000 376,000 379,000

1:30,000 (at A3)

0 150 300 600 900 1,200 1,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Roads

Disturbance Footprint

Acid Sulfate Soils Risk

High to moderate risk

Moderate to low risk

GHD

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

ASS Risk Map

Job Number	6127467
Revision	1
Date	29 Mar 2012

Figure 2

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Data source: Landgate: Bunbury 2008 Mosaic - 20111101; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint; GA: 250K Australian Topographic Series - 2006; DEC: Acid Sulfate Soils Risk Map - 20120327. Created by: erice

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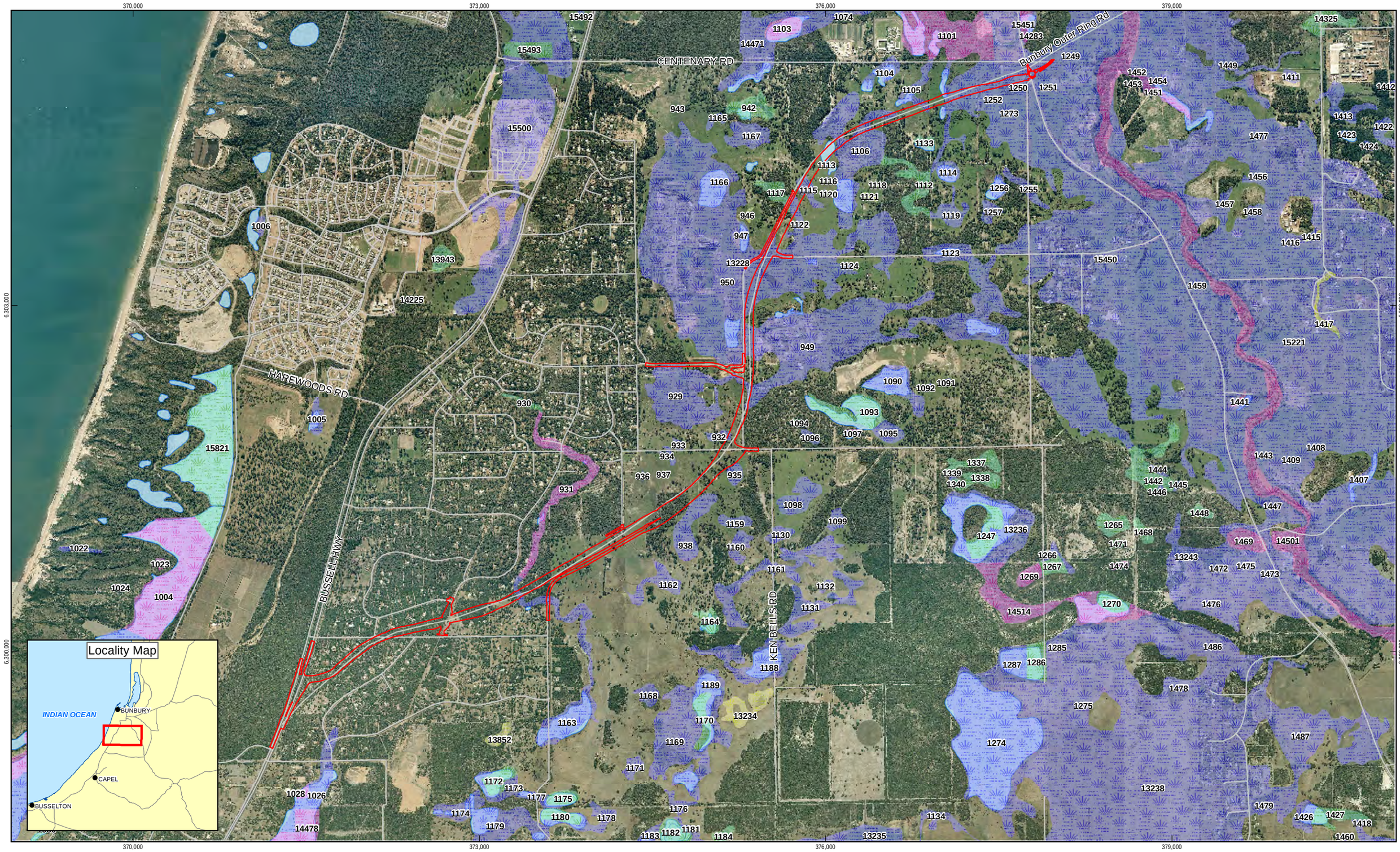

Locality Map

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Metres

Map Projection: Transverse Mercator
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Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Roads
- Disturbance Footprint
- Environmentally Sensitive Areas

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Hydrology

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number	6127467
Revision	3
Date	20 Nov 2012

Wetlands and Hydrological Features Figure 3

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Data source: Landgate: Bunbury 2008 Mosaic - 20111101, Hydrology - 20111206; DEC: Geomorphic Wetlands - 20111027, Environmentally Sensitive Areas - 20091105; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint; GA: 250K Australian Topographic Series - 2006. Created by: cagilbert, 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

370,500 371,000 371,500 372,000

6,300,000

6,299,500

370,500 371,000 371,500 372,000

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

- Open heath of *Melaleuca ?lateritia* and *Viminaria juncea* over sedgeland
- Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland
- Scattered remnant vegetation of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Low open forest of *Eucalyptus rudis* and *Melaleuca preissiana* over sedgeland
- Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland
- Open forest of *Banksia attenuata* and *Agonis flexuosa*
- Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Highly Disturbed
- Water Body

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Type

Job Number	6127467
Revision	3
Date	20 Nov 2012

Sheet 1 of 8

Figure 4

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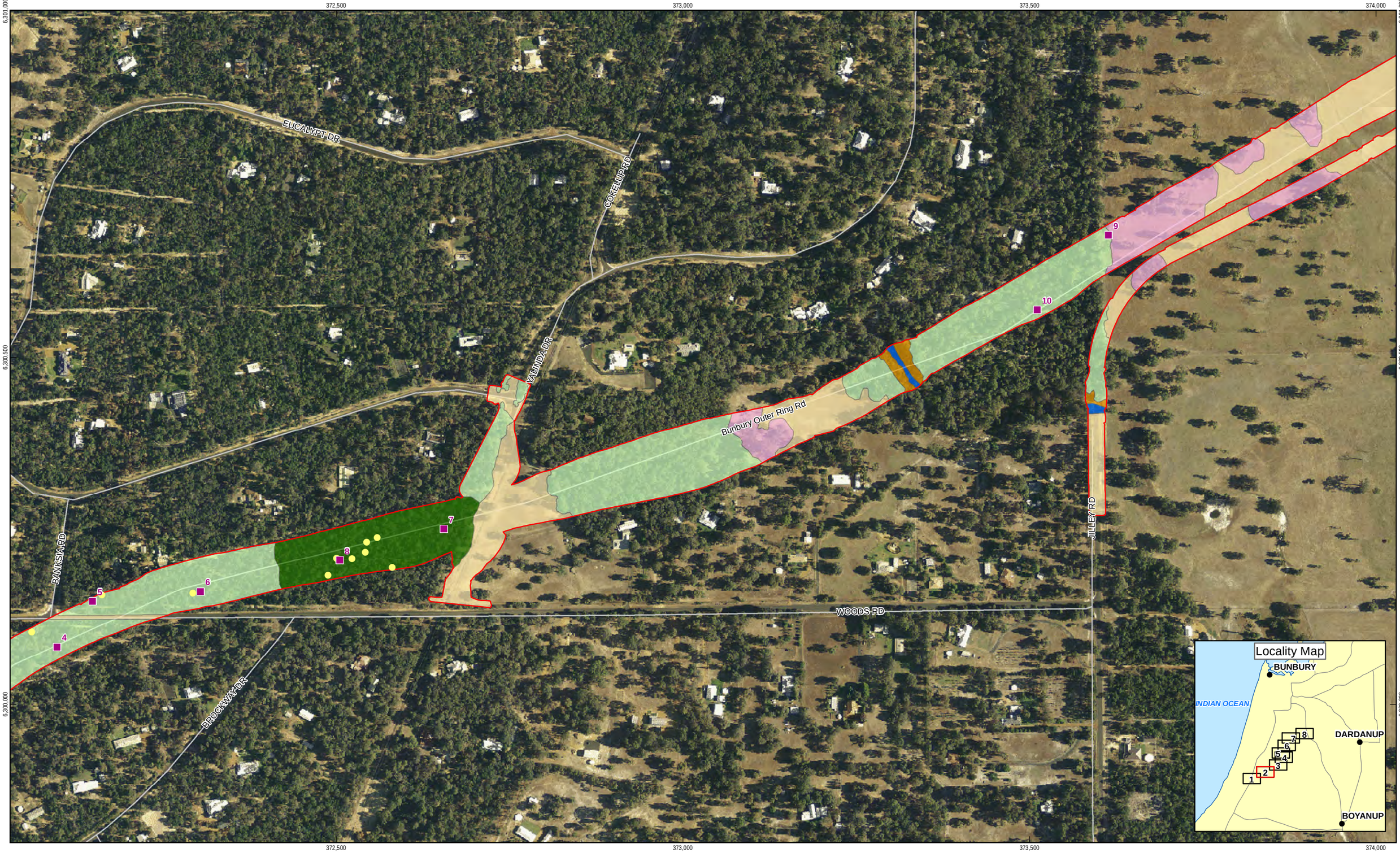
Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

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- Highly Disturbed
- Water Body

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 3
Date 20 Nov 2012

Sheet 2 of 8

Figure 4

Vegetation Type

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Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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374,000 374,500 375,000 375,500

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DUCANE RD

ZANADU CT

TARROCK CT

YALINDA DR

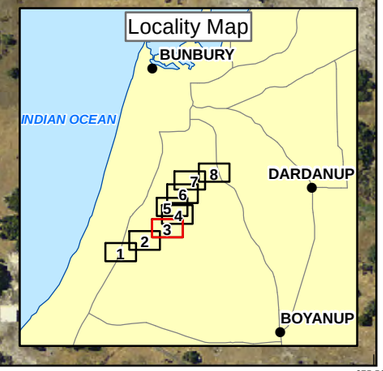
MARCHETTI RD

Bunbury Outer Ring Rd

11

12

9



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Grid: Map Grid of Australia 1994, Zone 50

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LEGEND

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- Water Body

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Type

Job Number	6127467
Revision	3
Date	20 Nov 2012

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Figure 4

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Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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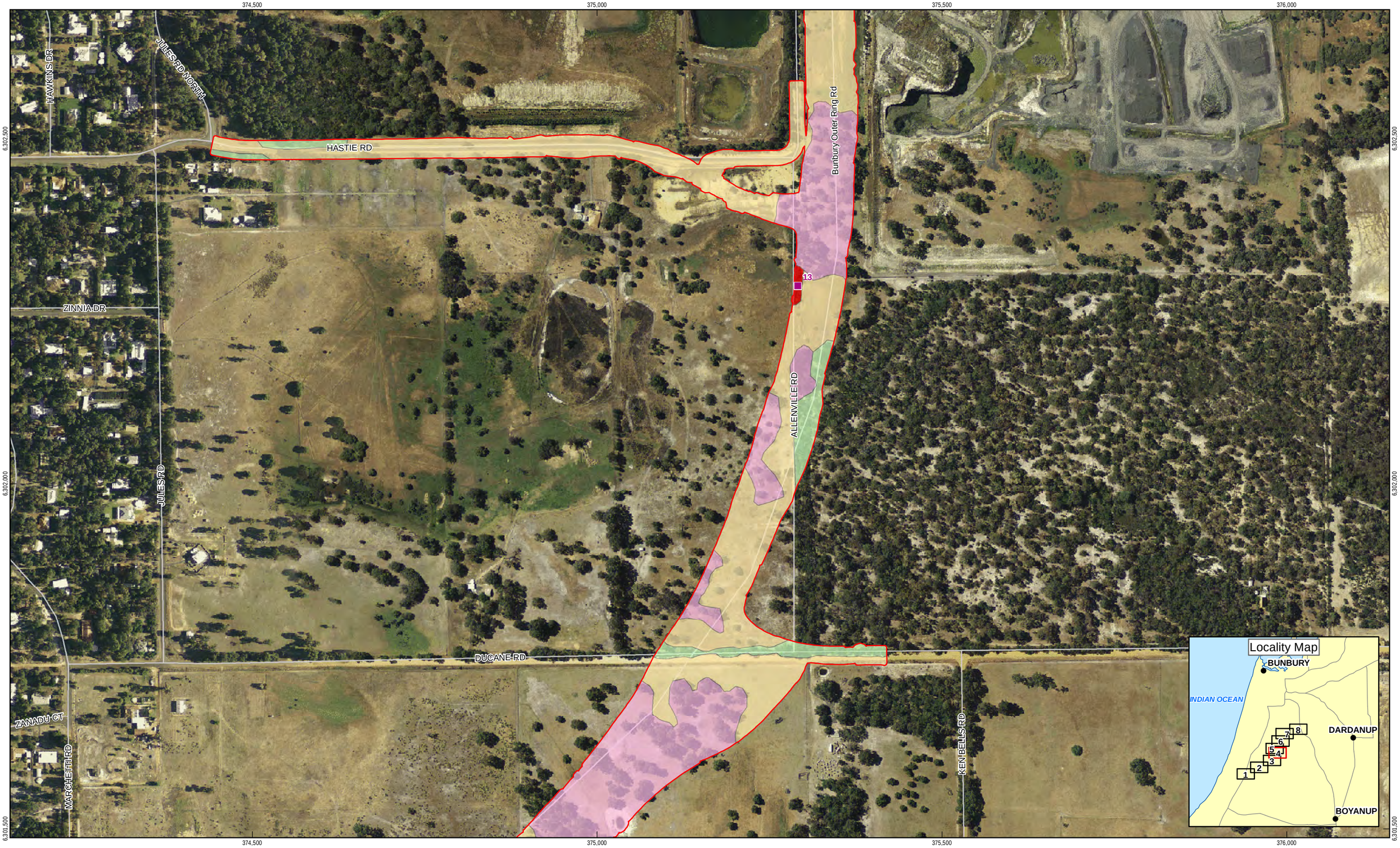

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

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- Disturbance Footprint

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Type

Job Number	6127467
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Figure 4

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Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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

374,000 374,500 375,000 375,500

6,303,000 6,302,500 6,302,000

HAWKINS DR
BOLEY CT
ORCHID PL
TEA TREE PL
JULES RD NORTH
ALLENVILLE RD
Bunbury Outer Ring Rd
HASTIE RD
YALINDA DR
COACHWOOD WY
ZINNIA DR
JULES RD
SIERRA PL
13

Locality Map
BUNBURY
INDIAN OCEAN
DARDANUP
BOYANUP
1 2 3 4 5 6 7 8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

- Open heath of *Melaleuca ?lateritia* and *Viminaria juncea* over sedgeland
- Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland
- Scattered remnant vegetation of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Low open forest of *Eucalyptus rudis* and *Melaleuca preissiana* over sedgeland
- Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland
- Open forest of *Banksia attenuata* and *Agonis flexuosa*
- Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Highly Disturbed
- Water Body

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Type

Job Number	6127467
Revision	3
Date	20 Nov 2012

Sheet 5 of 8

Figure 4

G:\61\27467\GIS\Maps\MXD\6127467_G005_Fig4_Rev3.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

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- Water Body

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Type

Job Number	6127467
Revision	3
Date	20 Nov 2012

Sheet 6 of 8

Figure 4

G:\61\27467\GIS\Maps\MXD\6127467_G005_Fig4_Rev3.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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375,000 375,500 376,000 376,500

6,304,500

6,304,000

Bunbury Outer Ring Rd

15

14

Locality Map

BUNBURY

INDIAN OCEAN

DARDANUP

BOYANUP

1 2 3 4 5 6 7 8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

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- Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Highly Disturbed
- Water Body

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 3
Date 20 Nov 2012

Sheet 7 of 8

Figure 4

Vegetation Type

G:\61\27467\GIS\Maps\MXD\6127467_G005_Fig4_Rev3.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

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- Water Body

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Type

Job Number	6127467
Revision	3
Date	20 Nov 2012

Sheet 8 of 8

Figure 4

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G:\61\27467\GIS\Maps\MXD\6127467_G005_Fig4_Rev3.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

370,500 371,000 371,500 372,000

6,300,000

6,299,500

3-4
6
3-4
3-4
3-4
6
3
3
6
4-5
3
WOODS RD
BANKSIA RD
Bunbury Outer Ring Rd
BROCKWAY DR
ST CLAIR PL
QUAMBI DR
BUSSELL HWY
MANEA DR
LAKES RD
CALINUP RD

Locality Map
EATON
BUNBURY
INDIAN OCEAN
DARDANUP
1
2
3
4
5
6
7
8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

- **Asparagus asparagoides*
- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

1. Pristine or Nearly So
2. Excellent
3. Very Good
4. Good
5. Degraded
6. Completely Degraded

WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number 6127467
Revision 2
Date 29 Mar 2012

Sheet 1 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, erice

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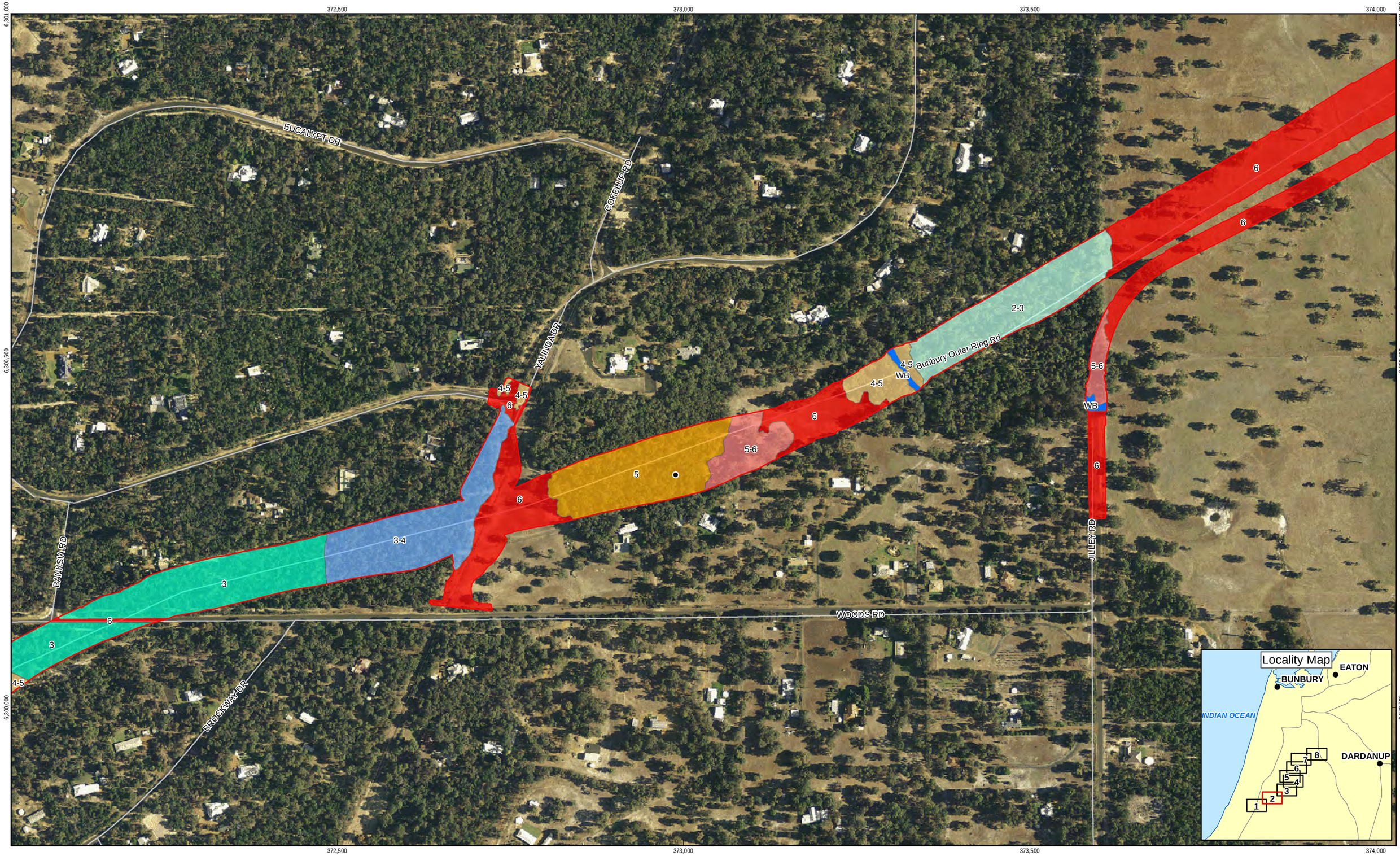

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

- **Asparagus asparagoides*
- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

- 1. Pristine or Nearly So
- 2. Excellent
- 3. Very Good
- 4. Good
- 5. Degraded
- 6. Completely Degraded
- WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number	6127467
Revision	2
Date	29 Mar 2012

Sheet 2 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, erice

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374,000 374,500 375,000 375,500

6,301,500

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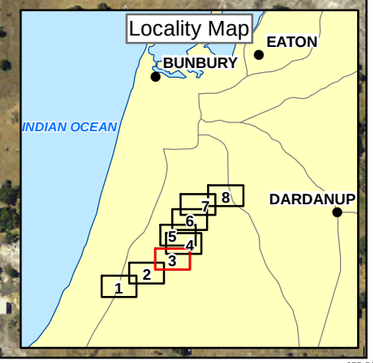
ZANADU CT
TARROCK CT
YALINDA DR
MARCHETTI RD
DUCANE RD
Bunbury Outer Ring Rd

6
5-6
5
4-5
1
3-4
2-3



1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

- **Asparagus asparagoides*
- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

- 1. Pristine or Nearly So
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- 6. Completely Degraded
- WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number 6127467
Revision 2
Date 29 Mar 2012

Sheet 3 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, erice

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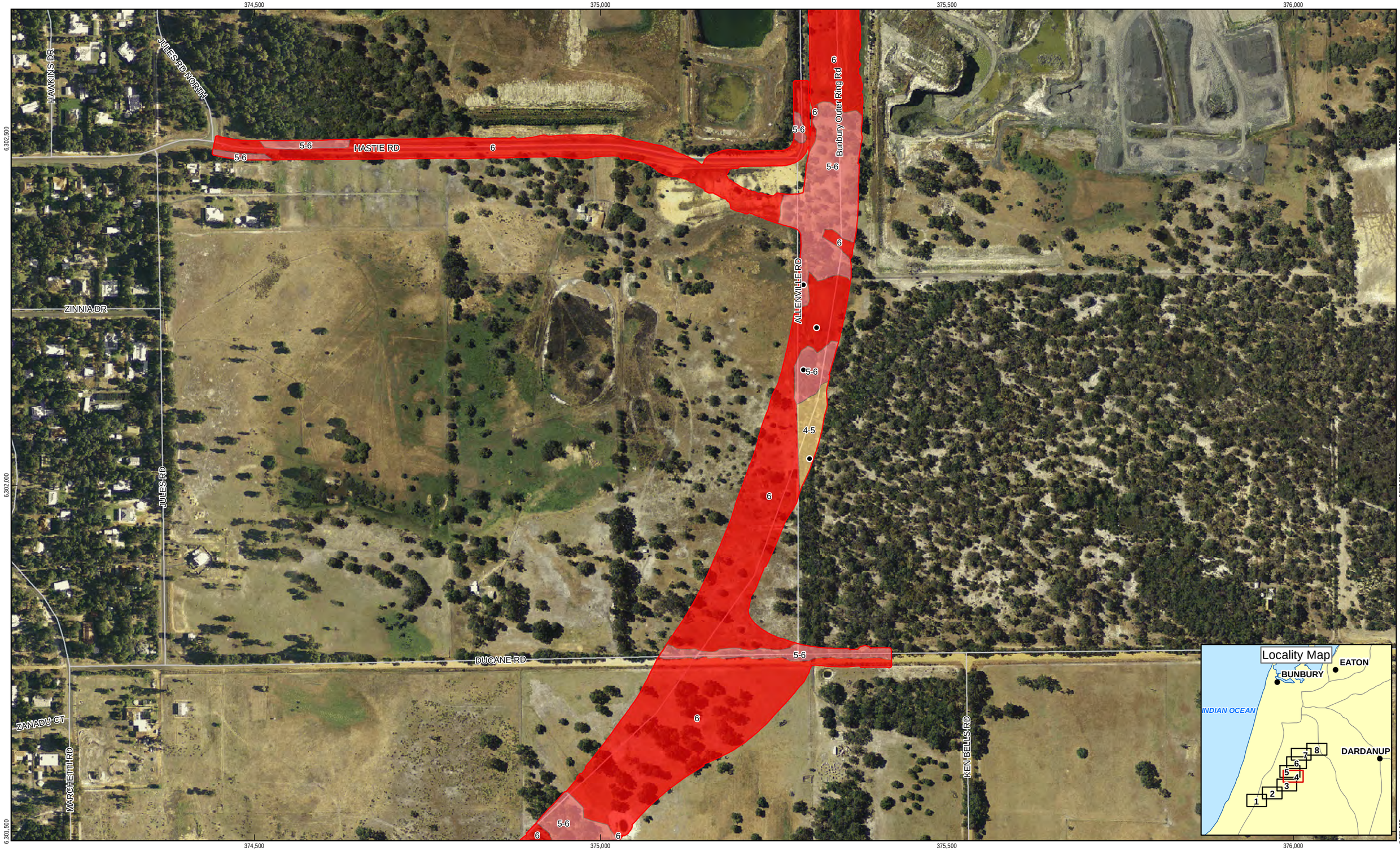

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

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- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

1. Pristine or Nearly So
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4. Good
5. Degraded
6. Completely Degraded

WB: Water Body

GHD CLIENTS | PEOPLE | PERFORMANCE

mainroads WESTERN AUSTRALIA

powered by SLIP ENABLER

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number	6127467
Revision	2
Date	29 Mar 2012

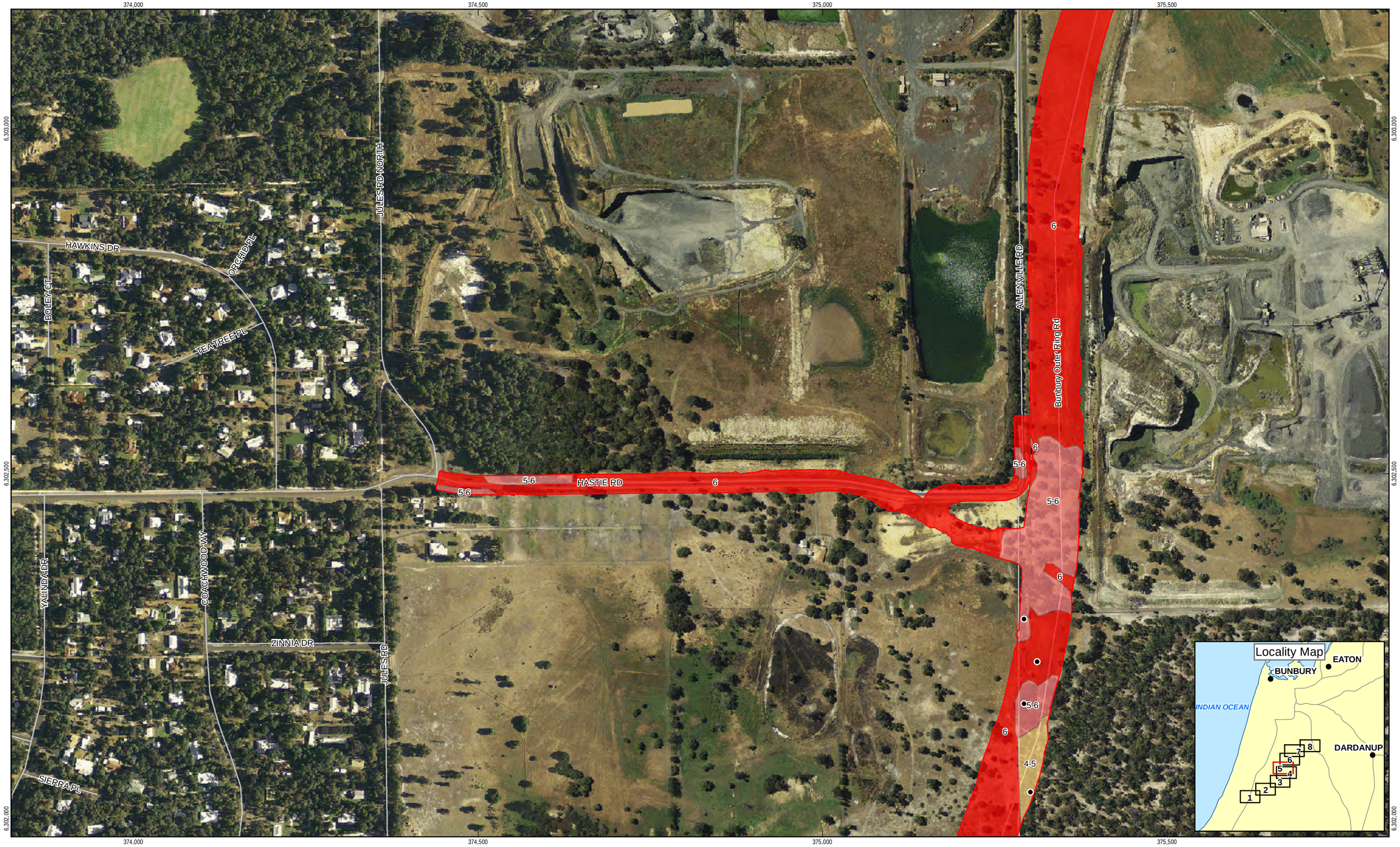
Sheet 4 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, 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



1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

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- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

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3. Very Good
4. Good
5. Degraded
6. Completely Degraded

WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number 6127467
Revision 2
Date 29 Mar 2012

Sheet 5 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, erice

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1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

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Roads

Disturbance Footprint

Vegetation Condition

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- 5. Degraded
- 6. Completely Degraded
- WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number	6127467
Revision	2
Date	29 Mar 2012

Sheet 6 of 8

Figure 5

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Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, erice

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375,000 375,500 376,000 376,500

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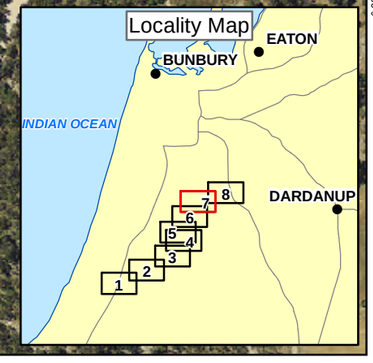
6,304,000

Bunbury Outer Ring Rd

6 5-6 4 3 6 3 5-6 6



1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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LEGEND

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GHD CLIENTS | PEOPLE | PERFORMANCE

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number	6127467
Revision	2
Date	29 Mar 2012

Sheet 7 of 8

Figure 5

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Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert, erice

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377,000 377,500 378,000 378,500

6,305,000

6,304,500

CENTENARY RD

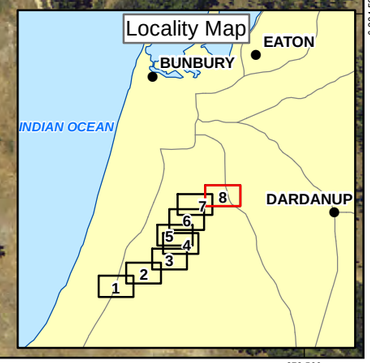
CENTENARY ST

Bunbury Outer Ring Rd

SOUTH WESTERN HWY

QUEELUP RD

6 5-6



1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

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Roads

Disturbance Footprint

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WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weeds

Job Number	6127467
Revision	2
Date	29 Mar 2012

Sheet 8 of 8

Figure 5

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370,000 373,000 376,000 379,000

6,303,000

CENTENARY RD

Bunbury Outer Ring Rd

HAREWOODS RD

BUSSELL HWY

KEN BELLS RD

6,300,000

Locality Map

INDIAN OCEAN

BUNBURY

CAPEL

BUSSELTON

370,000 373,000 376,000 379,000

1:30,000 (at A3)

0 150 300 600 900 1,200 1,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Threatened Flora

- (T) Threatened Flora - Extant Taxa
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa

- Roads
- Disturbance Footprint

Threatened & Priority Ecological Communities

- Priority
- Threatened

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Conservation Significant Communities and Species

Job Number	6127467
Revision	1
Date	20 Nov 2012

Figure 6

G:\61\27467\GIS\Maps\MXD\6127467_G009_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111101, DEC: Declared Rare & Priority Species - 20111101, Threatened Ecological Communities - 20111110. Main Roads WA: Roads - 20111027; GA: 250K Australian Topographic Series - 2006; GHD: Disturbance Footprint. Created by: cagilbert

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Appendix B – Flora and Vegetation Assessment Report

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia

Bunbury Outer Ring Road Southern Section, South Western Highway to Bussell Highway

Flora and Vegetation Assessment

March 2012

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

This **Bunbury Outer Ring Road Southern Section, South Western Highway to Bussell Highway Flora and Vegetation Assessment** *("Report"):*

1. *has been prepared by GHD Pty Ltd ("GHD") for* ***Main Roads Western Australia****;*
2. *may only be used and relied on by* ***Main Roads Western Australia****;*
3. *must not be copied to, used by, or relied on by any person other than* ***Main Roads Western Australia*** *without the prior written consent of GHD;*
4. *may only be used for the purpose of a* ***Flora and Vegetation Assessment*** *(and must not be used for any other purpose).*

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To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- *were limited to* ***sections 1.3.***

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to):

- *The assessment is based on the Project footprint provided by Main Roads Western Australia, as listed in section 1.2 and shown in Figure 1, Appendix A. Any changes to the project, outside the description provided above, are outside the scope of this assessment.*
- *GHD has relied upon external data, namely publicly available database, to identify species previously recorded in the area. The accuracy of this data lies with the provider, not with GHD.*

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until 12 months after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

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Executive Summary

Main Roads Western Australia commissioned GHD to conduct a flora and vegetation assessment of the proposed Bunbury Outer Ring Road Southern Section, South Western Highway to Bussell Highway (the Project), which is located south east of Bunbury as shown at Figure 1. The Study Area for the survey was the existing and proposed road reserve as detailed in concept plans provided by Main Roads Western Australia.

The purpose of the survey is to provide an appropriate examination of the flora and vegetation focusing on conservation significant flora and vegetation within the receiving environment of the Project.

Information from this survey will be used in the preparation of a project Environmental Impact Assessment and subsequent State and Commonwealth approvals documentation.

The flora and vegetation assessment of the Study Area included a Level 2 flora and vegetation survey. This 2011 survey supplements a similar survey conducted for the project in October 2008 (GHD, 2009).

The findings of the flora and vegetation assessment include:

Existing Environment

- The Study Area intercepts 11 wetlands, with most being Multiple Use, sumpland wetlands;
- Conservation Category Wetlands UFI 931, 1101 and 15451 are in close proximity to the proposed alignment;
- A search of the Department of Water (DoW) Geographic Data Atlas indicates that the Study Area overlies the Bunbury west and Bunbury east Groundwater sub-areas of the Bunbury Groundwater Proclaimed Groundwater Area;
- A Public Drinking Water Source Area, Protection Area P3, occurs adjacent to the north of the Study Area between Bussell Highway and Marchetti Road, Gelorup; and
- Six ESAs are within close proximity of the Study Area. No ESAs are located within the Study Area.

Vegetation and Flora

- Seven vegetation types, not including highly disturbed vegetation and water bodies were located within the Study Area;
- Vegetation types Southern River Complex and Bassendean Complex – Central and South have less than 30% remaining and are considered *Vulnerable*;
- There are six Threatened Ecological Communities s and two Priority Ecological Communities within 10 km of the Study Area. They include the TEC SCP3c *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain - listed as “Critically Endangered” under the State DEC listing and as “Endangered” under the Commonwealth TEC listing (State and Commonwealth significance). The flora and vegetation assessment did not record the Threatened ecological community SCP3c, *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands within the Study Area;
- The PEC SCP25 Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands - listed as “Priority 3’ under the State Department of Environment and Conservation listing and mapped as being located within the southern section of the Study Area. The results of a PATN statistical

analysis indicate that the vegetation types mapped by GHD as Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa* and Open forest of *Banksia attenuata* and *Agonis flexuosa* do not represent an occurrence of the PEC SCP25. PEC SCP25 is however located within the alignment, which strongly suggests GHD vegetation types Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa* and Open forest of *Banksia attenuata* and *Agonis flexuosa* are the PEC SCP25. Factors affecting the PATN analysis are the timing of the survey and vegetation condition.

- The flora and vegetation assessment did not record the Threatened ecological community SCP3c, *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands within the Study Area.
- The vegetation condition of the Study Area ranged from *Pristine* (1) to *Completely Degraded* (6). Most of the Study Area rated between *Degraded* (5) to *Completely Degraded* (6);
- The Study Area can be described as having a moderate degree of species diversity with a total of 155 taxa from 43 plant families of these 32 of these were introduced (exotic) species;
- No Declared Rare flora species were recorded by GHD within the Study Area;
- The Priority Flora species *Caladenia speciosa*, a Priority 4, was recorded within the Study Area;
- Three Declared Plants were recorded within the Study Area: **Asparagus asparagoides* (Bridal Creeper), **Moraea flaccida* (One-leaf Cape Tulip) and **Zantedeschia aethiopica* (Arum Lily); and
- One Weed of National Significance (WONS) **Asparagus asparagoides,* was recorded within the Study Area.

Wetlands

- The Study Area intercepts 11 wetlands, with most being Multiple Use, sumpland wetlands. The vegetation condition of the wetlands generally rated between *Degraded* (5) to *Completely Degraded* (6);
- A small Resource Enhancement wetland (UFI 1117) was located within the alignment north of Lillydale Road. The vegetation condition rating was *Very Good* (3);
- The proposed alignment intercepts the northern section of a large, permanent Multiple Use, sumpland wetland UFI 1106, associated with the ESA at 5 Centenary Road, and 262 Lillydale Road, North Boyanup. The vegetation condition rated between *Very Good* (3) to *Degraded* (5); and
- The Project traverses Five Mile Brook. The vegetation condition of the brook rated *Good* (4) to *Degraded* (5). This area was infested with weed species and has been heavily grazed. Approximately 110 m upstream of Five Mile Brook is CCW (UFI 931) which is also an ESA. This ESA is outside of the proposed alignment.

1. Introduction

1.1 Background

Main Roads Western Australia commissioned GHD to conduct a flora and vegetation assessment of the proposed Bunbury Outer Ring Road Southern Section, South Western Highway to Bussell Highway (the Project), which is located south east of Bunbury as shown at Figure 1. The Study Area for the survey was the existing and proposed road reserve as detailed in concept plans provided by Main Roads Western Australia.

The Bunbury Outer Ring Road Southern Section, South Western Highway to Bussell Highway (BORR) is a planned Controlled Access Highway linking the four major highways radiating from Bunbury on the outer edge of the City's development to the planned Bunbury Port Access Road (PAR). The BORR and PAR will provide a high standard route for traffic wishing to access the Bunbury Port and the developing industrial areas to the east of Bunbury without the need to travel through the developed areas of Bunbury. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic.

The BORR is planned with the capacity to be upgraded to freeway status over the long term. It will initially be constructed as a four lane dual carriageway and upgraded to a freeway as traffic volumes increase in time with ongoing development in the Greater Bunbury and South West Regions.

The Bunbury Outer Ring Road Southern Section provides for the construction of 9km of dual carriageway from South Western Highway (south) to Bussell Highway, including intersections at:

- Lillydale Road
- Hastie Road
- Ducane Road. Service road to service private properties east of Lilydale Road
- Bussell Highway

It will include construction of an overpass and associated road works at Yalinda Drive and construction of a 2.3km long service road from Ducane Road to Jilley Road.

Preliminary designs for the southern stage of the Project has now been completed to allow scope of works, land requirements and environmental impacts to be determined.

The concept for the BORR was originally developed in the early 1970's and the concept report completed in 1995. The land requirement was identified in the Greater Bunbury Region Scheme.

The purpose of the survey is to provide an appropriate examination of the flora and vegetation focusing on conservation significant flora and vegetation within the receiving environment of the BORR.

Information from this survey will be used to prepare a Project Environmental Impact Assessment and subsequent State and Commonwealth approvals documentation.

1.2 Study Area

The location of the Study Area is shown at Figure 1, Appendix A and commences on the South Western Highway and terminates at the Bussell Highway near Woods Road, approximately 8.5 kilometres south of Bunbury. The Project is approximately 9 km in length.

The Study Area comprises sections of native vegetation including those found in road reserves, privately owned property and the existing proposed road corridor in the Gelorup area. Much of the alignment is within large sections of cleared agricultural land.

1.3 Scope of Work

The primary objectives of the Level 2 flora and vegetation survey are to provide and present the following information:

- An inventory of the vascular plant species in the Study Area, undertaken through quadrat survey methods;
- A review of, and search for, significant flora species;
- A description and location, including mapping, of plant communities;
- A rating of condition of the vegetation communities or areas;
- An inventory of dominant exotic plants, including declared noxious plants and environmental weed species;
- Advice on whether weeds are likely to spread to, and result in, environmental harm to adjacent areas of native vegetation that is in good or better condition;
- An assessment of the conservation significance of the flora and vegetation at a regional and local level;
- An assessment with regards to EPA Guidance Statement No. 51;
- Delineation and evaluation of wetland boundaries and public drinking water catchment areas within the Study Area according to the Department of Environment and Conservation (DEC) Geomorphic Wetland Swan Coastal Plain dataset and the DoW Geographic Data Atlas (or the outcome of the field survey); and
- A determination whether the Study Area impacts on an Environmentally Sensitive Area (ESA); and
- An assessment of the vegetation condition within the Study Area.

This report provides results of the above components and an assessment of potential clearing against the Environmental Protection Act's Ten Clearing Principles (Schedule 5). Each principle has been assessed in accordance with the DEC's Guideline to Assessment – Clearing of Native Vegetation. Information is also provided on likely environmental approvals should development of the Project proceed.

1.4 Assumptions

Impacts have been derived on preliminary information available from Main Roads Western Australia, as listed in the project description above. Any changes to the project, outside the description provided above, are outside the scope of this assessment.

GHD has relied upon external data, namely publicly available database, to identify species previously recorded in the area. The accuracy of this data lies with the provider, not with GHD.

2. Methodology

2.1 Desktop Assessment

Prior to the commencement of the field survey, a comprehensive desktop review was undertaken. The desktop review included:

- Physical environment;
- Climate and hydrology;
- A search of the Department of Water (DoW) Geographic Data Atlas;
- A review of Conservation Estates and Reserves occurring within the Study Area;
- A review of databases and literature to identify the potential for Threatened Flora to be present within the Study Area. This included a review of Threatened Flora species listed under the Commonwealth *Environment Protection and Biodiversity Conservation* Act *1999* (EPBC Act), the Western Australian *Wildlife Conservation* Act 1950 (WC Act) and Priority Flora listed by Department of Environment and Conservation (DEC);
- DEC, Western Australian Museum (*NatureMap*) database searches for conservation significant flora;
- A review of the Department of Sustainability, Environment, Water, Population and Climate (DSEWPaC) EPBC Act Protected Matters database – to identify Threatened Ecological Communities (TECs);
- A review of DEC's Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) databases;
- A review of the GHD, 2009 Flora and Vegetation Survey;
- A search of the Department of Environment Native Vegetation Viewer; and
- A search of the Department of Agriculture and Food Declared Plants list.

2.2 Field Survey

GHD undertook a flora and vegetation assessment of the Study Area from the 21 to 23 September 2011. The survey was undertaken to provide a description of the dominant vegetation types present, vegetation condition and flora species present at the time of the survey.

Field assessment methodology involved a combination of sampling using quadrat and relevés located in representative vegetation types and meandering transects of the Study Area on foot to record plant species present (visible) at the time of the survey.

The survey methodology GHD employed was consistent with the EPA guidelines for flora surveys as outlined in Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a).

2.2.1 Flora Identification

Species that were well known to the survey botanists were identified in the field, while species that were unknown were collected and assigned a unique number to facilitate tracking. Plant species were

identified by the use of local and regional flora keys and by comparison with the named species held at the Western Australian Herbarium. Plant taxonomists who are considered to be an authority on a particular plant group were consulted when necessary.

The conservation status of all recorded flora was compared against the current lists available on *FloraBase* (DEC, 2011b) and the EPBC Threatened species database provided by DSEWPaC (2011a).

2.2.2 Flora Survey Limitations

Complete flora and vegetation 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.

Flora composition changes over time, with flora species having specific growing periods, especially annuals and ephemerals (some plants lasting for a markedly brief time, some only a day or two). Therefore, the results of future botanical surveys in this location may differ from the results of this survey.

2.2.3 Desktop Survey Limitations

Desktop investigations use a variety of online resources, the responsibility for the accuracy of such data remains with the issuing authority, not with GHD. The Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters database is used to identify species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This data base draws on various sources to report on the potential of the species occurrence within the area. The DSEWPaC search tool is broad-scale in its' reporting and often the specific habitat requirements of the species do not occur within project sites and are unlikely to occur within the area. For this reason not all species reported by the search tool need to be considered or anticipated as appearing in the Study Area. The Department of Environment and Conservation NatureMap database reports on records of the species within the designated area and can provide more accurate information of the likelihood of species presence.

3. Desktop Assessment Results

3.1 Physical Environment

The Project is situated approximately 8 km to the south of Bunbury and links the South Western Highway to the Bussell Highway. The land is generally flat to gently sloping to the west. The alignment crosses Five Mile Brook and several wetland areas. Most of the Study Area is cleared farm and semi-rural land, with scattered blocks of remnant vegetation.

3.2 Climate Conditions

Bunbury is located on the south-western corner of Western Australia and the climate of the Study Area is broadly described as Mediterranean, with warm dry summers and mild wet winters. The nearest Bureau of Meteorology (BoM) official recording station is Bunbury, located approximately 8 km north of the Study Area. Table 1 shows the climatic data (BoM, 2011).

Table 1 Climatic Data for the Bunbury Region

Mean Annual Maximum Temperature Range:	17.3°C in July/August to 29.8°C in February
Mean Annual Minimum Temperature Range:	7.2°C in July/August to 15.6°C in February
Mean Annual Rainfall:	738 mm
Mean Annual Rain days per year:	83.9

3.3 Hydrology

3.3.1 Wetlands and Waterways

Wetlands on the Swan Coastal Plain have been classified using a geomorphic wetland classification system. These wetlands have also been evaluated and assigned an appropriate management category. The management category provides guidance on the nature of the management and protection the wetland should be afforded.

The Study Area traverses 11 wetlands, with most being Multiple Use, sumpland wetlands. These wetlands are presented in Table 2 and shown at Figure 2.

Table 2 Geomorphic Wetlands Within Study area

Geomorphic Wetland Identification (UFI)	Evaluation	Classification
1163	Multi Use	Sumpland
932	Multi Use	Dampland
949	Multi Use	Dampland
929	Multi Use	Dampland
13228	Multi Use	Dampland
1117	Resource Enhancement	Sumpland
1122	Multi Use	Sumpland
1115	Multi Use	Sumpland
1106	Multi Use	Sumpland
1105	Multi Use	Palusplain
15450	Multi Use	Palusplain

"Multiple Use Wetlands" (MUW) are wetlands with few important ecological attributes and functions remaining. "Resource Enhancement Wetlands" are wetlands that have been altered in some way and have no clear human uses (EPA, 1993). These wetlands may present opportunities for future developments that will improve the conservation values of these wetlands. The EPA (2004b) states that all reasonable measures should be taken to retain the wetlands hydrological functions (including on-site water infiltration and flood detention) and, where possible, other wetland functions.

A "Conservation Category Wetland" (CCW) is a wetland that retains a high amount of naturalness (EPA, 1993).

CCW UFI 1101 and 15451 lie approximately 200 metres north of the Study Area at the far northern section of the alignment near the South West Highway.

Five Mile Brook has been mapped as both an MUW and CCW (UFI 931 and 1163). Where the Project crosses the brook it is mapped as MUW while the CCW portion occurs some 65 m due north of the Project and approximately 110 m upstream of the proposed road crossing. The CCW portion of the brook has also been recognised as an Environmentally Sensitive Area.

The EPBC Act Protected Matters Search Tool did not indicate the presence of any Wetlands of National or International Significance (Ramsar Sites) within the Study Area.

3.3.2 Groundwater

A search of the Department of Water (DoW) Geographic Data Atlas indicates that the Study Area is within the Bunbury West and Bunbury East sub-areas of the Bunbury Groundwater Area.

Proclaimed groundwater areas are protected under the *Rights in Water and Irrigation Act 1914.* The Act gives the DoW the power to manage ground and surface areas and use of land that may impact upon these water sources.

3.3.3 Public Drinking Water Source Areas

Public Drinking Water Source Areas (PDWSAs) is a collective term used for the description of Water Reserves, Catchment Areas and Underground Pollution Control Areas declared (gazetted) under the provisions of the *Metropolitan Water Supply, Sewage and Drainage* (MWSSD) *Act* 1909 or the *Country Area Water Supply* (CAWS) *Act 1947.*

The DoW Geographic Data Atlas indicates that the Bunbury Water Reserve, a Public Drinking Water Source Area, Protection Area P3, occurs immediately north of the Study Area from the Bussell Highway to Marchetti Road, Gelorup.

3.4 Reserves and Conservation Areas

No conservation areas or reserves are located within the boundaries of the Study area or in adjacent areas.

3.5 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are subject to definition under Section 51B of the *Environmental Protection Act 1986* and may include areas requiring special management attention to protect important scenic values, fish and wildlife resources, historical and cultural values, and other natural systems or processes.

A search of the DEC's Native Vegetation Viewer indicates six ESAs within proximity of the Study Area as shown at Figure 3. No ESAs are located within the Project Area (DEC, 2011e).

- Two ESAs are located at the far northern end of the alignment approximately 200 m north from the proposed alignment and are associated with Conservation Category Wetlands UFI 1101 and 15451;
- A large ESA located at 5 Centenary Road and 262 Lillydale Road, North Boyanup lies 30 m immediately south of the proposed alignment and is associated with the occurrence of geomorphic wetland UFI 1106, which is a Multiple Use, sumpland wetland;
- The CCW (UFI 931) portion of Five Mile Brook approximately 110 m upstream of the road crossing is also an ESA. This ESA is outside of the proposed alignment;
- An ESA associated with a hard rock quarry is located adjacent to Allenville Road, north of Hastie Road. This ESA is 80 m from the Project alignment. It is associated with the occurrence of geomorphic wetland UFI 13228, which is a Multiple Use, dampland wetland; and
- Two small ESAs lie west and east of the alignment near Lillydale Road approximately 200 m and 250 m from the alignment respectively. These are associated with a Multiple Use dampland wetland UFI 13228.

The areas of the ESAs are shown in Figure 3.

3.6 Vegetation

3.6.1 Native Vegetation Extent and Status

According to mapping by Heddle *et al.* (1980) the vegetation of the Study area is considered to be representative of the Southern River Vegetation Complex, the Bassendean Vegetation Complex - Central and South and the Karrakatta Complex-Central and South.

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

Vegetation extents of the pre-European vegetation complex (Mattiske and Havel,1998, Heddle *et al.*1980 and Molloy *et al.* 2007) within the Study area and the remaining percent of the vegetation associations present within the Study area, for the Shire of Capel, is detailed in Table 3.

Table 3 Vegetation association, extent and status within the Study area

Vegetation Complex	Pre-European Extent (Ha)	Remaining Extent (Ha)	Remaining Extent (%)	Protection (DEC CONS)	DEC SF (Ha)	Local Natural Areas (Ha)
Southern River Complex	9727	2102	22	180	63	1859
Bassendean Complex - Central and South	4947	1244	25	-	-	1244
Karrakatta Complex-Central And South	5584	3129	56	956	-	2173

According to the EPA (2006), the vegetation of the Southern River Complex and Bassendean Complex – Central and South are classified as '*Vulnerable'* in terms of extent of vegetation remaining compared to pre-European extents.

3.6.2 Threatened 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, and Vulnerable.

TECs are listed under both State and Federal legislation. Federally listed TECs are protected under the EBPC Act. DEC maintains a list of TECs for Western Australia, some of which are also protected under the EPBC Act.

DEC also maintains a Priority Ecological Community (PEC) List. PECs are not specifically listed under any formal Federal or State legislation but are considered by the DEC as important as whole ecosystems (including their processes and communities). Priorities 1, 2 and 3 PECs are ecological communities that are adequately known; are rare but not threatened, or 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.

A search of the DEC TEC database (2011c and 2011d) and the EPBC Protected Matters search tool (2011a) indicates there are six TECs and two PECs within 10 km of the Study Area as shown at Figure 4:

- SCP09, Dense shrublands on clay flats - listed as "Vulnerable" under the State DEC listing;
- SCP3c, *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain - listed as "Critically Endangered" under the State DEC listing and as "Endangered" under the Commonwealth TEC listing (State and Commonwealth significance);
- SCP07, Herb rich saline shrublands in clay pans- listed as "Vulnerable" under the State DEC listing;
- SCP08, Herb rich shrublands in clay pans - listed as "Vulnerable" under the State DEC listing;
- SCP18, Shrublands on calcareous silts of the Swan Coastal Plain - listed as "Vulnerable" under the State DEC listing;
- SCP19b, Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain (original description; Gibson et al. (1994) - listed as "Critically Endangered" under the State DEC listing;
- SCP25: Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands - listed as "Priority 3' under the State DEC listing; and
- SCP21b: Southern *Banksia attenuata* woodlands - listed as "Priority 3' under the State DEC listing.

Priority Ecological Community SCP 25 Southern *Eucalyptus gomphocephala - Agonis flexuosa* woodlands is listed as "Priority 3' under the State DEC listing and is mapped as being located within the southern section of the Study Area north of Woods Road (Figure 4).

Threatened ecological community SCP3c is formally protected under the Commonwealth *EPBC* Act 1999. The search results indicate there are a total of six SCP 3c TEC quadrats (id no.s ROSE01, ROSE02, ROSE04, ROSE05, WATER03, WATER05). Two TEC quadrats (WATER03 and WATER05) are located approximately 9.5 km north east of the northern most section of the alignment. The remaining TEC quadrats are located approximately 4 km south west of the most southern end of the alignment.

3.6.3 Conservation Significant Flora

Species of significant flora are protected under both State and Federal Acts. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act and the *State Wildlife Conservation Act 1950* (WC Act) can trigger referral to DSEWPaC and/or the EPA.

Also in Western Australia, the DEC produces a supplementary list of Priority Flora, these being species that are not considered Threatened under the WC Act but for which the Department feels there is a cause for concern. These species have no special legislative protection, but their presence would normally be considered relevant to an assessment of the conservation status of an area. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened flora.

Desktop queries of the EPBC Protected Matters Search, NatureMap Database and the DEC Rare Flora Database was undertaken. These searches identified the occurrence of 28 DEC Priority species and five Threatened species within 5 km of the Study Area and the possible occurrence of five EPBC listed species within 5 km of the Study Area. These species are shown below in Table 4 and further discussed in section 4.2.5.

Table 4 Conservation Significant species recorded as occurring or possibly occurring within or near to the Study Area

Family	Species	DEC Status	EPBC Status
Proteaceae	*Franklandia triaristata*	P4	
Apiaceae	*Brachyscias verecundus*	T	Critically Endangered
Apiaceae	*Platysace ramosissima*	P3	
Aponogetonaceae	*Aponogeton hexatepalus*	P4	
Asparagaceae	*Chamaescilla gibsonii*	P3	
Asteraceae	*Angianthus drummondii*	P3	
Asteraceae	*Rhodanthe pyrethrum*	P3	
Asteraceae	*Trichocline* sp. *Treeton* (B.J. Keighery & N. Gibson 564)	P2	
Centrolepidaceae	*Centrolepis caespitosa*	P4	Endangered

Family	Species	DEC Status	EPBC Status
Cyperaceae	*Carex tereticaulis*	P1	
Cyperaceae	*Schoenus benthamii*	P3	
Cyperaceae	*Schoenus capillifolius*	P2	
Cyperaceae	*Schoenus loliaceus*	P2	
Ericaceae	*Andersonia gracilis*	T	Endangered
Fabaceae	*Acacia flagelliformis*	P4	
Fabaceae	*Acacia semitrullata*	P4	
Fabaceae	*Pultenaea skinneri*	P4	
Goodeniaceae	*Anthotium junciforme*	P4	
Loganiaceae	*Mitreola minima*	P3	
Malvaceae	*Lasiopetalum membranaceum*	P3	
Menyanthaceae	*Ornduffia submersa*	P4	
Myrtaceae	*Darwinia foetida*	T	Critically Endangered
Myrtaceae	*Eucalyptus rudis subsp. cratyantha*	P4	
Myrtaceae	*Verticordia attenuata*	P3	
Myrtaceae	*Verticordia fimbrilepis* subsp. *fimbrilepis*	T	Endangered
Orchidaceae	*Caladenia huegelii*	R	
Orchidaceae	*Caladenia longicauda* subsp. *clivicola*	P4	
Orchidaceae	*Caladenia speciosa*	P4	
Orchidaceae	*Diuris drummondii*	T	
Poaceae	*Austrostipa jacobsiana*	P1	
Rutaceae	*Boronia humifusa*	P1	
Santalaceae	*Leptomeria furtiva*	P2	
Stylidiaceae	*Stylidium longitubum*	P3	

4. Field Investigation Results

4.1 Methodology

4.1.1 Flora and Vegetation Survey Methodology

The flora assessment included desktop investigations and field survey, conducted with regard to the EPA's Guidance Statement No. 51 (EPA, 2004a), where possible. GHD ecologist Gaynor Owen conducted the field flora survey on 21st to the 23rd September 2011.

The Study Area was traversed (using relévés) to record flora species visible and map vegetation types and condition (including weed status). Aerial photography was used to assist in the delineation of vegetation types present in the Study Area. Detailed information was collected in fifteen 10 x 10 metre quadrats.

The information recorded at each quadrat is provided in Table 5. Quadrat data is presented in Appendix D.

Table 5 Information recorded at each quadrat

Location	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System (GPS), to an accuracy usually within 5m; reading taken for the north-east corner of the quadrat
Physical Features	Aspect, soil attributes Percentage surface cover by: rocks, logs and branches, leaf litter, bare open soil
Vegetation Classification	Broad vegetation description
Vegetation Condition	As per Bush Forever Vegetation Condition Rating Scale (Keighery, 1994)
Disturbance	Level and nature of disturbances (e.g. weed presence, time since last fire, grazing)
Flora	List of flora within quadrat Measure of plant heights and percentage foliar cover. % Cover classed into ranges (<2%, 2-10%, 10-30%, 30-70%, 70-100%)

A list of flora species, collated from the quadrats and relévés, was generated for the Study Area. Where identification of flora species was uncertain, confirmation was made at the Western Australian State Herbarium.

The presence of EPBC Act, WC Act or Priority Flora was assessed through searching areas of suitable habitat. Vegetation was also assessed to determine the presence of TECs and PECs within the Study Area.

4.2 Vegetation and Flora Field Results

4.2.1 Vegetation Types

The vegetation in the Study Area was classified into seven vegetation types, not including highly disturbed vegetation, where clearing or other activities have fundamentally altered the composition of the native vegetation. Water bodies were also not included in the vegetation types.

These vegetation types have been mapped at Figure 5 and are summarised in Table 6.

Table 6 Vegetation types recorded in the Study Area

Vegetation Type	Vegetation Description	Site Photo
Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*	Open forest of *Eucalyptus marginata* and *Corymbia calophylla* over low open forest of *Banksia attenuata* and *Agonis flexuosa* over tall shrubland of *Kunzea glabrescens* and *Xylomelum occidentale* over shrubland of *Hibbertia hypericoides*, *Acacia* spp. and *Xanthorrhoea brunonis* over grassland over **Ehrharta* spp. over herbland of *Conostylis* spp., **Hypochaeris* sp. and *Drosera* spp. over open sedgeland of *Lepidosperma* spp.	
Open forest of *Banksia attenuata* and *Agonis flexuosa*	Open forest of *Banksia attenuata* and *Agonis flexuosa* over shrubland of *Hibbertis hypericoides*, *Macrozamia riedlei* and *Leucopogon propinquus* over open grassland of **Ehrharta* spp. and **Briza maxima* over herbland of *Conostylis aculeata* subsp. *gracilis*, **Hypochaeris* sp. and **Freesia alba* x *leichtlinii* over open sedgeland of *Schoenus grandiflorus*	

Open heath of *Melaleuca ?lateritia* and *Viminaria juncea* over sedgeland	Open heath of *Melaleuca ?lateritia* and *Viminaria juncea* over grassland of **Ehrharta calycina* over herbland of **Lotus angustissimus, *Romulea rosea* and **Cotula turbinata* over sedgeland of *Juncus subsecundus* and *Isolepis ?cernua*	
Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland	Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over grassland of Poaceae sp. over open herbland of *Hypochaeris* sp., **Freesia alba* x *leichtlinii* and **Ornithopus compressus* over sedgeland of Restionaceae sp.	
Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland	Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland of *Lepidosperma ?longitudinale*, *Juncus pallidus* and **Isolepis marginata* over herbland of **Ornithopus compressus*, **Romulea rosea* and **Cotula coronopifolia*	

Low open forest of *Eucalyptis rudis* and *Melaleuca preissiana* over sedgeland	Low open forest of *Eucalyptis rudis* and *Melaleuca preissiana* over grassland of **Ehrharta longiflora* over sedgeland of *Lepidosperma longitudinale* over herbland of **Lysimachia arvensis*, *Crassula colorata* and **Hypochaeris* sp.	
Scattered remnant vegetation of *Eucalypts* spp., *Banksia attenuata* and *Agonis flexuosa*	Scattered remnant vegetation of *Eucalypts* spp., *Banksia attenuata* and *Agonis flexuosa*	

4.2.2 Threatened Ecological Communities

The PEC SCP25 Southern *Eucalyptus gomphocephala* - *Agonis flexuosa* woodlands - listed as "Priority 3' under the State DEC listing is mapped within the southern section of the Study Area north of Woods Road (Figure 4). Throughout this section of the proposed alignment, GHD recorded the vegetation type as Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa* and Open forest of *Banksia attenuata* and *Agonis flexuosa*.

A statistical analysis of all GHD quadrat data located within the vicinity of the PEC SCP25 in relatively *Good* (4) vegetation condition was undertaken using PATN. PATN reports using the Bray Curtis dissimilarity, which is a statistic used to quantify the compositional dissimilarity between two different sites. It is equivalent to the total number of species that are unique to any one of the sites divided by the total number of species over the sites.

The floristic data from GHD quadrats 4 to 11 were compared to the quadrat data of Floristic Community Types (FCTs) from the Swan Coastal Plain (SCP) (Gibson *et al*., 1994 and Department of Environment and Protection, 1996). Two other FCTs were identified as potentially similar community types to GHD quadrat data. The two similar FCT quadrat data in the general location of the Study Area were included in the analysis.

FCTs identified as potentially similar to GHD quadrats and included in the analysis were:

- SCP21a Central *Banksia attenuata – Eucalyptus marginata* woodlands; and
- TEC SCP1b *Eucalyptus calophylla* woodlands on heavy soils of the southern Swan Coastal Plain - listed as "Vulnerable" under the State DEC listing.

A dendogram of the results is presented in Plate 1.

The results of the statistical analysis indicate that all GHD quadrats are similar to one another in species composition. It also shows that PEC SCP25 (quadrats bunb01, gelor01, MINN-1, MINN-2, MINN3 and C71-4) and SCP21a (quadrats AUSTRA-1, C71-2, MANEA-2, KEME-2 and C71-3) quadrats show affinities in plant species composition. Threatened Ecological Community SCP1b quadrats are not similar in plant species composition to the other FCTs.

The results of the statistical analysis indicate that the vegetation types mapped by GHD as Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa* and Open forest of *Banksia attenuata* and *Agonis flexuosa* do not represent an occurrence of the PEC SCP25, listed as "Priority 3' under the State DEC listing. PEC SCP25 is however located within the alignment, which strongly suggests GHD vegetation types Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa* and Open forest of *Banksia attenuata* and *Agonis flexuosa* are the PEC SCP25. Factors affecting the PATN analysis are the timing of the survey, which can affect the level of species identification (little or no flowering parts) and vegetation condition. The quadrat data used for the PEC SCP25 was collected in the early 1990s (A Webb 2011, pers comm., 16th). During this time, the vegetation condition within the Study Area may have declined through weed invasion and clearing. This can affect the results of the PATN analysis, as the species composition would be altered due to these two disturbance factors.

The flora and vegetation assessment did not record the Threatened ecological community SCP3c, *Eucalyptus calophylla - Xanthorrhoea preissii* woodlands within the Study Area.

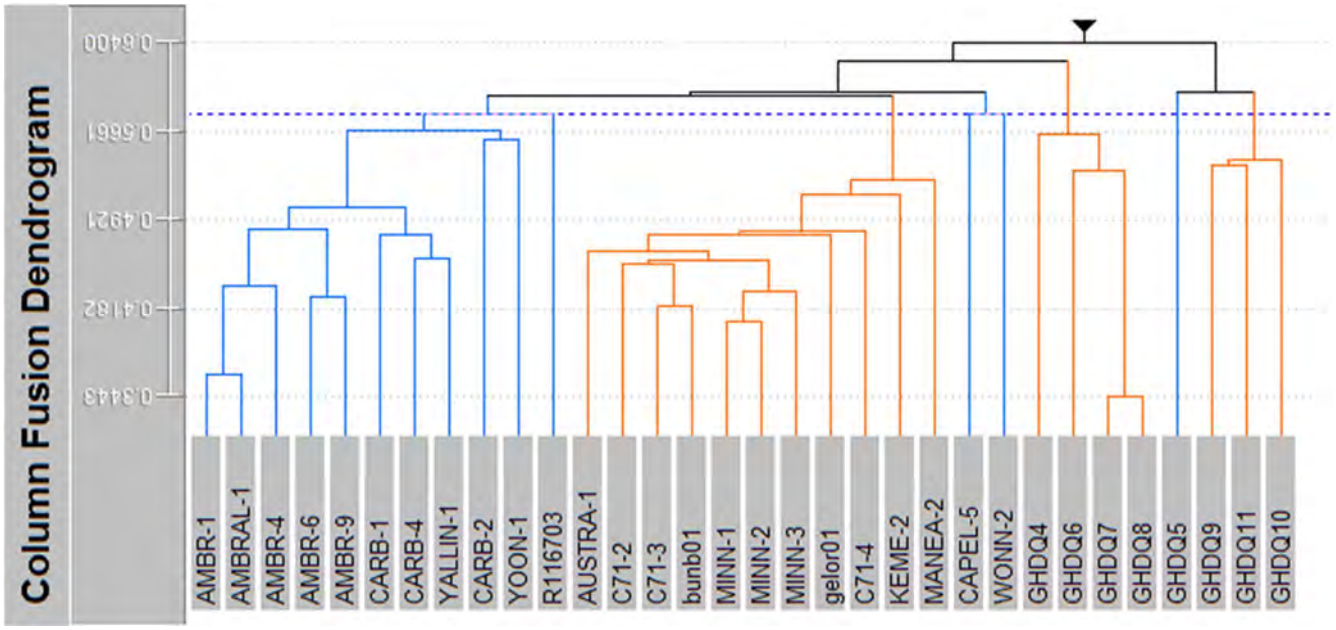

Plate 1 Dendogram comparing GHD quadrat data with Floristic Community Types from the Swan Coastal Plain within the vicinity of the Study Area

4.2.3 Vegetation Condition

The vegetation condition of the Study Area was assessed using the vegetation condition rating scale developed by Keighery (1994) that recognises the intactness of vegetation, which 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 scale consists of six rating levels as outlined below in Table 7.

Table 7 Vegetation Condition Rating Scale

Vegetation Condition Rating	Vegetation Condition	Description
1	*Pristine or Nearly So*	No obvious signs of disturbance.
2	*Excellent*	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
3	*Very Good*	Vegetation structure altered, obvious signs of disturbance.
4	*Good*	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability

Vegetation Condition Rating	Vegetation Condition	Description
		to regenerate it.
5	*Degraded*	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
6	*Completely Degraded*	The structure of the vegetation is no longer intact and the area is completely or almost without native species.

The vegetation condition of the Study Area ranged from *Pristine* (1) to *Completely Degraded* (6). Most of the Study Area rated between *Degraded* (5) to *Completely Degraded* (6). Clearing in the past and aggressive weed species have influenced the structure and composition of the native vegetation. Scattered *Eucalypt*, *Banksia* and *Agonis flexuosa* species and a degraded native understorey dominated along the majority of the proposed alignment.

Through the southern section of the Study Area the vegetation condition predominantly rated between *Very Good* (3) to *Degraded* (5). Most of the native vegetation within this section of the alignment has not been completely cleared. However native bushland has been severely impacted by weed invasion and some partial clearing. A small area of native vegetation type: Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*, adjacent to Jilley Road, rated *Excellent* (2) to *Very Good* (3). Minimal clearing and weed invasion was observed within this patch of bushland.

Native vegetation located adjacent to Marchetti Road rated *Pristine* (1). No evidence of disturbance was recorded during the survey for this vegetation type: Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*.

The vegetation condition of the geomorphic wetland UFI 1106, which is associated with the ESA located at 5 Centenary Road, and 262 Lillydale Road, North Boyanup, rated *Very Good* (3) to *Good* (4). Areas surrounding this wetland are *Completely Degraded* (pastureland). The wetlands vegetation type of Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland, has been invaded by weeds and grazing presently occurs on the edges of its boundaries.

The vegetation along the proposed alignment has predominantly not been burnt in the last 5 to 20 yrs. Small patches of vegetation have been burnt in the last 5- 10 years, but have not significantly impacted the vegetation condition of the Study Area.

Vegetation condition has been mapped at Figure 6, Appendix A.

4.2.4 Flora

Vegetation within the Study Area is considered to have a moderate degree of species diversity. A total of 155 plant taxa (including subspecies and varieties) representing 101 genera and 43 plant families was recorded in the Study Area. This total is comprised of 122 native species and 32 introduced (exotic) species. The dominant families represented from the survey included Myrtaceae (17 native species), Fabaceae (16 native species and six introduced species) and Asteraceae (four native species and nine introduced species).

A full list of flora species identified within the Study Area is presented in Appendix D.

4.2.5 Conservation Significant Flora

No Threatened (previously called Declared Rare) as listed by the DEC (2011a) or species of national conservation significance listed under the EPBC Act (DSEWPaC, 2011a) were recorded from the Study Area. This assessment reflects the results of the assessment conducted in spring 2008 (GHD, 2008).

Sandplain White Spider Orchid *(Caladenia speciosa)*, a Priority 4 as listed by the DEC (2011a), was recorded within the Study Area (Plate 2). This species was mostly recorded in small populations throughout the southern section of the alignment between Yalinda Drive and Bussell Highway. A total of 71 *Caladenia speciosa* (P4) plants were recorded within the Project road reserve. One population of *Caladenia speciosa* (Easting 371476.72, Northing 6299909.05) was located just outside the alignment.

The numbers within each population and their locations are presented in Table 8 and mapped in Figure 5.

Plate 2 ***Caladenia speciosa* (P4) recorded within Study area**

Table 8 **Recorded Locations of *Caladenia speciosa* (P4) Within the Study area, September 2011**

DESC_	Status	Number of plants	Easting	Northing
Caladenia speciosa	P4	1	371445.84	6299687.39
Caladenia speciosa	P4	2	372060.39	6300104.31
Caladenia speciosa	P4	1	372292.64	6300160.67
Caladenia speciosa	P4	1	372161.52	6300158.25

DESC_	Status	Number of plants	Easting	Northing
Caladenia speciosa	P4	1	372488.02	6300186.62
Caladenia speciosa	P4	1	372500.92	6300210.27
Caladenia speciosa	P4	20	372522.41	6300210.27
Caladenia speciosa	P4	3	372543.91	6300233.92
Caladenia speciosa	P4	7	372558.96	6300240.37
Caladenia speciosa	P4	5	372580.46	6300197.37
Caladenia speciosa	P4	20	372541.76	6300218.87
Caladenia speciosa	P4	5	372500.32	6300210.50
Caladenia speciosa	P4	3	374187.93	6301048.10
Caladenia speciosa	P4	1	371476.72	6299909.05

This species has previously been recorded directly adjacent to the Study Area, in the southern end of the alignment besides Bussell Highway (Figure 4, Appendix A).

An assessment of the likelihood of occurrence of the threatened and priority listed species listed that potentially occur within the Study Area has been prepared and is provided in Appendix E. The likelihood of occurrence has been assessed based on the known locations and distributions of the species and habitat requirements. Definitions for the likelihood of occurrence assessment are provided in Table 9.

This assessment identified one taxa which is likely to occur within the Study Area: *Caladenia speciosa* (P4) and twenty four taxa have been identified that may possibly occur within the Study Area based on the presence of suitable habitat. None of these additional species were identified during the 2008 or 2011 flora surveys.

Table 9 Definitions for likelihood of occurrence

Likelihood of Occurrence	Definition
Known	Species definitely recorded within the Site either from previous records or field survey results
Likely	Species previously recorded within a 10 km radius and suitable habitat occurs on the Site
Possible	Species previously recorded within a 10 km radius with marginally suitable habitat occurring on the Site
Unlikely	Species previously recorded within a 10 km radius but suitable habitat does not occur on the Site
Highly Unlikely	Species not previously recorded within a 10 km radius, suitable habitat does not occur on the Site and/ or Site is outside the species' natural distribution

4.2.6 Introduced Flora

A total of 32 weed species were recorded from within the Study Area. They are listed in the full flora species list presented in Appendix D.

The most common weed species recorded were **Ehrharta* spp. (Veldt Grass), **Hypochaeris* sp. and **Freesia alba* x *leichtlinii*.

4.2.1 Declared Plants

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*. The Department of Agriculture and Food Western Australia (DAFWA) and the Agriculture Protection Board 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 control that plant on their properties. 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. Among the factors considered in categorising declared plants are:

- The impact of the plant on individuals, agricultural production and the;
- Community in general;
- Whether it is already established in the area; and
- The feasibility and cost of possible control measures.

These Declared Plants are divided into 5 classes, which are detailed in Appendix D. Three of these species, **Asparagus asparagoides* (Bridal Creeper), **Moraea flaccida* (One-leaf Cape Tulip) and **Zantedeschia aethiopica* (Arum Lily) are listed as Declared Plant species pursuant to Section 37 of the *Agricultural and Related Resources Protection Act 1976* (WA). **Zantedeschia aethiopica* is listed as P1 and P4 for the whole state and **Moraea flaccida* is listed as P1 for the whole state and P4 for the municipal districts of the Shire of Capel, **Asparagus asparagoides* is listed as P1 for the whole state and is regarded as a Weed of National Significance (WONs).

Five populations of **Asparagus asparagoides*, six populations of **Zantedeschia aethiopica* and one population of **Moraea flaccida* were recorded. These populations are presented in Table 10 and have been mapped at Figure 6.

Table 10 Declared weeds located within Study Area September 2011

Species	Number of plants	Easting	Northing
**Asparagus asparagoides*	1	375293	6302166
**Asparagus asparagoides*	10	375293	6302289
**Asparagus asparagoides*	1	375312	6302227
**Asparagus asparagoides*	1	375302	6302038
**Asparagus asparagoides*	1	372989	6300335
* *Moraea flaccida*	1	376128	6304382

Species	Number of plants	Easting	Northing
**Zantedeschia aethiopica*	1	376099	6304380
**Zantedeschia aethiopica*	3	376097	6304335
**Zantedeschia aethiopica*	1	377592	6304840
**Zantedeschia aethiopica*	1	377594	6304934
**Zantedeschia aethiopica*	1	377536	6304930
**Zantedeschia aethiopica*	15	371989	6300008

4.3 Dieback

Main Roads Western Australia has initiated a dieback assessment of the project area which is being conducted separately to this Flora and Vegetation Assessment.

4.4 Wetland and Waterways Assessment

The Study Area intercepts 11 wetlands, with most being Multiple Use, sumpland wetlands located in the cleared / degraded northern half of the alignment. The vegetation condition of the wetlands generally rated between *Degraded* (5) to *Completely Degraded* (6). The areas where the wetlands occur have generally been cleared in the past for grazing and are now vegetated with weed species.

A small Resource Enhancement wetland (UFI 1117) was located within the alignment north of Lillydale Road (Figure 2). The vegetation type of this wetland was Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland (Figure 5). The vegetation condition rating was *Very Good* (3) as the area was invaded by weed species. This wetland was not inundated with water at the time of the survey.

The proposed alignment also intercepted the northern section of a large, permanent Multiple Use, sumpland wetland UFI 1106, associated with the ESA at 5 Centenary Road, and 262 Lillydale Road, North Boyanup. The vegetation type of this wetland was Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland (Figure 5). The vegetation condition rated between *Very Good* (3) to *Degraded* (5) as the area was invaded by weed species.

North of the wetland UFI 1106 is a geomorphic Multiple Use palusplain wetland UFI 1105 (Plate 3). At the time of the survey, this area was inundated with water. The vegetation type of this wetland was Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland. The vegetation condition of this wetland rated *Degraded* (5) to *Completely Degraded* (6).

The Study Area intercepted Five Mile Brook, north of Woods Road and at Jilley Road in the southern section of the alignment (Plate 4). The vegetation type along the edges of the brook were Low open forest of *Eucalyptis rudis* and *Melaleuca preissiana* over sedgeland. The vegetation condition of the brook rated *Good* (4) to *Degraded* (5). This area was infested with weed species and has been heavily grazed.

Plate 3 Geomorphic Multiple Use palusplain wetland UFI 1105

Plate 4 Five Mile Brook

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Appendix A

Figures

1:30,000 (at A3)

0 150 300 600 900 1,200 1,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Roads

Disturbance Footprint

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road Southern Section,
South Western Highway to Bussell Highway
Environmental Services

Job Number	6127467
Revision	0
Date	21 Feb 2012

Site Location

Figure 1

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Data source: Landgate: Bunbury 2008 Mosaic - 20111101; Main Roads WA: Roads - 20111027; GA: Geodata Topo 250K Series III - 2006; GHD: Disturbance Footprint. Created by: cagilbert, mczekaj

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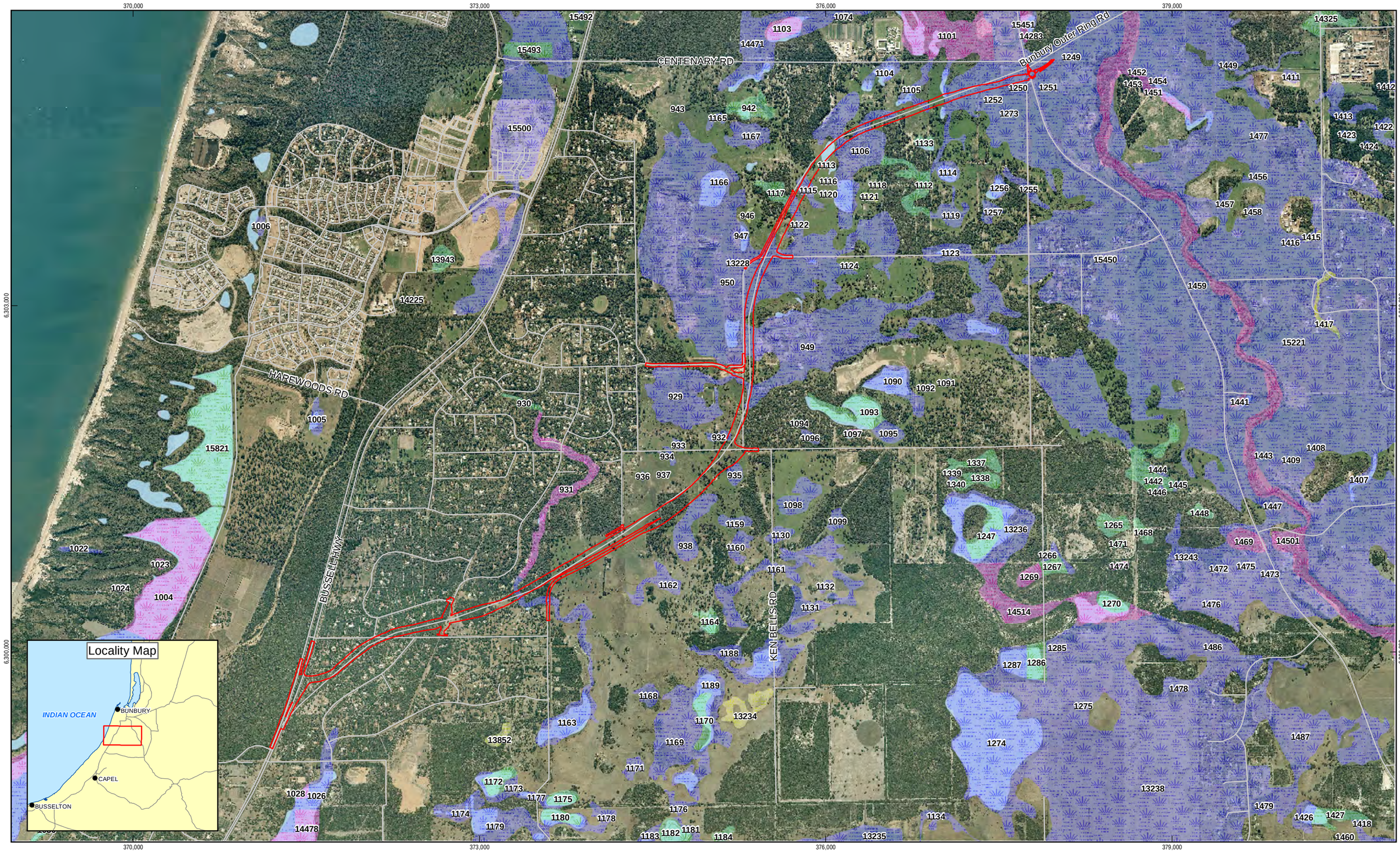

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Roads
- Disturbance Footprint
- Hydrology

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed

GHD CLIENTS | PEOPLE | PERFORMANCE

mainroads WESTERN AUSTRALIA

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number	6127467
Revision	1
Date	21 Feb 2012

Wetlands and Hydrological Features Figure 2

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Data source: Landgate: Bunbury 2008 Mosaic - 20111101, Hydrology - 20111206; DEC: Geomorphic Wetlands - 20111027; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint; GA: 250K Australian Topographic Series - 2006. Created by: cagilbert

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6,303,000

CENTENARY RD

Bunbury Outer Ring Rd

HAREWOODS RD

BUSSELL HWY

KEN BELLS RD

6,300,000

Locality Map

INDIAN OCEAN

BUNBURY

CAPEL

BUSSELTON

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1:30,000 (at A3)

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Roads
- Environmentally Sensitive Areas
- Disturbance Footprint

GHD CLIENTS | PEOPLE | PERFORMANCE

mainroads WESTERN AUSTRALIA

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number	6127467
Revision	0
Date	21 Feb 2012

Environmentally Sensitive Areas

Figure 3

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Data source: Landgate: Bunbury 2008 Mosaic - 20111101; DEC: Environmentally Sensitive Areas - 20111111; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint; GA: 250K Topographic Series - 2006. Created by: cagilbert

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CENTENARY RD

Bunbury Outer Ring Rd

HAREWOODS RD

BUSSELL HWY

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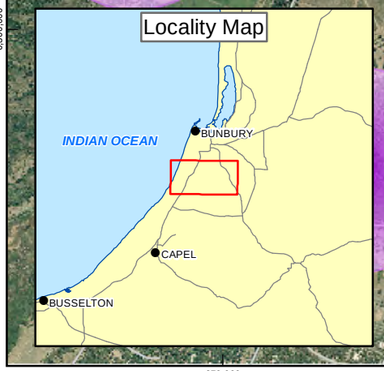

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1:30,000 (at A3)

0 150 300 600 900 1,200 1,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Threatened Flora

- (T) Threatened Flora - Extant Taxa
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa

- Roads
- Disturbance Footprint

Threatened & Priority Ecological Communities

- Priority
- Threatened

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Conservation Significant Communities and Species

Job Number	6127467
Revision	0
Date	21 Feb 2012

Figure 4

G:\61\27467\GIS\Maps\MXD\6127467_G009_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111101, DEC: Declared Rate & Priority Species - 20111101, Threatened Ecological Communities - 20111110. Main Roads WA: Roads - 20111027; GA: 250K Australian Topographic Series - 2006; GHD: Disturbance Footprint. Created by: cagilbert

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1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

- Open heath of *Melaleuca ?lateritia* and *Viminaria juncea* over sedgeland
- Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland
- Scattered remnant vegetation of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Low open forest of *Eucalyptus rudis* and *Melaleuca preissiana* over sedgeland
- Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland
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- Open forest of *Eucalyptus* spp., *Banksia attenuata* and *Agonis flexuosa*
- Highly Disturbed
- Water Body

GHD CLIENTS|PEOPLE|PERFORMANCE

mainroads WESTERN AUSTRALIA

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 1 of 8

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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372,500 373,000 373,500 374,000

6,301,000 6,300,500 6,300,000

EUCALYPT DR
COKELUP RD
YALINDA DR
Bunbury Outer Ring Rd
JILLEY RD
BANKSIA RD
WOODS RD
BROCKWAY DR

1 2 3 4 5 6 7 8 9 10

Locality Map
INDIAN OCEAN

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

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- Highly Disturbed
- Water Body

GHD CLIENTS|PEOPLE|PERFORMANCE

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Sheet 2 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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374,000 374,500 375,000 375,500

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ZANADU CT

TARROCK CT

YALINDA DR

MARCHETTI RD

DUCANE RD

Bunbury Outer Ring Rd

11

12

9

Locality Map

INDIAN OCEAN

1 2 3 4 5 6 7 8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

- Open heath of *Melaleuca ?lateritia* and *Viminaria juncea* over sedgeland
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- Highly Disturbed
- Water Body

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 3 of 8

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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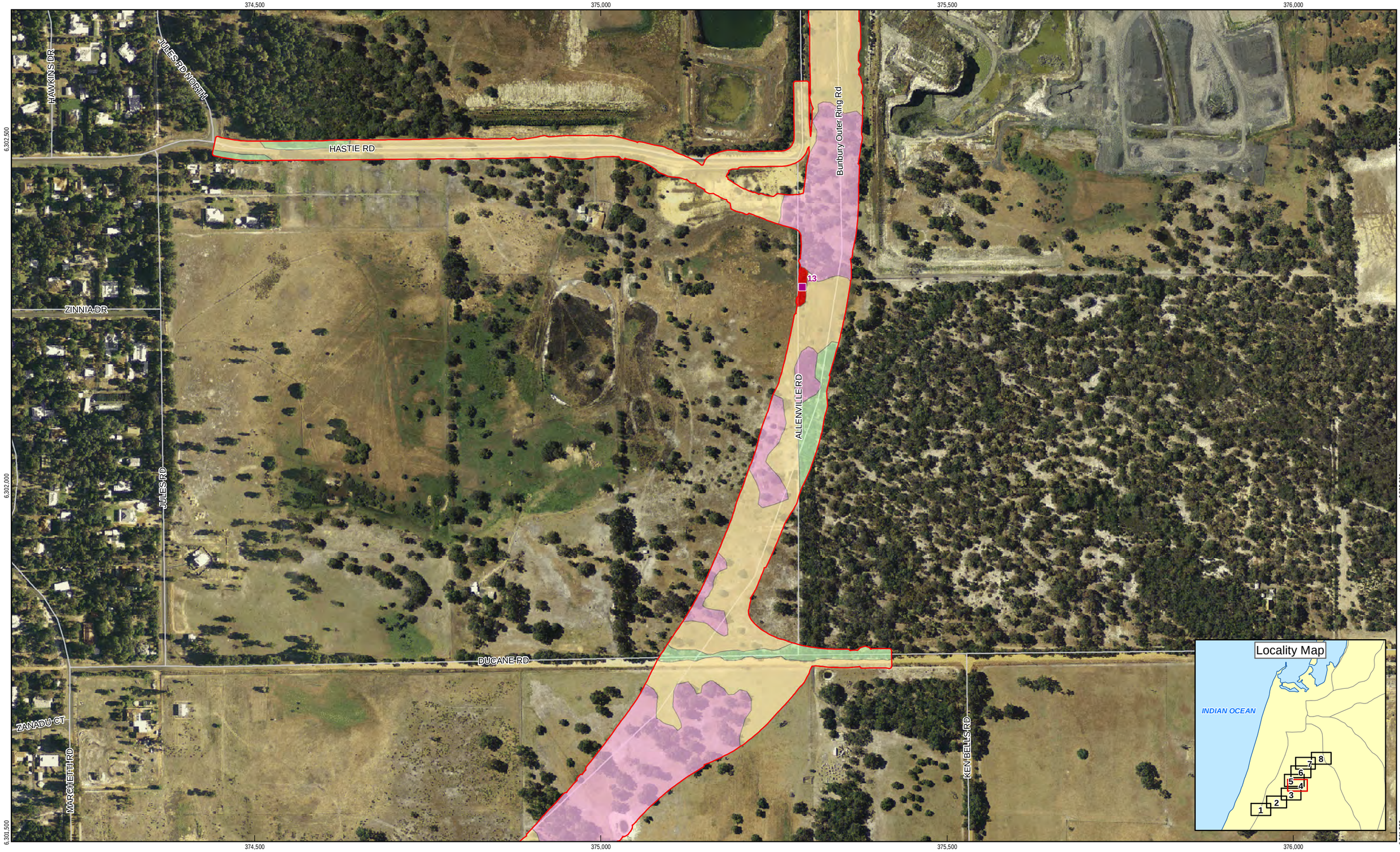

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

Vegetation Description

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 4 of 8

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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HAWKINS DR
BOLEY CT
ORCHID PL
TEATREE PL
JULES RD NORTH
ALLENVILLE RD
Bunbury Outer Ring Rd
HASTIE RD
YALINDA DR
COACHWOOD WY
ZINNIA DR
JULES RD
SIERRA PL
13

Locality Map
INDIAN OCEAN
1 2 3 4 5 6 7 8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

- Quadrat
- *Caladenia speciosa* (P4)
- Roads
- Disturbance Footprint

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Sheet 5 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Sheet 6 of 8

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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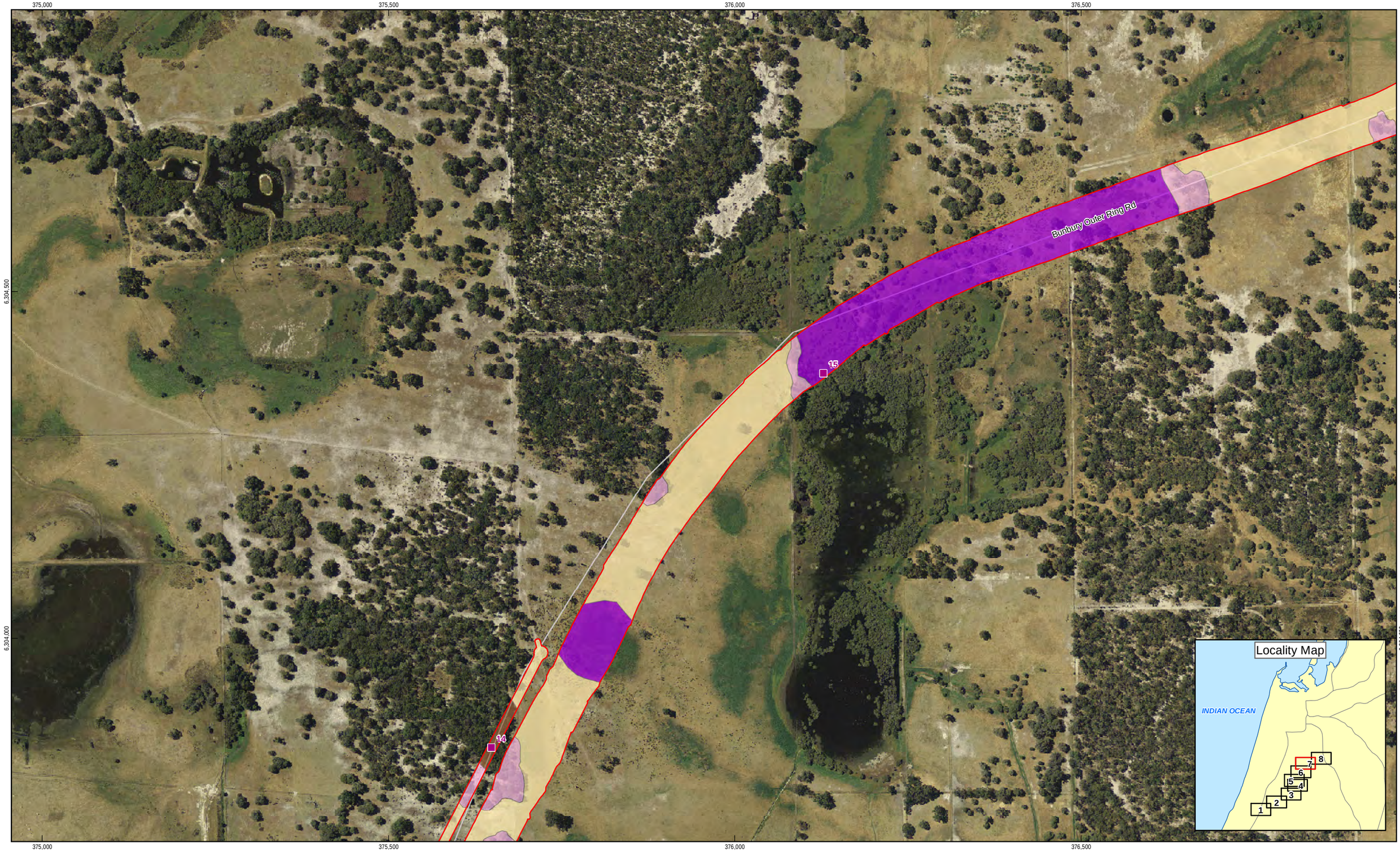

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

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- Highly Disturbed
- Water Body

CLIENTS | PEOPLE | PERFORMANCE

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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377,000 377,500 378,000 378,500

6,305,000

6,304,500

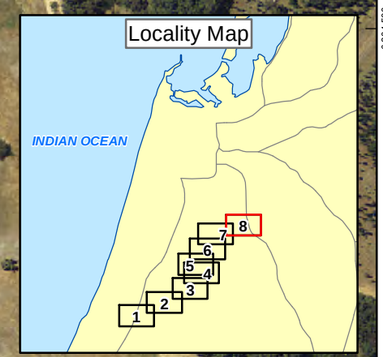
CENTENARY RD

CENTENARY ST

Bunbury Outer Ring Rd

SOUTH WESTERN HWY

QUEELUP RD



1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

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- Water Body

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 8 of 8

Vegetation Types, Quadrat Locations and Conservation Significant Flora

Figure 5

G:\61\27467\GIS\Maps\MXD\6127467_G005_Rev1.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GA: Topographic 250K Series 3 - 2006; GHD: Disturbance Footprint - 20111103, Vegetation Description - 20111104, Quadrat - 20111104, *Caladenia speciosa* (P4) - 20111104 Created by: cagilbert

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370,500 371,000 371,500 372,000

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BANKSIA RD

WOODS RD

Bunbury Outer Ring Rd

BROCKWAY DR

ST CLAIR PL

QUAMBI DR

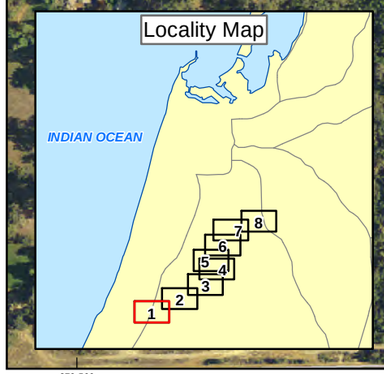
BUSSELL HWY

MANEA DR

LAKES RD

CALINUP RD

3 3 6 3-4 6 3-4 4-5 3-4 3-4 6



1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

- **Asparagus asparagoides*
- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

- 1. Pristine or Nearly So
- 2. Excellent
- 3. Very Good
- 4. Good
- 5. Degraded
- 6. Completely Degraded
- WB: Water Body

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weed Locations

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 1 of 8

Figure 6

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert

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EUCALYPT DR
COKELUP RD
YALINDA DR
BANKSIA RD
JILLEY RD
WOODS RD
Bunbury Outer Ring Rd
WB
4-5
5-6
6
5
3-4
3
2-3

Locality Map
INDIAN OCEAN
1 2 3 4 5 6 7 8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

- **Asparagus asparagoides*
- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

Vegetation Condition

- 1. Pristine or Nearly So
- 2. Excellent
- 3. Very Good
- 4. Good
- 5. Degraded
- 6. Completely Degraded
- WB: Water Body

CLIENTS | PEOPLE | PERFORMANCE

Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Job Number 6127467
Revision 1
Date 20 Feb 2012

Vegetation Condition and Declared Weed Locations

Figure 6

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Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert

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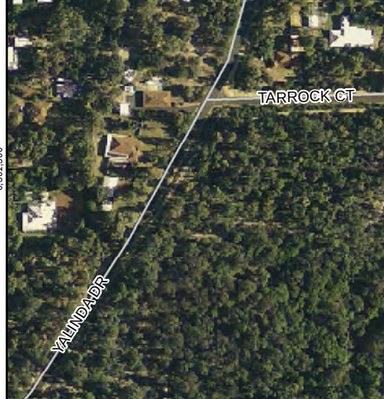
ZANADU CT
TARROCK CT
YALINDA DR
MARCHETTI RD
DUCANE RD
Bunbury Outer Ring Rd

6 5-6 6 6 5-6 6 6 5 4-5 5-6 6 1 3-4 6 6



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0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds

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- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads

Disturbance Footprint

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- 4. Good
- 5. Degraded
- 6. Completely Degraded
- WB: Water Body

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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weed Locations

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 3 of 8

Figure 6

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert

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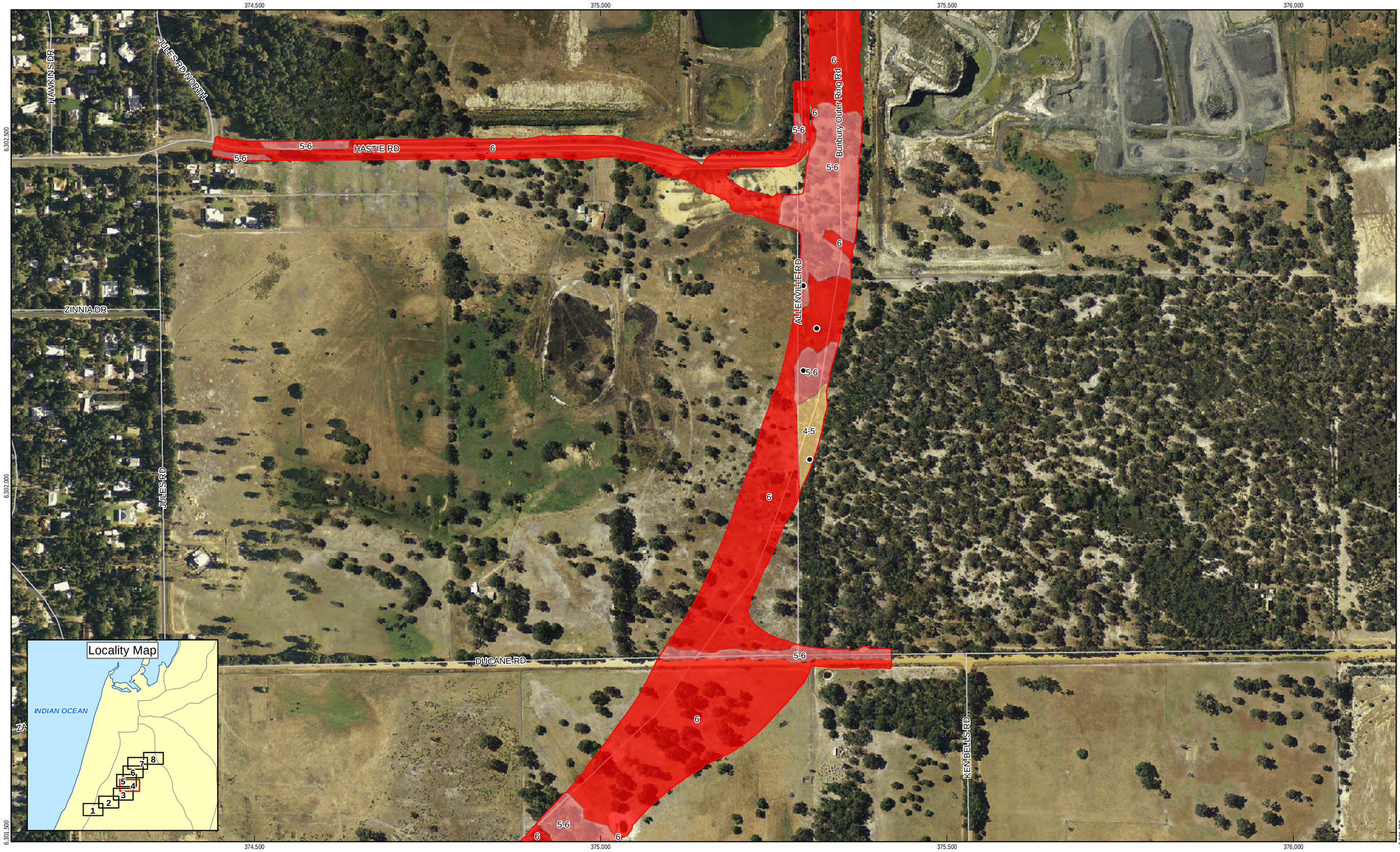

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Main Roads Western Australia
Bunbury Outer Ring Road
Southern Section, South Western Highway to Bussell Highway

Vegetation Condition and Declared Weed Locations

Job Number 6127467
Revision 1
Date 20 Feb 2012

Sheet 4 of 8

Figure 6

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert

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

374,000 374,500 375,000 375,500

6,303,000 6,302,500 6,302,000

HAWKINS DR
ORCHID PL
BOLEY CT
TEA TREE PL
JULES RD NORTH
ALLENVILLE RD
Bunbury Outer Ring Rd
HASTIE RD
YALINDA DR
COACHWOOD WY
ZINNIA DR
JULES RD

6
5-6
4-5

Locality Map
INDIAN OCEAN
1 2 3 4 5 6 7 8

1:5,000 (at A3)
0 25 50 100 150 200 250
Metres
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Declared Weeds
- **Asparagus asparagoides*
- **Moraea flaccida*
- **Zantedeschia aethiopica*

Roads
Disturbance Footprint

Vegetation Condition
1. Pristine or Nearly So
2. Excellent
3. Very Good
4. Good
5. Degraded
6. Completely Degraded
WB: Water Body

GHD CLIENTS|PEOPLE|PERFORMANCE

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Southern Section, South Western Highway to Bussell Highway

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Sheet 5 of 8

Vegetation Condition and Declared Weed Locations

Figure 6

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1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Main Roads Western Australia
Bunbury Outer Ring Road
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Job Number 6127467
Revision 1
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Sheet 6 of 8

Vegetation Condition and Declared Weed Locations

Figure 6

G:\61\27467\GIS\Maps\MXD\6127467_G006_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111005; Main Roads WA: Roads - 20111027; GHD: Disturbance Footprint - 20111103, Vegetation Condition - 20111104, Declared Weeds - 20111109; GA: 250K Topographic Series 3 - 2006. Created by: cagilbert

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375,000 375,500 376,000 376,500

6,304,500

6,304,000

Bunbury Outer Ring Rd

6 5-6 4 3 6 6 3 5-6 6

Locality Map

INDIAN OCEAN

1 2 3 4 5 6 7 8

1:5,000 (at A3)

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Figure 6

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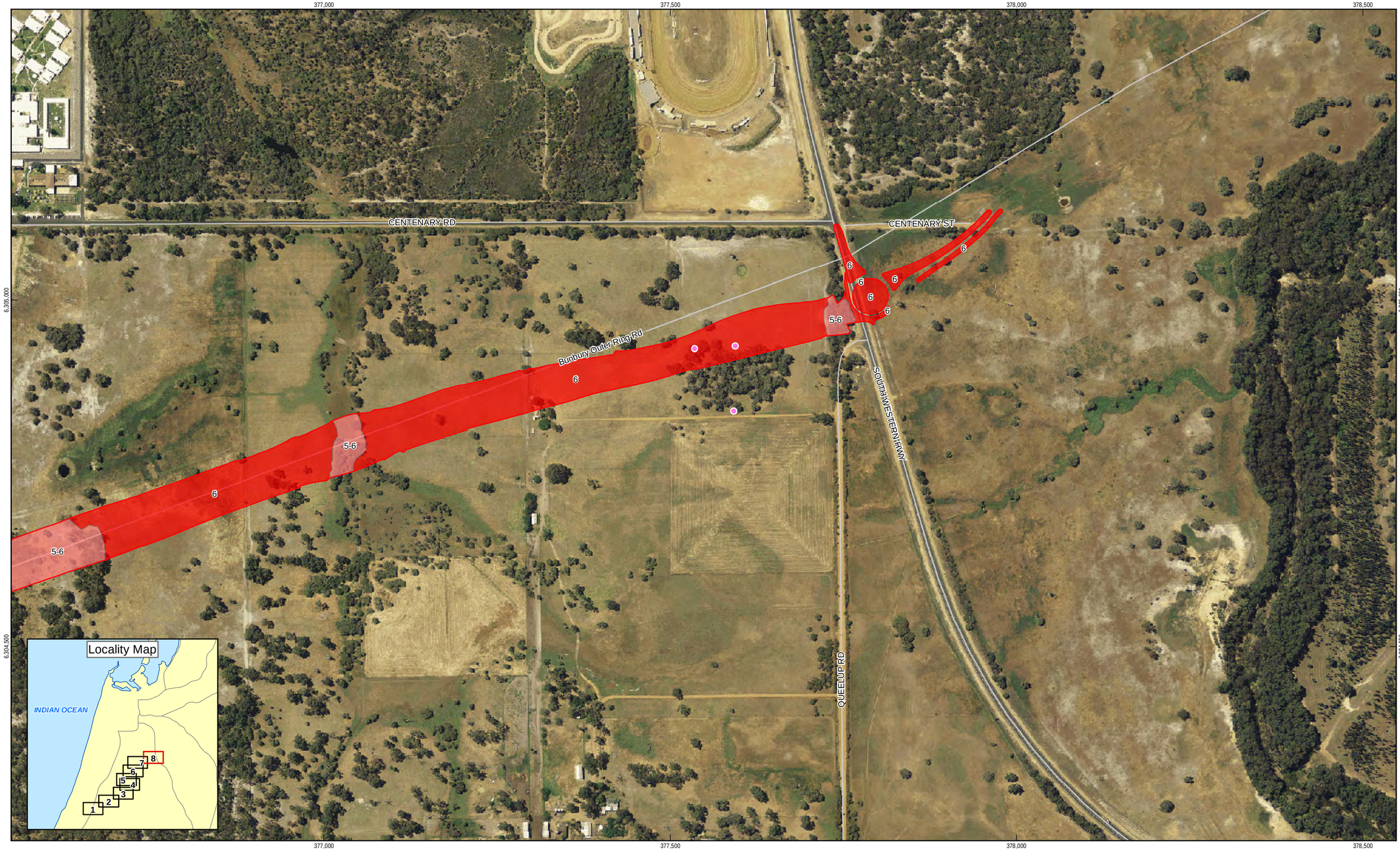

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Sheet 8 of 8

Vegetation Condition and Declared Weed Locations

Figure 6

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Appendix B

Flora Legislation

Conservation categories and definitions for *Environment Protection and Biodiversity Conservation Act 1999* Act listed flora and fauna species

Conservation codes and descriptions for DEC Declared Rare and Priority flora species

Conservation codes for Western Australian Flora and Fauna listed under the *Wildlife Conservation Act 1950* and the DEC

DEC Priority fauna codes (Species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern)

Department of Agriculture Declared Plant Classes (Standard Control Codes)

EPBC Act Fauna Conservation Categories

Listed threatened species and ecological communities

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- extinct in the wild,
- critically endangered,
- endangered, or
- vulnerable.

Critically endangered and endangered species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- lead to a long-term decrease in the size of a population, or
- reduce the area of occupancy of the species, or
- fragment an existing population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or
- disrupt the breeding cycle of a population, or
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or
- interfere with the recovery of the species.

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.*

Vulnerable species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- lead to a long-term decrease in the size of an important population of a species, or
- reduce the area of occupancy of an important population, or
- fragment an existing important population into two or more populations, or
- adversely affect habitat critical to the survival of a species, or

- disrupt the breeding cycle of an important population, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or

result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or

- interferes substantially with the recovery of the species.

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.*

Listed migratory species

The EPBC Act protects lands and migratory species that are listed under International Agreements.

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA);
- The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); and
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).
- other international agreements approved by the Commonwealth Environment Minister.

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species are also listed as threatened species.

The criteria below are relevant to migratory species that are not threatened.

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or

- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

- habitat utilized by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
- habitat utilized by a migratory species which is at the limit of the species range, or
- habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated).

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.*

Conservation categories and definitions for *Environment Protection and Biodiversity Conservation Act 1999* Act listed flora and fauna species

Conservation Category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years
Extinct in the Wild	Taxa known to survive only in captivity
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future
Endangered	Taxa facing a very high risk of extinction in the wild in the near future
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term
Near Threatened	Taxa that risk becoming Vulnerable in the wild
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not considered Threatened

Conservation codes and descriptions for DEC Declared Rare and Priority flora species

Conservation Code	Description
Threatened: Declared Rare Flora – Extant Taxa	Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
P1: Priority One – Poorly Known Taxa	Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2: Priority Two – Poorly Known Taxa	Taxa which are known from one or a few (generally<5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P3: Priority Three – Poorly Known Taxa	Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
P4: Priority Four – Taxa in need of monitoring	Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.

Conservation codes for Western Australian Flora and Fauna listed under the *Wildlife Conservation Act 1950* and the DEC.

Code	Conservation Category	Description
T	Schedule 1 under the WC Act	**Threatened Fauna** (Fauna that is rare or is likely to become extinct **Threatened Flora** (Declared Rare Flora – Extant) Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such. **CR:** Critically Endangered – considered to be facing an extremely high risk of extinction in the wild. **EN:** Endangered – considered to be facing a very high risk of extinction in the wild. **VU**: Vulnerable – considered to be facing a high risk of extinction in the wild.
X	Schedule 2 under the WC Act	**Presumed Extinct Fauna** **Presumed Extinct Flora** (Declared rare Flora – Extinct) Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
IA	Schedule 3 under the WC Act	**Birds protected under an international agreement** Birds that are subject to an agreement between governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.
S	Schedule 4 under the WC Act	**Other specially protected fauna** Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.
1	Priority One: Poorly-known taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads Western Australia WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

Code	Conservation Category	Description
2	Priority Two: Poorly-known taxa	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
3	Priority Three: Poorly-known taxa	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4	Priority Four: Rare, Near Threatened and other taxa in need of monitoring	**(a**) **Rare**. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. **(b) Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. **(c)** Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5	Priority 5: Conservation Dependent taxa	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

DEC Priority fauna codes (Species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern)

Conservation Code	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc.
Priority 3	Taxa which are known from few specimens or sight records, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	Rare taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Department of Agriculture Declared Plant Classes (Standard Control Codes)

Priority Class	Description
P1	Prohibits movement of plants or their seeds within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
P2	Eradicate infestation to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3	Control infestation in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants.
P4	Prevent the spread of infestation from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set on all plants.
P5	Infestations on public lands must be controlled

Appendix C

Desktop Searches

EPBC Protected Matters search

NatureMap flora

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

EPBC Act Protected Matters Report: Coordinates

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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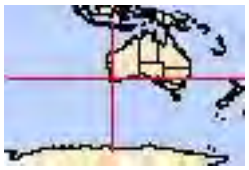

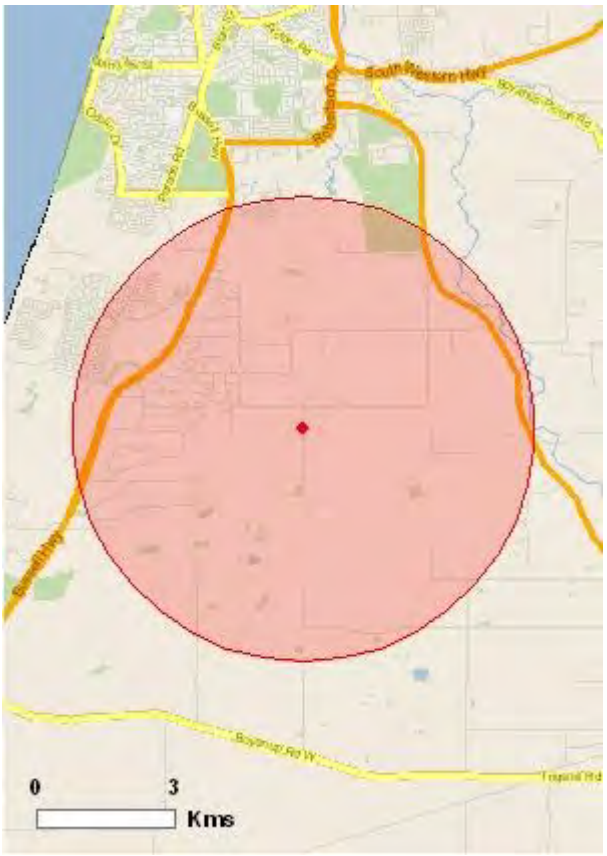

Coordinates
Buffer: 5.0Km

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance (Ramsar Wetlands):	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communitites:	None
Threatened Species:	13
Migratory Species:	7

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	5
Whales and Other Cetaceans:	None

Critical Habitats:	None
Commonwealth Reserves:	None

Report Summary for Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	None
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	None

Details

Matters of National Environmental Significance

Threatened Species **[Resource Information]**

Name	Status	Type of Presence
BIRDS		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo [67034]	Vulnerable	Species or species habitat may occur within area
Calyptorhynchus baudinii Baudin's Black-Cockatoo, Long-billed Black-Cockatoo [769]	Vulnerable	Breeding known to occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Breeding likely to occur within area
Sternula nereis nereis Fairy Tern (Australian) [82950]	Vulnerable	Species or species habitat may occur within area
MAMMALS		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Pseudocheirus occidentalis Western Ringtail Possum [25911]	Vulnerable	Species or species habitat likely to occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat may occur within area
PLANTS		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Brachyscias verecundus Ironstone Brachyscias [81321]	Critically	Species or species habitat may occur within area

	Endangered	
Centrolepis caespitosa [6393]	Endangered	Species or species habitat likely to occur within area
Darwinia foetida Muchea Bell [83190]	Critically Endangered	Species or species habitat likely to occur within area
Verticordia fimbrilepis subsp. fimbrilepis Shy Featherflower [24631]	Endangered	Species or species habitat may occur within area

Migratory Species **[Resource Information]**

Name	Status	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species **[Resource Information]**

Name	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Invasive Species **[Resource Information]**

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat may occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtiji Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:
- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:
- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:
- non-threatened seabirds which have only been mapped for recorded breeding sites;
- seals which have only been mapped for breeding sites near the Australian continent.

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-33.42059 115.66131

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts

-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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NatureMap Species Report

Created By Guest user on 20/09/2011

Kingdom Plantae
Method 'By Circle'
Centre 115°39' 29" E,33°24' 50" S
Buffer 5km
Group By Family

Family	Species	Records
Amaranthaceae	1	1
Anarthriaceae	3	4
Anthericaceae	1	1
Apiaceae	4	10
Araliaceae	2	5
Asparagaceae	15	23
Asteraceae	17	25
Boryaceae	1	1
Campanulaceae	3	4
Caprifoliaceae	1	2
Caryophyllaceae	1	1
Casuarinaceae	1	2
Celastraceae	1	2
Centrolepidaceae	3	5
Chenopodiaceae	1	1
Colchicaceae	3	3
Commelinaceae	1	1
Crassulaceae	1	1
Cyperaceae	24	33
Dasypogonaceae	1	2
Dennstaedtiaceae	1	1
Dilleniaceae	8	17
Droseraceae	8	11
Elaeocarpaceae	2	3
Ericaceae	11	16
Euphorbiaceae	2	4
Fabaceae	36	79
Geraniaceae	1	1
Goodeniaceae	7	8
Haemodoraceae	5	8
Hemerocallidaceae	5	8
Hydatellaceae	1	1
Iridaceae	3	5
Juncaceae	1	2
Lamiaceae	1	4
Lauraceae	1	1
Lentibulariaceae	2	2
Loganiaceae	1	1
Loranthaceae	1	1
Malvaceae	1	2
Menyanthaceae	2	3
Myrtaceae	12	18
Orchidaceae	43	64
Oxalidaceae	1	1
Phyllanthaceae	1	2
Poaceae	23	36
Podocarpaceae	1	1
Polygalaceae	1	1
Pottiaceae	1	1
Proteaceae	15	30
Restionaceae	5	9
Rubiaceae	2	2
Rutaceae	5	9
Santalaceae	2	2
Solanaceae	1	1
Stylidiaceae	12	14
Xanthorrhoeaceae	1	1
Zamiaceae	1	2
TOTAL	**312**	**499**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Amaranthaceae					
1.	25840	*Amaranthus blitum*	Y		
Anarthriaceae					
2.	1062	*Anarthria prolifera*			
3.	1097	*Lyginia barbata*			
4.	18049	*Lyginia imberbis*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Anthericaceae					
5.	-3646	*Thysanotus sp. manglesianus/patersonii scps*			
Apiaceae					
6.	6203	*Actinotus glomeratus*			
7.	6222	*Homalosciadium homalocarpum*			
8.	6249	*Platysace compressa (Tapeworm Plant)*			
9.	6289	*Xanthosia huegelii*			
Araliaceae					
10.	6223	*Hydrocotyle alata*			
11.	6280	*Trachymene pilosa (Native Parsnip)*			
Asparagaceae					
12.	1280	*Chamaescilla corymbosa (Blue Squill)*			
13.	-9574	*Hyacinthoides sp.*			Y
14.	1308	*Laxmannia sessiliflora (Nodding Lily)*			
15.	1228	*Lomandra hermaphrodita*			
16.	1234	*Lomandra nigricans*			
17.	1239	*Lomandra preissii*			
18.	1240	*Lomandra purpurea (Purple Mat Rush)*			
19.	1243	*Lomandra sericea (Silky Mat Rush)*			
20.	1246	*Lomandra suaveolens*			
21.	20664	*Ornithogalum longebracteatum*	Y		
22.	1312	*Sowerbaea laxiflora (Purple Tassels)*			
23.	1319	*Thysanotus arenarius*			
24.	1339	*Thysanotus multiflorus (Many-flowered Fringe Lily)*			
25.	1343	*Thysanotus patersonii*			
26.	1351	*Thysanotus sparteus*			
Asteraceae					
27.	7829	*Angianthus drummondii*		P3	
28.	7833	*Angianthus preissianus*			
29.	7851	*Asteridea pulverulenta (Common Bristle Daisy)*			
30.	7947	*Cotula turbinata (Funnel Weed)*	Y		
31.	-3777	*Craspedia sp. scps (Perth Flora, GJK 13121)*			
32.	13354	*Craspedia variabilis*			
33.	15137	*Euchiton sphaericus*			
34.	29594	*Helichrysum luteoalbum (Jersey Cudweed)*			
35.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
36.	8105	*Millotia myosotidifolia*			
37.	-4117	*Picris sp.*			
38.	8175	*Podolepis gracilis (Slender Podolepis)*			
39.	13300	*Rhodanthe citrina*			
40.	8225	*Siloxerus humifusus (Procumbent Siloxerus)*			
41.	9367	*Sonchus hydrophilus (Native Sowthistle)*			
42.	38388	*Ursinia anthemoides subsp. anthemoides*	Y		
43.	8282	*Waitzia suaveolens (Fragrant Waitzia)*			
Boryaceae					
44.	1272	*Borya scirpoidea*			
Campanulaceae					
45.	7408	*Lobelia tenuior (Slender Lobelia)*			
46.	37440	*Monopsis debilis var. depressa*	Y		
47.	7389	*Wahlenbergia preissii*			
Caprifoliaceae					
48.	7366	*Centranthus macrosiphon*	Y		
Caryophyllaceae					
49.	19825	*Petrorhagia dubia*	Y		
Casuarinaceae					
50.	1732	*Allocasuarina humilis (Dwarf Sheoak)*			
Celastraceae					
51.	4733	*Stackhousia monogyna*			
Centrolepidaceae					
52.	1117	*Aphelia cyperoides*			
53.	1121	*Centrolepis aristata (Pointed Centrolepis)*			
54.	1134	*Centrolepis polygyna (Wiry Centrolepis)*			
Chenopodiaceae					
55.	2491	*Chenopodium macrospermum*	Y		

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Colchicaceae					
56.	12770	*Burchardia congesta*			
57.	1385	*Burchardia multiflora (Dwarf Burchardia)*			
58.	1387	*Burchardia umbellata (Milkmaids)*			
Commelinaceae					
59.	1162	*Cartonema philydroides*			
Crassulaceae					
60.	11563	*Crassula colorata var. colorata*			
Cyperaceae					
61.	743	*Baumea juncea (Bare Twigrush)*			
62.	748	*Baumea vaginalis (Sheath Twigrush)*			
63.	768	*Cyathochaeta avenacea*			
64.	792	*Cyperus eragrostis (Umbrella Sedge)*	Y		
65.	822	*Eleocharis acuta (Common Spikerush)*			
66.	835	*Evandra pauciflora*			
67.	912	*Isolepis cyperoides*			
68.	919	*Isolepis oldfieldiana*			
69.	925	*Lepidosperma angustatum*			
70.	930	*Lepidosperma costale*			
71.	932	*Lepidosperma effusum (Spreading Sword-sedge)*			
72.	937	*Lepidosperma longitudinale (Pithy Sword-sedge)*			
73.	940	*Lepidosperma pubisquameum*			
74.	-12318	*Lepidosperma sp.*			
75.	945	*Lepidosperma squamatum*			
76.	946	*Lepidosperma striatum*			
77.	970	*Schoenus acuminatus*			
78.	984	*Schoenus curvifolius*			
79.	986	*Schoenus efoliatus*			
80.	999	*Schoenus loliaceus*		P2	
81.	17614	*Schoenus plumosus*			
82.	1012	*Schoenus rodwayanus*			
83.	1013	*Schoenus sculptus (Gimlet Bog-rush)*			
84.	1020	*Schoenus sublateralis*			
Dasypogonaceae					
85.	1218	*Dasypogon bromeliifolius (Pineapple Bush)*			
Dennstaedtiaceae					
86.	57	*Pteridium esculentum (Bracken)*			
Dilleniaceae					
87.	5109	*Hibbertia amplexicaulis*			
88.	5118	*Hibbertia cunninghamii*			
89.	5135	*Hibbertia hypericoides (Yellow Buttercups)*			
90.	5162	*Hibbertia racemosa (Stalked Guinea Flower)*			
91.	5164	*Hibbertia rhadinopoda*			
92.	5172	*Hibbertia stellaris (Orange Stars)*			
93.	5173	*Hibbertia subvaginata*			
94.	5176	*Hibbertia vaginata*			
Droseraceae					
95.	3095	*Drosera erythrorhiza (Red Ink Sundew)*			
96.	13217	*Drosera erythrorhiza subsp. erythrorhiza*			
97.	15453	*Drosera gigantea subsp. gigantea*			
98.	13216	*Drosera menziesii subsp. penicillaris*			
99.	3117	*Drosera paleacea (Dwarf Sundew)*			
100.	3118	*Drosera pallida (Pale Rainbow)*			
101.	3131	*Drosera stolonifera (Leafy Sundew)*			
102.	13205	*Drosera tubaestylis*			
Elaeocarpaceae					
103.	4524	*Platytheca galioides*			
104.	4535	*Tetratheca hirsuta (Black Eyed Susan)*			
Ericaceae					
105.	6306	*Andersonia caerulea (Foxtails)*			
106.	6334	*Astroloma pallidum (Kick Bush)*			
107.	6348	*Conostephium pendulum (Pearl Flower)*			
108.	6360	*Leucopogon australis (Spiked Beard-heath)*			
109.	6374	*Leucopogon conostephioides*			
110.	6427	*Leucopogon parviflorus (Coast Beard-heath)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
111.	6436	*Leucopogon propinquus*			
112.	6439	*Leucopogon pulchellus (Beard-heath)*			
113.	6440	*Leucopogon racemulosus*			
114.	29492	*Leucopogon sp. Busselton (D. Cooper 243)*			
115.	34736	*Lysinema pentapetalum*			
Euphorbiaceae					
116.	4585	*Amperea ericoides*			
117.	4666	*Monotaxis occidentalis*			
Fabaceae					
118.	15466	*Acacia applanata*			
119.	3331	*Acacia extensa (Wiry Wattle)*			
120.	3339	*Acacia flagelliformis*		P4	
121.	3374	*Acacia huegelii*			
122.	3502	*Acacia pulchella (Prickly Moses)*			
123.	15481	*Acacia pulchella var. glaberrima*			
124.	15482	*Acacia pulchella var. goadbyi*			
125.	3537	*Acacia semitrullata*		P4	
126.	3557	*Acacia stenoptera (Narrow Winged Wattle)*			
127.	3602	*Acacia willdenowiana (Grass Wattle)*			
128.	3688	*Aotus gracillima*			
129.	3710	*Bossiaea eriocarpa (Common Brown Pea)*			
130.	3832	*Daviesia physodes*			
131.	3835	*Daviesia preissii*			
132.	3872	*Euchilopsis linearis (Swamp Pea)*			
133.	3880	*Eutaxia virgata*			
134.	20475	*Gastrolobium capitatum*			
135.	3948	*Gompholobium capitatum*			
136.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
137.	3961	*Hardenbergia comptoniana (Native Wisteria)*			
138.	3968	*Hovea trisperma (Common Hovea)*			
139.	3992	*Isotropis cuneifolia (Granny Bonnets)*			
140.	4012	*Jacksonia furcellata (Grey Stinkwood)*			
141.	4017	*Jacksonia horrida*			
142.	4029	*Jacksonia sternbergiana (Stinkwood)*			
143.	4044	*Kennedia prostrata (Scarlet Runner)*			
144.	-7782	*Kennedia rubicunda*			
145.	4052	*Latrobea tenella*			
146.	4059	*Lotus angustissimus (Narrowleaf Trefoil)*	Y		
147.	8564	*Lotus subbiflorus*	Y		
148.	4085	*Melilotus indicus*	Y		
149.	4113	*Ornithopus compressus (Yellow Serradella)*	Y		
150.	4183	*Pultenaea skinneri (Skinner's Pea)*		P4	
151.	4313	*Trifolium subterraneum (Subterranean Clover)*	Y		
152.	4320	*Vicia hirsuta (Hairy Vetch)*	Y		
153.	11474	*Vicia sativa subsp. nigra*	Y		
Geraniaceae					
154.	4332	*Erodium botrys (Long Storksbill)*	Y		
Goodeniaceae					
155.	7428	*Dampiera coronata (Wedge-leaved Dampiera)*			
156.	7454	*Dampiera linearis (Common Dampiera)*			
157.	7462	*Dampiera pedunculata*			
158.	7517	*Goodenia incana (Hoary Goodenia)*			
159.	12551	*Goodenia micrantha*			
160.	19284	*Goodenia pulchella subsp. Coastal Plain B (L.W. Sage 2336)*			
161.	7572	*Lechenaultia expansa*			
Haemodoraceae					
162.	1411	*Anigozanthos manglesii (Mangles Kangaroo Paw)*			
163.	1416	*Anigozanthos viridis (Green Kangaroo Paw)*			
164.	1418	*Conostylis aculeata (Prickly Conostylis)*			
165.	1453	*Conostylis serrulata*			
166.	1478	*Phlebocarya ciliata*			
Hemerocallidaceae					
167.	1261	*Agrostocrinum scabrum (Blue Grass Lily)*			
168.	1276	*Caesia micrantha (Pale Grass-lily)*			
169.	1277	*Caesia occidentalis*			
170.	1295	*Johnsonia acaulis*			
171.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Hydatellaceae					
172.	-11638	*Trithuria sp.*			
Iridaceae					
173.	18392	*Freesia alba x leichtlinii*	Y		
174.	19179	*Moraea flaccida (One-leaf Cape Tulip)*	Y		
175.	1550	*Patersonia occidentalis (Purple Flag)*			
Juncaceae					
176.	1179	*Juncus caespiticius (Grassy Rush)*			
Lamiaceae					
177.	6839	*Hemiandra pungens (Snakebush)*			
Lauraceae					
178.	2957	*Cassytha racemosa (Dodder Laurel)*			
Lentibulariaceae					
179.	7145	*Utricularia menziesii (Redcoats)*			
180.	-4625	*Utricularia sp.*			
Loganiaceae					
181.	16395	*Mitreola minima*		P3	
Loranthaceae					
182.	2401	*Nuytsia floribunda (Christmas Tree)*			
Malvaceae					
183.	5038	*Lasiopetalum membranaceum*		P3	
Menyanthaceae					
184.	36160	*Liparophyllum capitatum*			
185.	36181	*Ornduffia parnassifolia*			
Myrtaceae					
186.	5316	*Agonis flexuosa (Peppermint)*			
187.	-3780	*Astartea aff. fascicularis sthcst*			
188.	20283	*Astartea scoparia*			
189.	5415	*Calothamnus lateralis*			
190.	5458	*Calytrix flavescens (Summer Starflower)*			
191.	5708	*Eucalyptus marginata (Jarrah)*			
192.	35070	*Hypocalymma angustifolium subsp. Swan Coastal Plain (G.J. Keighery 16777)*			
193.	5841	*Kunzea recurva*			
194.	5946	*Melaleuca pauciflora*			
195.	5952	*Melaleuca preissiana (Moonah)*			
196.	5980	*Melaleuca thymoides*			
197.	6006	*Pericalymma ellipticum (Swamp Teatree)*			
Orchidaceae					
198.	15332	*Caladenia attingens subsp. attingens*			
199.	-512	*Caladenia cairnsiana subsp. cairnsiana*			
200.	15579	*Caladenia chapmanii*			
201.	1586	*Caladenia discoidea (Dancing Orchid)*			
202.	1592	*Caladenia flava (Cowslip Orchid)*			
203.	15348	*Caladenia flava subsp. flava*			
204.	1599	*Caladenia latifolia (Pink Fairy Orchid)*			
205.	13859	*Caladenia longicauda subsp. clivicola*			
206.	15365	*Caladenia longicauda subsp. longicauda*			
207.	17760	*Caladenia nobilis*			
208.	15503	*Caladenia paludosa*			
209.	-3761	*Caladenia paludosa Hopper & AP Brown scps*			
210.	-11423	*Caladenia paludosa x speciosa*			
211.	15377	*Caladenia reptans subsp. reptans*			
212.	1616	*Caladenia sericea (Silky Blue Orchid)*			
213.	13862	*Caladenia speciosa*		P4	
214.	18019	*Caladenia vulgata*			
215.	15114	*Cyanicula gemmata*			
216.	15404	*Cyanicula sericea*			
217.	19649	*Disa bracteata*	Y		
218.	11049	*Diuris corymbosa*			
219.	1635	*Diuris longifolia (Common Donkey Orchid)*			
220.	11156	*Drakaea livida*			
221.	1643	*Elythranthera brunonis (Purple Enamel Orchid)*			
222.	15410	*Eriochilus dilatatus subsp. dilatatus*			
223.	15412	*Eriochilus dilatatus subsp. multiflorus*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
224.	1653	*Leporella fimbriata (Hare Orchid)*			
225.	1655	*Lyperanthus nigricans (Red Beak Orchid)*			
226.	1665	*Monadenia bracteata (South African Orchid)*	Y		
227.	1674	*Prasophyllum giganteum (Bronze Leek Orchid)*			
228.	1676	*Prasophyllum hians (Yawning Leek Orchid)*			
229.	1680	*Prasophyllum parvifolium (Autumn Leek Orchid)*			
230.	10853	*Prasophyllum plumiforme*			
231.	15426	*Pterostylis aspera*			
232.	1690	*Pterostylis nana (Snail Orchid)*			
233.	1693	*Pterostylis recurva (Jug Orchid)*			
234.	1694	*Pterostylis rogersii (Curled-tongue Shell Orchid)*			
235.	18655	*Pterostylis sp. crinkled leaf (G.J. Keighery 13426)*			
236.	18645	*Pterostylis sp. limestone (B.J. Keighery & G.J. Keighery 65)*			
237.	1698	*Pterostylis vittata (Banded Greenhood)*			
238.	-476	*Pterostylis vittata var. vittata*			
239.	1705	*Thelymitra crinita (Blue Lady Orchid)*			
240.	20730	*Thelymitra paludosa*			
Oxalidaceae					
241.	4352	*Oxalis glabra*	Y		
Phyllanthaceae					
242.	4675	*Phyllanthus calycinus (False Boronia)*			
Poaceae					
243.	184	*Aira caryophyllea (Silvery Hairgrass)*	Y		
244.	186	*Aira elegantissima*	Y		
245.	13380	*Amphibromus nervosus*			
246.	200	*Amphipogon turbinatus*			
247.	202	*Anthoxanthum odoratum (Sweet Vernal Grass)*	Y		
248.	17949	*Austrodanthonia occidentalis*			
249.	17234	*Austrostipa compressa*			
250.	38481	*Austrostipa jacobsiana*		P1	
251.	234	*Avena fatua (Wild Oat)*	Y		
252.	244	*Briza maxima (Blowfly Grass)*	Y		
253.	277	*Cortaderia selloana (Pampas Grass)*	Y		
254.	293	*Danthonia occidentalis*			
255.	299	*Deyeuxia quadriseta (Reed Bentgrass)*			
256.	306	*Dichelachne crinita (Longhair Plumegrass)*			
257.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
258.	349	*Ehrharta longiflora (Annual Veldt Grass)*	Y		
259.	376	*Eragrostis curvula (African Lovegrass)*	Y		
260.	444	*Holcus lanatus (Yorkshire Fog)*	Y		
261.	485	*Microlaena stipoides (Weeping Grass)*			
262.	573	*Poa drummondiana (Knotted Poa)*			
263.	583	*Polypogon tenellus*			
264.	-3763	*Stipa semibarbata group scps*			
265.	722	*Vulpia bromoides (Squirrel Tail Fescue)*	Y		
Podocarpaceae					
266.	86	*Podocarpus drouynianus (Wild Plum)*			
Polygalaceae					
267.	4564	*Comesperma virgatum (Milkwort)*			
Pottiaceae					
268.	32439	*Syntrichia papillosa*			
Proteaceae					
269.	1790	*Adenanthos meisneri*			
270.	1791	*Adenanthos obovatus (Basket Flower)*			
271.	1800	*Banksia attenuata (Slender Banksia)*			
272.	1819	*Banksia grandis (Bull Banksia)*			
273.	1822	*Banksia ilicifolia (Holly-leaved Banksia)*			
274.	1830	*Banksia littoralis (Swamp Banksia)*			
275.	1863	*Conospermum capitatum*			
276.	1945	*Franklandia triaristata (Lanoline Bush)*		P4	
277.	2216	*Hakea varia (Variable-leaved Hakea)*			
278.	2267	*Persoonia longifolia (Snottygobble)*			
279.	2273	*Persoonia saccata (Snottygobble)*			
280.	2299	*Petrophile linearis (Pixie Mops)*			
281.	2316	*Stirlingia latifolia (Blueboy)*			
282.	2326	*Synaphea polymorpha (Albany Synaphea)*			
283.	2331	*Xylomelum occidentale (Woody Pear)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Restionaceae					
284.	1070	*Hypolaena exsulca*			
285.	19833	*Leptocarpus laxus*			
286.	1082	*Leptocarpus tenax (Slender Twine Rush)*			
287.	1093	*Loxocarya fasciculata*			
288.	1096	*Loxocarya pubescens*			
Rubiaceae					
289.	18254	*Opercularia apiciflora*			
290.	7348	*Opercularia hispidula (Hispid Stinkweed)*			
Rutaceae					
291.	4417	*Boronia dichotoma*			
292.	16618	*Boronia humifusa*		P1	
293.	4454	*Diplolaena dampieri (Southern Diplolaena)*			
294.	4476	*Eriostemon spicatus (Pepper and Salt)*			
295.	18529	*Philotheca spicata (Pepper and Salt)*			
Santalaceae					
296.	17702	*Leptomeria furtiva*		P2	
297.	2353	*Leptomeria scrobiculata*			
Solanaceae					
298.	6949	*Anthocercis littorea (Yellow Tailflower)*			
Stylidiaceae					
299.	7677	*Levenhookia stipitata (Common Stylewort)*			
300.	25831	*Stylidium araeophyllum*			
301.	7693	*Stylidium brunonianum (Pink Fountain Triggerplant)*			
302.	25801	*Stylidium hesperium*			
303.	7745	*Stylidium junceum (Reed Triggerplant)*			
304.	7756	*Stylidium longitubum (Jumping Jacks)*		P3	
305.	7774	*Stylidium piliferum (Common Butterfly Triggerplant)*			
306.	7785	*Stylidium repens (Matted Triggerplant)*			
307.	7798	*Stylidium schoenoides (Cow Kicks)*			
308.	-7339	*Stylidium sp.*			
309.	7806	*Stylidium utricularioides (Pink Fan Triggerplant)*			
310.	7808	*Stylidium violaceum (Violet Triggerplant)*			
Xanthorrhoeaceae					
311.	1256	*Xanthorrhoea preissii (Grass tree)*			
Zamiaceae					
312.	85	*Macrozamia riedlei (Zamia)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Appendix D

Flora

Quadrat and Relevè data

Species list

BORR Stage 2 **Site** Q01

Described by GO **Date** 21/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 371467 **mE** 6299586 **mN**

Soil White sand

Veg Condition Degraded

Fire Age Old (5-20 years)

Notes NNE aspect.
Weed invasion, some clearing.
Rock 0%
Bare ground 2-10%
Logs 2-10%
Twigs 10-30%
Leaves 10-30%

SPECIES LIST:

Name	Cover	C Class
Acacia saligna	2-10	1.2
**Arctotheca calendula*	<2	0.1
Caladenia flava	<2	0.2
Conostylis aculeata subsp. *preissii*	10-30	0.4
Daviesia ?divaricata	2-10	0.8
Diuris ?longifolia	2-10	0.3
**Ehrharta calycina*	30-70	0.8
**Ehrharta longiflora*	<2	0.7
**Erodium botrys*	<2	0.05

Eucalyptus marginata	30-70	9
**Freesia alba x leichtlinii*	<2	0.2
**Hypochaeris glabra*	<2	0.1
**Hypochaeris sp.*	10-30	0.05
**Lupinus angustifolius*	<2	0.06
**Lupinus cosentinii*	<2	0.2
Spyridium globulosum	<2	0.5
Trifolium sp.	30-70	0.05
**Trifolium subterraneum*	<2	0.2
**Ursinia anthemoides*	30-70	0.3
Xanthorrhoea brunonis	10-30	1.5

BORR Stage 2 **Site** Q02

Described by GO **Date** 21/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 371641 **mE** 6299750 **mN**

Soil White/grey sand

Veg Condition Degraded

Fire Age Old (5-20 years)

Notes NW aspect.
Weeds, clearing adjacent to site.
Rock 0%
Bare ground <2%
Logs 0%
Twigs 2-10%
Leaves 10-30%

SPECIES LIST:

Name	Cover	C Class
**Acacia iteaphylla*	<2	1.1
Agonis flexuosa	2-10	6
**Arctotheca calendula*	2-10	0.1
Banksia attenuata	30-70	8
Conostylis aculeata subsp. *gracilis*	<2	0.2
**Ehrharta calycina*	30-70	0.4
**Ehrharta longiflora*	<2	0.5
**Freesia alba x leichtlinii*	2-10	0.2

Hibbertia hypericoides	<2	0.2
Hibbertia hypericoides	2-10	0.3
**Hypochaeris sp.*	2-10	0.1
Kunzea glabrescens	2-10	3.5
Macrozamia riedlei	<2	0.6
**Romulea rosea*	30-70	0.4
Sowerbaea laxiflora	<2	0.2
**Trifolium subterraneum*	2-10	0.03

BORR Stage 2 **Site** Q03

Described by GO **Date** 21/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 371736 **mE** 6299825 **mN**

Soil Dark brown loamy sand

Veg Condition Good - Degraded

Fire Age Old (5-20 years)

Notes Rock 0%
Bare ground 0%
Logs 0%
Twigs 10-30%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Banksia attenuata	30-70	8
Conostylis aculeata	<2	0.2
Conostylis aculeata subsp. *gracilis*	30-70	0.4
**Ehrharta calycina*	2-10	0.5
Eucalyptus marginata	10-30	10
Hibbertia hypericoides	<2	0.2

**Hypochaeris sp.*	2-10	0.07
Lepidosperma pubisquameum	<2	0.5
Trifolium sp.	10-30	0.1
Xylomelum occidentale	10-30	8

BORR Stage 2 **Site** Q04

Described by GO **Date** 21/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 372097 **mE** 6300083 **mN**

Soil Brown loamy sand

Veg Condition Very Good

Fire Age Old (5-20 years)

Notes S aspect.
Weeds.
Bare ground 0%
Logs 0%
Twigs 2-10%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Banksia attenuata	30-70	9
Caladenia flava	<2	0.2
Conostylis aculeata subsp. *gracilis*	2-10	0.4
Desmocladus fasciculatus	<2	0.2
Drosera ?erythrorhiza	<2	0.01
**Ehrharta calycina*	10-30	0.15
Eucalyptus marginata	10-30	12
Hardenbergia comptoniana	<2	climber
Hardenbergia comptoniana	<2	climber
Hibbertia hypericoides	2-10	0.4

Hibbertia racemosa	<2	0.2
**Hypochaeris sp.*	<2	0.05
Kunzea glabrescens	2-10	2.5
Lepidosperma pubisquameum	10-30	0.5
Lepidosperma squamatum	10-30	0.6
Leucopogon propinquus	<2	0.25
Leucopogon sp.	2-10	1.1
Persoonia longifolia	2-10	5
Pimelea ?rosea subsp. *rosea*	<2	0.5
Pterostylis vittata	3	0.4
Sowerbaea laxiflora	<2	0.4
Stypandra glauca	<2	0.15
Trachymene pilosa	<2	0.03
Trifolium sp.	2-10	0.3
**Ursinia anthemoides*	<2	0.2

BORR Stage 2 **Site** Q05

Described by GO **Date** 21/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 372148 **mE** 6300149 **mN**

Soil Brown sandy loam

Veg Condition Excellent - Very Good

Fire Age Old (5-20 years)

Notes W aspect.
Weeds, firebreak on each side.
Rock 0%
Bare ground 0%
Logs <2%
Twigs 2-10%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Banksia attenuata	30-70	7
Banksia grandis	<2	3
Burchardia congesta	<2	0.5
Caladenia flava	<2	0.2
Conostylis aculeata subsp. *preissii*	2-10	0.4
Drosera ?porrecta	<2	0.3
Drosera pallida	<2	0.3
Eucalyptus sp.	<2	1
**Freesia alba x leichtlinii*	<2	0.4

Gompholobium tomentosum	<2	0.3
Hemiandra pungens	2-10	0.07
Hibbertia hypericoides	30-70	0.5
**Hypochaeris sp.*	2-10	0.05
Kennedia prostrata	30-70	climber
Kunzea glabrescens	10-30	1.9
Lepidosperma sp.	30-70	0.7
Lomandra micrantha subsp. *micrantha*	<2	0.3
Orthrosanthus laxus	<2	0.3
Sowerbaea laxiflora	<2	0.5
Xanthorrhoea brunonis	2-10	1.1

BORR Stage 2 **Site** Q06

Described by GO **Date** 22/09/2011 **Type** Q

Location Bunbury

MGA Zone 50 372304 **mE** 6300163 **mN**

Soil Dark brown sandy loam

Veg Condition Very Good

Fire Age Old (5-20 years)

Notes W aspect.
Weed invasion.
Rock 0%
Bare ground 0%
Logs 10-30%
Twigs 10-30%
Leaves 2-10%

SPECIES LIST:

Name	Cover	C Class
?Haemodoraceae sp.	<2	0.5
Banksia attenuata	10-30	5.5
Banksia grandis	2-10	9
Bossiaea eriocarpa	<2	0.3
**Briza maxima*	2-10	0.2
Caesia micrantha	<2	0.3
Crassula ?glomerata	30-70	0.03
Crassula colorata	30-70	0.03
Daviesia ?divaricata	<2	1

Desmocladus fasciculatus	<2	0.2
Drosera ?porrecta	<2	0.2
Eucalyptus marginata	2-10	12
**Freesia alba x leichtlinii*	2-10	0.3
Gompholobium tomentosum	<2	0.3
Hibbertia hypericoides	30-70	0.5
Hyalosperma cotula	<2	0.15
**Hypochaeris sp.*	30-70	0.05
Kennedia prostrata	<2	creeper
Lagenophora huegelii	<2	0.3
Leucopogon propinquus	10-30	0.6
Logania serpyllifolia subsp. *angustifolia*	<2	0.25
Lomandra sp.	<2	0.2
**Lysimachia arvensis*	<2	0.03
Macrozamia riedlei	2-10	0.7
Philotheca spicata	<2	0.2
Sowerbaea laxiflora	<2	0.3
Trachymene pilosa	<2	0.08
**Ursinia anthemoides*	30-70	0.05

BORR Stage 2 **Site** Q07

Described by GO **Date** 22/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 372655 **mE** 6300253 **mN**

Soil Brown loamy sand

Veg Condition Very Good - Good

Fire Age Old (5-20 years)

Notes Weeds.
Rock 0%
Bare ground <2%
Logs 0%
Twigs 2-10%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Agonis flexuosa	30-70	10
Asteraceae sp.	10-30	0.25
Asteraceae sp.	<2	0.2
Austrostipa flavescens	<2	0.3
Banksia attenuata	30-70	11
Banksia grandis	<2	1.1
**Briza maxima*	<2	0.2
Caladenia flava	<2	0.15
Caladenia latifolia	<2	0.4
Conostylis aculeata subsp. *gracilis*	30-70	0.25

**Ehrharta longiflora*	30-70	0.4
Ehrharta sp.	2-10	0.3
Ehrharta sp.	<2	0.3
**Freesia alba x leichtlinii*	10-30	0.2
Hardenbergia comptoniana	<2	creeper
Hibbertia hypericoides	2-10	0.5
Hybanthus calycinus	<2	0.2
**Hypochaeris sp.*	10-30	0.05
Kennedia prostrata	<2	creeper
Lagenophora huegelii	10-30	0.25
Leucopogon propinquus	2-10	0.6
**Lysimachia arvensis*	2-10	0.05
Macrozamia riedlei	2-10	0.8
Opercularia vaginata	<2	0.3
Orthrosanthus laxus	<2	0.2
Phyllanthus calycinus	<2	0.2
Pimelea ?rosea subsp. *rosea*	<2	0.2
Schoenus grandiflorus	10-30	0.4
Sowerbaea laxiflora	<2	0.3
Trachymene pilosa	2-10	0.06
Trifolium sp.	<2	0.1
**Ursinia anthemoides*	2-10	0.3

BORR Stage 2 **Site** Q08

Described by GO **Date** 22/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 372505 **mE** 6300208 **mN**

Soil Brown loamy sand

Veg Condition Very Good - Good

Fire Age Old (5-20 years)

Notes Weeds.
Rock 0%
Bare ground <2%
Logs 0%
Twigs 2-10%
Leaves 10-30%

SPECIES LIST:

Name	Cover	C Class
**Acacia iteaphylla*	<2	1.1
Agonis flexuosa	70-100	13
Agrostocrinum sp.	<2	0.03
**Arctotheca calendula*	<2	0.2
Banksia attenuata	2-10	2.1
Bossiaea eriocarpa	<2	0.3
**Briza maxima*	2-10	0.2
Caladenia flava	<2	0.2
Caladenia speciosa	<2	0.6

Conostylis aculeata subsp. *gracilis*	30-70	0.2
Craspedia variabilis	<2	0.4
Desmocladus fasciculatus	<2	0.15
Drosera sp.	<2	creeper
**Ehrharta longiflora*	2-10	0.4
**Ehrharta longiflora*	<2	0.3
**Freesia alba x leichtlinii*	10-30	0.2
Hardenbergia comptoniana	<2	creeper
Hibbertia hypericoides	10-30	0.25
Hibbertia racemosa	<2	0.2
Hybanthus calycinus	<2	0.2
**Hypochaeris sp.*	10-30	0.03
Kennedia prostrata	30-70	creeper
Lagenophora huegelii	<2	0.3
Lepidosperma pubisquameum	<2	0.6
Leucopogon propinquus	10-30	0.5
Macrozamia riedlei	10-30	0.8
Orthrosanthus laxus	<2	0.5
**Petrorhagia dubia*	<2	0.3
Schoenus grandiflorus	10-30	0.8
Sowerbaea laxiflora	<2	0.3
Trachymene pilosa	10-30	0.15
**Ursinia anthemoides*	10-30	0.2

BORR Stage 2 **Site** Q09

Described by GO **Date** 22/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 373614 **mE** 6300677 **mN**

Soil Dark brown sandy loam

Veg Condition Pristine

Fire Age Old (5-20 years)

Notes SW aspect.
Adjacent to paddock.
Bare ground 0%
Logs 0%
Twigs 10-30%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Acacia pulchella	<2	0.2
Adenanthos meisneri	30-70	0.8
Agonis flexuosa	30-70	5
Caladenia flava	<2	0.2
Conostylis aculeata	2-10	0.6
Dasypogon bromeliifolius	2-10	0.4
Drosera pallida	<2	creeper
Eucalyptus marginata	70-100	15
Hardenbergia comptoniana	<2	creeper
Hibbertia hypericoides	10-30	0.3

Lepidosperma squamatum	2-10	0.7
Philotheca spicata	<2	0.2
Pterostylis ?recurva	<2	0.25
Tetratheca hirsuta	<2	0.2
Xylomelum occidentale	2-10	0.5

BORR Stage 2 **Site** Q10

Described by GO **Date** 22/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 373511 **mE** 6300569 **mN**

Soil Grey loamy sand

Veg Condition Very Good

Fire Age Old (5-20 years)

Notes Some clearing/logging.
Rock 0%
Bare ground 2-10%
Logs 2-10%
Twigs 10-30%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Acacia pulchella	<2	0.3
Agonis flexuosa	<2	0.2
Banksia attenuata	30-70	7
Burchardia congesta	<2	0.5
Caladenia flava	<2	0.2
Corymbia calophylla	10-30	10
Drosera ?porrecta	<2	creeper
Eucalyptus marginata	30-70	15
Hibbertia hypericoides	10-30	0.3
Hypocalymma robustum	<2	0.7

Lepidosperma ?pubisquameum	<2	0.25
Lepidosperma squamatum	<2	0.7
Orthrosanthus laxus	<2	0.2
Persoonia longifolia	10-30	4
Phlebocarya ciliata	10-30	0.6
Pterostylis ?recurva	<2	0.6
Pyrorchis nigricans	<2	0.01
Xanthorrhoea brunonis	<2	1
Xylomelum occidentale	<2	2

BORR Stage 2 **Site** Q11

Described by GO **Date** 22/09/2011 **Type** Q

Location Bunbury

MGA Zone 50 374192 **mE** 6301076 **mN**

Soil Grey loamy sand

Veg Condition Pristine - Excellent

Fire Age Old (5-20 years)

Notes Bare ground 0%
Logs 0%
Twigs 2-10%
Leaves 30-70%

SPECIES LIST:

Name	Cover	C Class
Bossiaea ?eriocarpa	<2	0.5
Burchardia congesta	<2	0.4
Conostylis aculeata	<2	0.3
Dasypogon bromeliifolius	2-10	0.4
Hibbertia hypericoides	2-10	0.3
Hypocalymma robustum	<2	0.8
Kunzea glabrescens	<2	1.1

Kunzea glabrescens	30-70	6
Phlebocarya ciliata	10-30	0.4
Pterostylis ?recurva	<2	0.2
Pyrorchis nigricans	2-10	0.01
Stirlingia latifolia	<2	1
Xylomelum occidentale	30-70	8

BORR Stage 2 **Site** Q12

Described by GO **Date** 23/09/2011 **Type** Quadrat
Season **Uniformity**

Location Bunbury

MGA Zone 50 374617 **mE** 6301205 **mN**
Soil Grey sand
Veg Condition Good
Fire Age Old (5-20 years)
Notes Track nearby, cleared in past, weds, grazing, logging.
Bare ground 2-10%
Logs 0%
Twigs 2-10%
Leaves 10-30%

SPECIES LIST:

Name	Cover Class	Height
Acacia pulchella	<2	0.2
Agonis flexuosa	<2	7
Banksia attenuata	30-70	10
Caladenia flava	<2	0.2
Conostylis aculeata	<2	0.3
Conostylis aculeata subsp. *preissii*	<2	0.3
Drosera sp.	<2	creeper
Eucalyptus marginata	10-30	20
Hibbertia hypericoides	30-70	0.3

Hypocalymma robustum	<2	0.3
**Isolepis marginata*	<2	0.02
Jacksonia furcellata	<2	0.5
Kennedia prostrata	<2	creeper
Lagenophora huegelii	<2	0.25
Leucopogon propinquus	<2	0.5
Lomandra sp.	2-10	0.3
Patersonia occidentalis	<2	0.2
Pterostylis sp.	<2	0.2
Pyrorchis nigricans	<2	0.01
Trachymene pilosa	<2	0.03
**Ursinia anthemoides*	<2	0.2
Xylomelum occidentale	<2	0.3

BORR Stage 2 **Site** Q13

Described by GO **Date** 23/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 375291 **mE** 6302287 **mN**

Habitat Dampland

Veg Condition Degraded

Fire Age Old (5-20 years)

Notes Weeds, grazing, clearing.
Bare ground 2-10%
Logs 10-30%
Twigs 10-30%
Leaves <2%

SPECIES LIST:

Name	Cover	C Class
?Rumex sp.	<2	0.15
Burchardia congesta	<2	0.3
**Ehrharta calycina*	30-70	0.6
Isolepis ?cernua	30-70	0.02
Juncus subsecundus	30-70	0.7
**Lotus angustissimus*	30-70	0.07
Viminaria juncea	30-70	2.1
**Arctotheca calendula*	2-10	0.2
***Cotula turbinata*	2-10	0.2
Melaleuca ?lateritia	10-30	1.2

**Romulea rosea*	10-30	0.1

BORR Stage 2 **Site** Q14

Described by GO **Date** 23/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 375648 **mE** 6303842 **mN**

Habitat Wetland (dry)

Veg Condition Very Good

Fire Age

Notes Weeds.
Rock 0%
Bare ground 10-30%
Logs 2-10%
Twigs 10-30%
Leaves 2-10%

SPECIES LIST:

Name	Cover Class	Height
Agonis flexuosa	10-30	5.5
Astartea scoparia	70-100	2
**Freesia alba x leichtlinii*	<2	0.2
**Hypochaeris sp.*	10-30	0.05
Kunzea glabrescens	10-30	2.1
**Ornithopus compressus*	<2	0.1
Poaceae sp.	30-70	0.04
Restionaceae sp.	30-70	0.6

BORR Stage 2 **Site** Q15

Described by GO **Date** 23/09/2011 **Type** Quadrat

Location Bunbury

MGA Zone 50 376128 **mE** 6304382 **mN**

Habitat Permanent wetland

Soil

Veg Condition Very Good - Good

Fire Age

Notes Weeds. Inundated with water.
Rock 0%
Bare ground 30-70%
Logs <2%
Twigs 2-10%
Leaves 2-10%

SPECIES LIST:

Name	Cover Class	Height
?Rumex sp.	0.2	2-10
**Arctotheca calendula*	<2	0.2
**Cotula coronopifolia*	<2	0.2
**Isolepis marginata*	30-70	0.03
Juncus pallidus	2-10	1.5
Lepidosperma ?longitudinale	10-30	0.8
Melaleuca preissiana	10-30	3.1
Melaleuca viminea	30-70	4.5
**Moraea flaccida*	<2	0.8

**Ornithopus compressus*	30-70	0.03
**Romulea rosea*	2-10	0.2

BORR Stage 2 **Site** R1

Described by GO **Date** 22/09/2011 **Type** Releve

Location Bunbury

MGA Zone 50 372860 **mE** 6300313 **mN**

Veg Condition Degraded - Completely Degraded

SPECIES LIST:

Name

Acacia saligna

Agonis flexuosa

**Arctotheca calendula*

Banksia attenuata

Caladenia flava

Conostylis aculeata subsp. *gracilis*

**Ehrharta longiflora*

Hibbertia cuneiformis

**Hypochaeris sp.*

**Lysimachia arvensis*

Macrozamia riedlei

**Oxalis pes-caprae*

Phyllanthus calycinus

**Romulea rosea*

Sowerbaea laxiflora

BORR Stage 2 **Site** R2

Described by GO **Date** **Type** Releve

Location Bunbury

MGA Zone 50 375335 **mE** 6301760 **mN**

Veg Condition Degraded - Completely Degraded

Notes Weeds, clearing, logging, rubbish.

SPECIES LIST:

Name

Acacia incurva

**Asparagus asparagoides*

Conostylis aculeata subsp. *preissii*

Corymbia calophylla

Dampiera lindleyi

Kunzea glabrescens

**Paspalum dilatatum*

Pericalymma ellipticum

**Romulea rosea*

BORR Stage 2 **Site** R3

Described by GO **Date** 22/09/2011 **Type** Releve

Location Bunbury

MGA Zone 50 373327 **mE** 6300446 **mN**

Habitat Creek

Notes Lots of water 0.5-1 m deep, 20-30 m wide. Frogs.

SPECIES LIST:

Name

**Asparagus asparagoides*

Caladenia latifolia

**Conyza bonariensis*

Crassula colorata

**Ehrharta longiflora*

Eucalyptus rudis

**Hypochaeris sp.*

Lepidosperma ?longitudinale

Lepidosperma longitudinale

**Lysimachia arvensis*

Melaleuca preissiana

Orthrosanthus laxus

**Oxalis pes-caprae*

**Romulea rosea*

**Sonchus asper*

Tetratheca hirsuta

BORR Stage 2 **Site** R4

Described by GO **Date** **Type** Releve

Location Bunbury

MGA Zone 375306 **mE** 6302142 **mN**

SPECIES LIST:

Name

Agonis flexuosa

Banksia attenuata

Burchardia congesta

Caladenia flava

Conostylis aculeata subsp. *preissii*

Hibbertia cuneiformis

Hibbertia hypericoides

Kunzea glabrescens

Macrozamia riedlei

Stypandra glauca

BORR Stage 2 **Site** R5

Described by GO **Date** 23/09/2011 **Type** Releve

Location Bunbury

MGA Zone 50 371307 **mE** 6299406 **mN**
Veg Condition Very Good
Fire Age <10 years
Notes Weeds, rubbish.

SPECIES LIST:
Name

Acacia extensa

Acacia pulchella

Banksia attenuata

Banksia grandis

Bossiaea ?eriocarpa

Burchardia congesta

Caesia micrantha

Caladenia flava

Callistemon phoeniceus

Calothamnus quadrifidus

Conostylis aculeata subsp. *preissii*

Corymbia calophylla

Daviesia ?divaricata

Drosera ?porrecta

**Ehrharta longiflora*

**Eragrostis curvula*

**Freesia alba x leichtlinii*

Hibbertia hypericoides

Kennedia prostrata

Lepidosperma ?pubisquameum

Lomandra ?preissii

Lomandra nigricans

Macrozamia riedlei

Melaleuca viminea

**Oxalis pes-caprae*

Philotheca spicata

Phyllanthus calycinus

Pterostylis ?recurva

Spyridium globulosum

Thysanotus patersonii/manglesianus

Vicia sp.

Xanthorrhoea brunonis

Xylomelum occidentale

BORR Stage 2 **Site** R6

Described by GO **Date** 23/09/2011 **Type** Releve

Location Bunbury

MGA Zone 50 374448 **mE** 6301103 **mN**
Veg Condition Degraded - Completely Degraded
Fire Age >10 years
Notes Logging, fire, cleared understorey, grazing

SPECIES LIST:
Name

Acacia pulchella

Agonis flexuosa

**Arctotheca calendula*

Banksia attenuata

Banksia ilicifolia

Burchardia congesta

Caladenia flava

Conostylis aculeata subsp. *preissii*

Corymbia calophylla

Crassula colorata

Dasypogon bromeliifolius

**Ehrharta calycina*

**Ehrharta longiflora*

Eucalyptus marginata

Hemiandra pungens

Hibbertia hypericoides

Hypocalymma robustum

**Hypochaeris sp.*

Leucopogon propinquus

Nuytsia floribunda

Schoenus grandiflorus

**Ursinia anthemoides*

Xanthorrhoea brunonis

Flora Species Recorded within Bunbury Outer Ring Road Southern Section, South Western Highway to Bussell Highway, September 2011

Family	*Name*	Weed
Anarthriaceae	*Lyginia imberbis*	
Anthericaceae	*Agrostocrinum* sp.	
Anthericaceae	*Thysanotus patersonii/manglesianus*	
Araceae	*Zantedeschia aethiopica*	*
Araliaceae	*Trachymene pilosa*	
Asparagaceae	*Asparagus asparagoides*	*
Asparagaceae	*Lomandra ?preissii*	
Asparagaceae	*Lomandra micrantha* subsp. *micrantha*	
Asparagaceae	*Lomandra nigricans*	
Asparagaceae	*Lomandra preissii*	
Asparagaceae	*Lomandra* sp.	
Asparagaceae	*Sowerbaea laxiflora*	
Asteraceae	*Arctotheca calendula*	*
Asteraceae	*Conyza bonariensis*	*
Asteraceae	*Cotula coronopifolia*	*
Asteraceae	*Cotula turbinata*	*
Asteraceae	*Craspedia variabilis*	
Asteraceae	*Hyalosperma cotula*	
Asteraceae	*Hypochaeris glabra*	*
Asteraceae	*Hypochaeris* sp.	*
Asteraceae	*Lagenophora huegelii*	
Asteraceae	*Sonchus asper*	*
Asteraceae	sp.	
Asteraceae	*Taraxacum officinale*	*
Asteraceae	*Ursinia anthemoides*	*
Caryophyllaceae	*Petrorhagia dubia*	*
Colchicaceae	*Burchardia congesta*	
Crassulaceae	*Crassula ?glomerata*	

Family	*Name*	Weed
Crassulaceae	*Crassula colorata*	
Cyperaceae	*?Caustis dioica*	
Cyperaceae	*Isolepis ?cernua*	
Cyperaceae	*Isolepis marginata*	*
Cyperaceae	*Lepidosperma ?longitudinale*	
Cyperaceae	*Lepidosperma ?pubisquameum*	
Cyperaceae	*Lepidosperma longitudinale*	
Cyperaceae	*Lepidosperma pubisquameum*	
Cyperaceae	*Lepidosperma* sp.	
Cyperaceae	*Lepidosperma squamatum*	
Cyperaceae	*Schoenus grandiflorus*	
Dasypogonaceae	*Dasypogon bromeliifolius*	
Dilleniaceae	*Hibbertia cuneiformis*	
Dilleniaceae	*Hibbertia hypericoides*	
Dilleniaceae	*Hibbertia racemosa*	
Droseraceae	*Drosera ?erythrorhiza*	
Droseraceae	*Drosera ?porrecta*	
Droseraceae	*Drosera pallida*	
Droseraceae	*Drosera* sp.	
Elaeocarpaceae	*Tetratheca hirsuta*	
Ericaceae	*Leucopogon ?conostephioides* s.lat.	
Ericaceae	*Leucopogon* sp.	
Ericaceae	*Leucopogon propinquus*	
Fabaceae	*Acacia cyclops*	
Fabaceae	*Acacia extensa*	
Fabaceae	*Acacia incurva*	
Fabaceae	*Acacia iteaphylla*	*
Fabaceae	*Acacia pulchella*	
Fabaceae	*Acacia saligna*	
Fabaceae	*Bossiaea ?eriocarpa*	

Family	*Name*	Weed
Fabaceae	*Bossiaea eriocarpa*	
Fabaceae	*Daviesia ?divaricata*	
Fabaceae	*Daviesia physodes*	
Fabaceae	*Gompholobium tomentosum*	
Fabaceae	*Hardenbergia comptoniana*	
Fabaceae	*Jacksonia furcellata*	
Fabaceae	*Kennedia prostrata*	
Fabaceae	*Lotus angustissimus*	*
Fabaceae	*Lupinus angustifolius*	*
Fabaceae	*Lupinus cosentinii*	*
Fabaceae	*Ornithopus compressus*	*
Fabaceae	*Trifolium* sp.	
Fabaceae	*Trifolium subterraneum*	*
Fabaceae	*Vicia* sp.	
Fabaceae	*Viminaria juncea*	
Geraniaceae	*Erodium botrys*	*
Goodeniaceae	*Dampiera lindleyi*	
Haemodoraceae	*Anigozanthos manglesii*	
Haemodoraceae	*Conostylis aculeata*	
Haemodoraceae	*Conostylis aculeata* subsp. *gracilis*	
Haemodoraceae	*Conostylis aculeata* subsp. *preissii*	
Haemodoraceae	*Phlebocarya ciliata*	
Haemodoraceae	sp.	
Hemerocallidaceae	*Caesia micrantha*	
Hemerocallidaceae	*Stypandra glauca*	
Hemerocallidaceae	*Tricoryne elatior*	
Iridaceae	*Freesia alba* x *leichtlinii*	*
Iridaceae	*Moraea flaccida*	*
Iridaceae	*Orthrosanthus laxus*	
Iridaceae	*Patersonia occidentalis*	

Family	*Name*	Weed
Iridaceae	*Romulea rosea*	*
Juncaceae	*Juncus pallidus*	
Juncaceae	*Juncus subsecundus*	
Lamiaceae	*Hemiandra pungens*	
Loganiaceae	*Logania serpyllifolia* subsp. *angustifolia*	
Loranthaceae	*Nuytsia floribunda*	
Myrtaceae	*Agonis flexuosa*	
Myrtaceae	*Astartea scoparia*	
Myrtaceae	*Callistemon phoeniceus*	
Myrtaceae	*Calothamnus quadrifidus*	
Myrtaceae	*Corymbia calophylla*	
Myrtaceae	*Eucalyptus gomphocephala*	
Myrtaceae	*Eucalyptus marginata*	
Myrtaceae	*Eucalyptus rudis*	
Myrtaceae	*Eucalyptus* sp.	
Myrtaceae	*Hypocalymma robustum*	
Myrtaceae	*Kunzea glabrescens*	
Myrtaceae	*Kunzea micrantha*	
Myrtaceae	*Melaleuca ?lateritia*	
Myrtaceae	*Melaleuca preissiana*	
Myrtaceae	*Melaleuca teretifolia*	
Myrtaceae	*Melaleuca viminea*	
Myrtaceae	*Pericalymma ellipticum*	
Orchidaceae	*Caladenia flava*	
Orchidaceae	*Caladenia hirta* subsp. *hirta*	
Orchidaceae	*Caladenia latifolia*	
Orchidaceae	*Caladenia speciosa*	P4
Orchidaceae	*Diuris ?longifolia*	
Orchidaceae	*Diuris corymbosa*	
Orchidaceae	*Pterostylis ?recurva*	

Family	*Name*	Weed
Orchidaceae	*Pterostylis* sp.	
Orchidaceae	*Pterostylis vittata*	
Orchidaceae	*Pyrorchis nigricans*	
Orobanchaceae	*Orobanche minor*	*
Oxalidaceae	*Oxalis pes-caprae*	*
Phyllanthaceae	*Phyllanthus calycinus*	
Poaceae	*Austrostipa flavescens*	
Poaceae	*Briza maxima*	*
Poaceae	*Ehrharta calycina*	*
Poaceae	*Ehrharta longiflora*	*
Poaceae	*Ehrharta* sp.	
Poaceae	*Eragrostis curvula*	*
Poaceae	*Paspalum dilatatum*	*
Poaceae	sp.	
Polygonaceae	*?Rumex* sp.	
Primulaceae	*Lysimachia arvensis*	*
Proteaceae	*Adenanthos meisneri*	
Proteaceae	*Banksia attenuata*	
Proteaceae	*Banksia grandis*	
Proteaceae	*Banksia ilicifolia*	
Proteaceae	*Hakea varia*	
Proteaceae	*Persoonia longifolia*	
Proteaceae	*Stirlingia latifolia*	
Proteaceae	*Xylomelum occidentale*	
Restionaceae	*Desmocladus fasciculatus*	
Restionaceae	*Hypolaena exsulca*	
Restionaceae	sp.	
Rhamnaceae	*Spyridium globulosum*	
Rubiaceae	*Galium murale*	*
Rubiaceae	*Opercularia vaginata*	

Family	*Name*	Weed
Rutaceae	*Philotheca spicata*	
Solanaceae	*Solanum nigrum*	*
Thymelaeaceae	*Pimelea ?rosea* subsp. *rosea*	
Violaceae	*Hybanthus calycinus*	
Xanthorrhoeaceae	*Xanthorrhoea brunonis*	
Zamiaceae	*Macrozamia riedlei*	

Appendix E

Flora Likelihood of Occurrence Assessment

Family	Species	DEC Status	EPBC Status	Details and Habitat	Likelihood of Occurrence
Proteaceae	*Franklandia triaristata*	P4		Erect, lignotuberous shrub, 0.2-1 m high. Fl. white-cream-yellow/brown-purple, Aug to Oct. White or grey sand.	Possible
Apiaceae	*Brachyscias verecundus*	T	Critically Endangered	Annual (or ephemeral), herb, 0.012-0.022 m high, entirely glabrous. Fl. white/cream. In a moss sward. On a granite outcrop.	Unlikely
Apiaceae	*Platysace ramosissima*	P3		Perennial, herb, to 0.3 m high. Fl. white-cream, Oct to Nov. Sandy soils.	Possible
Aponogetonaceae	*Aponogeton hexatepalus*	P4		Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green-white, Jul to Oct. Mud. Freshwater: ponds, rivers, claypans.	Possible
Asparagaceae	*Chamaescilla gibsonii*	P3		Clumped tuberous, herb. Fl. blue, Sep. Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.	Possible
Asteraceae	*Angianthus drummondii*	P3		Erect annual, herb, to 0.1 m high. Fl. yellow, Oct to Dec. Grey or brown clay soils, ironstone. Seasonally wet flats.	Possible
Asteraceae	*Rhodanthe pyrethrum*	P3		Erect, slender annual, herb, 0.05-0.2 m high. Fl. white & yellow, Oct to Dec. Clay, sandy clay. Winter-wet depressions, clay pans, swamps.	Possible

Family	Species	DEC Status	EPBC Status	Details and Habitat	Likelihood of Occurrence
Asteraceae	*Trichocline sp. Treeton* (B.J. Keighery & N. Gibson 564)	P2		Tuberous, perennial, herb, to 1.6 m high. Sand over limestone, sandy clay over ironstone. Seasonally wet flats.	Unlikely
Centrolepidaceae	*Centrolepis caespitosa*	P4	Endangered	Tufted annual, herb (forming a rounded cushion up to 25 mm across). Fl. Oct to Dec. White sand, clay. Salt flats, wet areas.	Possible
Cyperaceae	*Carex tereticaulis*	P1		Monoecious, rhizomatous, tufted perennial, grass-like or herb (sedge), 0.7 m high. Fl. brown, Sep to Oct. Black peaty sand.	Unlikely
Cyperaceae	*Schoenus benthamii*	P3		Tufted perennial, grass-like or herb (sedge), 0.15-0.45 m high. Fl. brown, Oct to Nov. White, grey sand, sandy clay. Winter-wet flats, swamps.	Possible
Cyperaceae	*Schoenus capillifolius*	P2		Semi-aquatic tufted annual, grass-like or herb (sedge), 0.05 m high. Fl. green, Oct to Nov. Brown mud. Claypans.	Unlikely
Cyperaceae	*Schoenus loliaceus*	P2		Annual, grass-like or herb (sedge), 0.03-0.06 m high. Fl. Aug to Nov. Sandy soils. Winter-wet depressions.	Possible
Ericaceae	*Andersonia gracilis*	T	Endangered	Slender erect or open straggly shrub, 0.1-0.5(-1) m high. Fl. white-pink-purple, Sep to Nov. White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Possible

Family	Species	DEC Status	EPBC Status	Details and Habitat	Likelihood of Occurrence
Fabaceae	*Acacia flagelliformis*	P4		Rush-like, erect or sprawling shrub, 0.3-0.75(-1.6) m high. Fl. yellow, May to Sep. Sandy soils. Winter-wet areas.	Possible
Fabaceae	*Acacia semitrullata*	P4		Slender, erect, pungent shrub, (0.1-)0.2-0.7(-1.5) m high. Fl. cream-white, May to Oct. White/grey sand, sometimes over laterite, clay. Sandplains, swampy areas.	Possible
Fabaceae	*Pultenaea skinneri*	P4		Slender shrub, 1-2 m high. Fl. yellow/orange & red, Jul to Sep. Sandy or clayey soils. Winter-wet depressions.	Possible
Goodeniaceae	*Anthotium junciforme*	P4		Open, erect to prostrate perennial, herb, 0.05-0.4 m high, leaves linear to terete, 0.5-1 mm wide; flowering stems 12-40 cm long. Fl. blue-violet-purple, Nov or Jan to Mar. Sandy clay, clay. Winter-wet depressions, drainage lines.	Possible
Loganiaceae	*Mitreola minima*	P3		Slender, erect annual, herb, 0.025-0.04 m high. Fl. white, Oct to Dec. Grey sand. Peaty swampy areas.	Possible
Malvaceae	*Lasiopetalum membranaceum*	P3		Multi-stemmed shrub, 0.2-1 m high. Fl. pink-blue-purple, Sep to Dec. Sand over limestone.	Unlikely
Menyanthaceae	*Ornduffia submersa*	P4		Perennial, herb, aquatic to 0.6 m tall. Fl. White, yellow. Freshwater up to 0.6 m deep.	Possible

Family	Species	DEC Status	EPBC Status	Details and Habitat	Likelihood of Occurrence
Myrtaceae	*Darwinia foetida*	T	Critically Endangered	Shrub to 0.6 m. Fl. between October to November. Grows in grey-white sand on swampy, seasonally wet sites (DSEWPaC, 2011)	Possible
Myrtaceae	*Eucalyptus rudis* subsp. *cratyantha*	P4		Tree, 5-20 m high, bark rough, box-type. Fl. white, Jul to Sep. Loam. Flats, hillsides.	Unlikely
Myrtaceae	*Verticordia attenuata*	P3		Shrub, 0.4-1 m high. Fl. pink, Dec or Jan to May. White or grey sand. Winter-wet depressions.	Possible
Myrtaceae	*Verticordia fimbrilepis* subsp. *fimbrilepis*	T	Endangered	Shrub, 0.3-0.7 m high. Fl. pink-white, Oct to Dec or Jan. Gravelly sandy or clayey soils. Flats, road verges.	Unlikely
Orchidaceae	*Caladenia huegelii*	R		Tuberous, perennial, herb, 0.25-0.6 m high. Fl. green & cream & red, Sep to Oct. Grey or brown sand, clay loam.	Possible
Orchidaceae	*Caladenia longicauda* subsp. *clivicola*	P4		Tuberous, perennial, herb, 0.3-0.5 m high. Fl. white-green-yellow, Sep to Oct. Clayey loam, gravel, sand. Granite outcrops.	Unlikely
Orchidaceae	*Caladenia speciosa*	P4		Tuberous, perennial, herb, 0.35-0.6 m high. Fl. white-pink, Sep to Oct. White, grey or black sand.	Likely
Orchidaceae	*Diuris drummondii*	R		Tuberous, perennial, herb, 0.5-1.05 m high. Fl. yellow, Nov to Dec or Jan. Low-lying depressions, swamps.	Possible

Family	Species	DEC Status	EPBC Status	Details and Habitat	Likelihood of Occurrence
Poaceae	*Austrostipa jacobsiana*	P1		Winter wet flats. Grey sandy clay.	Possible
Rutaceae	*Boronia humifusa*	P1		Low-growing, wiry perennial, herb, 0.1-0.2 m high. Fl. pink/red, Jun or Sep. Gravelly clay loam over laterite. Jarrah-marri open forest.	Possible
Santalaceae	*Leptomeria furtiva*	P2		Lax, sprawling shrub, 0.2-0.45 m high. Fl. orange-brown, Aug to Oct. Grey or black peaty sand. Winter-wet flats.	Possible
Stylidiaceae	*Stylidium longitubum*	P3		Erect annual (ephemeral), herb, 0.05-0.12 m high. Fl. pink, Oct to Dec. Sandy clay, clay. Seasonal wetlands.	Possible

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev 0	G. Owen	N McCarthy	N.McCarthy	F Hannon	Frannde Hannon	6/3/12

Appendix C – Dieback Assessment Report

GHD

Assessment for the presence of *Phytophthora cinnamomi* – Bunbury Outer Ring Road, Stage 2

Report compiled by Evan Brown of Glevan Consulting

GLEVAN
CONSULTING

Disclaimer

This report has been prepared in accordance with the scope of work agreed between GHD and Glevan Consulting and may contain results and recommendations specific to the scope. Results and recommendations in this report should not be referenced for other projects without the written consent of Glevan Consulting.

Procedures and guidelines stipulated in various Department of Environment and Conservation and Dieback Working Group manuals are applied as the base methodology used by Glevan Consulting in the delivery of the services and products required by this scope of work. These guidelines, along with overarching peer review and quality standards ensure that all results are presented to the highest standard.

Version Control

Document ID	Author	Date	Comments
A	EB	09/11/11	

Contents

Tables

Figures

Executive Summary

GHD contracted Glevan Consulting to conduct an assessment for the presence of *Phytophthora cinnamomi* (Dieback) along the route of the proposed Stage 2 section of the Bunbury Outer Ring Road.

The route is shown in the following figure.

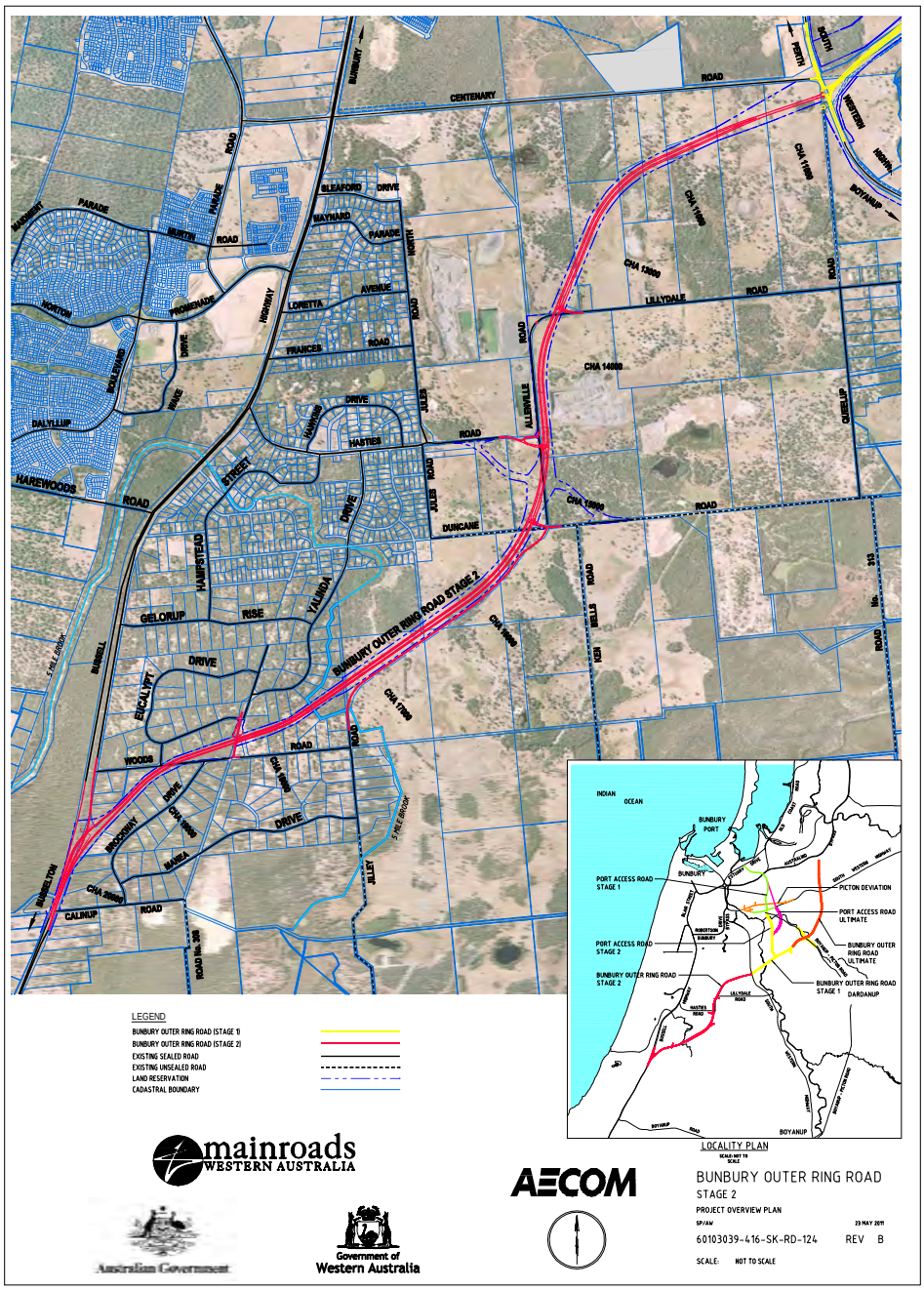


Figure 1 - Bunbury Outer Ring Road route

The route traverses private property and designated road reserves with varying levels of natural vegetative structure and entirety of species. The areas of cleared pasture or extensively grazed vegetation have been classified as Unmappable, whilst the section of the alignment west of Jilley Road has been classified as Uninfested. The vegetation within this Uninfested area is not completely intact, however for ease of management, the area could be treated as one management unit.

The following recommendations are made and are explained further in the report;

- All sections of the alignment east of Jilley Road are considered Unmappable.
- All sections west of Jilley Road are considered Uninfested.
- The property east of the alignment on Duncane Road contains uninfested vegetation and the road reserve on the western boundary of this site should not be used for access to the alignment without hygiene restrictions.
- A Dieback Management Plan for the construction of the alignment should be developed to manage the import and export of materials and vehicle movements across the site.

Introduction

The *P. cinnamomi* occurrence assessment is the first step in developing an effective management plan for the pathogen. Assessments can assign four possible categories to landscape of a project area. These categories are; Unmappable, Infested, Uninfested and Uninterpretable.

The following table describes *P. cinnamomi* occurrence categories as defined by the Department of Environment and Conservation in the manual "*Phytophthora cinnamomi*. and disease caused by it, Volume 1, Management Guidelines, 2003". The superior categories "Mappable" and "Unmappable" definitions are not yet published by the department, but are in general use at this time.

Table 1 - Category Definitions

<table>
<tr><td>Unmappable
Areas that are sufficiently disturbed so that P. cinnamomi occurrence mapping is not possible at the time of inspection.</td><td colspan="2">Further categorisation may be possible after variable regeneration periods for different types of disturbance</td></tr>
<tr><td rowspan="3">Mappable
Natural undisturbed vegetation. P. cinnamomi occurrence mapping is possible. Three categories may result.</td><td>Infested</td><td>Areas that a qualified person has determined to have plant disease symptoms consistent with the presence of the pathogen P. cinnamomi.</td></tr>
<tr><td>Uninfested</td><td>Areas that a qualified person has determined to be free of plant disease symptoms that indicate the presence of the pathogen P. cinnamomi</td></tr>
<tr><td>Uninterpretable</td><td>Areas where indicator plants are absent or too few to determine the presence or absence of disease caused by P. cinnamomi</td></tr>
</table>

Once *P. cinnamomi* occurrence information has been assessed, Protectable and Unprotectable management categories can be overlayed on occurrence information

to further simplify the management of the area. All infested area is Unprotectable. Unmappable, Uninterpretable and Uninfested may be given Protectable or Unprotectable status depending on local variations and influences.

This report will give results of the *Phytophthora* Dieback occurrence assessment, stating relevant Uninfested and Unmappable areas. Recommendations of Protectable area will also be made, but the final rationalisation of protectable area categories should be confirmed in consultation with Glevan Consulting (if required), Department of Environment and Conservation (if appropriate) and other relevant land owners during the development of detailed Dieback Management Plans.

Method

The vegetation within and immediately adjacent to the proposed Stage 2 of the Bunbury Outer Ring Road was assessed at a desktop level utilising GIS software using the appropriate data sets and appropriate aerial photographs in geo-referenced digital form. Other datasets referenced included previous positive recoveries of *Phytophthoras* (point data), mapped infested areas (poly data) and climatic information (poly data). This desktop assessment can be used to assist the field interpretation of the disease status.

Following the desktop assessment, the field assessment of the vegetation was conducted by Evan Brown (Dieback disease interpreter) of Glevan Consulting. All senior personnel used by Glevan Consulting are accredited by the Department of Environment and Conservation (DEC) in the detection, diagnosis and mapping of the Dieback disease in all vegetation communities and bio-regions of Western Australia. This accreditation from the DEC acknowledges that the personnel of Glevan Consulting have the skills and experience to determine the Dieback disease occurrence in the vegetation and landform types within the assessment area.

During the field assessment, the interpretation of the vegetation is specifically looking for those areas that are:

- Infested with *Phytophthora cinnamomi*;
- Possibly infested by other *Phytophthora* species;
- Uninfested (free of plant disease caused by *Phytophthora cinnamomi*), and;
- Uninterpretable (areas where presence or absence of *Phytophthora cinnamomi* cannot be determined).

Following the establishment of any disease occurrence, the interpreter will then determine and recommend any areas that may be Unprotectable, and subsequently, which areas of Uninfested, Unmappable and Uninterpretable are Protectable.

The detection of the presence of the plant pathogen *Phytophthora cinnamomi* involves the observation and interpretation of plant deaths (or reduction of biomass or perceived temporal change in vegetation structure) using a logical assessment of factors that imply pathogen presence above other possible causes of plant deaths or vegetation change.

A combination of the following factors may indicate the presence of disease caused by *Phytophthora cinnamomi* or other *Phytophthora* species.

Deaths of disease indicating species:

An indicator species is a plant species, which is reliably susceptible to *Phytophthora cinnamomi* (i.e. will die). Common indicator species include *Banksia grandis, Patersonia* spp., *Persoonia longifolia*, and *Xanthorrhoea* spp. The distribution and composition of indicator species will vary from place to place according to vegetation and landform types.

Chronology of deaths:

As the pathogen spreads through an area, some or all susceptible plants become infected and die. Consequently there will be an age range from more recent deaths with yellowing or brown leaves through to older leafless stags to remnant stumps in the ground.

Pattern of deaths:

The topography, soil type, vegetation type and drainage characteristics of an area together with the influence of climatic patterns and disturbances will affect the shape or pattern of an infested area over time. A typical recent infestation may show a small cluster of dead indicator species that, in time, will spread to become a small circular shape 'the ulcer effect' and then begin lengthening towards natural drainage channels. A fringe of recent deaths is often seen around the edge of the infested area. Patterns may be further highlighted by a paucity of ground cover within the infested area.

Environmental factors:

Sites will vary in the way that disease is expressing both spatially and temporally. Environmental conditions can either favour or disfavour the growth and spread of the pathogen. Sites that are moist but not saturated are most favourable; sites that are fertile, well drained and mostly dry are least favourable.

Other causes of indicator species death:

Phytophthora cinnamomi is not the only agent to cause death of native vegetation. Other agents include, but are not limited to:

- other *Phytophthora* spp, *Armillaria luteobubalina*, various cankers, insects;
- drought, wind scorch, frost, salinity, water logging, fire and lightning;
- senescence, competition, physical damage;
- herbicides, chemical spills (for example fuel).

All interpretation and management procedures used by Glevan Consulting are consistent with the methodologies detailed in DEC manuals "*PHYTOPHTHORA CINNAMOMI AND DISEASE CAUSED BY IT Volume I – Management Guidelines*" (2003) and *PHYTOPHTHORA CINNAMOMI AND DISEASE CAUSED BY IT Volume II - Interpreter Guidelines for Detection, Diagnosis and Mapping* (2001). (CALM, 2001)

Results and discussion

The vegetation within and adjacent to the Bunbury Outer Ring Road alignment was assessed for the presence of the Dieback disease, with no symptoms of the disease noted. Recommendations are made in this report for the hygienic use of the alignment, however a detailed Dieback Management Plan for the construction of the road should be prepared prior to any soil moving activities.

The vegetation east of Jilley Road traverses cleared farmland or areas of grazed vegetation. The determination of the Dieback disease in this area is inconclusive with no vegetation present to confidently display the symptoms of the disease, if present. It has also been demonstrated by studies conducted by Dr Elaine Davison that random soil only sampling does not achieve a confident assessment of Dieback disease presence.(Davison & Tay, 2003) This Unmappable section also covers an area with little relief, and many areas subject to seasonal inundation. During the assessment in October 2011, some areas were not trafficable due to water laying across the area. Sites infested with Dieback are situated relatively close to this section of the alignment, particularly in the north with vegetated areas on the southern boundary of Manea Park (northern side of Centenary Road) infested. Due to the limited relief of the alignment, it could be expected that infested material may have entered the confines of the alignment due to water movement and uncontrolled use of the land.

The unmade road reserve for Allanville Road, on the northern side of Ducane Road can be used as an access to the alignment. The vegetation on Lot 1 Ducane Road, on the eastern side of this road appears to contain intact vegetation that is not displaying disease symptoms, despite the road reserve used for the dumping of rubbish. If this road is used to access the alignment, a hygiene point will be required for all vehicles traversing the road south, from the Bunbury Outer Ring Road alignment.

The majority of the alignment west of Jilley Road is upland and associated with a change in landscape. This vegetated section contains intact remnant stands of Jarrah/Marri/Tuart forest over Banksia woodland. Whilst some deaths in disease indicating species were observed, the scattered deaths were not indicative of the symptoms normally associated with the presence of the Dieback disease. The calcareous soils of this landscape are also less favourable to the development of the Dieback disease. (CALM, 2003) A hygiene point should be installed at Jilley Road to clean all machinery traversing the alignment from east to west. All machinery accessing any portion of the alignment west of Jilley Road will be free of soil and plant material prior to entering the vegetation.

For the following calculations of the hygiene areas, an alignment width of 50 metres has been assumed over the approximately nine kilometre alignment.

Table 2 - Disease Occurrence Status

Disease occurrence status	Hectares	Percentage of total
Uninfested	12.7 ha	27.7%
Uninterpretable		
Unmappable	33.1 ha	72.3%
Infested		
Total	45.8 ha	

This correlates to the following protectable / unprotectable status of the road, shown in Table 3.

Table 3 - Hygiene Status

Hygiene status	Hectares	Percentage of total
Protectable	12.7 ha	27.7 %
Unprotectable	33.1 ha	72.3 %

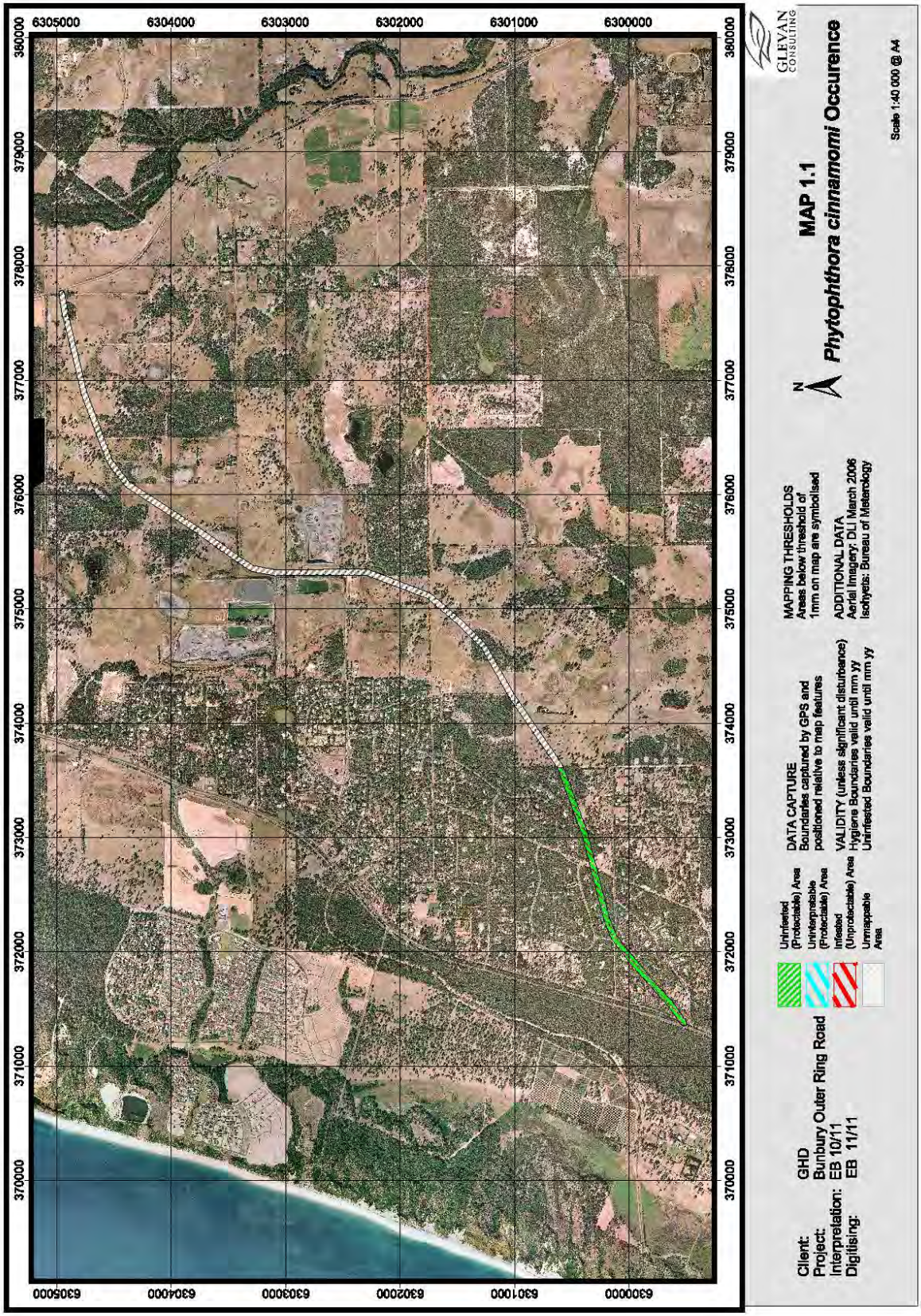
Bibliography

CALM. (2001). *Phytophthora Cinnamomi and Disease Caused By It Volume 2 - Interpreter Guidelines for Detection, Diagnosis and Mapping.*

CALM. (2003). *Phytophthora cinnamomi and disease caused by it. Volume 1 - Management Guidelines.* Unpublished.

Davison, E., & Tay, F. (2003). *A Sampling Strategy for Phytophthora for 'Difficult' Sites.* Curtin University of Technology, Department of Environmental Biology. MERIWA.

Appendix 1 – Maps



Appendix D – Fauna Assessment Report

CLIENTS | PEOPLE | PERFORMANCE

Main Roads WA

Bunbury Outer Ring Road Southern Section, South Western to Bussell Highways

Fauna Assessment

March 2012

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

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Executive Summary

Main Roads Western Australia (Main Roads) commissioned GHD to conduct a fauna assessment of the proposed Bunbury Outer Ring Road Southern Section (the Project) ,which is located south east of Bunbury as shown at Figure 1. The Study area for the survey was the existing and proposed road reserve as detailed in concept plans provided by Main Roads.

The Project provides for the construction of 9 km of dual carriageway from South Western Highway (south) to Bussell Highway.

Previous surveys were undertaken by GHD (2009) and found that the dominant land use of the area is agricultural and is used for cattle grazing, although there are several naturally vegetated bush areas present. The remnant vegetation in some areas is in good condition.

Several significant species were identified at numerous locations along the alignment; these being Western Ringtail Possum, Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Black Cockatoo, Rainbow Bee-eater and Southern Brown Bandicoot.

The fauna survey was carried out in conjunction with the flora investigation in September 2011 and consisted of ground trothing the entire alignment recording all sightings and sign for fauna species present. Specific focus was given to species previously recorded over the alignment or those identified during desktop assessment that is likely to occur in the region.

The results of the survey are:

Five important fauna habitat types were identified within the Project area. These habitat types are listed below;

- Damplands and Wetlands, dominated by Melaleuca spp. and sedges often in grazed paddocks.
- Riverine and riparian zones on Five Mile Brook.
- Jarrah/Banksia Mixed Woodland which comprise of a Jarrah (Eucalyptus marginata) dominated over storey, over mixed herb shrub layer on sandy soils.
- Marri/Banksia Mixed Woodland which comprise of a Marri (Corymbia calophylla) dominated over storey, often with an equal density of Banksia attenuata and scattered Banksia grandis, Agonis flexuosa on well drained slopes over mixed herb and shrub layer.
- Peppermint/Mixed Banksia spp. Woodland which comprise of a Peppermint (Agonis flexuosa) dominated woodland, with low mixed understorey of shrubs and annuals. Generally adjacent wetlands, Peppermint were often co-dominant with Melaleuca spp. or in low lying areas.

Eleven fauna trees were identified within the alignment that showed evidence of chews by Black Cockatoos or have hollows suitable for Black Cockatoo breeding. One of these trees has a large Wedge-tailed Eagle nest and would not be used by Black Cockatoos while the eagles are present.

In total 59 birds, 3 native mammals (5 introduced), 8 reptiles and 3 amphibians were observed during the field survey. Off these species 4 are listed under federal protection and 1 listed under DEC priority fauna list.

- Carnaby's Black Cockatoo (endangered) Calyptorhynchus latirostris

- Baudin's Black Cockatoo (vulnerable) Calyptorhynchus baudinii
- Forest Red-tailed Black Cockatoo (vulnerable) Calyptorhynchus banksia naso
- Western Ringtail Possum (vulnerable) Pseudocheirus occidentalis
- Southern Brown Bandicoot (Priority 5) Isoodon obesulus fusciventer

Based on Risk Referral table assessment Black Cockatoos will trigger referral based on the clearing of approximately 23 hectares of potential breeding habitat, clearing of approximately 19 hectares of known feeding habitat. Other potential impacts include hydrological changes to adjoining feeding habitat, the degradation of habitat through land changes in particular further edging effect of feeding habitat, increased competition of breeding habitat by other species by removing hollows and potential movement or establishment of Phytophthora spp. into Black Cockatoo habitat.

Western Ringtail Possums were assessed as habitat usage rather than population assessment. Within the alignment approximately 17 hectares was identified as being utilised by Western Ringtail Possums.

Based on the Commonwealth 'Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia (2009) the Project triggers two of the three possible impact criteria. Consequently the Project will require formal referral to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) under the provisions of the *Environment Protection and Biodiversity Conservation Act, 1999*.

Due to the potential impact of the Project on Western Ringtail Possum, recent requirements of DSEWPaC, and the possible level of public interest in the Project it would be prudent to undertake population assessments of Western Ringtail Possum to quantify the impact of the roadworks clearing. In order to estimate population size and habitat use distance sampling is required as the results will quantify the impacts on existing local and regional populations and enable the environmental regulators to better assess the project.

The Southern Brush-tailed Phascogale was identified from desktop assessment and has the potential to occur within the Study area in areas of intact remnant vegetation. These areas exist between the Bussell Highway and Jilley Road in the Gelorup area.

1. Introduction

1.1 Background

Main Roads Western Australia (Main Roads) commissioned GHD to conduct a fauna assessment of the proposed Bunbury Outer Ring Road Southern Section (the Project) ,which is located south east of Bunbury as shown at Figure 1. The Study area for the survey was the existing and proposed road reserve as detailed in concept plans provided by Main Roads.

The Bunbury Outer Ring Road (BORR) is a planned Controlled Access Highway linking the four major highways radiating from Bunbury on the outer edge of the City's development to the planned Bunbury Port Access Road (PAR). The BORR and PAR will provide a high standard route for traffic wishing to access the Bunbury Port and the developing industrial areas to the east of Bunbury without the need to travel through the developed areas of Bunbury. The completed BORR will also provide an effective bypass of Bunbury for inter-regional traffic.

The Project is planned with the capacity to be upgraded to freeway status over the long term. It will initially be constructed as a four lane dual carriageway and upgraded to a freeway as traffic volumes increase in time with ongoing development in the Greater Bunbury and South West Regions.

The Project provides for the construction of 9 km of dual carriageway from South Western Highway (south) to Bussell Highway, including intersections at:

- Lillydale Road
- Hastie Road
- Ducane Road
- Service road to service private properties east of Lilydale Road
- Bussell Highway

It will include construction of an overpass and associated road works at Yalinda Drive and construction of a 2.3 km long service road from Ducane Road to Jilley Road.

Preliminary design for the southern stage of the Project has now been completed to allow scope of works, land requirements and environmental impacts to be determined.

The concept for the BORR was originally developed in the early 1970's and the concept report completed in 1995. The land requirement was identified in the Greater Bunbury Region Scheme.

The purpose of the survey is to provide an appropriate examination of fauna focusing on conservation significant fauna within the receiving environment of the BORR.

In 2009 GHD undertook a Level 1 fauna survey of the proposed alignment at the time and identified fauna constraints. From the results of this survey the alignment has been slightly modified to address some of the fauna concerns.

Information from this survey will be used in a project Environmental Impact Assessment and subsequent State and Commonwealth approvals documentation.

1.2 Study Area

The location of Study area is shown in Figure 1 and commences on the South West Hwy and terminating on the Bussell Highway near Woods Road, approximately 8.5 kilometres south of Bunbury and comprising of approximately 65 hectares.

Along the corridor are areas of native vegetation including that found in road reserves, privately owned bush blocks and the existing proposed road corridor in the Gelorup area. Much of the alignment is within large sections of cleared agricultural land.

1.3 Previous Studies

GHD undertook a significant fauna survey of four days and 3 nights between the 17th February and March 2009. The survey area comprised the entire BORR proposed alignment (19 km in length) from the Picton to Boyanup Road to South Western Highway (North Boyanup), NPBH to the Picton to Boyanup Road and from South Western Highway (North Boyanup) to Bussell Highway. The study comprised of diurnal and nocturnal searches, focusing on conservation listed fauna identified during desktop assessment.

The results of the assessment are summarised below:

- The dominant land use of the area is agricultural and is used for cattle grazing, although there are several naturally vegetated bush areas present. The remnant vegetation in some areas is in good condition.
- Several significant species were identified at numerous locations along the alignment; these being Western Ringtail Possum, Carnaby's Black Cockatoo, Forest Red-tailed Black Cockatoo, Baudin's Black Cockatoo, Rainbow Bee-eater and Southern Brown Bandicoot.
- Assessment against the 10 Clearing Principles identified that this project maybe at variance with principles a and b. This being the impacts to biodiversity and impact on significant habitat for fauna, in particular the Western Ringtail Possum and Black Cockatoo species.

This study undertook a desktop assessment of the entire alignment which included a 10 km buffer. The large survey area and buffer included a number of additional conservation significant species, most of which were historical records, or included a marine environment which is irrelevant to the Study area or are no longer present in the region.

2. Methodology

2.1 Field Assessment

GHD's qualified Zoologist –Glen Gaikhorst conducted the fauna investigation in conjunction with the flora investigation in September 2011 (The flora component is presented in a standalone report). The fauna survey included desktop investigations and field surveys and was conducted in accordance with Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia – Guidance Statement No. 56 (EPA 2004) and Technical Guide- Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2010).

The fauna survey was an opportunistic survey and did not involve any fauna trapping. The survey involved visual and aural surveys for any fauna species utilising the Study area. The Study area was also searched for any fauna signs, such as tracks, scats, bones, diggings and feeding signs.

Surveys also included systematic searching across all habitat types, which is an effective method of surveying for many wildlife species. This involved searching through microhabitats where wildlife is known to frequent, including turning over logs or rocks, turning over leaf litter and examining hollow logs. Reptiles were also sighted as they basked during the day.

Species – specific search strategies were used to identify any conservation protected species in the area or evidence that they utilise the study area. Desktop assessment and data from the GHD (2009) report indicated that four conservation significant species that are federally and /or state listed that are known to persist in the area. These species were assessed as follows.

2.1.1 Western Ringtail Possum

- Signs of this species were identified based on dreys, dropping and feeding areas sightings.
- Visual encounters of live possums.
- Recording all signs via a GPS to establish habitat use in an area.

2.1.2 Black Cockatoos

Three species of Black Cockatoo's were surveyed in line with;

- *Environment Protection and Biodiversity Act 1999* draft referral guidelines for three threatened black cockatoo species: Carnaby's Black Cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's Black Cockatoo (vulnerable) *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo (vulnerable) *Calyptorhynchus banksia naso* (DSEWPaC 2011).
- *The assessment involved a visual and aural assessment of the site identifying actual and potential breeding trees, feeding habitat, roosting areas, current activity and any other signs of use by Black Cockatoos.*

Information collected during the field survey included;

- *Identification of feeding habitat (through accepted feed plant species and /or evidence of feeding),*
- *Identification of roosting areas*,

- *GPS location of actual and/or potential breeding trees that are >500mm diameter at breast height (DBH) and have hollows suitable for breeding,*
- *A map of the feeding habitat and of actual and/or potential breeding habitat or roost sites.*

2.2 Nomenclature

Nomenclature used in this report follows that used by the NatureMap database as they are deemed to contain the most up-to-date species information for Western Australian reptiles, mammals and invertebrates. Birds however follow Christidis and Boles (2008).

3. Desktop Assessment

3.1 Physical Environment

The project is situated approximately 8 km to the south of Bunbury and links the Bussell Highway to the South West Highway. The land is generally flat to gently sloping to the west. The alignment crosses Five Mile Brook and several wetland areas. Most of the Study area is cleared farm and semi-rural land, with scattered blocks of remnant vegetation. The southern 3.5 km from Five Mile Brook to Bussell Highway comprises a continuous strip of native vegetation.

3.2 Climate Conditions

Bunbury is located on the south-western corner of Western Australia and the climate of the Study area is broadly described as Mediterranean, with warm dry summers and mild wet winters. The nearest Bureau of Meteorology (BoM) official recording station is Bunbury located approximately 8 km north of the Study area. Table 1 shows the climatic data (BoM 2011).

Table 1 Climatic Data for the Bunbury Region (BoM 2011)

Mean Annual Maximum Temperature Range:	**17.3°C in July/August to 29.8°C in February**
Mean Annual Minimum Temperature Range:	7.2°C in July\August to 15.6°C in February
Mean Annual Rainfall:	738 mm
Mean Annual Rain days per year:	83.9

3.3 Database search results

The conservation of fauna species and their significance status is currently assessed under both State and Commonwealth Acts. The acts include the Western Australian *Wildlife Conservation Act 1950* and federal *Environmental and Protection of Biodiversity Conservation Act 1999.*

Significance levels for fauna within the *EPBC Act* are the same as those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN). The Western Australian *Wildlife Conservation Act 1950* utilises a set of Schedules as well as some of the IUCN categories. Two databases are used to identify species within a Study area, these are;

- *The Department of Sustainability, Environment, Water, Population and Climate (DSEWPaC) Protected Matters database search – to identify threatened and migratory species listed under the EPBC Act 1999 potentially occurring within the Study area; and*
- *The Western Australian Museum (WAM) and DEC NatureMap database – to determine vertebrate fauna species lodged in the Museum's collection from within or adjacent to the Study area.*

Prior to conducting the field survey, a search of the above databases was undertaken on the 16th of September 2011 to identify significant fauna that could potentially occur in the Study area. A 5 km buffer was placed on the search to identify all species that mat occur within the Study area.

3.3.1 Species Identified NatureMap

The NatureMap search identified 89 birds (2 introduced), 1 reptile, 4 amphibians and 7 mammals (including 4 introduced species). The conservation significant listed species identified from NatureMap are listed below in **Table 2**. The complete species list is presented in **Table 9**, Appendix B.

3.3.2 Significant Fauna Search (DSEWPaC Protected Matters Search)

The Protected Matters fauna search identified 10 birds and 9 mammals (including 4 introduced species) as potentially occurring in close proximity to the Study area. The below table presents the conservation listed species identified from both NatureMap and DSEWPaC protected matter search. The complete species list is presented in **Table 9**, Appendix B.

The species identified in Table 2 are discussed further in section 4 and includes a likelihood of occurrence with in the Study area.

Table 2 Conservation Listed Species identified from Desktop Searches

Species	Common Name	Listing under *WC Act 1950* or DEC Priority List	Listing under *EPBC Act*	Source of Information	
				DSEWPaC	Nature Map
Birds					
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	Schedule 1	Vulnerable	+	+
Calyptorhynchus baudinii	Baudin's Black Cockatoo	Schedule 1	Vulnerable	+	+
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	Schedule 1	Endangered	+	+
Botaurus poiciloptilus	Australasian Bittern	Schedule 1	Endangered	+	-
Sternula nereis nereis	Fairy Tern	-	Vulnerable	+	-
Mammals					
Dasyurus geoffroii	Chuditch	Schedule 1	Vulnerable	+	
Setonix brachyurus	Quokka	Schedule 1	Vulnerable	+	+
Pseudocheirus occidentalis	Western Ringtail Possum	Schedule 1	Vulnerable	+	+
Isoodon obesulus fusciventer	Southern Brown Bandicoot	Priority 5	-	-	+
Macropus irma	Western Brush Wallaby	Priority 4	-	-	+
Migratory Birds					
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	Migratory	+	-
Apus pacificus	Fork-tailed Swift	-	Migratory	+	-
Merops ornatus	Rainbow Bee-eater	-	Migratory	+	+
Ardea alba	Great Egret	-	Migratory	+	+
Ardea ibis	Cattle Egret	-	Migratory	+	-

4. Field Investigation

4.1 Fauna Species Observed

In total 59 birds, 3 native mammals (5 introduced), 8 reptiles and 3 amphibians were observed during the field survey. The species are list in Appendix B. Off these species 4 are listed under federal protection and 1 listed under DEC priority fauna list. These species and the observations are discussed further in Section 4.2.

4.2 Conservation Listed Species Observed

4.2.1 Western Ringtail Possum (*Pseudocheirus occidentalis*) DEC Schedule 1, EPBC Vulnerable

Western Ringtail Possums occur only in the south west region of Western Australia where they feed upon Peppermint (*Agonis flexuosa*) and *Eucalyptus spp*. trees. In populated areas they will also feed on introduced plant species which include roses, *Ficus spp*. and suburban fruit trees. The species is now restricted to wetter coastal areas of the south west; with smaller populations occurring inland in Jarrah, Wandoo and Marri forests (Menkhorst, 2004). The reduction in population size is primarily due to the loss of habitat however the species is also preyed upon by feral predators.

Species Assessment During the field survey several individuals were observed active during the day after being disturbed in dreys. A number of dreys (resting platforms in trees) were recorded throughout the Study area and their locations are presented in Figure 2. Most dreys were present in *Banksia attenuata, Agonis flexuosa, Melaleuca spp.* and low *Corymbia calophylla.* Droppings were recorded in most areas particularly where the canopy had some connectivity and logs were present on the ground or perch against trees. These locations are presented in Figure 2.

Western Ringtail Possum were also observed in the 2009 survey within the current Study area.

4.2.2 Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) DEC Schedule 1, EPBC Endangered

Carnaby's Black Cockatoo, also known as the Short-billed Black-Cockatoo and is distributed across the south-west of Western Australia (Morcombe 2004). The species preferred habitat is uncleared or remnant areas of Eucalyptus Woodland and Shrubland or Kwongan heath (DEC 2007). 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 (DEC 2007). These Cockatoos feed on the seeds of a variety of native plants, including *Banksia spp., Eucalyptus spp., Grevillea spp.* and *Hakea spp*., and some introduced plants (Johnstone and Storr 1998). They will also feed on the nectar from flowers of a number of species, and on insect larvae living under bark.

Over the last 50 years most of the feeding habitat of Carnaby's Black Cockatoo has been destroyed by agricultural clearing and urban development. Any suitable habitat that remains is fragmented, and often degraded by soil salinity and weed invasion. Feeding habitat is often too far away from nests that the growth rate and survival of nestlings is significantly reduced. The original food sources for Carnaby's Black Cockatoo have been largely replaced by urban development and introduced pine plantations that are to be reduced significantly in the future.

Species Assessment Carnaby's Black Cockatoo were sighted twice during the 2011 field assessment, a flock of 6 birds in Gelorup close to the intersection of Woods and Banksia Roads and 26 in *Eucalyptus spp.*\ *Banksia* woodland near Ducane Road. The Study area also contains habitat for Carnaby's Black Cockatoo for both feeding and breeding. *Banksia attenuata* trees within the Study area showed evidence of feeding at numerous locations (see Plate 1).

In 2009 no Carnaby's Black Cockatoo were observed but multiple sites of feeding on Marri, and Banksia were recorded.

In total 565 potential Black Cockatoo breeding trees lie within the alignment and are mapped in Figure 2. These trees are Marri, Jarrah, *E.rudus* and Tuart and all have a >500 mm at DBH, several of these have large hollows with evidence of chewing. These are presented below in Table 3. All trees are mapped and presented figure 2.

Plate 1 Carnaby's Black Cockatoo feeding evidence on *., attenuate*.

4.2.3 Forest Red tailed- Black Cockatoo (*Calyptorhynchus banksia naso*) DEC Schedule 1 EPBC Vulnerable

The Forest Red-tailed Black Cockatoo species is essentially a cockatoo of the Jarrah forest (*Eucalyptus marginata*) but also uses Marri (*Corymbia calophylla*) and woodlands for foraging, with Marri seeds (along with Jarrah) being its principal food source (Johnstone and Kirkby 1999). *Allocasuarina spp*. is also another species utilised by this species.

The Forest Red-tailed Black Cockatoo has reduced in range in the South West due to habitat loss and now persists in the remaining Jarrah forest. In recent years the species has been increasingly observed on the Swan Coast Plain, where it appears to be adapting to developed areas feeding on introduced

species like Cape Lilac. The species has also been recorded breeding in the Mandurah and Murdoch area of the Swan Coast Plain.

Species Assessment Forest Red-tailed Black Cockatoo were sighted twice during the field assessment, a flock of 4 birds along Marchetti Road feeding in *Eucalyptus marginata* and a flock of 6 in the same area feeding on *Eucalyptus marginata*. This group appeared to have a juvenile present, which was heard begging for food.

This species is known to occur in the area and contains good habitat for Forest Red-tailed Black Cockatoo for both feeding and breeding. Feeding habitat is present throughout the alignment in remnant habitat areas, primarily on Marri and Jarrah nuts. Plate 2 below shows evidence of feeding on Marri nuts.

No actual breeding observations were recorded (other than the juvenile recorded along Marchetti Road). Several trees (Jarrah, Marri and Tuart) were observed in the Study area which had hollows that showed signs of chewing and could be used by Forest Red-tailed Black Cockatoo. These are presented in Table 3. A large number of other trees have a size suitable for the development of nesting hollows in the future as they have a >500 mm DBH. These trees are presented in Figures 2.

In 2009 GHD observed and heard Forest Red-tailed Black Cockatoos at multiple locations along the alignment, most of which, were in the southern section in the Gelorup area (Woods Road and Bussell Highway) and in a section of bush on Wallrodt Road. Feeding was observed along the alignment primarily on Marri.

Plate 2 Forrest Red-tailed Black Cockatoo feeding evidence on Marri nuts.

4.2.4 Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) 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 (Van dyke and Strahan 2008).

The Quenda is a Priority 5 species, which means that it is not considered threatened but is subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years. Quenda populations on the Swan Coastal Plain and coastal regions are threatened by urban development, which has resulted in loss of habitat. This species is relatively common in parts of the south west region.

Species Assessment The Study area has limited understorey and ground cover plants to support a long term population of Southern Brown Bandicoot. However some diggings were observed in the median strip of the Bussell Highway and was likely Bandicoot. This area is next to a large bushland reserve (Reserves 23000, 28835 and 28836) located west of the highway and is likely to maintain a Bandicoot population with dispersal into the Study area.

In 2009 bandicoot diggings were recorded along the Australind Bypass in an ephemeral wetland that had dense sedges and grasses.

4.3 Additional species identified by GHD (2009)

4.3.1 Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) Schedule 1, Endangered

Baudin's Black Cockatoo is found in the south-west of Western Australia in the Forest and Woodlands of Jarrah (*Eucalyptus marginata*), Karri (*E. diversicolor*) and Marri (*Corymbia calophylla*). It also occurs in Wandoo (*E. wandoo*) woodland, and in orchards, and is occasionally recorded in farmland and grasslands (DEC 2011). This species mainly feeds on the seeds and flowers of Marri in the forested regions of the south-west, and the seeds of the proteaceous *Banksia grandis, B. littoralis, B. ilicifolia, Hakea undulata, H. prostrata, H. trifurcata*, as well as *Erodium botrys*, Jarrah and insect larvae. They also feed on apple and pear seeds in orchards. Baudin's Black Cockatoo nests in mature trees such as Marri, Karri, Jarrah and Wandoo in the lower south-west of Western Australia (DEC 2011). The northern-most breeding record for Baudin's Black Cockatoo is at Lowden, near Donnybrook (DEC 2011).

The principal cause of the decline of this species range has been historical clearing of the eastern margins of the forests for agriculture. Other threatening processes are killing by illegal shooting, feral honeybees (*Apis mellifera*), habitat loss, nest shortage and competition for available nest hollows (DEC 2011). Baudin's Black Cockatoo is currently listed as endangered in Western Australia and listed as vulnerable under the Commonwealth *EPBC Act 1999*. Baudin's Black Cockatoo fits the criteria for endangered because of a projected or suspected decline in the population of 50 per cent or more within the next ten years or three generations, whichever is the longer (up to a maximum of 100 years) (DEC, 2011).

Species Assessment This species is known to occur in the area and was observed by GHD in 2009. The Survey area contains significant habitat for Baudin's Black Cockatoo feeding and breeding. Feeding habitat is present throughout the alignment in remnant habitat areas.

No actual breeding observations were recorded. Several trees (Jarrah, Marri and Tuart) were observed in the alignment which has hollows that show signs of chewing and could be used by Baudin's Black Cockatoo. These trees are presented in Table 3. A large number of other trees have a size suitable for

the development of nesting hollows in the future as they have a >500 mm DBH. These trees are shown in Figure 2.

4.3.2 Southern Brush-tailed Phascogale (*Phascogale tapoatafa tapoatafa*) Vulnerable, Schedule 1

The Southern Brush-tailed Phascogale (SBTP) is observed in dry sclerophyll forests and open woodlands with a generally sparse understorey. This species' habitat requirements also include hollow-bearing trees, rotted stumps or tree cavities which they use as nest sites (Van Dyck and Strahan, 2008). Tree hollows that have a small and secure entrance with a large internal cavity are highly favoured by breeding SBTPs. Southern Brush-tailed Phascogale will also use existing bird's nests as their small size and weight allows them to use such existing nests successfully (Van Dyck and Strahan, 2008).

Habitat clearing and fragmentation as a result of agriculture and land development; and habitat alteration from logging and mining have reduced the availability of trees with hollows required for this species to nest and breed. Another cause for decline of this species is predation by foxes and cats. What suitable habitat remains is often fragmented, isolating populations and impeding genetic exchange.

Species Assessment No signs of the species have been recorded, however, as large intact patches of habitat persists in the Gelorup and sections of the alignment in the area of Jilley Road. Both areas have the potential to support a SBTP population.

4.3.3 Rainbow Bee-eater (*Meriops ornatus*) Migratory, Marine

The Rainbow Bee-eater is a brightly coloured species that migrates to and within Australia in the warmer drier months of southern Australia. In the northern parts of Australia it can live all year round without migration. The species prefers woodlands, open forests, semi-arid scrub, grasslands or farmlands. They prefer to breed in open cleared areas in heavily forested woodlands or in farmlands (Morcombe 2004). Its breeding season is from November to February and is achieved by constructing a burrow on the ground in sandy or clay soils.

Species Assessment The Rainbow Bee-eater was observed several times along the alignment in 2009 (GHD 2009) on a sand ridge of Banksia Woodland off Wallrodt Road (in the northern section). Breeding was also recorded at this location. Although not observed this time the species is known to utilise the area and breed within the alignment.

4.4 Species Identified from Desktop Assessment

4.4.1 Chuditch (*Dasyurus geoffroii*) Schedule 1, Vulnerable

The Chuditch or Western Quoll formerly ranged over nearly 70% of Australia but now retains only a patchy distribution through the sclerophyll forests (Jarrah forest and mixed Karri, Marri, Jarrah forest) of south-western WA (Orell and Morris, 1994). More recently the species is also known to occur in the Kalbarri area and Forrestania area east of Hyden. The 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 (Orell and Morris, 1994). This species is currently listed as vulnerable under the *EPBC Act 1999*.

Species Assessment Chuditch are known to occur in the Collie area and in large areas of intact forest. More recently the species has been observed in the Byford region and adjoining areas of the Darling Range. A specimen was captured in Paganoni Reserve south of Perth along the new Forest Highway. The species is known to move large distances where habitat is available and predation is reduced (via baiting programs). Due to the Study area's proximity to suburban and rural areas (therefore increased fire, disturbance and feral predators) and fragmentation of the remaining available habitat it is unlikely that Chuditch would be present.

4.4.2 Quokka (*Setonix brachyurus*) Schedule 1, Vulnerable

The Quokka is a small macropod that inhabits low lying scrub or dense heath and swamps with dense vegetation (Maxwell *et al*., 1996). This species is a browser, with peppermint (*Agonis flexuosa*) and *Thomasia* species being dominant in their diet (DEC 2008). The range of the Quokka once extended across the south west of Western Australia; however, with the impact of colonization and the introduction of predators such as the fox this range has been highly reduced.

Species Assessment This species is known to occur in large intact protected areas in the region, however due to the Study area's proximity to suburban and rural lots (therefore increased fire, disturbance and feral predators) and fragmentation of the remaining available habitat it is unlikely that Quokka would be present. There is no suitable habitat along the alignment.

4.4.3 Western Brush Wallaby (*Macropus irma*) Priority 4

The Western Brush Wallaby is 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 (DEC, 2008).

The Western Brush Wallaby occurs on the Swan Coastal Plain only in a select number of large vegetation remnants, peripheral to urban areas (Government of Western Australia, 2000).

Species Assessment The Western Brush Wallaby is known to occur in the general area in large vegetated areas. This species was not identified during the fauna surveys, and it would be unlikely to occur on the Study Area due to the lack of large vegetated areas and the close proximity to urban areas which increase the risk of dog activities.

4.4.4 Fairy Tern (*Sternula nereis nereis*) Vulnerable

The Fairy Tern is not listed in Western Australia but is listed federally as Vulnerable due to the species decline on the east coast of Australia (Morcombe 2004). This species prefers marine areas and those sheltered by the coast. Areas include bays, coves, inlets, estuaries, lagoons and sheltered beaches. The species has also been observed using coastal salt ponds, lakes and wetlands (Morcombe 2004).

Species Assessment This species is unlikely to occur in the Study area as no suitable habitat for this species is present.

4.4.5 Australasian Bittern (*Botaurus poiciloptilus*) Schedule 1, Endangered

The Australasian Bittern is the largest of the bittern species and second in weight only to the Great-billed Heron (McKilligan 2005). The species occupies the south west and east corners of Australia (Morcombe 2004). Freshwater and Brackish swamps with heavily vegetated areas are preferred habitat of the Australasian Bittern. Vegetation provides refuge and advantage points while feeding as the species is an ambush predator feeding on a large range of items including fish,, frogs, crayfish, invertebrates, rats and birds (McKilligan 2005). This species is very secretive and little is known about its breeding or behaviour. Assessments on population size estimate it to be approximately 2500 breeding birds (Garnett and Crowley 2000, McKilligan 2005).

Species Assessment This species is unlikely to occur in the Study area as no habitat for this species is present.

4.5 EPBC Migratory and Marine Bird Species

A number of species included in the list of significant fauna species that could potentially occur in the Study area were listed as migratory terrestrial, marine and wetland species. These species are recognised under international treaties such as CAMBA, ROKAMBA and JAMBA, as well as the Bonn Convention for migratory species and *EPBC Act 1999* list of marine species. Many of these bird species have extended home ranges throughout Australia and the world. The Study area is not considered to contain significant habitat for migratory species. Potential impacts on these species are considered to be negligible.

4.6 Introduced Fauna Species

Six introduced mammals and two bird species were identified in the field and from desktop assessment occurring in the Study area. These species are Black Rat, Rabbit, Cat, Dog, Pig, Red Fox, Eastern Long-billed Corella and Laughing Kookaburra. The Eastern Long-billed Corella is a recent coloniser in Western Australia and originates from the aviculture industry. The species is commonly observed in the Perth, Mandurah areas and one record from Albany. This record is the only one from the Bunbury area (NatureMap 2011) and is likely an aviary escapee.

4.7 Fauna Habitat

4.7.1 Important Fauna Habitat Types

Five important fauna habitat types were identified within the Project area. This is based on species observations or evidence of conservation listed species in the form of scats, dreys, feathers, sign of feeding and activity. Other areas are known habitats of listed species or have greater biodiversity. These habitat types are listed below;

- *Damplands and Wetlands, dominated by Melaleuca spp. and sedges often in grazed paddocks.*
- *Riverine and riparian zones on Five Mile Brook.*
- *Jarrah/Banksia Mixed Woodland which comprise of a Jarrah (Eucalyptus marginata) dominated over storey, over mixed herb shrub layer on sandy soils.*

- *Marri/Banksia Mixed Woodland which comprise of a Marri (Corymbia calophylla) dominated over storey, often with an equal density of Banksia attenuata and scattered Banksia grandis, Agonis flexuosa on well drained slopes over mixed herb and shrub layer.*
- *Peppermint/Mixed Banksia spp. Woodland which comprise of a Peppermint (Agonis flexuosa) dominated woodland, with low mixed understorey of shrubs and annuals. Generally adjacent wetlands, Peppermint were often co-dominant with Melaleuca spp. or in low lying areas.*

4.8 Important Fauna Trees Identified

Eleven fauna trees were identified within the alignment that showed evidence of chews by Black Cockatoos or have hollows suitable for Black Cockatoo breeding. One of these trees has a large Wedge-tailed Eagle nest and would not be used by Black Cockatoos while the eagles are present. These trees are presented in **Table 3** and mapped and presented in Figure 2. Several of these trees are present within or on the edge of the expected clearing footprint and maybe able to be retained reducing the impacts on Black Cockatoo and Western Ringtail Possum.

Table 3 Important Breeding Trees

Tree Type	Easting	Northing	Comments
Large Tuart Tree	373098	6300378	Very large tuart with multiple hollows present, one observed to have extensive chews present by Black Cockatoo. Whistling Kites were also nesting in the crown and Ringnecks nesting in a smaller hollow.
Jarrah Tree	373474	6300548	Large Jarrah with hollows present suitable for Black Cockatoo.
Marri Tree	373405	6300524	Large Marri with hollows present suitable for Black Cockatoo.
Marri Tree	374524	6301069	Large Marri with hollows present suitable for Black Cockatoo.
Marri Tree	374731	6301233	Large Marri with hollows present and chews observed at one hollow, possible Black Cockatoo.
Marri Tree	374863	6301403	Large Marri with hollows present suitable for Black Cockatoo.
Marri Tree	374925	6301388	Large Marri with hollows present suitable for Black Cockatoo.
Marri Tree	375547	6303552	Large Marri with hollows present suitable for Black Cockatoo.
Large dead stag	375536	6303642	Large dead stag with hollows present suitable for Black Cockatoo.
Jarrah Tree	376618	6304678	Large Jarrah with hollows present suitable for Black Cockatoo.
Marri Tree	374527	6301072	Wedge-tailed Eagles nesting in the crown of this tree. Large hollows also present suitable for Black Cockatoo, however would not be used while Wedge-tailed Eagles are present.

4.9 Habitat linages

In the southern section of the Project area (Gelorup section) the road reservation was purposefully retained for this road. In doing so has provided a vegetated linkage between privately owned remnant

vegetation in the area to the reserve adjoining the Bussell Highway. This linkage is now being used by Western Ringtail Possum and Black Cockatoos as well as a number of native birds, reptiles and amphibians. North of the Gelorup suburb, the remnant vegetation is patchy with little connectivity to other areas. Some areas of road side vegetation do have connectivity linear in nature. These areas are along South West Highway, Ducane Road and Lillydale Road but are small and often degraded.

At the northern end of the project near South West Highway a patch of Peppermint woodland is loosely connected to the roadside vegetation. This patch showed signs of a Western Ringtail Possum population based on the presence of dreys and droppings.

5. Discussion

5.1 Likelihood of Occurrence and Known Impacts

Species identified from 2011 observation, GHD (2009) and desktop assessments are described above in Section 4. **Table 4** below identifies the likelihood of occurrence and the impacts that the Project is expected to have on each species. The three Black Cockatoo species are discussed together as their impacts are the same as identified in DSEWPaC (2011). Black Cockatoo "Known Impact" areas are inclusive, therefore there is overlap in area between feeding and potential breeding areas.

The clearing areas detailed in Table 4 are based on the road concept design provided by Main Roads in 2011 (Drawing Numbers 201102 – 0103 to 201102 – 0012 Rev B apart from 201102 – 0110 Rev C). These areas do not include clearing required for service relocations, fences, noise walls and/or noise bunds. The clearing will be more refined as the project develops.

Table 4 Likelihood of Occurrence and Known Impacts

Species	Likelihood of Occurrence	Known Impacts (Approximate)
Forest Red-tailed Black Cockatoo	Known	**Foraging Habitat** Approximately 19 ha will be impacted. **Potential Breeding Habitat** Approximately 23 ha will be impacted. **Actual Breeding** No actual breeding events were observed. **Roosting** No roosting areas were recorded.
Baudin's Black Cockatoo	Known	
Carnaby's Black Cockatoo	Known	
Australasian Bittern	Unlikely	No known impacts
Fairy Tern	Unlikely	No known impacts
Chuditch	Unlikely	No known impacts
Quokka	Unlikely	No known impacts
Western Ringtail Possum	Known	Known Impact is loss of habitat, habitat connectivity, fragmentation and loss of individuals. The possum habitat impact identified from this study comprise approximately 17 ha. This area of possum habitat is based on use from records of actual possums, dreys, droppings and other signs. This species is being assessed in greater detail by UWA or GHD for this project.
Southern Brown Bandicoot	Known	Loss of habitat, by including good management practices such as the installation of underpasses and rehabilitating of areas, impacts to the

		species would be minimal.
Western Brush Wallaby	Unlikely	No known impacts
Southern Brush-tailed Phascogale	Possible	Loss of habitat, by including good management practices such as the installation of underpasses, overpasses and rehabilitating of areas, impacts to the species would be minimal.
White-bellied Sea-Eagle	Unlikely	No known impacts
Fork-tailed Swift	Possible	An aerial species which rarely utilises a terrestrial environment, no known impacts.
Rainbow Bee-eater	Known	Loss of habitat, however as the species is migratory the impacts to the species would be minimal.
Great Egret	Possible	Limited available habitat, No known impacts.
Cattle Egret	Possible	Limited available habitat, No known impacts.

5.2 Risk Referral Table for Black Cockatoos

DSEWPaC (2011) provides a risk table that gives guidance on what the department views as risks\impacts to Black Cockatoos that will trigger referral. Risk is broken into 3 categories high, uncertain and low and primarily focuses on breeding, feeding and roosting areas as well as indirect impacts. If there is uncertainty in regards to risks on Black Cockatoo's then the department recommends referring the project or contacting the department to ensure legal certainty. **Table 5** below identifies the risks and whether or not the risk triggers referral.

Based on Table 5 Black Cockatoos trigger referral based on;

- *Clearing of 23 hectares of potential breeding habitat.*
- *Clearing of 19 hectares of known feeding habitat.*
- *Potential hydrological changes to adjoining feeding habitat.*
- *Degradation of habitat through land changes in particular further edging effect of feeding habitat.*
- *Increased competition of breeding habitat by other species by removing hollows.*
- *And potential movement or establishment of Phytophthora spp. into Black Cockatoo habitat.*

Table 5 Risk Referral table for Black Cockatoos

High Risk of Significant Impacts: Referral Recommended	Referral Trigger
Clearing of any known nesting tree.	No
Clearing of any part or degradation of breeding habitat in a woodland or forest within a species known breeding range.	Yes
Clearing of more than 1 ha of quality foraging habitat.	Yes
Creating a gap or greater than 4 km between patches of Black Cockatoo Habitat (Breeding, Foraging or Roosting).	No
Clearing or degradation (including pruning of top canopy) of a known roosting site.	No
Uncertainty: Referral recommended or contact the department	
Degradation (such as through altered hydrology or fire regimes) of more than 1 ha of foraging habitat. Significance will depend on the level and extent of degradation and the quality of the habitat.	Possible
Clearing or disturbance in areas surrounding Black Cockatoo habitat that has the potential to degrade habitat through introduction of invasive species, edge effect, hydrological changes, increase human visitation or fire.	Yes
Actions that do not directly affect the listed species but that have the potential for indirect impacts such as increasing competitors for nest hollows.	Yes
Actions with the potential to introduce known plant diseases such as *Phytophthora spp*.	Possible
Low Risk of significant impacts: referral may not be required but you may refer for legal certainty	
Actions that do not affect Black Cockatoo habitat or individuals.	No
Actions whose impacts occur outside the modelled distribution of the three Black Cockatoos.	No

5.3 Western Ringtail Possum Impact Significance

The Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia (Commonwealth of Australia, 20090 has identified the Project Area as providing supporting habitat for Western Ringtail Possum. The vegetation immediately north of the Bussell Highway has been identified as core habitat for the species. The guidelines note that in respect to supporting habitat there is the chance or possibility of a significant impact on the species based on three criteria. These criteria and expected impact from the Project are detailed in Table 6.

Table 6 Western Ringtail Possum Impact Significance

Significant Impact Assessment Criteria	Expected Project Impact	Referral Trigger
Clearing in a remnant habitat patch that is greater than 0.5 ha in size	Project clearing of approximately 17 ha will occur in a habitat patch greater than 0.5 ha	Yes
Clearing more than 50% of a remnant habitat patch that is 0.2-0.5 ha in size	N/A	No
Fragmentation of existing habitat linkages	The project will sever existing habitat linkages	Yes

Based on the Commonwealth 'Significant impact guidelines for the vulnerable western ringtail possum (*Pseudocheirus occidentalis*) in the southern Swan Coastal Plain, Western Australia (2009) the Project triggers two of the three possible impact criteria. Consequently the Project will require formal referral to DSEWPaC under the provisions of the *EPBC Act, 1999*.

6. Conclusion

This study has identified four species listed under the EPBC Act and WA Conservation Act to be present and utilising habitat within the Study area. These are Carnaby's Black Cockatoo, Baudin's Black Cockatoo, Forrest Red-tailed Black Cockatoo and Western Ringtail Possum. Direct and indirect impacts to Black Cockatoo's have been identified and primarily relate to potential breeding and feeding habitat. Referral will be required based on these impacts. No actual breeding events or roosting sites have been recorded within the alignment.

Western Ringtail Possums were assessed as habitat usage rather than population assessment. Within the alignment approximately 17 hectares was identified as being utilised by Western Ringtail Possums. Referral is required based on the loss of habitat and impacts on this species.

Southern Brown Bandicoots were also observed in the southern portion of the alignment. This species is listed Priority 4 under DEC priority fauna list and carries no protection under the WA *Wildlife Conservation Act* (1950). However the species is still monitored by DEC in case of further decline.

The Southern Brush-tailed Phascogale was identified from desktop assessment and has the potential to occur within the Study area in areas of intact remnant vegetation. These areas exist between the Bussell Highway and Jilley Road in the Gelorup area.

A number of other listed species were identified from Desktop assessment that may occur within the Study area, however after field assessment these are considered not to occur or are very unlikely to occur within the alignment.

6.1 Recommendations

Due to the recent requirements of DSEWPaC and the possible level of public interest in the project it would be prudent to undertake population assessments on Western Ringtail Possum to further quantify the impact of the roadworks clearing. In order to estimate population size and habitat use distance sampling is required as the results will quantify the impacts on existing local and regional populations and enable environmental regulators to better assess the project.

7. Report Limitations

This report presents the results of a Level 1 Fauna Assessment prepared for the purpose of this commission. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent scientist/zoologist before being used for any other purpose. GHD accepts no responsibility for other use of the data.

Where previous reports, fauna surveys and similar work have been performed and recorded by others the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

An understanding of site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experience based. Hence, this report should not be altered, amended or abbreviated, issued in part or incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances that arise from the issue of the report that has been modified in any way as outlined above.

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Appendix A

Conservation Codes

EPBC Act

Wildlife Conservation Act

Priority Fauna

EPBC Act Fauna Conservation Categories

Listed threatened species and ecological communities

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- *extinct in the wild,*
- *critically endangered,*
- *endangered, or*
- *vulnerable.*

Critically endangered and endangered species

An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

- *lead to a long-term decrease in the size of a population, or*
- *reduce the area of occupancy of the species, or*
- *fragment an existing population into two or more populations, or*
- *adversely affect habitat critical to the survival of a species, or*
- *disrupt the breeding cycle of a population, or*
- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*, or*
- *interfere with the recovery of the species.*
- **Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.*

Vulnerable species

An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

- *lead to a long-term decrease in the size of an important population of a species, or*
- *reduce the area of occupancy of an important population, or*
- *fragment an existing important population into two or more populations, or*
- *adversely affect habitat critical to the survival of a species, or*
- *disrupt the breeding cycle of an important population, or*
- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or*

- *result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or*
- *interferes substantially with the recovery of the species.*

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- *key source populations either for breeding or dispersal,*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species range.*

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.*

Listed migratory species

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species are also listed as threatened species. The criteria below are relevant to migratory species that are not threatened.

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- *substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or*
- *result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or*
- *seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.*
- *An area of important habitat is:*
- *habitat utilized by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or*
- *habitat utilized by a migratory species which is at the limit of the species range, or*
- *habitat within an area where the species is declining.*

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated).

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.*

The Commonwealth marine environment

An action will require approval from the Environment Minister if:

- *the action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant effect on the environment, or*
- *the action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant effect on the environment in a Commonwealth marine area.*

An action has, will have or is likely to have a significant impact on the environment in a Commonwealth marine area if it does, will, or is likely to:

- *result in a known or potential pest species becoming established in the Commonwealth marine area*, or*
- *modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results, or*
- *have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (eg. breeding, feeding, migration behaviour, and life expectancy) and spatial distribution, or*
- *result in a substantial change in air quality** or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or*
- *result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.*

**Translocating or introducing a pest species may result in that species becoming established.*

***The Commonwealth marine area includes any airspace over Commonwealth waters.*

Table 7 Western Australian Wildlife Conservation Act 1950 Conservation Codes

Conservation Code for Threatened Fauna	Description
Schedule 1	"…fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection."
Schedule 2	"…fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection."
Schedule 3	"…birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection."
Schedule 4	"…fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3]"

Table 8 DEC Priority Fauna Codes

Conservation Code	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land, water reserves, etc.
Priority 3	Taxa which are known from few specimens or sight records, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	Rare taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

(Species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern by DEC).

Appendix B

Species List

Table 9 Species Identified from Desktop and Field Assessment

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Anatidae	*Tadorna*	*tadornoides*	Australian Shellduck		X	X	
Anatidae	*Chenonetta*	*jubata*	Australian Wood Duck		X	X	
Anatidae	*Anas*	*gracilis*	Grey Teal		X		
Anatidae	*Anas*	*superciliosa*	Pacific Black Duck		X	X	
Anatidae	*Aythya*	*australis*	Hardhead		X		
Anatidae	*Biziura*	*lobata*	Musk Duck		X		
Anatidae	*Cygnus*	*atratus*	Black Swan		X		
Anhingidae	*Anhinga*	*novaehollandiae*	Australasian Darter		X		
Ardeidae	*Egretta*	*novaehollandiae*	White-faced Heron			X	
Ardeidae	*Ardea*	*modesta*	Great Egret	X	X		Mi
Ardeidae	*Ardea*	*pacifica*	White-necked Heron		X		
Ardeidae	*Ardea*	*ibis*	Cattle Egret	X			Mi
Ardeidae	*Nycticorax*	*caledonicus*	Rufous Night Heron		X		
Ardeidae	*Botaurus*	*poiciloptilus*	Australasian Bittern	X			E, En
Threskiornithidae	*Threskiornis*	*molucca*	Australian White Ibis		X	X	
Threskiornithidae	*Threskiornis*	*spinicollis*	Straw-necked Ibis		X	X	

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Threskiornithidae	*Platalea*	*flavipes*	Yellow-billed Spoonbill		X	X	
Accipitridae	*Elanus*	*axillaris*	Black-shouldered Kite		X		
Accipitridae	*Haliastur*	*sphenurus*	Whistling Kite		X	X	
Accipitridae	*Accipiter*	*fasciatus fasciatus*	Brown Goshawk		X		
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle		X	X	
Accipitridae	*Haliaeetus*	*leucogaster*	White-bellied Sea-Eagle	X	X		Mi
Accipitridae	*Circus*	*approximans*	Swamp Harrier		X		
Falconidae	*Falco*	*berigora*	Brown Falcon		X		
Falconidae	*Falco*	*cenchroides cenchroides*	Australian Kestrel		X	X	
Falconidae	*Falco*	*longipennis longipennis*	Australian Hobby		X	X	
Pelecanidae	*Pelecanus*	*conspicillatus*	Australian Pelican		X		
Phalacrocoracidae	*Microcarbo*	*melanoleucos*	Little Pied Cormorant		X	X	
Phalacrocoracidae	*Phalacrocorax*	*sulcirostris*	Little Black Cormorant		X		
Phasianidae	*Coturnix*	*pectoralis*	Stubble Quail		X		
Podicipedidae	*Poliocephalus*	*poliocephalus*	Hoary-headed Grebe		X		
Rallidae	*Porphyrio*	*porphyrio bellus*	Purple Swamphen		X		
Rallidae	*Gallinula*	*tenebrosa tenebrosa*	Dusky Moorhen		X		
Rallidae	*Fulica*	*atra australis*	Eurasian Coot		X	X	
Turnicidae	*Turnix*	*varius varius*	Painted Button-quail			X	

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Recurvirostridae	*Himantopus*	*himantopus*	Black-winged Stilt		X		
Recurvirostridae	*Cladorhynchus*	*leucocephalus*	Banded Stilt		X		
Charadriidae	*Elseyornis*	*melanops*	Black-fronted Dotterel		X		
Laridae	*Sternula*	*nereis nereis*	Fairy Tern	X			V
Columbidae	*Streptopelia*	*senegalensis*	Laughing Dove		X		
Columbidae	*Phaps*	*chalcoptera*	Common Bronzewing		X	X	
Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon		X		
Cacatuidae	*Calyptorhynchus*	*banksii naso*	Forest Red-tailed Black Cockatoo	X	X	X	V, Vu
Cacatuidae	*Calyptorhynchus*	*latirostris*	Carnaby's Black Cockatoo	X	X	X	E, En
Cacatuidae	*Calyptorhynchus*	*baudinii*	Baudin's Black Cockatoo	X	X		E, En
Cacatuidae	*Cacatua*	*roseicapilla*	Galah		X	X	
Cacatuidae	*Cacatua*	*tenuirostris*	Eastern Long-billed Corella			X	*
Psittacidae	*Glossopsitta*	*porphyrocephala*	Purple-crowned Lorikeet		X	X	
Psittacidae	*Polytelis*	*anthopeplus westralis*	Regent Parrot		X	X	
Psittacidae	*Barnardius*	*zonarius semitorquatus*	Twenty-eight Parrot		X	X	
Psittacidae	*Purpureicephalus*	*spurius*	Red-capped Parrot		X	X	
Psittacidae	*Platycercus*	*icterotis icterotis*	Western Rosella		X		
Psittacidae	*Neophema*	*elegans*	Elegant Parrot		X	X	
Cuculidae	*Cacomantis*	*flabelliformis*	Fan-tailed Cuckoo		X	X	

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Cuculidae	*Chalcites*	*basalis*	Horsfield's Bronze Cuckoo		X		
Cuculidae	*Chalcites*	*lucidus plagosus*	Shining Bronze Cuckoo		X		
Strigidae	*Ninox*	*novaeseelandiae*	Boobook Owl		X		
Podargidae	*Podargus*	*strigoides brachypterus*	Tawny Frogmouth		X	X	
Apodidae	*Apus*	*pacificus*	Fork-tailed Swift	X			Mi
Halcyonidae	*Dacelo*	*novaeguineae*	Laughing Kookaburra		X	X	*
Halcyonidae	*Todiramphus*	*sanctus*	Sacred Kingfisher		X		
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater	X	X		Mi
Maluridae	*Malurus*	*splendens*	Splendid Fairy-wren		X	X	
Maluridae	*Stipiturus*	*malachurus westernensis*	Southern Emu-wren		X		
Pardalotidae	*Pardalotus*	*striatus westraliensis*	Striated Pardalote		X	X	
Acanthizidae	*Sericornis*	*frontalis maculatus*	White-browed Scrubwren		X	X	
Acanthizidae	*Smicrornis*	*brevirostris*	Weebill		X	X	
Acanthizidae	*Gerygone*	*fusca*	Western Gerygone		X	X	
Acanthizidae	*Acanthiza*	*apicalis*	Inland Thornbill		X		
Acanthizidae	*Acanthiza*	*inornata*	Western Thornbill		X	X	
Acanthizidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumped Thornbill		X	X	
Meliphagidae	*Lichmera*	*indistincta*	Brown Honeyeater		X	X	
Meliphagidae	*Sugomel*	*niger*	Black Honeyeater		X		

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater		X	X	
Meliphagidae	*Phylidonyris*	*novaehollandiae*	New Holland Honeyeater		X	X	
Meliphagidae	*Acanthorhynchus*	*superciliosus*	Western Spinebill		X		
Meliphagidae	*Anthochaera*	*lunulata*	Western Little Wattlebird			X	
Meliphagidae	*Anthochaera*	*carunculata*	Red Wattlebird		X	X	
Meliphagidae	*Epthianura*	*albifrons*	White-fronted Chat		X		
Petroicidae	*Microeca*	*fascinans assimilis*	Jacky Winter			X	
Petroicidae	*Petroica*	*boodang*	Scarlet Robin			X	
Petroicidae	*Eopsaltria*	*griseogularis*	Western Yellow Robin		X	X	
Neosittidae	*Daphoenositta*	*chrysoptera pileata*	Black-capped Sitella		X	X	
Pachycephalidae	*Pachycephala*	*pectoralis fuliginosa*	Golden Whistler			X	
Pachycephalidae	*Pachycephala*	*rufiventris rufiventris*	Rufous Whistler			X	
Pachycephalidae	*Colluricincla*	*harmonica rufiventris*	Grey Shrike-thrush			X	
Monarchidae	*Grallina*	*cyanoleuca*	Magpie-lark		X	X	
Rhipiduridae	*Rhipidura*	*albiscapa*	Grey Fantail		X	X	
Rhipiduridae	*Rhipidura*	*leucophrys*	Willie Wagtail		X	X	
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike		X	X	
Campephagidae	*Lalage*	*sueurii*	White-winged Triller		X		
Artamidae	*Artamus*	*cinereus cinereus*	Black-faced Woodswallow		X	X	

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Artamidae	*Artamus*	*cyanopterus*	Dusky Woodswallow		X		
Cracticidae	*Cracticus*	*torquatus leucopterus*	Grey Butcherbird		X	X	
Cracticidae	*Cracticus*	*tibicen dorsalis*	White-backed Magpie		X	X	
Cracticidae	*Strepera*	*versicolor plumbea*	Grey Currawong		X	X	
Corvidae	*Corvus*	*coronoides perplexus*	Australian Raven		X	X	
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow		X	X	
Hirundinidae	*Petrochelidon*	*nigricans nigricans*	Tree Martin		X	X	
Timaliidae	*Zosterops*	*lateralis chloronotus*	Silvereye		X	X	
Sylviidae	*Acrocephalus*	*australis gouldi*	Australian Reed Warbler		X		
Motacillidae	*Anthus*	*novaeseelandiae*	Australasian Pipit		X	X	
Amphibians							
Hylidae	*Litoria*	*adelaidensis*	Slender Tree Frog			X	
Limnodynastidae	*Heleioporus*	*eyrei*	Moaning Frog		X		
Myobatrachidae	*Crinia*	*georgiana*	Quacking Frog		X		
Myobatrachidae	*Crinia*	*glauerti*	Clicking Frog			X	
Myobatrachidae	*Crinia*	*insignifera*	Squelching Froglet		X	X	
Myobatrachidae	*Geocrinia*	*leai*	Ticking Frog		X		
Reptiles							

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Scincidae	*Acritoscincus*	*trilineatum*	South-western Cool Skink			X	
Scincidae	*Cryptoblepharus*	*buchananii*	Fence Skink			X	
Scincidae	*Egernia*	*napoleonis*	Napoleon Skink			X	
Scincidae	*Hemiergis*	*quadrilineata*	Two-toed Mulch Skink		X	X	
Scincidae	*Menetia*	*greyii*	Common Dwarf Skink			X	
Scincidae	*Morethia*	*obscura*	Shrubland Pale Flecked Morethia			X	
Scincidae	*Tiliqua*	*rugosa rugosa*	Western Bobtail			X	
Elapidae	*Pseudonaja*	*affinis affinis*	Dugite			X	
Mammals							
Tachyglossidae	*Tachyglossus*	*aculeatus*	Echidna			X	
Dasyuridae	*Dasyurus*	*geoffroii*	Western Quoll, Chuditch	X			V, Vu
Peramelidae	*Isoodon*	*obesulus fusciventer*	Southern Brown Bandicoot		X	X	P5
Macropodidae	*Macropus*	*fuliginosus*	Western Grey Kangaroo			X	
Macropodidae	*Macropus*	*irma*	Western Brush Wallaby		X		P4
Macropodidae	*Setonix*	*brachyurus*	Quokka	X	X		V, Vu
Phalangeridae	*Trichosurus*	*vulpecula vulpecula*	Common Brushtail Possum		X	X	
Pseudocheiridae	*Pseudocheirus*	*occidentalis*	Western Ringtail Possum	X	X	X	V, Vu
Muridae	*Rattus*	*rattus*	Black Rat		X		*
Leporidae	*Oryctolagus*	*cuniculus*	Rabbit	X		X	*

Family	Genus	Species	Common Name	EPBC Listing	DEC Nature Map	Observed GHD	Listing and Introduced Species
Aves							
Canidae	*Canis*	*lupus familiaris*	Dog			X	*
Canidae	*Vulpes*	*vulpes*	Red Fox	X		X	*
Felidae	*Felis*	*catus*	Cat	X		X	*
Suidae	*Sus*	*scrofa*	Pig	X			*

EPBC	*Environmental Protection and Biodiversity Conservation Act 1999* Protected Matters Search Tool
DEC	Department of Environment and Conservation (DEC) NatureMap search
E	Endangered – EPBC Act
V	Vulnerable – EPBC Act
Mi	Migratory – EPBC Act
EN	Schedule 1 (Endangered) – *Western Australian Wildlife Conservation Act 1950* (WC Act)
VU	Schedule 1(Vulnerable) – WC Act
P4	Priority 4 (Taxa in need of monitoring) – DEC
P5	Priority 5 (Taxa in need of monitoring (conservation dependent)) – DEC
*	Introduced Species

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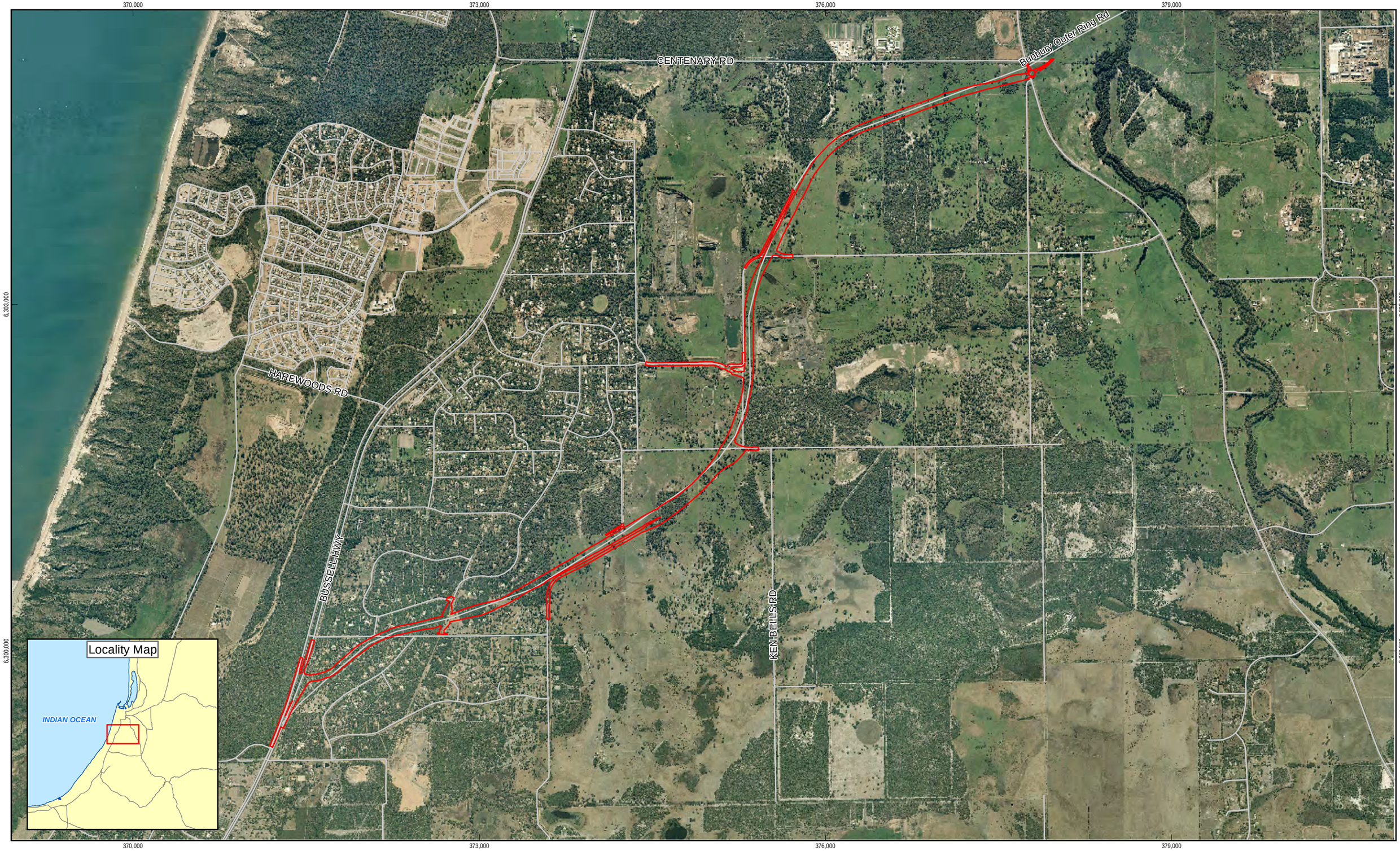
Appendix C

Figures

Study Location

Fauna Constraints



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Roads

Disturbance Footprint

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Main Roads WA - ETS
BORR Southern Section
Environmental Services

Job Number	6127467
Revision	0
Date	13 Jan 2012

Site Location

Figure 1

G:\61\27467\GIS\Maps\MXD\6127467_G010_Fig1_Rev0.mxd

Data source: Landgate: Bunbury 2008 Mosaic - 20111101; Main Roads WA: Roads - 20111027; GA: Geodata Topo 250K Series III - 2006; GHD: Disturbance Footprint. Created by: cagilbert, mczekaj

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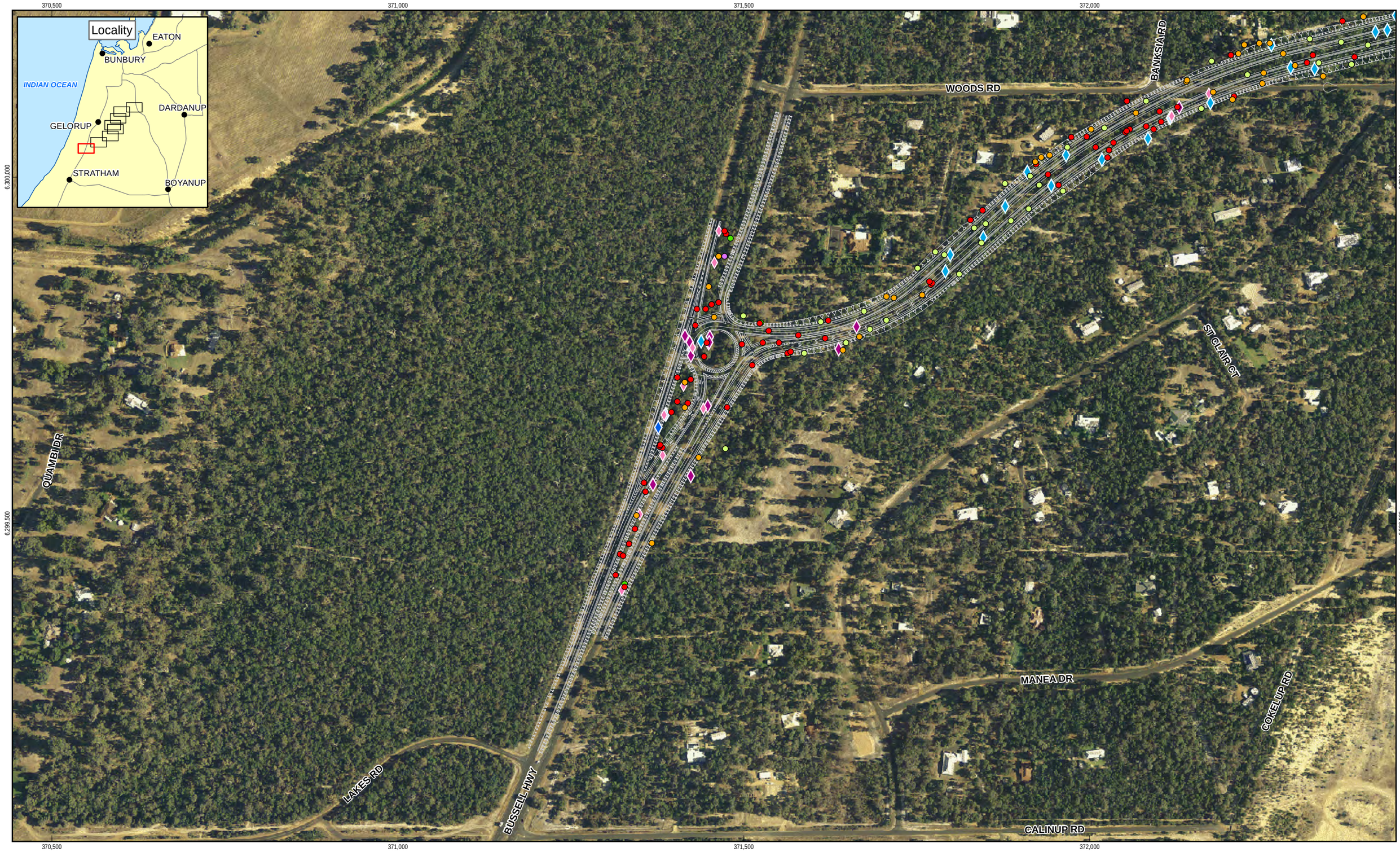

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Possum Location
- Active Dreys
- Old Drey
- Undetermined use Drey
- Western Ringtail Possum droppings
- Western Ringtail Possum live animal

Cockatoo Locations
Feeding Evidence
- Feeding Evidence Banksia attenuata
- Feeding Evidence Marri
- Feeding Evidence Jarrah

Potential Breeding
- Marri\Jarrah\E. rudis\stag, >500mm DBH
- Marri\Jarrah\stag, >500mm DBH with hollows
- Marri\Jarrah\Tuart, >500mm DBH - hollows with evidence of Cockatoo chewing

Other Data
- Bandicoot Diggings
- Wedge-tailed Eagle nest
- Road Design

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BORR Southern Section - Environmental Services

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Revision	0
Date	11 Jan 2012

Fauna Constraints

Figure 2

G:\61\27467\GIS\Maps\MXD\6127467_G003_Fig2_Rev0.mxd

Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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1:5,000 (at A3)

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Metres

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N

LEGEND

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Fauna Constraints

Figure 2

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Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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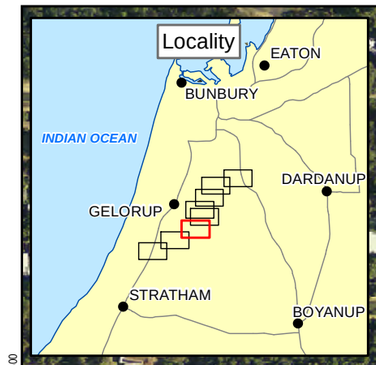

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MARCHETTI RD

YALINDA DR

JILLEY RD

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Metres

Map Projection: Transverse Mercator
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N

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Fauna Constraints

Figure 2

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Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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BORR Southern Section - Environmental Services

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Fauna Constraints

Figure 2

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Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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BORR Southern Section - Environmental Services

Job Number	61-27467
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Fauna Constraints

Figure 2

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Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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Fauna Constraints

Figure 2

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Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

Possum Location
- Active Dreys
- Old Drey
- Undetermined use Drey
- Western Ringtail Possum droppings
- Western Ringtail Possum live animal

Cockatoo Locations
Feeding Evidence
- Feeding Evidence Banksia attenuata
- Feeding Evidence Marri
- Feeding Evidence Jarrah

Potential Breeding
- Marri\Jarrah\E. rudis\stag, >500mm DBH
- Marri\Jarrah\stag, >500mm DBH with hollows
- Marri\Jarrah\Tuart, >500mm DBH - hollows with evidence of Cockatoo chewing

Other Data
- Bandicoot Diggings
- Wedge-tailed Eagle nest
- Road Design

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Main Road WA
BORR Southern Section - Environmental Services

Job Number	61-27467
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Fauna Constraints

Figure 2

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Data source: MRWA: Road Design - 20110920; GHD: Possum Locations - 20111005, Cockatoo Locations - 20111005, Other Data - 20111005; GA: Geodata Topo 250K Series III - 2006; Landgate: Bunbury 2010 Mosaic - 20111005, Road Names - 20110920. Created by: cagilbert, mczekaj

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev 0	Glen Gaikhorst	N McCarthy	N. McCarthy	F Hannon	Fiona Hannon	3/12

Appendix E – Vegetation Clearing Assessment

The clearing of any native vegetation in Western Australia is regulated by DEC and requires a permit under Part V of the Environmental Protection Act (1986). Main Roads has been issued with a Statewide Purpose Clearing Permit (CPS 818/6) which provides for clearing for roadworks. CPS 818/6 requires an assessment of Project clearing against the 'Ten Clearing Principles' to define the significance of the clearing impact.

This assessment has identified that the Project clearing is:

- Proposal is at variance with Principle (b)
- Proposal is likely to be variance with Principle (f)
- Proposal may be at variance with Principle (a, e and i)

Table 18 Assessment Against the 10 Clearing Principles

Principle Number	Principle	Assessment	Outcome
(a)	Native vegetation should not be cleared if it comprises a high level of biological diversity.	Biodiversity within the Project Area ranges from poor in the cleared/pasture areas to moderate in the patches of remnant vegetation. A total of 154 taxa were recorded, of these, 32 taxa were introduced plant species. The biodiversity of the Study area has been greatly reduced by previous clearing, grazing and the high density of weeds present. One priority flora species was located by GHD during the field survey, *Caladenia speciosa* (P4). These plants will be impacted by the proposed clearing for roadworks.	The proposal may be at variance with the Principle.
(b)	Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous Western Australia.	Four species listed under the EPBC Act and WA Conservation Act were present and utilising habitat within the road reserve. These are: Carnaby's Black Cockatoo, Baudin's Black Cockatoo, Forrest Red-tailed Black Cockatoo and Western Ringtail Possum. Within the road alignment, 23 hectares of potential Black Cockatoo breeding habitat and 19 hectares of known feeding habitat were identified. An additional 9 ha of potential feeding and 5 ha of potential breeding habitat has been identified for subsidiary infrastructure, including fences, noise walls and paths. Within the road alignment 17 hectares was identified as being utilised by Western Ringtail Possums, with a further 6 ha required for subsidiary infrastructure.	The proposal is at variance with the Principle.

Principle Number	Principle	Assessment	Outcome
(c)	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No Threatened flora species were recorded during the survey of the Project Area.	The proposal is unlikely to be at variance with the Principle.
(d)	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	*The PEC SCP25 Southern Eucalyptus gomphocephala - Agonis flexuosa woodlands - listed as "Priority 3' under the State DEC listing is located within the southern section of the Study area. The flora assessment conducted by GHD did not record Eucalyptus gomphocephala (Tuart) within this section of the alignment within the PEC SCP25.* *A statistical analysis of all GHD quadrat data collected from the vicinity of the mapped TEC occurrence was undertaken using PATN. Although a number of factors can influence the PATN analysis these vegetation survey data was collected appropriately as possible based on site conditions. The DEC quadrat data used for the PEC SCP25 was collected in the early 1990s and over the intervening period the vegetation condition in the Project Area may have declined through weed invasion and clearing. This can affect the results of the PATN analysis, as the species composition would be altered due to these two disturbance factors.* *No other TEC or PEC were identified within the Project Area.*	The proposal unlikely to be at variance with the Principle.
(e)	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	Within the Study area, three vegetation complexes are present, with two having less than 30% remaining and are considered *Vulnerable.* Southern River Complex has 22% remaining. The Bassendean Complex (Central and South) vegetation association has 25% remaining and the Karrakatta Complex (Central and South) has 56% remaining.	The proposal may be at variance with the Principle.
(f)	Native	The Study area intercepts 11	The

Principle Number	Principle	Assessment	Outcome
	vegetation should not be cleared if it is growing in or in association with a watercourse or wetland.	wetlands, with most being degraded Multiple Use, sumpland wetlands. The vegetation condition of the wetlands mostly rated between *Degraded* (5) to *Completely Degraded* (6). The areas where the wetlands were located have generally been cleared in the past for grazing and are now vegetated with weed species. A small Resource Enhancement wetland (6017) was located within the alignment north of Lillydale Road. The vegetation type of this wetland was Closed tall scrub of *Astartea scoparia* and *Kunzea glabrescens* over sedgeland. The vegetation condition rating was *Very Good* (3). The proposed alignment also intercepted a large, permanent Multiple Use, sumpland wetland 6011 in the northern section of the alignment. This wetland is associated with the ESA at 5 Centenary Road, and 262 Lillydale Road, North Boyanup. The vegetation type of this wetland was Low open forest of *Melaleuca preissiana* and *Melaleuca viminea* over sedgeland. The vegetation condition rated between *Very Good* (3) to *Degraded* (5). The Project will cross Five Mile Brook. The vegetation type along the edges of the brook were Low open forest of *Eucalyptis rudis* and *Melaleuca preissiana* over sedgeland. The vegetation condition of the brook rated *Good* (4) to *Degraded* (5). This area was infested with weed species and has been heavily grazed.	proposal is likely to be at variance with the Principle.
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The northern section of the alignment passes through paddock where the clearing of native vegetation is unlikely to cause significant alterations to the health of adjacent lands. Clearing of vegetation in the southern section of the alignment may increase the risk of runoff, sedimentation, and weed dispersal. The Project Area is in an area susceptible to the development of the pathogen Dieback. Clearing of vegetation may increase the risk of the spread of Dieback to unaffected areas.	The proposal is unlikely to be at variance with the Principle

Principle Number	Principle	Assessment	Outcome
		Preliminary ASS investigations should be conducted prior to works to determine the potential issues of ASS. Appropriate management will address these potential impacts.	
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	No conservation areas or reserves are located within the boundaries of the Project Area or in adjacent areas. No Bush Forever sites are located within 2 km of the Study area. Six ESAs are located within close proximity to the Study area. The proposed development has the potential to increase the volume of stormwater runoff and pollutants into these ESAs.	The proposal is unlikely to be at variance with the Principle.
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	The clearing of native vegetation has a potential to cause deterioration in the quality of surface and underground waters. A Public Drinking Water Source Area, Protection Area P3, occurs adjacent to the north of the Project Area from Marchetti Road to Bussell Highway, Gelorup. The Project also traverses a Proclaimed Groundwater Area. The Project traverses the ephemeral Five Mile Brook. and a seasonally inundated Multiple Use, sumpland wetland 6011, associated with the ESA at 5 Centenary Road, and 262 Lillydale Road, North Boyanup. Appropriate management plans including a Foreshore management Plan for Five Mile Brook and Drainage, Nutrient and Water Management Plan for the length of Project will manage some impact of surface and groundwater.	The proposal may be at variance with the Principle
(j)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the intensity of flooding.	Clearing of native vegetation adjacent to Five Mile Brook will be required. Stabilisation and rehabilitation at the crossing and over the entire Project Area will reduce the potential for, and extent of any flooding impact All road drainage should be designed to maintain existing surface water	The proposal is unlikely to be at variance with the Principle.

Principle Number	Principle	Assessment	Outcome
		flows.	

Appendix F – Aboriginal Heritage Survey Report

AN ABORIGINAL HERITAGE SURVEY OF THE PROPOSED BUNBURY OUTER RING ROAD (STAGE 2) AT GELORUP, WESTERN AUSTRALIA.

A report prepared for GHD Pty Ltd on behalf of Main Roads Western Australia

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HERITAGE SURVEY

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The authors would like to thank the following organisations and individuals who helped with the management of the heritage survey.

- Mr Neil McCarthy – GHD Pty Ltd (Senior Environmental Manager)
- Ms Fionnuala Hannon – GHD Pty Ltd (Principle Environmental Consultant)
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- Mr Alan Grist – Main Roads (SW Region Manager)
- Mr Daniel Voery – Main Roads (Graduate Engineer)
- Mr Sean O'Hara – Gnaala Karla Booja Native Title Claim (Future Acts Officer)
- Mr Mathew Hansen – Gnaala Karla Booja Native Title Claim (Claim Lawyer)
- Mr Joseph Northover – Ngalang Booja Council (Director)
- Mr Colin (Floyd) Irvine – Brad Goode & Associates Pty Ltd (Ethnographer)
- Mr Tom O'Reilly – Brad Goode & Associates Pty Ltd (Senior Archaeologist)
- Mr Stuart Johnston – Brad Goode & Associates Pty Ltd (Archaeologist)

Gnaala Karla Booja (WC98/58) Native Title Claim group representatives

Ethnographic survey informants:

- Mr James Khan
- Ms Marie Khan
- Ms Dorothy Winmar
- Mr Joe Northover
- Mr Les Wallam
- Mr Peter Michael
- Ms Violet Bennell
- Mr Ritchie Bennell
- Mr Denis Hill

DISCLAIMER

All of the information contained in this report is believed to be correct and accurate at the time it was recorded. The author does not take responsibility or accept any liability for errors or omissions contained in the report based upon information supplied by others.

*Note: This report, in terms of its assessment under section 5 of the Western Australian Aboriginal Heritage Act (1972), should be read in conjunction with the *Report on the Archaeological Survey of the Bunbury Outer Ring Road (Southern Section) Project Area Bunbury Western Australia*, by Mr Thomas O'Reilly, 2012.

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GLOSSARY OF TERMS

The Proponent – Main Roads Western Australia
The Consultant - Brad Goode & Associates Pty Ltd
AHA - Western Australian Aboriginal Heritage Act (1972)
DIA - Department of Indigenous Affairs
ACMC - Aboriginal Cultural Material Committee
SWALSC - South West Aboriginal Land and Sea Council
GKB - Gnaala Karla Booja native title claim group

EXECUTIVE SUMMARY

Main Roads Western Australia (Main Roads) is planning to construct stage 2 of the Bunbury Outer Ring Road (BORR). This road is required to reduce traffic congestion within the city and to complete a bypass link around Bunbury.

Stage 2 of the BORR will be built from where stage 1 of the BORR intersects the South Western Highway near Centenary Road. It will then run south west intersecting Bussell Highway between Woods Road and Calinup Road at Gelorup, a total of 9 km (see map-Appendix 3).

The survey corridor is irregular in shape and varies in width form 50m to 150m.

Several access roads to service the BORR stage 2 were also surveyed. These intersections are at Lillydale Road, at Hastie's Road, at Decan Road, at Jilly Road, Eucalyptus Road and at Woods Road (see map-Appendix 3).

Archival research conducted for this survey, which consisted of a search of the DIA Aboriginal Sites Register by GIS auto down load in January 2012, and verified by a search of the DIA web based search engine on 12th April 2012) revealed that **no** previously recorded ethnographic sites or places are located within the survey corridor.

The search **did** however **identify** one previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site 1 to be located within the survey corridor at the BORR intersection with Hastie Road. This site has a DIA polygon that predominately affects the ramp connection of the BORR with Hastie Road. The full detail regards the nature, extent and the scientific significance of this site will be detailed within the accompanying archaeological report by Mr Thomas O'Reilly (2012).

In terms of the sites cultural significance to contemporary Nyungar people it has been determined from consultations with 9 members of the GKB native title claim group that the past level of disturbance and the small quantity of material recorded at the place is off little contemporary cultural significance. Support for ministerial consent was given conditional to salvage and relocation to the offset repository used for material from BORR stage 1.

As a result of this survey the following recommendations are made;

As no new ethnographic sites of significance as defined by Section 5 of the Western Australian Aboriginal Heritage Act (1972) were identified to be located along the proposed corridor for Stage 2 of the Bunbury Outer Ring Road, **it is recommended** that the project should proceed as planned.

As a result of the survey it is likely **that** previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site 1will be affected by the construction of the ramp connection of the BORR with Hastie Road.

As such **it is recommended** that Main Roads make application under Section 18 the Western Australian Aboriginal Heritage Act (1972) for consent to use the land that may contain an Aboriginal site.

As most representatives from Gnaala Karla Booja WC 98/058 Native Title Claim Group who were consulted advised that the sites had little contemporary cultural significance **it is further recommended** that ministerial consent should be given.

Should ministerial consent be given, **it is recommended** that prior to any work commencing that Main Roads in consultation with the above claim group **develop a cultural heritage**

management plan whereby the salvage and relocation of the material can occur prior to construction.

In terms of all salvaged archaeological material **it is recommended** that Main Roads provide suitable land as a repository site. Ideally this site would be close by to where the artefacts have come from. However Nyungar community monitors should be able to determine where to place material during the salvage operation. The repository should then be registered and protected under the AHA.

It is recommended that Main Roads give due recognition of the Nyungar community as prior owners of the land and as a community willing to accommodate development that affects cultural values. This could be achieved by the naming of roads and bridges with Nyungar names.

It is finally recommended hat Main Roads give due consideration to the use of local native species for rehabilitation and the creation of employment opportunities are considered

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REPORT

An Aboriginal Heritage Survey of the Proposed Bunbury Outer Ring Road (Stage 2) at Gelorup, Western Australia

ISSUE

Main Roads Western Australia (Main Roads) is planning to construct stage 2 of the Bunbury Outer Ring Road (BORR). This road is required to reduce traffic congestion within the city and to complete a bypass link around Bunbury.

Main Roads wish to ensure that no sites/places of significance as defined by section 5 of the Western Australian Aboriginal Heritage Act (1972). -AHA is affected by this proposal, thereby fulfilling their obligations under the AHA.

REPORT OBJECTIVES

To report on archival research in order to identify any previously recorded Aboriginal Heritage sites/places located within the proposed survey corridor (see Appendix 3 map).

To determine if any of these previously recorded Aboriginal Heritage sites/places will be impacted upon by the actual road route as it is currently planned.

To report on consultations held with representatives of the Gnaala Karla Booja (WC98/058) Native Title Claim group in order to determine if any new Aboriginal heritage sites/places will be affected by this proposal.

To provide significance assessments for the sites/places determined to be impacted upon by the actual road route and to document the views of the Gnaala Karla Booja (WC98/058) Native Title Claim group in regard to the proposed disturbance of these sites.

To provide management recommendations for any Aboriginal heritage sites/places that may be located within the project area, should the proposal proceed.

BACKGROUND

On the 15th December 2011, Mr Neil McCarthy, Environmental Manager for GHD Pty Ltd acting upon behalf of Main Roads, commissioned Brad Goode & Associates Pty Ltd, to conduct a 'Site Identification Aboriginal Heritage survey' to Section 18 standards, of stage 2 of the BORR.

Previously heritage assessments have been commissioned along various stages of the project as planning has evolved over time in response to constraints (see McDonald 1995 & 1997, Goode 2002a).

In November 2009 Brad & Associates Pty Ltd was commissioned to conduct a desktop study of the road planning corridor in order to consolidate all heritage information into one report to assist in planning a road design (see Goode 2009b).

From this study, and in consideration of other issues, Main Roads have now determined a final route selection for stage 2 of the BORR.

Stage 2 of the BORR will be built from where stage 1 of the BORR intersects the South Western Highway near Centenary Road and will run south west to Bussell Highway between Woods Road and Calinup Road at Gelorup, a total of 9 km (see map-Appendix 3).

The survey corridor is irregular in shape and varies in width form 50m to 150m.

Several access roads to service the BORR stage 2 were also surveyed. These intersections are at Lillydale Road, at Hastie's Road, at Decan Road, at Jilly Road, Eucalyptus Road and at Woods Road (see map-Appendix 3).

As a result of the above brief an archaeological survey of the road corridor and access roads was conducted in January 2011 by Mr Tom O'Reilly (Senior Archaeologist) and Stuart Johnston (Archaeologist) with two GKB assistants.

Ethnographic consultations focused were conducted on the 21st of February 2012 by Mr Brad Goode (Anthropologist), Mr Colin (Floyd) Irvine (Ethnographer), and nine representatives of the Gnaala Karla Booja WC 98/58 Native Title Claim Group.

Mr Neil McCarthy (Senior Environmental Scientist from GHD Pty Ltd) and Mr Gerry Zoetelief (Project Manager from Main Roads) were also present to provide technical information.

The findings of the archaeological and ethnographic surveys are detailed in the following report.

LOCATION

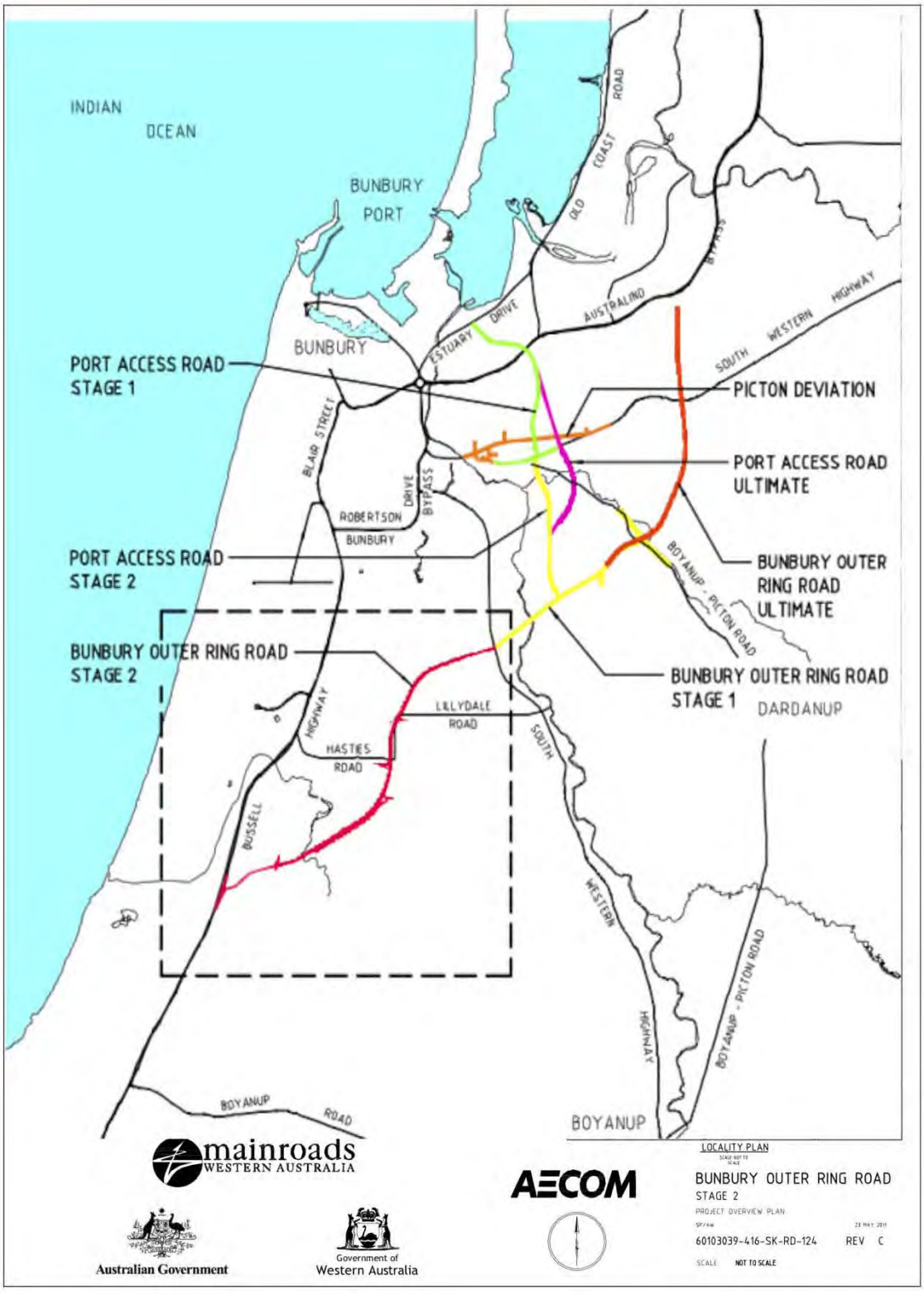

Figure 1: Location of the project area.

ETHNOGRAPHIC & HISTORICAL BACKGROUND

TRADITIONAL NYUNGAR CULTURE

Prior to European settlement Western Australia's southwest was home to thirteen socio-dialectal groups who shared traditions and a common language with local variations. These groups, known collectively as *Nyungar* encompassed a triangle from Jurien Bay in the north to Esperance in the southeast (Berndt 1979, Tindale 1974, Tilbrook 1983). Before linguistic boundaries were formed these people were known as *Bibbulmun* and were said to be 'the finest group in all West Australia' (Bates 1938: 59-61). The word *Bibbulmun* means many breasts, a name derived, perhaps, from the fertility of the region or the great number of women and children among the seventy subgroups.

Bates records the *Kunniung* (west) *Bibbulmun* people as having occupied the Bunbury/Donnybrook area prior to colonization. She records the dialect of the Bunbury region as *Burrong Wongi* (Bates 1985: 54). Tindale (1974: 244, 260) and Berndt (1979) both record this region as home to the *Kaneang.* Unlike their inland neighbours who employed the 'Old Australian tradition' of circumcision (Berndt & Berndt 1979) Nyungars restricted the physical marks of initiation to nasal septum piercing and cicatrisation. A boy at age nine or ten would be removed from his home camp to live with his maternal uncles for several years. During this time upper body cicatrisation and nasal septum piercing would take place and he would learn the lore of the country before returning to live with his immediate family, having passed into manhood (Bates 1985: 151-158).

The two primary social moieties of the Nyungar, the *Manitchmat* (white cockatoo) and *Wordungmat* (crow) were the basis for marriage between a further four semi-moieties or clan groups. The semi-moieties *Tondarup* and *Didarruk* were derivatives of the former and *Ballaruk* and *Nagarnook* derivatives of the latter (Berndt 1979:82, Bates 1985:74). It was strictly forbidden to marry within one's own moiety. In fact, the only lawful marriage was seen to be the cross cousin marriage of paternal aunts' children to the maternal uncles' children. This form of social organization was identical in tribes across all of Western Australia (Bates 1966: 24-25).

The basis for Aboriginal spirituality, land use and ownership lies in their Dreaming. In the Dreaming ancestral beings created the world and all within it thereby defining spiritual, social, moral and territorial division for its inhabitants. The spiritual essence of all ancestral beings not only transformed the landscape but also infused it with living spirit. The beings remained in significant sites and so all generations are linked to the Dreaming and to the eternal spiritual beings (Berndt 1979). The Nyungar held one central creator spirit, the *Waugal* (after Moore 1842, Berndt 1979; *woggal* after Bates 1938 &1985), who created and is still present in all sources of water in the southwest. Bates (1985:219-221) notes that wherever the *Waugal* stopped or camped was sacred. As a consequence, these places were generally avoided (*winnaitch*). O'Connor, Quartermaine and Bodney (1989) provide a theoretical explanation of what they term "the ubiquitous Waugal myth." The *Waugal*, they say, is a water creative spiritual force with a serpentine physical manifestation, which created many of the south west rivers and whose essence remains in such as the Collie and Preston Rivers to this day. The author's state the imputation of religious significance to water sources is at least as old as recorded human history and that it is not surprising that in an arid country such as Australia it occurs in many totemic forms. O'Connor et al note *Waugal* sites of significance at various locations on the Collie River at Collie, namely Bottoms Pool, Wuridjong Pool, Telfer Pool and Wellington Dam.

Aborigines throughout all of Australia have historically held two distinct and complementary forms of relationship to the land: esoteric (sacred, ritual, mythological and ceremonial) and economic (biographical, historical and habitation). Stanner clarifies their difference by using the terms *estate*, *range and domain*. Estate refers to the home ground or Dreaming place of a particular descent group. Range refers to the tract of country over which the group travelled for hunting and foraging, and included their estate. In short, range gave economic boundaries and estate offered a sense of place and of spiritual meaning for both the individual and the group as a whole. A descent group's domain refers to the combination of both estate and range (Stanner 1965:2). The strength of attachment to a particular place would vary from person to person and/or family to family but the associations with the land were, and remain today, crucial elements of Aboriginal society.

Nyungars employed a mobile lifestyle and movement by local family groups was usually along a series of well-defined tracks or paths (*bidi)* which followed the corridors of easiest movement. The fluidity of the kinship system among Nyungars was recorded in early ethnographic studies as individuals were noted to have moved freely between these family runs (Salvado 1977:130-131).

WATER AND ABORIGINAL SIGNIFICANCE

There is no doubt that water, especially fresh water, was of vital importance to traditional Aboriginal people right across Australia. The rivers, pools and wetlands link campsites along walk tracks and are places of mythological and spiritual significance. In the case of the Southwest, rivers also defined the territories or estates of the Nyungar people (Dortch 2002, Hallam 1979).

Various authors, in various regions have recorded specific narratives (Goode 2000b, Jackson and de Gand 1996, Toussaint et al 2005) and generalised narratives (O'Connor 1989, 1995, Villiers 2002, Goode 2003) with regards to the importance and significance of water sources from both a mundane and spiritual position.

In a mundane sense, rivers, wetlands, springs and soaks are seen by both traditional and contemporary Nyungar people as important places to camp, fish, hunt, and gather food and resources that are made plentiful by the supply of fresh running water (O'Connor 1989, 1995, Goode 2008c).

In regard to the spiritual significance of water across Aboriginal Australia, the Rainbow Serpent is generally deemed as being responsible for both the creation and the ongoing maintenance of the water cycle. The Rainbow Serpent as a spirit creature is believed to have excavated and created the beds of the rivers during its travels throughout Australia. It is often the belief that it had reached down from the sky to the waterholes and pools, bringing water to the earth (Jackson 2004). Throughout Arnhem Land and the Kimberley the Rainbow Serpent is associated with other myths regarding fertility and is sometimes regarded as male and at others as female. Ceremonies and rituals are performed in order to renew species that are associated with Rainbow serpents (Reed 2001).

Throughout Western Australia, the Rainbow Serpent is known by various different names by various Aboriginal groups, for example; the *Waugal* (Southwest), the *Beemarra* (Midwest), the *Warlu* (Pilbara), the *Mardjit* (South Coast), *Marghet* (Great Southern) and the *Norm* (Esperance).

There also exist specific creation myths attesting to other ancestral beings in relation to the creation of water sources that is not related to the rainbow serpent mythology. The Margaret River is an example of this where *Wooditch*, an evil medicine man who wished to abduct the daughter of a rival, had cast a magic stick between himself and his adversary which was responsible for the creation of the Margaret River (Buller-Murphy 1958).

Historically, Bates (1966) recorded that in the Southwest: "Their only deity was a *Waugal* or serpent god that dominated the earth, the sky, the sea, and punished evil doers".

> "All permanent native waters have legends attached to them, legends of the 'dream' time, which go back to the days when birds and animals possessed human attributes, or were human beings, or were groups of which the bird or animal was representative, or were magic animals and birds possessing the power of human speech. The natives cannot say that the 'founders' of the various permanent waters were altogether human, although birds or beasts, or half bird half human, but the bird or animal name only is always given in the legend never a human name." (Bates 1966:157)

Bates (1985:221) also reports that the "*Waugal* made all the big rivers of the Southwest and that wherever it travelled it made a river." Bates (1985:219) stated that the *Waugal* was not just seen as responsible for the creation of waterways but also created hills and other features of the landscape. The *Waugal* as a mythic creature was revered and often feared by Nyungar people who would have to offer articles of food or sing and throw sand when approaching pools or places where it was known to live as a form of propitiatory ritual in order that no harm would befall those who approached.

In regards to the current study area Mr Joe Northover, and other members of the Gnaala Karla Booja Native Title Claim group, have provided a modern, contextualized narrative with regards to the creation of the Collie River system (inclusive of the Leschenault Inlet, the Preston, Ferguson, Harris and Brunswick Rivers) in regard to a Dreamtime ancestor known as '*Ngarngungudditj Walgu'*; the hairy faced rainbow serpent.

> "The '*Ngarngungudditj Walgu*' came from the north east of Collie where he travelled forming the rivers and creeks resting along the way making waterholes…
>
> … 'He came through what we know today as Collie forming the Collie River and as he moved he created hills visiting places in and around Collie he moved towards the coast and came out where Eaton is today as he came to the end he turned his body creating what is the estuary today, as he turned he pushed the land out and then he travelled back up the Collie River he travelled about the Collie area finally he rests at Mininup a well known swimming place on the Collie River…
>
> …The old people used to say you can see his spirit in the water late at night during the full moon and his long silvery beard'…
>
> …It is also said that if a stranger to the area comes and wishes to swim in the Collie River or fish he must wipe his armpit and then pick up some sand in the same hand and then throw the sand in the water for the spirit to smell this and he would not be harmed in any way or if he is not welcomed the water will become rough and the weather might change" (Joe Northover per comm. 2000)

Comparative studies of serpent mythologies and the significance of water have been conducted in the Northern Territory and other regions of Australia. In these studies water bodies have almost always had mythic dimensions. Studies by Barber and Rumley (2003), Langton (2002), Toussaint *et al* (2001) and Yu (2000), state that Aboriginal people, as they do with the land, conceptualize that water sources (rivers, lakes and wetlands) have derived from the Dreaming. These studies emphasise the importance of stories about the actions of mythic beings in the origin and maintenance of such water sources. In these stories cultural affiliations to water are expressed in many ways, through social etiquette, narratives about places, rituals and practices of such rituals. Water is described as the "living element that both creates and defines the shape and character of the country" and gives it sacredness and identity (Jackson 2004).

Modern Nyungar people believe that that as the custodians of the land it is their jural responsibility to "look after water" and not to allow the region's water sources to be "mucked up by man". This view of jural responsibility is tied to the view that the *Waugal* will punish Nyungars who do not respect water and who allow the natural order of things to be changed. Nyungar people from the region take the view that water is there for all the organisms that depend upon it for survival, and that it is not there just for man to use irresponsibly. Failure to respect these core values will ultimately lead to sickness in the Nyungar community (Goode 2008c, 2009, McDonald 2002).

In previous surveys conducted upon the Collie and other southwest rivers (Goode 2002d, 2005, 2008c, 2009a) it has been determined that various activities threaten these Aboriginal cultural values that relate to water sources. Nyungar people have consistently voiced concerns that are in keeping with the findings of research conducted by Villiers (2002) regarding the Swan & Canning Rivers. Villiers found that sites known to contain the *Waugal* can be threatened by: any below ground work, any work likely to pollute or dirty the water and loud noises or vibrations of the earth. Conditions attached to Section 18 applications which impact directly on the rivers tend to be concerned with: ensuring that the river's flow is not impeded in any way; ensuring that the river bed and embankments are not damaged; ensuring the area is revegetated with the appropriate local native species and that any run-off or drainage water flowing into the rivers is appropriately filtered in order to minimise pollution of the river.

Proponents of development which impacts on rivers in the Southwest can use this research to inform themselves regarding strategies to minimise the potential affects that their development can have on the cultural values held by Nyungar people for these rivers.

EUROPEAN SETTLEMENT AND ABORIGINAL SOCIAL DISRUPTION

According to Bates (1985:54) the population of the Nyungars before settlement was around 40,000 but more recent research suggests a far lower estimation of around 6,000 (Berndt 1979, Green 1984, Tilbrook 1983) who lived mainly on the coastal plain. Population of the less favourable forest and woodland environments is thought to have been sparse (Anderson 1984, Tilbrook 1983).

During his expedition of 1829, Lieutenant Preston, officer on the HMS Sulphur, was accompanied by naval surgeon Dr Collie and set sail from the Swan River Settlement to examine the south-western coast. Passing through the channel between Garden Island and Cape Peron they chartered the water south to Murray River. Following this they travelled on to Port Leschenault and, upon entering the inlet discovered a river about three miles from their camp. They named it the Preston River, after the Lieutenant. On the same day they discovered another river just a few miles downstream of the Preston and named it the Collie River, in honour of the doctor. Collie, the mining town, was also later named in his honour. The explorers reported seeing a group of about 30 Aborigines at the mouth of the Collie River. They found themselves:

> "In the midst of natives who testified the greatest and most friendly eagerness to be allowed to approach us… carrying green boughs and without any weapons of offence or defence… after a very amicable interview during which we did not admit them close to the tents they returned seemingly very much gratified with what they had seen and with a few trifles which they had gotten" (Martinick 1994:15).

Surveyor-General Lieutenant Roe followed on from this first party in 1930 to survey the 'very good' land surrounding the Preston and Collie Rivers. He discovered valuable forestland and a range of hills that he named after himself (Sanders 1975:3). During his explorations around the Preston and Collie Rivers, Lieutenant Roe reported no sightings of Aborigines but noted traces of old habitations that were constructed of boughs and grass. It is thought these may have been the remnants of Nyungars winter camps. Lieutenant Henry William St Pierre Bunbury formed a post at Pinjarra on the Murray River in 1836 in order to investigate the district and was known

for his good relations with the Aborigines. Before his return to England in 1837 he pioneered land exploration between Pinjarra and the emerging district of Vasse. An Aboriginal guide named Monang and others from the *Pinjarrup* tribe led the party to Leschenault Inlet, where the Collie and Preston Rivers flow into Koombana Bay. Here the *Gomborrup* people lived well as food was plentiful and the land was rich (Sanders 1975:99). Bunbury reported his encounters with hundreds of people from differing groups of Aborigines as he travelled from the inlet up the Collie and Preston Rivers and inland from the Preston River (Hallam 1979:69). Interaction between Aborigines and settlers in the Bunbury region was commonplace by 1840 and was said to have been 'a mixture of cordiality, mutual support and yet underlying suspicion and fear' (Barker & Laurie 1992:8). Although many settlers perceived them as "unattractive and dirty", Preston and Collie formed a very different impression and had friendly communications with local Aborigines.

Before 1890 the Southwest region supported only small pockets of agriculture and a young timber industry and both were strained by extreme transport difficulties (de Garis 1993:110). Although deposits of coal were known to exist at Collie in the 1880's mining did not begin until the 1890's. Completion of the Bunbury harbour works in 1907 and further ongoing development of the southwest's railway system opened up greater possibilities for coal export. By the 1920's heavy engines could run coal direct from Collie to Bunbury to be loaded onto ships. The first full cargo of Collie coal bound for South Australia left the Bunbury wharf in 1923 (Barker & Laurie 1992:171-224). The southwest's hardwoods, on the other hand, had already found markets in the eastern colonies and overseas before the 1870's. Before construction of a bridge across the Brunswick River in 1845, milled timber was placed on a lighter (semi submerged raft) and sailed to the port of Bunbury via the Collie River and Leschenault estuary. A second bridge across the Collie River was built in 1844, and a third over the Preston River in 1848 (Sanders 1975, O'Brien 1996:45).

Amidst ongoing tension as indigenous and colonial people jostled to retain their own cultural practices, farmers across Western Australia regularly employed Aborigines as a convenient and cheap source of labour. Heavily relied upon to support the foundation of European farming techniques, Aborigines were generally offered little if any payment for work and were often given goods such as flour, sugar and tobacco in exchange for farm labour and domestic help (Shann 1926). Their importance was verbally acknowledged when in 1898 John Forrest said 'Colonization would go on with very slow strides if we had no natives to assist us' (Goddard & Stannage 1984). Although some continued to pursue a traditional way of life others worked on homesteads or were involved in the timber industry.

By the turn of the twentieth century over half of the Aboriginal population in the southwest was of mixed race descent (Haebich 1988:47). Colonial rulers saw children of one British parent as having potential if they could be trained to live as Europeans and the Industrial Schools Act of 1874 brought their removal to missions where they were prepared for servant hood or menial apprentice work in the European community. Aboriginal parents of these children were afforded no comment in this process. The Depression of the 1930's saw unemployed Nyungars receive a lower sustenance rate than unemployed Europeans. Nyungar people were often employed to clear for farming the land they formerly lived on. Living more or less permanently in fringe camps, seeking out seasonal employment and supplementing their diet with game, fish and some bush tucker was a lifestyle which predominated for many Aboriginal people until late into the 1960's (McDonald et al 1994).

ARCHIVAL RESEARCH

Archival research involved an examination of the Department of Indigenous Affairs (DIA) Sites Register, a review of any relevant site files and a review of any ethnographic Aboriginal heritage survey reports that relate to the survey area.

SITES REGISTER SEARCH

The DIA Aboriginal Sites Register categorises places reported to be of importance and significance to Aboriginal people into two separate categories.

The first category contains sites classified as **'Registered',** which have been assessed by the ACMC as meeting the definition of section 5 of the AHA and are fully protected in law. Disturbance to land that contains such sites requires a section 18 application for ministerial consent should proponents wish to use the land that contain these sites.

'Other Heritage Places' is the second category within the Aboriginal sites register. This category includes reported sites both 'Lodged' and awaiting ACMC assessment, and 'Information Assessed' by the ACMC, however awaiting a final decision on the places status. Also there are places where the ACMC have determined there is 'Insufficient' information for these places to be fully 'Registered' under the AHA, however that there is enough information to warrant their temporary protection. Within the category of 'Other Heritage Places' sites that are awaiting assessment or are lodged are protected by the provisions of the AHA, until assessed and their final status determined. Other heritage places that have been assessed and fail to meet the definition of section 5 of the AHA are classified as 'Stored Data'. Places in this category are not sites under the AHA as they have failed to meet the definition of section 5.

In relation to this survey a search of the DIA Aboriginal Sites Register was conducted by GIS auto down load in January 2012, and verified (12th April 2012) prior to reporting by a search of the DIA web based search engine. The searches were required in order to identify if any previously registered sites or places will intersect the road corridor (see Appendix 1: Sites Register Search).

As a result of these searches there are **no** previously recorded ethnographic sites or places within the survey corridor.

The search **did** however **identify** one previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site 1 to be located within the survey corridor at the BORR intersection with Hastie Road. This site has a DIA polygon that predominately overlays the ramp connection of the BORR with Hastie Road. As the places is archaeological the full details regards the nature, significance and extent of this place will be provided in the accompanying archaeological report by O'Reilly and Johnston 2012.

Table 1: Summary of Aboriginal heritage sites/places located within the search area

Site ID	Name	Status	Access	Restriction	Location (GDA94 Zone 50)* mE	mN	Site Type
Reported Other Heritage Place							
18884	Bunbury Bypass Archaeological site 1	L	O	N	375149	6302418	Artefacts Scatter

***** Please note: Coordinates are indicative locations that represent the centre of sites as shown on maps produced by the DIA – they may not necessarily represent the true centre of all sites.

LEGEND

R – Registered Site, **I** - Insufficient Information, **S** - Stored Data, **L** - Lodged awaiting assessment, **IA** - Information Assessed, **O** – Access Open, **C** - Closed Access, **N** – File Not Restricted.

***** Please note: Coordinates are indicative locations that represent the centre of sites as shown on maps produced by the DIA – they may not necessarily represent the true centre of all sites.

REVIEW OF RELEVANT ETHNOGRAPHIC SITE FILES

As there are no ethnographic sites or places affected by the road corridor, there are no files to review.

REVIEW OF RELEVANT ETHNOGRAPHIC REPORTS

Goode, B 2002a, *Ethnographic Survey of the proposed Bunbury Outer Ring Road and the Bunbury Port Access Road, Bunbury Western Australia,* A report prepared for Halpern Glick Maunsell on behalf of Main Roads WA.

Brad Goode and Associates Pty Ltd were commissioned to conduct an ethnographic survey of the proposed BORR and the PAR. Two previous surveys had been conducted for the proposals; McDonald, Hales & Associates 1995 and 1997.

In October 2001 Halpern Glick Maunsell (acting on behalf of Main Roads) received advice from the DIA that they were unable to process the Section 18 applications recommended with the McDonald 1995 & 1997 reports as it is DIA policy that ethnographic surveys are current for five years only.

The following recommendations were made by the Aboriginal community regarding the archaeological sites located on or within 300 meters of the proposed road routes:

- An archaeologist acting under a Section 16 permit with Aboriginal community representatives assisting to locate and salvage artefact material from the sites located on the proposed road route (sites ID 4880 Bunbury 20, ID 5168 Natgas 262 and ID 4875 Bunbury 14) prior to construction of the roads and that salvaged materials are to be dealt with in a manner that is consistent with the community's wishes.
- That the other archaeological sites identified to be located within 300 meters of the road works are marked by an archaeologist in order that contractors working for Main Roads WA do not disturb these sites.
- That the contractors are to be made aware of their obligations with regards to these sites.
- That archaeological monitoring is to be carried out during construction of the Bunbury Port Access Road and the sections of the BORR from Hines Road to the intersection with the PAR.

The following recommendations were made by the Aboriginal community regarding ethnographic sites located on or within 300 meters of the proposed road routes:

- That bridging the Ferguson and Preston Rivers does not affect the flow of the water and that the impact on the banks does not take place within 30 meters of the water (span bridges are the preferred option).
- That during the bridging of the Preston and Ferguson Rivers and during road works at the Boyanup Picton Road Camps Aboriginal community monitors should be present.
- That the heritage values of these rivers and camps are to be acknowledged by Main Roads WA in the form of an interpretive plaque placed at these locations.

Relevance: The 2002a proposed routes for the BORR and PAR are different to that of the current proposal; however the bridging of the Ferguson and Preston rivers remains a common issue. The recommendations made by the Aboriginal community are consistent with those made in other reports regarding the disturbance of rivers in the Southwest and are expected to be expressed regarding the current proposal. The recommendations made regarding the affected archaeological sites and archaeological salvaging/monitoring are also consistently expressed.

Goode, B 2009b, *A Desktop Aboriginal Heritage Survey of the Proposed Bunbury Outer Ring Road, Western Australia,* A report prepared for GHD Pty Ltd on behalf of Main Roads Western Australia.

In November 2009 Brad Goode & Associates Pty Ltd was commissioned to conduct a desktop study of the BORR and PAR road planning corridor in order to consolidate all heritage information into one report to assist in planning a road design.

Research identified 16 previously recorded Aboriginal heritage sites that overlay the wider project development.

Examination of the DIA site files has revealed that 2 sites, ID 19795 Preston River and ID 19796 Ferguson River, would be directly affected where the proposed roads intersect them.

6 archaeological sites would require further archaeological investigation to determine their actual locations and extents and the remaining 8 archaeological sites were determined to not be affected.

As a result of this report the following recommendations were made:

In regard to the two sites determined to be directly affected, ID 19795 Preston River and ID 19796 Ferguson River, it was recommended that once the bridge locations and bridge designs are determined, that consultation takes place with the sites informants prior to Main Roads lodging notice pursuant to Section 18 of the AHA.

In relation to bridge design it was further recommended that Main Roads identify a bridge design that will minimise affects to the bed and embankments of the Preston and Ferguson rivers. Bridges that span the watercourse and minimise obstruction to the water flow are always the culturally preferred option.

In regard to the identified archaeological sites it was recommended that Main Roads conduct an archaeological inspection to located and rerecord these sites to Section 18 standards, in order for Main Roads to lodge an application under Section 18 of the AHA for consent to disturb the sites, if it is determined that they are to be affected by the proposed project.

It was finally recommended that Main Roads conduct a comprehensive archaeological survey along the specific road corridor, once it is determined, as previous researches have expressed a likelihood of further, yet to be discovered, archaeological material to exist.

Relevance: The above recommended action has been put to practice within the current ethnographic and archaeological surveys.

Goode, B, Harris, J & Johnston, S 2010, *An Aboriginal Heritage Survey of the Proposed Bunbury Outer Ring Road (Stage 1) and the Port Access Road (Stage 2) at Picton, Western Australia,* A report prepared for GHD Pty Ltd on behalf of Main Roads Western Australia.

This report considered Stage 1 of the BORR and stage 2 of the PAR.

Resulting from the survey it was determined that two ethnographic sites, **Sites ID 19795 Preston River and ID 19795 Ferguson River will be directly affected** where the road routes bridge the rivers and creeks.

Ministerial consent conditional to the performance of propitiatory rituals and archaeological monitoring was recommended to mitigate site disturbance should Main Roads proceed under a section 18 notice.

During the survey up to seven archaeological sites were located along Moore Road within the survey corridor between the PAR and where Moore Road intersects with and Boyanup Picton Road.

Up to four of these sites **were to be directly affected** by the road construction with the others likely affected by ancillary works.

It was recommended that ministerial consent under section 18 of the AHA be sought to salvage and relocate all archaeological material from these sites to a block of land acquired by Main Roads as an offset for clearing where they would be reburied by nominated Nyungar Elders under supervision of an archaeologist.

Based upon the report a heritage Management Plan was developed to implement all these recommendations and any further conditions set as a requirement by the minister following consent.

Relevance: This report considers stage 1 of the project to the north. The above recommended action resulting from this survey may also be relevant to the current road proposal.

OUTCOMES OF ARCHIVAL RESEARCH

Searches of the DIA Sites Register were conducted in order to determine the Aboriginal Heritage sites that would be affected by the proposal (see Appendix 1: Site Register Searches).

As a result of these searches there are **no** previously recorded ethnographic sites or places within the survey corridor.

The search **did** however **identify** one previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site to be located within the survey corridor at the BORR intersection with Hastie Road. This site has a DIA polygon that predominately affects the ramp connection of the BORR with Hastie Road.

If Main Roads are required to affect this place then they **will be required** to seek ministerial consent pursuant to making application under section 18 of the AHA for consent to use the land that may contain an Aboriginal site should they wish to proceed.

As the heritage place is archaeological the full details regarding the nature, significance and extent of this place will be provided in the accompanying archaeological report by O'Reilly and Johnston 2012.

The archaeologist will determine if the site actual extent will be affected.

IDENTIFICATION OF SPOKESPEOPLE

THE RIGHT TO SPEAK ON HERITAGE ISSUES

Various authors have discussed the contemporary problem of who in the Aboriginal Community has the authority to speak on heritage issues within an area. O'Connor et al. (1989:51) suggest that when this question is posed to people in Aboriginal Australia, answers are usually framed by such terms as 'the traditional owners', i.e., those people who are defined by place of birth i.e. descent. Myers presents a broader and more contemporary view of 'ownership' based upon descent and association:

> An estate, commonly a sacred site, has a number of individuals who may identify with it and control it. They constitute a group solely in relationship to this estate. Identification refers to a whole set of relationships a person can claim or assert between himself or herself and a place. Because of this multiplicity of claims, land holding groups take essentially the form of bilateral, descending kindred. Membership as a recognised owner is widely extended (cited in Machin 1993:22).

Myers then goes on to further clarify the current perception of 'ownership' when he states:

> ....such rights exist only when they are accepted by others. The movement of the political process follows a graduated series of links or claims of increasing substantiality, from mere identification and residual interest in a place to actual control of its sacred association. The possession of such rights as recognised by others, called 'holding' (kanyininpa) a country, is the product of negotiation (Ibid.).

While the notion of descent is clearly an important criterion within Myers analysis, it must be seen in terms of the contemporary Nyungar situation. Nyungar tradition in the south west has been seriously eroded since colonisation, lines of descent have been broken and previously forbidden and mixed marriages have interconnected many Nyungar groups who would not have traditionally had a close association (Ibid.). Consequently, in contemporary times the criteria of historical 'association' seems to be important in regards to the 'right to speak' on heritage issues within an area:

> Traditional subsistence no longer sufficed to support Aboriginals so they combined this with menial work on farms and over time new relationships to land developed. As a consequence, the more recent history associated with their involvement with European agriculture and labour patterns is often more relevant than the pre-contact mode of attachment to an old way of life and the roots of the identity as original owners of the land. Biographical associations are often tied to post-settlement labour patterns and identification. These can predominate. This is part of a dynamic process of ethnicity, identity and tradition (Machin 1995:11).

O'Connor, et al. (1989) identified several criteria for determining contemporary community spokes people. A spokesperson must have a long-term association with an area, usually as a young person, and had extensive contact with a member or members of the 'pivotal generation of the culture transmitters'; those people whom, as children themselves, had contact with people who could pass on their traditional knowledge. A spokesperson must also demonstrate knowledge of the region's natural resources, its hunting, fishing and camping grounds, its local water sources, and the flora. This is important because a person without this knowledge is unlikely to be seen by their fellow Nyungars as truly being from that country, despite having been born or lived in that area. In some cases, people from outside a specific region have established themselves by political activism. They are accepted by their fellow Nyungar because they may have participated in mainstream white pursuits, such as advanced education, or legal and political careers, that have empowered them within the broader community. As such, these people are a valuable resource to the local Aboriginal Community. The people consulted in this survey fulfil at least one of these criteria.

NATIVE TITLE CLAIMS OVER THE SURVEY AREA

Currently, there is one registered and one unregistered Native Title Claim application that overlays the project area, lodged with the Register of Native Title Claims and the Schedule of Applications held by the Commonwealth Native Title Tribunal. The Schedule of Applications includes registered applications, unregistered applications, and applications still undergoing the registration test.

- **Single Noongar Claim (Area 2) WC03/7 (awaiting registration)**

  Applicants: Anthony Bennell, Alan Blurton, Alan Bolton, Martha Borinelli, Robert Bropho, Glen Colbung, Ken Colbung, Donald Collard, Clarrie Collard-Ugle, Albert Corunna, Shawn Councillor, Dallas Coyne, Dianna Coyne, Margaret Colbung, Edith De Giambattista, Rita Dempster, Aden Eades, Trevor Eades, Doolan-Leisha Eattes, Essard Flowers, Greg Garlett, John Garlett, Ted Hart, George Hayden, Reg Hayden, John Hayden, Val Headland, Eric Hayward, Jack Hill, Oswald Humphries, Robert Isaacs, Allan Jones, James Khan, Justin Kickett, Eric Krakouer, Barry McGuire, Wally McGuire, Winnie McHenry, Peter Michael, Theodore Michael, Samuel Miller, Diane Mippy, Fred Mogridge, Harry Narkle, Doug Nelson, Joe Northover, Clive Parfitt, John Pell, Kathleen Penny, Carol Petterson, Fred Pickett, Rosemary Pickett, Phillip Prosser, Robert Riley, Lomas Roberts, Bill Reidy, Mal Ryder, Ruby Ryder, Charlie Shaw, Iris Slater, Barbara Stamner-Corbett, Harry Thorne, Angus Wallam, Charmaine Walley, Joseph Walley, Richard Walley, Trevor Walley, William Warrell, William Webb, Beryl Weston, Bertram Williams, Gerald Williams, Richard Wilkes, Mervyn Winmar, Andrew Woodley, Humphrey Woods, Dianne Yappo, Reg Yarran, Saul Yarran, Myrtle Yarran.

- **Gnaala Karla Booja WC 98/058**

  Applicants: Mr Derrick Smith, Mr Franklyn Nannup, Mr Harry Narkle, Mr Joseph Northover, Mr Joseph Walley, Mr Mervyn Abraham, Mr Peter Michael, Ms Barbara Corbett-Stammner, Ms Lorraine Bellotti.

SELECTION OF SPOKESPEOPLE FOR THIS SURVEY

The selection of spokespeople for this survey was based on initial advice given from Mr Kevin Fitzgerald of the South West Aboriginal Land and Sea Council (SWALSC) who represent the Gnaala Karla Booja WC 98/058 with regards to Native Title/heritage issues in the region.

Prior to this survey Mr Sean O'Hara at SWALSC was again contacted regards the suitability of the survey team previously selected for stage 1being appropriate to be consulted for stage 2. Mr O'Hara advised that SWALSC was comfortable with those previously selected for stage 1 being consulted for stage 2.

The consultant has a vast knowledge of the Nyungar consultants in the region having conducted consultations in the south west for over a decade and participated in the selection of spokespeople for this survey.

As a result of this pre-consultation process, the following Nyungar people were selected to participate in the survey:

Mr Joe Northover was born in the Collie region to parents Joe Northover Snr and Kathleen Mears. Mr Joe Northover's grandparents on his mother's side are Phoebe Newell (Collie /Badjaling area) and Jack Mears (Roebourne). Phoebe Newel's parents were Rosie Mippy (Collie) and Jack Newell (Wadjela's from Collie). Mr Joe Northover's grandparents on his father' side is Percy Riley (Dumbleyung) and Bella Kelly (Collie). Mr Joe Northover is an applicant to the Gnaala Karla Booja Native Title Claim is the former chairperson of the Ngalang Booja Council of Collie and was formerly employed as an Aboriginal Heritage Officer with the

Department of Indigenous Affairs in Bunbury. Mr Northover is widely recognised as the primary informant of the '*Ngarngungudditj Walgu'* mythology regarding the creation of the Collie River.

Mr Peter Michael is an applicant of the Gnaala Karla Booja Native Title Claim group and the chairperson of the Bunbury Nyungar Employment Education Development Aboriginal Corporation (NEEDAC). Mr Michael was born in Collie and has spent most of his life in Bunbury where he currently resides. Mr Michael has a long history in being active in heritage circles and is a current member and co-ordinator of the Bunbury Elders Heritage Committee that has formed in order to speak on heritage matters that affect Bunbury and the surrounding region.

Mr James Khan was born in the Narrogin to parents James Khan Snr (Quindanning) and Irene Hart (Narrogin). James Khan's grandparents on his mother's side were Melbourne Hart (Collie) and Lula Flox's (Lake Yealering). James Khan's grandparents on his father's side were John Regan (Bridgetown) and Alice Mary Bolton (Narrogin). The Khan name came from Phatta Khan who was an Afghan that was legally married to Alice Bolton. Mr James Khan is a member of the Gnaala Karla Booja Native Title Claim group and sits on the working party at SWALSC. Mr Khan is the vice chairperson of Ngalang Booja Council in Collie. Mr Khan is also the treasurer of South West Aboriginal Medical Service (SWAMS) and was an Aboriginal Education Officer at the Collie Senior High School.

Ms Marie Khan was born in Collie to Mrs Gloria (Sima) Khan-White (deceased). Mrs Khan-White was born in Duranillin to parents Mr Simon Kelly and Ms Bessie Hart, her paternal Grandparents were Mr Tim Kelly and Ms Sarah Narkle, and her maternal Grandparents were Mr Melbourne Hart (Collie) and Ms Lulu Flox (Lake Yealering). Mrs Khan-White attended school in Quindanning, Williams and Collie before being 'stolen' at the age of 11 and placed in the Wandering Mission. Mrs Khan-White returned to Collie where she was married and raised her three children for over 40 years. Mrs Khan-White was a site informant for the Collie River site complex and her daughter Ms Marie Khan was selected to participate in this survey by nomination through the Gnaala Karla Booja working party at SWALSC.

Mrs Violet Bennell (nee Khan) was born in Williams to parents Mr Henry Khan (Bridgetown) and Ms Blanche Hart (Collie). Mrs Bennell grandparents on her father's side are Phatta Khan (Afghan) and Alice Mary Bolton (Narrogin). Mrs Bennell grandparents on her mother's side are Mr Frank Hart (Collie) and Ms Jeffrey Dyer. Mrs Bennell went to school at Roelands Mission. Mrs Bennell resides in Bunbury and has lived there for over 35 years. Mrs Bennell worked at the Bunbury Hospital and also the Gardiner Abattoirs in Dardanup prior to getting married. Mrs Bennell is a member of the Gnaala Karla Booja Native Title Claim group and the Bunbury Elders group.

Mr Ritchie Bennell was born in Pingelly to parents Mr Andy Bennell and Ms Alice Hill. Mr Bennell attended school in Pingelly and on completion of his education has been employed in numerous positions and is currently employed as a bus driver in Bunbury. Mr Ritchie Bennell has lived in Bunbury for over 30 years has a long historical association with the Bunbury area and considerable heritage knowledge stating that his grandfather on his mother's side Mr Charlie Hill had camped at Burekup and Waterloo for many years when working in the area on potato farms. Mr Bennell is a member of the Gnaala Karla Booja Native Title Claim group and was identified to participate in this survey to represent the Hill/Bennell clan.

Mr Les Wallam is the son of Mr Lee Hart and Ms Mabel Wallam and was born in Bunbury. Mr Wallam's grandparents on his father's side were Jack Hart and Tottie Cockie. On his mother's side his grandparents were Bob Wallam and Grace Gillespie. Mr Les Wallam spent his early childhood at Roelands mission and attended high school at Harvey. He is currently employed at Roelands Village as a Project Manager.

Mr Denis Hill was born in Pingelly to parents Mr Charlie Hill and Ms Rachael Abraham. Mr Hills great grandfather is Joseph Hill. Mr Hill attended school at Burekup and since leaving school has worked various jobs including a farm labourer on potato farms in the Bunbury area. Mr Hill is a member of the Gnaala Karla Booja Native Title claim.

Ms Dorothy Winmar is the daughter of Ms Nancy Riley and Mr Claude Hanson. Ms Winmar's grandparents on her mother's side are Ms Eva Kelly and Mr Percy Riley, and on her father's side are Mr Larry Hanson and an Ms Cornwall. Ms Winmar is a member of the Ngalang Booja Council of Collie and the GKB Native Title Claim group.

COMMUNITY CONSULTATION

AIMS

- To establish contact with Aboriginal people who retain traditional or current knowledge pertaining to the region.
- To determine if there are any sites of significance as defined by Section 5 of the Western Australian Aboriginal Heritage Act (1972) within the project area.
- To record any ethnographic information provided about identified sites.
- To generate consensual recommendations from the Aboriginal community representatives in regards to any Section 18 requests and to record management strategies for identified ethnographic and archaeological sites.

METHOD

Representatives from Gnaala Karla Booja WC 98/058 Native Title Claim Group were contacted by phone with a meeting arranged at the Main Roads office in Bunbury. The informants were orientated to the project with the aid of a large aerial photo with the locations of the previously recorded Aboriginal heritage sites marked. Following this orientation the survey team conducted an inspection of areas of interest by vehicle and on foot. Following this inspection, recommendations made by the Nyungar representatives were recorded by the anthropologist in a notebook. Photos and GPS (Garmin CX 60's) coordinates of locations visited were also taken throughout the consultation process.

COMMUNITY CONSULTATION PROCESS

On the 21st February 2012, the consultants; Mr Brad Goode (Anthropologist) and Mr Colin (Floyd) Irvine (Ethnographer) in company with representatives from Main Roads; Mr Gerry Zoetelief (Senior Project Manager), Mr Alan Grist (Project Manager SW Region), Mr Daniel Voery (Graduate Engineer), and Mr Neil Mc McCarthy (Senior Environmental Scientist - from GHD) met representatives from Gnaala Karla Booja WC 98/058 Native Title Claim Group; Mrs Violet Khan (nee Bennell), Mrs Marie Khan, Mr Denis Hill, Mr Peter Michaels, Mrs Janine Williams (for Mr Les Wallam), Mr James Khan, Mr Richard Bennell, Dorothy Winmar and Mr Joe Northover at the Main Roads office in Bunbury for a briefing.

The group viewed a power point presentation that included several overhead projections of large aerial photographs and plans showing the route of the intended by-pass road and the location of a reported Aboriginal heritage place.

The aerial photograph indicated to the group the type of country that the proposed by-pass road will traverse. For much of the route the proposed road will cross mainly cleared land presently used for farming. It will cross through or close to several degraded seasonally inundated wetlands (some stands of Melaleucas exist but the understory has been removed through years of grazing). The section of road closest to the Gelorup end runs through some areas of high quality vegetation consisting of Jarrah and Banksia woodland with a largely intact understory. This area also contains part of the Five Mile Brook and is characterised by high secondary sand dunes.

The group was informed that an artefact scatter had previously been recorded on the corner of Hastings Road. The alignment of the proposed road was investigated by archaeologists and they determined that the site was likely to be affected by the road proposal. At the stage that planning was at for the project it was unclear if the site would be actually affected.

The group advised that as the area was disturbed by a sand quarry that any material left had limited cultural significance, all agreed that avoidance would be their preference but if this is

not possible then a section 18 consent notice followed by salvage and relocation would be the next best course of action.

Several members of the group asked if the road would disturb ground water levels and if flora surveys had been conducted through the area. The group was told that most of the roadway would be raised above the existing ground level by around 1.5 meters where it traversed the flat farm land and that there would be some cutting through the dune area to lower the level of the road. As there was no intention of lowering the road and potentially interfering with the groundwater the group was told the road would have no impact on the groundwater.

The road will be constructed in such a manner that there will be future potential to include a train line to Busselton running down the space between the north and southbound lanes.

The road will also include a 'fly-over' bridge which will allow Yolinda Drive, an existing residential service road, to pass over the Bunbury Outer Ring Road. It is currently planned for the fly over to incorporate a 5 meter wide 'planter box' as part of the bridge to establish a vegetated corridor for fauna (particularly Western Ringtail Possum) to cross above the Bunbury Outer Ring Road thereby linking areas of high quality vegetation. This is a proposed trial for the concept to determine if it is possible to establish the vegetated corridor and to see if animals will use it.

The group expressed their support for the proposal.

The group was told that in the Gelorup area the road would pass through high value vegetation and an area recognised as having potential to harbour Western Ring-tailed possums. The group was informed that this section of the road would entail around 20-25 ha of clearing and that Main Roads was purchasing an area of uncleared bushland to be kept as an offset to the proposed clearing for the construction of the road. The offset will link existing DEC Conservation Reserves creating a larger conservation area. The offset would eventually be ceded to DEC for management.

Mr Joe Northover commented that many conservation reserves have become places for people to dump their rubbish and to ride trail-bikes. He said that if we were able to find the necessary funding to build roads there needed to be allowances for the maintenance of the conservation reserves as well.

The road will be fenced to prevent stock and wildlife from entering the road reserve and 'noise walls' will be built where the road passes close to existing residential areas and where vehicle noise is likely to exceed acceptable limits.

Mrs Janine Williams suggested that the walls would provide an opportunity for Nyungar artists to paint and display their art and culture to the wider public. Mr Jerry Zoetelief told the group that where there were going to be noise walls there would be plantings of native vegetation varying between 10 -15 meters thick screening the wall from the road. He suggested that the bridge abutments would be more appropriate as places to display Aboriginal artworks.

Mr Brad Goode asked the group if they felt they had been adequately briefed on the proposed road works. The group replied they felt they had been and were then asked if they had any comments to make of the proposal.

Mr James Khan requested that provision to employ and train Nyungar people on the project be given support.

The group also requested that the road should be given a Nyungar name which reflected the heritage of the area.

Mr Gerry Zoetelief said he thought there would be a greater chance of getting support for Noongar names for the bridges than the actual highway but said that if the group was able to provide a list of suitable names Main Roads would support appropriate suggested names at the appropriate decision making level.

The group stated they were not happy with the naming of the Forrest Highway but were supportive of the dual naming of the bridges and rivers in the northern section of the Forrest Highway. The group said that the same dual naming of bridges and watercourses in the southern section of the highway including the Bunbury Outer Ring Road should continue. Mrs J Williams also said that the conservation offset which was also being used as a repository for artefacts disturbed during the road-works should also be given a Nyungar name.

The group then went on a site inspection by vehicle to see the location of the previously recorded archaeological site and other parts of the proposed road which were accessible.

The first stop was the location of the proposed roundabout on the corner of Queelup and Centenary Rd. This is open country currently used for farming with some stands of mature Peppermint and Marri trees. The group was told there would be some clearing of trees where necessary but that the road would mainly run through cleared land.

Figure 2: Other Heritage Place ID 18884 Bunbury Bypass Archaeological Site 1, view looking to southeast

The group then drove to Hastie's Rd, the location of the previously recorded artefact scatter. The recorded site location is between a large bund of earth and an area previously used to extract sand, the group declined to inspect the site to try to locate artefacts saying they were satisfied the archaeologists would have been thorough and that they could see the area had been highly disturbed in the past and now had little cultural significance.

The group requested that an archaeologist and monitors to be present during earthworks to salvage and relocate any artefacts or other cultural material should a ministerial consent notice be required to affect the area.

The group then drove to the end of Marchetti Rd which is located close to the end of the section of road which will run through the cleared farmland. To the east of the end of Marchetti Rd there is a small sandy hill which will require some cutting to allow for the proposed road. Mr Joe Northover identified this as having a higher potential to have been used as a camping place and also as a place which could contain burials, upon this basis he requested monitoring in this area.

Figure 3: Dunes that Mr Joe Northover identified as potential to contain burials located east of the end of Marchetti Rd

The group then drove to the end of Yolinda Drive to inspect the location of the proposed overpass which will contain the 'planter box' fauna link trial. It was suggested by the Nyungar informants that this overpass should be named '*Coomal'* – the local word for possum.

The group then drove to the end of Jilly Rd where the proposed road will run through the area of high quality vegetation. This area is also close to the point the road would cross the Five Mile Brook.

The group was told that the crossing of the Five Mile Brook would not be a bridge but a series of concrete culverts allowing the flow of water beneath the road. The group asked if the brook drained towards the Preston or Ferguson rivers and was told the brook drained towards a swampy area near the coast and was not a tributary of the other rivers.

Sections of the Five Mile Brook have clearly been modified (straightened and cleared of obstructions) although the area of the proposed crossing is apparently in a 'natural' state. That is to say the course of the creek does not appear to have been dug or straightened in the location of the proposed crossing although the banks of the creek (which was dry when inspected) were covered with introduced grass and had no native understory plants. It was also located in a modified semi-rural housing area and may be mowed by the residents.

Mr James Khan said the creek expressed the view that the creek was in a 'natural' state and said that he believed the creek should be registered as an Aboriginal heritage site as for all the other waterways in the region.

In response Mr Brad Goode asked Mr Khan to specify the cultural values of this waterway and to advise what values he sought to protect by reporting the creek under section 5 of the AHA.

Mr Khan said that it was because the traditional Aboriginal people would always have followed the creek on their seasonal fishing visits to the coast. He said that the creek was also important to the wildlife and said there must be water close by as the group had just seen kangaroos on their drive in. He said the waterway was a source of food and a path to the ocean. He also said that he would like to see the large trees preserved as much as possible. He said that the age of an old tree was culturally important as it was truly the same vegetation as had been seen by his ancestors.

Figure 4: Group discuss the crossing of the Five Mile Brook, the clearing of vegetation and Nyungar values regarding waterways.

Mr Goode asked Mr Khan and the rest of the group if they could specify any specific myth regarding this creek or if they knew of any customary use of places along its course either traditionally, historically or in contemporary times. In reply all stated that they had no specific knowledge of such myth or use.

In terms of the entire road alignment the group then discussed the possibility of burials existing in the sand dunes and agreed there was a high likelihood of burials in that type of country. The group said they could see that most of the route of the road was through cleared farmland and that where the road did pass through areas of high quality vegetation it tended to have been routed through areas that had been previously disturbed by grazing (evident were old fences and an altered understory but there is currently no stock on the land).

The group was asked if they had any other cultural or heritage issues with the proposed road. The group said they had no objections with the road and their only concerns were that there should be monitoring in the area of the previously recorded artefact site and also in the areas where the road passed through the secondary dunes nearer to where the Bunbury Outer Ring Road connects with the Bussell Highway.

COMMUNITY CONSULTATION OUTCOMES

As a result of the above consultations no new ethnographic sites of significance as defined by Section 5 of the Western Australian Aboriginal Heritage Act (1972) were identified to be located along the proposed corridor for Stage 2 of the Bunbury Outer Ring Road.

In terms of the potential affects upon previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site 1, all consulted;

- advised that as the area was disturbed by a sand quarry that any material left had limited cultural significance, all agreed that avoidance would be their preference but if this is not possible then a section 18 consent notice followed by salvage and relocation would be the next best course of action.

- That recognition of the cultural significance of the area to Nyungar people through the naming of bridges and roads with Nyungar names is considered.

- That dunes near the southern end of the road should be monitored as the group considers that there is some potential for burials in coastal sands

- That Main Roads should replant areas being cleared with local native species and protect all waterways and riparian areas.

- That Main Roads consider creating employment opportunities for Nyungar people during the construction stage of the project.

RECOMMENDATIONS

As a result of the above consultations no new ethnographic sites of significance as defined by Section 5 of the Western Australian Aboriginal Heritage Act (1972) were identified to be located along the proposed corridor for Stage 2 of the Bunbury Outer Ring Road, **it is recommended** that the project should proceed as planned.

As a result of the survey it is likely **that** previously recorded archaeological other heritage place ID 18884 Bunbury Bypass Archaeological Site 1 will be affected by the construction of the ramp connection of the BORR with Hastie Road.

As such **it is recommended** that Main Roads make application under Section 18 the Western Australian Aboriginal Heritage Act (1972) for consent to use the land that may contain an Aboriginal site.

As most representatives from Gnaala Karla Booja WC 98/058 Native Title Claim Group who were consulted advised that the site had little contemporary cultural significance **it is further recommended** that ministerial consent should be given.

Should ministerial consent be given, **it is recommended** that prior to any work commencing that Main Roads in consultation with the above claim group **develop a cultural heritage management plan** whereby the salvage and relocation of the material can occur prior to construction.

In terms of all salvaged archaeological material **it is recommended** that Main Roads provide suitable land as a repository site. Ideally this site would be close by to where the artefacts have come from. However Nyungar community monitors should be able to determine where to place material during the salvage operation. The repository should then be registered and protected under the AHA.

It is recommended that Main Roads give due recognition of the Nyungar community as prior owners of the land and as a community willing to accommodate development that affects cultural values. This could be achieved by the naming of roads and bridges with Nyungar names.

It is finally recommended that Main Roads give due consideration to the use of local native species for rehabilitation and the creation of employment opportunities are considered

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REPORT ON AN ARCHAEOLOGICAL SURVEY OF THE BUNBURY OUTER RING ROAD (SOUTHERN SECTION) PROJECT AREA, BUNBURY, WESTERN AUSTRALIA

Prepared for GHD Pty Ltd on behalf of Main Roads WA

by

Thomas O'Reilly

on behalf of

BRAD GOODE & ASSOCIATES

April 2012

EXECUTIVE SUMMARY

In January 2012, GHD Pty Ltd on behalf of Main Roads Western Australia, commissioned an archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, centred approximately 9km SSE of the Bunbury City centre. It comprises a single discrete survey area that is irregularly shaped and which traverses an area that comprises cleared paddocks and road reserve corridors with some patches of remnant bush. GHD Pty Ltd on behalf of Main Roads Western Australia proposes to construct a dual carriageway and associated overpasses and service roads within the Bunbury Outer Ring Road (Southern Section) Project Area.

The Bunbury Outer Ring Road (Southern Section) Project Area extends for approximately 9km from South Western Highway near the intersection of Centenary Road to Bussell Highway between Woods Road and Calinup Road and varies in width from 50m to 150m.

The archaeological survey discussed in this report was undertaken to identify and record any Aboriginal archaeological sites that may be located within the Bunbury Outer Ring Road (Southern Section) Project Area, in order that GHD Pty Ltd and Main Roads Western Australia can avoid disturbing them or, as required under Section 18 of the Western Australian *Aboriginal Heritage Act 1972*, seek the consent of the Minister for Indigenous Affairs to proceed with activities that may disturb Aboriginal heritage sites.

The archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area included research at the Heritage and Culture Division, Department of Indigenous Affairs (WA) to assess and investigate the results of any previous archaeological surveys and investigations undertaken in the immediate vicinity of this area as well as in the wider region. Sources of environmental information were also utilised before a systematic archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area was conducted.

As a result of research at the Heritage and Culture Division, Department of Indigenous Affairs (WA) and a search of their Aboriginal Sites Database, it was established that no registered Aboriginal archaeological sites or sites with an archaeological component, are located within the survey area. However, it was established that one 'other heritage place' (Bunbury Bypass Archaeological Site 1) has been registered at a position that abuts and is encompassed by the survey area. It is noted here that information pertaining to the Bunbury Bypass Archaeological Site 1 (DIA 18884) 'other heritage place' has been reported to the Registrar of Aboriginal Sites and assessed by the Site Assessment Group. This is not the final assessment. The final assessment is yet to be determined by the Aboriginal Cultural Material Committee. Consequently, the Bunbury Bypass Archaeological Site 1 (DIA 18884) appears on the Department of Indigenous Affairs' Aboriginal Sites Database as 'Other Heritage Place'. Despite this, the provisions of the *Aboriginal Heritage Act 1972* still apply to this other heritage place until it is assessed as a place to which the *Aboriginal Heritage Act 1972* does not apply.

The Bunbury Bypass Archaeological Site 1 (DIA 18884) was initially identified during an archaeological survey of the proposed Bunbury Bypass Road over fifteen years ago (Hammond and O'Reilly 1995). During the course of fieldwork associated with the archaeological survey described in this report, the Bunbury Bypass Archaeological Site 1 (DIA 18884) other heritage place was visited and scrutinised for the presence of Aboriginal archaeological material. As a consequence, it was established that the Bunbury Bypass Archaeological Site 1 (DIA 18884) other heritage place is a very sparse artefact scatter which abuts and is encompassed by the survey area. The Bunbury Bypass Archaeological Site 1 (DIA 18884) other heritage place was subsequently re-recorded and its precise location and extent determined. Its extent, location and artefact assemblage were found to be consistent with the descriptions and data recorded when this other heritage place was initially identified over fifteen years ago.

The Bunbury Bypass Archaeological Site 1 (DIA 18884) artefact scatter was identified within what appears to have been a dam structure where an area of yellow sand has been excavated and either removed or used to construct the southern dam wall. It is estimated to contain not more than twenty artefacts and has an artefact assemblage manufactured exclusively on quartz and dominated by flaked pieces and flake fragments. While a single quartz backed blade was identified, no grinding material or other retouched/utilised artefacts were observed at this site and although artefacts may be present below the surface, there is little or no potential for it to contain stratified cultural deposits. The artefact assemblage at the Bunbury Bypass Archaeological Site 1 artefact scatter is very small, unremarkable and generally typical of other artefact scatters located in the wider region. As a result of its size, limited artefact assemblage and disturbed context, the Bunbury Bypass Archaeological Site 1 artefact scatter is assessed here as having very low archaeological significance.

No other Aboriginal archaeological sites or material were identified as a result of the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area.

It is therefore recommended that GHD Pty Ltd and/or Main Roads Western Australia be allowed to proceed with their proposal to construct a dual carriageway and associated overpasses and service roads within the Bunbury Outer Ring Road (Southern Section) Project Area, on the condition that they avoid any impact upon or disturbance to the heritage place Bunbury Bypass Archaeological Site 1 (DIA 18884). If any impact upon or disturbance to the heritage place Bunbury Bypass Archaeological Site 1 (DIA 18884) cannot be avoided then GHD Pty Ltd and/or Main Roads Western Australia, as required under Section 18 of the Western Australian *Aboriginal Heritage Act 1972*, need to seek the consent of the Minister for Indigenous Affairs to proceed with activities that may disturb Aboriginal heritage sites.

INTRODUCTION

An archaeological survey for Aboriginal archaeological sites was commissioned by GHD Pty Ltd on behalf of Main Roads Western Australia, in January 2012. The primary aim of this survey was to examine the Bunbury Outer Ring Road (Southern Section) Project Area, south-southeast of Bunbury (WA) and to record and report any Aboriginal archaeological sites that may be located within it. A preliminary assessment of the archaeological significance of any such site(s) will be given and their extent determined in order that GHD Pty Ltd and Main Roads Western Australia can avoid disturbing them or, as required under Section 18 of the Western Australian *Aboriginal Heritage Act 1972*, seek the consent of the Minister for Indigenous Affairs to proceed with activities that may disturb Aboriginal heritage sites.

The area designated by GHD Pty Ltd to be surveyed was an irregularly shaped corridor that extends for approximately 9km from South Western Highway near the intersection of Centenary Road to Bussell Highway between Woods Road and Calinup Road and varies in width form 50m to 150m. In the following pages this is referred to as the survey area. GHD Pty Ltd proposes to construct a dual carriageway and associated overpasses and service roads within the survey area. Knowledge of the location and extent of any Aboriginal archaeological sites that exist within the survey area will facilitate the making of management decisions that will ensure that these sites are not inadvertently impacted upon by any road work or related activities.

As part of the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, data was gathered from reports on previous archaeological surveys and investigations undertaken in the vicinity of this area and in the wider region. Details of previously recorded and/or registered Aboriginal archaeological sites in the region were obtained from the relevant site files held at the Heritage and Culture Division, Department of Indigenous Affairs (WA) and, where possible, from unpublished reports on previous archaeological surveys. In addition to this, a review of maps, environmental information and academic research carried out within the wider region was also undertaken. Thomas O'Reilly and Stuart Johnston undertook the fieldwork associated with the archaeological survey in January 2012.

LOCATION OF THE SURVEY AREA

The Bunbury Outer Ring Road (Southern Section) Project Area is centred approximately 9km SSE of the Bunbury City centre and comprises a single discrete survey area (Figure 5). It is irregularly shaped and extends for approximately 9km from South Western Highway near the intersection of Centenary Road to Bussell Highway between Woods Road and Calinup Road and varies in width form 50m to 150m (Figure 6).

The Bunbury Outer Ring Road (Southern Section) Project Area traverses an area that comprises cleared paddocks and road reserve corridors with some patches of remnant bush.

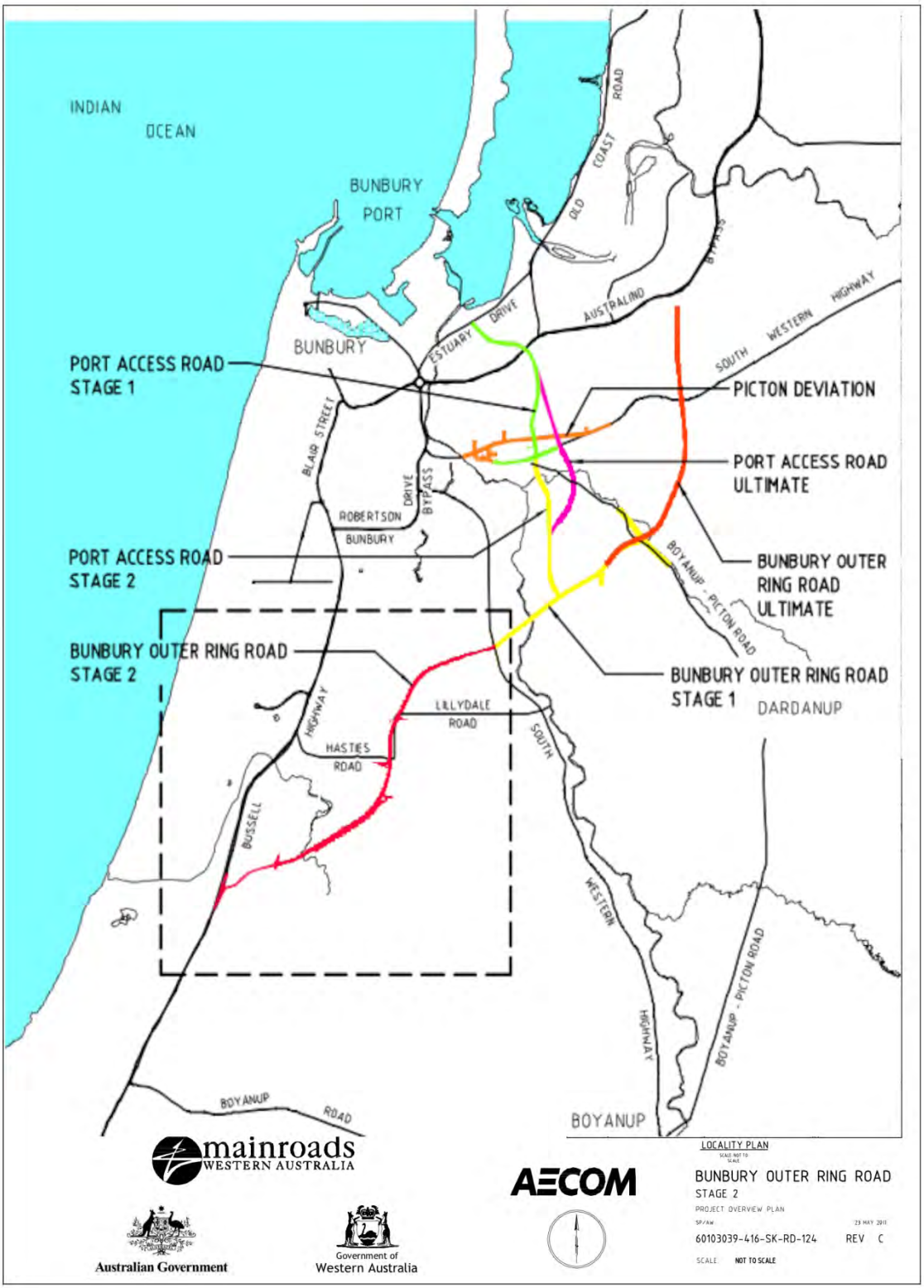

Figure 5: Location Plan: Bunbury Outer Ring Road (Southern Section) Project Area.

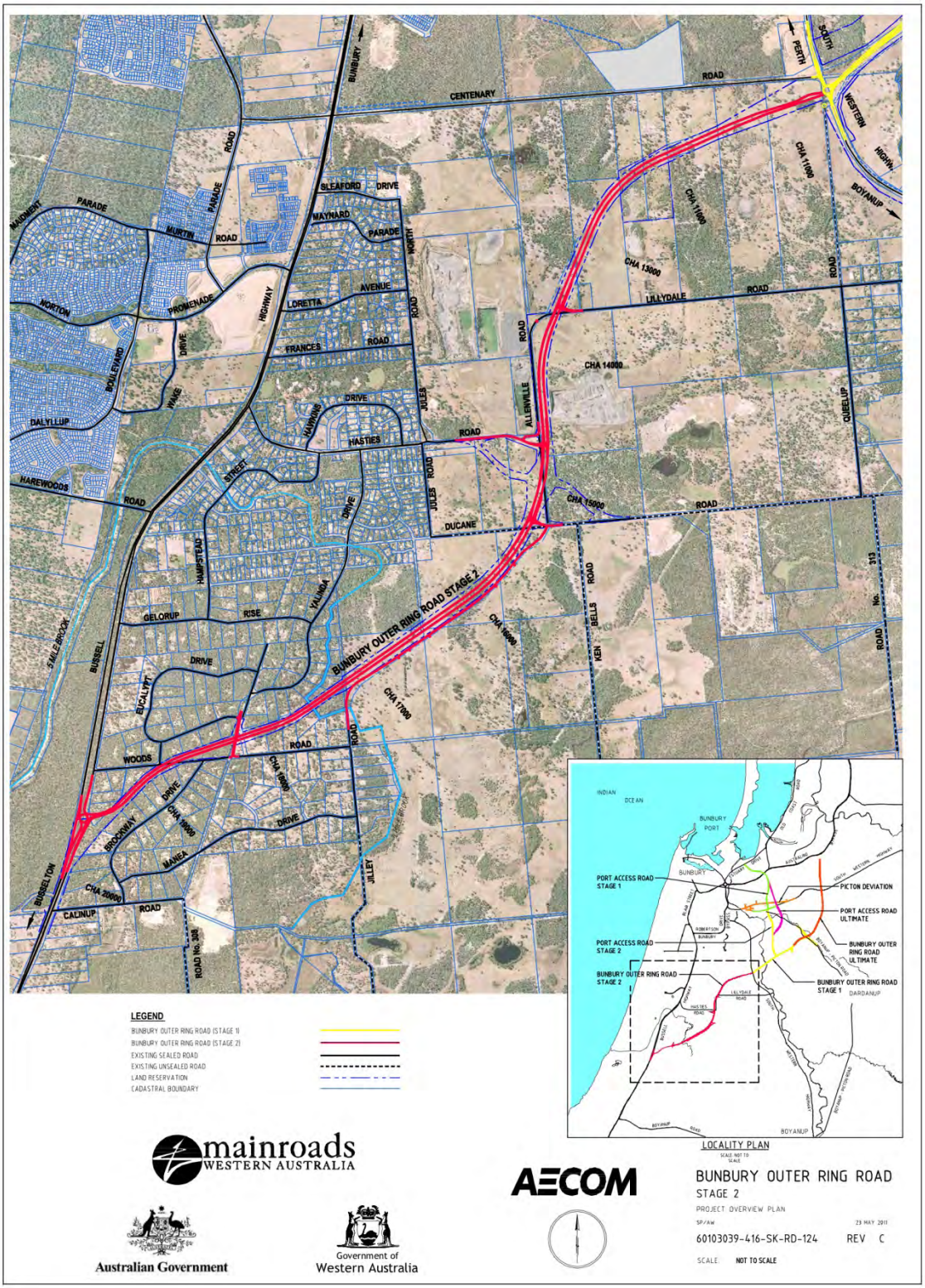

Figure 6: Bunbury Outer Ring Road (Southern Section) Project Area.

ENVIRONMENTAL BACKGROUND

CLIMATE

The survey area lies within a Dry Mediterranean climatic zone averaging between five and six dry months per year (Beard 1981). Climatic recording stations located at Bunbury have recorded weather conditions in the area for over a century. During the winter months (June-August) the long term average maximum temperature is 17.2°C, and the long term average minimum is 8.7°C. In summer (December-February) the equivalent temperatures are 27.0°C maximum and 14.8°C minimum (Bureau of Meteorology, Australia 2012). It is likely that average temperatures in and near the survey area follow a similar trend to those recorded in Bunbury.

The survey area and its surrounds lie within a region that has received an average annual rainfall of approximately 718mm since 1995. Approximately 57% of this rain falls in the winter months, and less than 5% in the summer, the rest being distributed between spring and autumn (Bureau of Meteorology, Australia 2012). Typically there is a summer drought of several months duration, when high evaporation exacerbates the shortage of surface water.

GEOLOGY AND LANDFORMS

The geology of the area in and around the survey area has been mapped and described in detail on the Collie 1:250 000 map sheet and accompanying notes (Wilde and Walker 1982) with a more detailed account given on the Bunbury-Burekup 1:50,000 urban geology map sheet (Geological Survey of Western Australia 1981).

In general, the survey area is located on the western edge of the Perth Basin, a polycyclic basin consisting of a Silurian to early Neocomian sequence deposited in an interior-fracture setting, and an overlying late Neocomian Quaternary sequence laid down in a marginal sag basin (Cockbain 1990:495). That part of the Perth Basin that lies between the Darling Fault and the Indian Ocean is known as the Swan Coastal Plain, a narrow strip of land between 15 and 30km wide, that extends from around Jurien Bay southwards to Busselton (McArthur 1991). Most of the Swan Coastal Plain is covered by Quaternary sediments of fluvial and aeolian deposits, deposited in a series of geomorphic entities zones sub-parallel to the present coastline (McArthur and Bettenay 1974). Five geomorphic entities are recognised by McArthur and Bettenay (1974) the most westerly of which is the Quindalup Dune System that borders the present coastline. This is bounded to the west by the Spearwood Dune System with the Bassendean Dune System lying between this and the Pinjarra Plain.

Geologically, all but the western end of the survey area is located on the Bassendean Dunes System of the Swan Coastal Plain. This system, which occurs immediately to the west of the Pinjarra Plain, generally comprises low hills of siliceous sand interspersed with poorly drained areas (McArthur and Bettenay 1974). The surface geology can be characterised as grey alluvial sand within and adjacent to that part of the survey area located on the Bassendean Dunes.

The western end of the survey area is located on the Spearwood Dunes System of the Swan Coastal Plain. This system, which occurs immediately to the west of the Bassendean Dunes System, generally comprises “a core of aeoloanite with a hard capping of secondary calcite overlain by variable depths of yellow or brown sand” (McArthur and Bettenay 1974:13). The surface geology within and around the western end of the survey area can also be characterised as grey alluvial sand.

As stated above, the Bunbury Outer Ring Road (Southern Section) Project Area traverses an area that comprises cleared paddocks and road reserve corridors with some patches of remnant bush. With the exception of a large sand hill south of Ducane Road and more elevated ground west of Cokelup Road, the survey area is generally flat.

While some low lying areas were observed in the paddocks mentioned above, well defined drainage features were generally absent from the survey area. The exception to this is a narrow ephemeral drainage line that crosses the survey area between Cokelup Road and Jilley Road. This drainage feature was dry at the time of the archaeological survey discussed in this report.

The Bunbury Outer Ring Road (Southern Section) Project Area is located in a region that has been and still is utilised by the pastoral industry and to a lesser degree by a small residential urban population. As a consequence, the majority of the land in and adjacent to the survey area has been universally disturbed and modified.

VEGETATION

Beard (1981) notes the relationship between specific soil types and vegetation. The survey area and its surrounds are located in the Drummond Botanical Sub-district of the Darling Botanical District (Beard 1981).

Generally, the vegetation within the survey area would probably have been characterised by scrub vegetation with *Banksia* low woodland dominated by *Banksia attenuata*, *B. menziesii*, *B. ilicifolia*, *Eucalyptus todtiana* and *Nuytsia floribunda*, with a dense understorey of sclerophyll shrubs. However, as noted above, the majority of the land within and adjacent to the survey area has been universally disturbed and modified which has resulted in almost all the native vegetation having been cleared.

At the time of the archaeological survey, the vegetation within those parts of the survey area that traverse cleared paddocks, was dominated by a moderate to dense cover of low (<0.3m) grasses in some places and generally sparse grasses in others. Some and *Eucalyptus* spp. trees to 15m, a small stand of pepper trees (*Agonis flexuosa*) to 4m and the occasional small paperbark tree (*Melaleuca* spp) to 3m were also observed in or adjacent to the survey area. As a consequence, surface visibility within that part of the survey area that traverses cleared paddocks was variable and ranged from <10% to approximately 40%. Areas of excellent visibility (>80%) were limited to cleared fire breaks, fence lines, tracks and other opportunistic exposures.

The vegetation on the large sand hill south of Ducane Road comprised numerous *Banksia* spp. trees to 10m over a sparse to moderate cover of low grasses. Visibility on this sand hill was generally good and averaged approximately 40%.

The vegetation within the remainder of the survey area comprised numerous areas of regrowth with *Eucalyptus* spp. trees to 10m over low shrubs to 1m, numerous grass trees (*Xanthorrhoea* spp.) to 1m and some grasses with a moderate to dense cover of leaf litter in some parts. Surface visibility within this part of the survey area was also variable and ranged from <10% to approximately 30%. It is noted here that where ground visibility was very low, adjacent cleared fence lines and fire breaks afforded excellent ground visibility at approximately 80%.

ARCHAEOLOGICAL BACKGROUND

DEFINITIONS

The commonest Aboriginal archaeological materials found in Australia are discarded stone tools, or the debris from making such tools by knapping. These artefacts formed a small but durable part of the Aboriginal tool-kit. Often stone tools were used to manufacture other tools from organic materials that have not survived. Where numerous artefacts occur in context and in association they constitute an artefact scatter and together comprise the scatter's artefact assemblage.

Artefact scatters generally represent campsites. Large scatters are places that were regularly occupied, sometimes for long periods and represent the accumulation of many overlapping smaller camps. Small scatters are the remains of sites that were briefly occupied, probably on several occasions. Very small scatters may be evidence of an overnight camp, meal-time camp or work area where specific activities were carried out.

Many stone arrangements have been interpreted as ceremonial sites, but this rarely can be established. Stone arrangements can consist of hundreds of stones arranged in elaborate lines or in mounds, or can be a single line or small cluster. Solitary placed or standing stones may have served as a sign; for example, as a warning to avoid a specific site or as an indicator of water. Some stone arrangements are the remains of hunting hides or the bases of huts.

A place where stone was obtained for making stone tools is a quarry. Generally quarries contain knapping centres or core reduction areas where knapping was intensive. Quarries are found at occurrences of highly siliceous stone, such as chalcedony, chert, silcrete, quartz, *etc*. Finished artefacts are not common at quarries and the vast majority of material found at this type of site is waste, called debitage or debris, from making tools or preparing cores for transport off the quarry for later use.

Apart from concentrations of artefacts at campsites, there are also solitary artefacts that are distributed at a very low density across the landscape. These form a background scatter that probably represents evidence of dispersed hunting and gathering activities. In some instances, isolated finds are found beside watercourses in a long ribbon known as a 'creekline scatter'.

For the purposes of the survey discussed in this report, an archaeological "site" is defined as a place where "significant traces of human activity are identified" (Renfrew & Bahn 1991:42). In other words, where there is substantial *in situ* evidence of past Aboriginal occupation or activity. This is a scientific definition, not a legal definition.

The decision as to whether a place might or might not constitute a "site" under Section 5 of the W.A. *Aboriginal Heritage Act 1972*, is made by the Aboriginal Cultural Material Committee. Excerpts from the Act are included in Appendices 2 and 3. Most types of Aboriginal sites are described in more detail in Appendix 3. It is important to note that all sites are protected under the W.A. *Aboriginal Heritage Act 1972*, whether known or not, and that it is an offence to disturb or conceal a site, or remove artefacts, without appropriate consent.

REGISTERED SITES

As a result of research undertaken at the Heritage and Culture Division, Department of Indigenous Affairs (WA) and a search of their Aboriginal Sites Database prior to the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, it was established that no registered Aboriginal archaeological sites or sites with an archaeological component are located within the survey area. However, it was established, on the basis of information given on the Department of Indigenous Affairs' Aboriginal Sites Database that one 'other heritage place' (Bunbury Bypass Archaeological Site 1) has been recorded at a

position that abuts and is encompassed by the survey area. It is noted here that information pertaining to the Bunbury Bypass Archaeological Site 1 (DIA 18884) 'other heritage place' has been reported to the Registrar of Aboriginal Sites and assessed by the Site Assessment Group. This is not the final assessment. The final assessment is yet to be determined by the Aboriginal Cultural Material Committee. Consequently, the Bunbury Bypass Archaeological Site 1 (DIA 18884) appears on the Department of Indigenous Affairs' Aboriginal Sites Database as 'Other Heritage Place'. Despite this, the provisions of the *Aboriginal Heritage Act 1972* still apply to this other heritage place until it is assessed as a place to which the *Aboriginal Heritage Act 1972* does not apply.

The Bunbury Bypass Archaeological Site 1 (DIA 18884) was initially identified during an archaeological survey of the proposed Bunbury Bypass Road over fifteen years ago (Hammond and O'Reilly 1995). According to Hammond and O'Reilly (1995), the Bunbury Bypass Archaeological Site 1 (DIA 18884) is located approximately 30m to the southwest of the intersection of Hasties Road and Allenville Road. They described it as a very low density artefact scatter situated within a large dam structure which measures approximately 50m x 100m. They identified two discrete artefact clusters on the dam wall, one in the southwest corner and one in the southeast corner which combined contained a total of fourteen artefacts. Hammond and O'Reilly (1995:31) subsequently recorded these artefacts and identified four complete flakes (28.6%), nine flake fragments (64.3%) and one core fragment (7.1%), all of which had been manufactured on quartz.

During the course of fieldwork associated with the archaeological survey described in this report, the Bunbury Bypass Archaeological Site 1 (DIA 18884) was visited and re-recorded. This artefact scatter is described and discussed in detail in 'Site Description' in the 'Results' section of this report.

Beyond the survey area but within approximately 3km of its boundaries, the Department of Indigenous Affairs has files on one registered Aboriginal archaeological site and twelve 'other heritage places' that have been registered as Aboriginal archaeological sites. Details of these registered sites and other heritage places are given in Table 2. Additional information was obtained from the relevant site files and unpublished reports held at the Department of Indigenous Affairs. A brief review of these will highlight the types of Aboriginal archaeological sites and other heritage places already known to exist in the vicinity of the survey area as well as their geomorphological context.

The Bunbury 23 archaeological site and the Bunbury 10, Bunbury 15, Bunbury 16, Bunbury 17, Bunbury 18, Bunbury 24 and Bunbury 08 other heritage places listed in Table 2 were all initially identified and recorded in 1978 by staff from the Western Australian Museum during the course of an archaeological survey of the wider Bunbury region. The Bunbury 23 site is described in the relevant site file as an artefact scatter that was identified on grey sand along part of cleared firebreak and which comprises numerous quartz flakes.

The Bunbury 10, Bunbury 15, Bunbury 16, Bunbury 17, Bunbury 18, Bunbury 24 and Bunbury 08 other heritage places have all been registered as artefact scatters. According to the relevant site file, the Bunbury 10 artefact scatter was identified in an area of yellow sand 220m x 170m that had been cleared for residential development. At the time it was recorded it artefact assemblage comprised three quartz flakes and one piece of fossiliferous chert.

The Bunbury 15 artefact scatter was identified on the pale yellow sand embankment of a large road cutting approximately 0.4km along Moore Rd from the junction of South Western Highway. While no estimate of the site extent is given in the relevant site file, its artefact assemblage is described as comprising numerous small quartz flakes and chips on the southeast embankment and two quartz chips on the northwest embankment. A recent visit to this other heritage identified six small flakes and chips that had been manufactured on quartz and crystal

quartz (Harris and Johnston 2010). These were identified on a mixed yellow and white sandy embankment.

The Bunbury 16 artefact scatter was identified in a road cutting 0.9km along Moore Road from South Western Highway on the west side of the junction of Moore Road and Wallrodt Road. At the time it was initially recorded the Bunbury 16 artefact assemblage was described as comprising mainly large unmodified quartz flakes, several modified quartz flakes and several chips. A more recent visit to the Bunbury 16 artefact scatter resulted in no artefacts being identified. According to Harris and Johnston (2010:49) it is possible that the entrance to Wallrodt Road may have widened over the years and, presumably, has resulted in the concealment of any artefacts that may have once been visible on the surface.

Table 2: Registered Aboriginal archaeological site and 'other heritage places' located within 3km of the survey area.

SITE ID.	Status	Access	Restriction	Name	Location (Zone 50) East	Location (Zone 50) North	Site Type
Registered Archaeological Site							
4873	R	O	N	Bunbury 23	377689	6306898	Artefact Scatter
Other Heritage Places							
4866	I	O	N	Bunbury 10	374639	6307648	Artefact Scatter
4876	I	O	N	Bunbury 15	380688	6307067	Artefact Scatter
4877	I	O	N	Bunbury 16	380380	6306751	Artefact Scatter
4878	I	O	N	Bunbury 17	380595	6306465	Artefact Scatter
4879	I	O	N	Bunbury 18	380293	6306026	Artefact Scatter
4881	I	O	N	Bunbury 24	373702	6303011	Artefact Scatter
4919	I	O	N	Bunbury 08	377439	6308148	Artefact Scatter
5169	S	O	N	Natgas 263	380639	6306648	Artefact Scatter
5814	I	O	N	Sand Dune Cutting Bunbury	374639	6307648	Artefact Scatter
5815	S	O	N	Bunbury Preston River	377639	6307648	Artefact Scatter
18884	L	O	N	Bunbury Bypass Archaeological Site 1	375149	6302418	Artefact Scatter
18965	L	O	N	Woodcrest Rise Development Marked Tree	374196	6305257	Modified Tree
21700	L	O	N	Hooper Place Burial	372852	6307081	Skeletal Material Burial

***** Please note: Coordinates are indicative locations that represent the centre of sites as shown on maps produced by the DIA – they may not necessarily represent the true centre of all sites.

LEGEND

R – Registered Site, **I** - Insufficient Information, **S** - Stored Data, **L** - Lodged awaiting assessment, **IA** - Information Assessed, **O** – Access Open, **C** - Closed Access, **N** – File Not Restricted.

***** Please note: Coordinates are indicative locations that represent the centre of sites as shown on maps produced by the DIA – they may not necessarily represent the true centre of all sites.

The Bunbury 17 artefact scatter was identified in a road cutting approximately 1.2km along Moore Road from its junction with South Western Highway. At the time it was initially recorded it was estimated that the Bunbury 17 artefact scatter comprised two quartz flakes on the eastern bank of the cutting and four quartz flakes on the western slope. These were all located on yellow sand.

The Bunbury 18 artefact scatter was identified in a road cutting 1.6km along Moore Road, southwest of the junction of South Western Highway and Moore Road. At the time it was initially recorded approximately a dozen quartz flakes, several quartz lumps, one chert flake and one silcrete flake were identified on the slopes of the road cutting. A recent search for the Bunbury 18 artefact scatter resulted in one silcrete flake being at identified on a yellow sandy road cutting (Harris and Johnston 2010).

According to the relevant site file, the Bunbury 24 artefact scatter comprises several quartz waste flakes that were identified on yellow sand around a soccer field somewhere west of the Bussell Highway south of Bunbury and in the vicinity of the Bunbury Cathedral Grammar School.

The Bunbury 08 artefact scatter was identified in a yellow sandy road cutting on Boyanup Road approximately 400m southeast of its junction with Dodson Road. It is described in the relevant site file as comprising a sparse scatter of mainly quartz flakes.

According to the relevant site file the Natgas 263 artefact scatter was identified in a road cutting where artefacts appear to be eroding out from the Pinjarra/Bassendean Sands interface. Its artefact assemblage is described as comprising a number of amorphous quartz chips.

According to the relevant site file the Sand Dune Cutting, Bunbury other heritage place comprises flakes and cores that were identified in a road cutting. No other information pertaining to this place is available from the relevant site file. There is a similar dearth of information in the Bunbury/Preston River site file that, in 1974, was described as comprising four quartz artefacts identified in an eroding section of sand dune on high ground west of a bend in the Preston River.

The Woodcrest Rise Development Marked Tree other heritage place has been recorded as a marked tree and described by Parker and Lantzke (2001) as displaying footholds that old people had cut into its trunk to allow them to access a bee-hive in a hole left by a fallen branch.

The Hooper Place Burial is a prehistoric Aboriginal grave uncovered at 5-7 Hooper Place in suburban Bunbury (Corsini 2004).

In addition to those referred to above, numerous other archaeological surveys and investigations have also been undertaken in the wider region around the survey area (*e.g*. Australian Interaction Consultants 2004; Edwards *et. al.* 1997; Goode 2002; Goode and Harris 2007, 2008; Greenfeld 2002, 2003; Harris 2001; Harris & Webb 2007; Martinick McNulty 2000; McDonald Hales 1998; McDonald *et. al.* 2000; Murphy 1999; Murphy *et. al.* 1990; O'Connor *et. al.* 1989; O'Reilly 2007, 2011; Parker and Lantzke 2002, 2003; Parker *et. al.* 2000; Tempus Archaeology 2007) which have resulted in the identification, recording and reporting of numerous Aboriginal archaeological sites, the majority of which are small open artefact scatters that are generally located near or adjacent to drainage features or other ephemeral water sources.

PREVIOUS ARCHEOLOGICAL RESEARCH

Bunbury in general and the survey area in particular, are located on the Swan Coastal Plain that is contained within the broader south-western region of Western Australia. Previous archaeological research conducted in the south-west of Western Australia documents, amongst other things, the antiquity of human occupation in this region. At present the earliest occupation date for the south-west of Western Australia is in the order of 47,000 years Before Present (BP)

obtained from archaeological deposits at Devil's Lair (Dortch 2002), located approximately 20km north of Cape Leeuwin in the Leeuwin-Naturaliste Region. Some other sites of Pleistocene age recorded in the south-west include Upper Swan *c*.38,000 BP (Pearce and Barbetti 1981), Helena River *c*.29,000 BP (Schwede 1983) and Kalgan Hall *c*.18,000 BP (Ferguson 1985). There are at least 46 dated archaeological sites in south-western Australia which together span the period from *c*.38,000 BP to the present (*cf*. Smith 1993). In a wider regional context, these sites provide a more or less continuous record of human occupation of this region.

The artefact assemblages at the majority of previously recorded sites on the Swan Coastal Plain are dominated by quartz. Many sites also contain a proportion of fossiliferous chert, a superior raw material for artefact manufacture. The sources of this material, believed to lie off the Western Australian coast in the general vicinity of Mandurah, were submerged approximately 6,000 years ago with the last eustatic change, a 140 metre rise in sea level (Glover 1975). Although the timing of the loss of access to this resource is not precise, the presence of fossiliferous chert in an assemblage may indicate the relative age of a site. Hallam (1987) developed a relative dating scheme based on the relative proportions of lithic material and artefact types represented in artefact assemblages that is outlined as follows. Sites classified as Early Phase assemblages include artefacts of fossiliferous chert. Middle Phase assemblages contain backed artefacts and adzes, while Late Phase assemblages are quartz-rich with high proportions of chips. Final Phase assemblages are those with worked glass and/or ceramic artefacts. Assemblages could, of course, belong to more than one phase (Hallam 1987:20). Although there are obvious inadequacies with this approach it is one of the only methods available for assigning a relative date to open artefact scatters on the Swan Coastal Plain.

The majority of previously recorded archaeological sites on the Swan Coastal Plain are usually found on intact or deflated Holocene dunes and represent a general background scatter reflecting single activity episodes or ephemeral activities. Much of the internal complexity of these sites has been destroyed due to natural processes such as aeolian deflation, or from disturbance as a result of development.

The distribution of archaeological sites on the Swan Coastal Plain is not uniform. Larger sites and site clusters are found at highly favourable locations indicating that these locations were occupied repeatedly over a long time frame. Favoured locations on the coastal plain included areas of predictably high productivity such as those with reliable fish runs and large seasonal game resources (Anderson 1984; Meagher and Ride 1979). At times of plenitude this resource security facilitated the support of large gatherings which served to enhance group identity and cohesion (Gibbs 1987). These favourable locations correspond to the major wetlands, lakes and estuaries of the coastal plain and the rivers that drain into them. The vast majority of sites that have been located are within 500 metres of water sources, indicating that Aboriginal habitation of the area was closely linked to the availability of wetland resources. The high seasonal productivity and the availability of fresh water at wetlands would clearly have made them a focus for Aboriginal habitation.

The results of previous archaeological surveys and research, as well as the data on registered sites presented above, demonstrates the types of Aboriginal archaeological sites already known to exist in the wider region around the designated survey area. In addition to this, these results, together with the environmental information already discussed, enables predictions to be made about probable site locations and the types of archaeological material and/or sites which could reasonably be expected to be found as a result of the survey of the designated survey area. The underlying geology and the vegetation regime within the survey area preclude the likelihood of sites such as quarries, rock shelters, engravings or art sites being present. The types of archaeological sites or material, if any, that are most likely to be located within the designated survey area would be various types of lithic artefacts either singularly or in scatters and possibly skeletal material or burials.

SIGNIFICANCE OF ARCHAEOLOGICAL SITES

The scientific significance of an archaeological site is determined by its ability to provide information that can address regional and site specific questions and by its representativeness (Bowdler 1984). Unique sites are more significant than common sites and sites with stratified deposits are more significant than un-stratified sites. It should be noted that significance is a mutable quality, changing as more sites are recorded, as research questions are answered and as new research directions arise.

Some research questions that any archaeological sites in the survey area may address include;

- what is the antiquity of the Aboriginal occupation of the Swan Coastal Plain?
- what social and technological changes, if any, may have occurred in the region in the mid-Holocene?
- specific patterns of occupation on the Swan Coastal Plain?
- the dating of industrial sequences in the region.

SURVEY METHODS

The archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area was undertaken in January 2012 by archaeologists Thomas O'Reilly and Stuart Johnston. The methods utilised prior to and during the archaeological survey are outlined below.

Prior to undertaking the field component of the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, a search of the Aboriginal Sites Database at the Department of Indigenous Affairs (WA) was made to determine if any Aboriginal archaeological sites, or sites with an archaeological component, or any other heritage places, are located within or adjacent to the survey area. At the same time, site files pertaining to any registered Aboriginal archaeological sites or sites with an archaeological component in the vicinity of the survey area were also examined as were site files pertaining to other heritage places. A review of reports detailing the results of previous archaeological surveys and investigations carried out in the vicinity of the survey area was also undertaken as was a review of archaeological research conducted in the wider region.

Geological and vegetation maps were also examined prior to the field survey to ascertain the physical geography and geomorphology of the land within the survey area. Any areas of interest identified from these maps, or areas identified as having a high probability of containing Aboriginal archaeological sites, would subsequently be targeted during the field survey.

That part of the survey area between Cokelup Road and Jilley Road and which is traversed by a narrow ephemeral drainage line, was targeted and scrutinised for the presence of Aboriginal archaeological material by walking along the sides and margins of this drainage line and examining the exposed banks and adjacent cleared ground. In general, ground visibility in this part of the survey area was excellent and averaged approximately 80%.

The remainder of the survey area was surveyed for the presence of Aboriginal archaeological sites by walking a series of transects along the entire length of the survey area. These transects followed the general alignment of the survey area and were spaced at approximately 20m to 30m intervals.

In general, ground visibility throughout the survey area was variable and ranged from as low as <10% in some parts as a result of grass cover and leaf litter, to as high as approximately 40% throughout the remainder. Areas of excellent visibility (>80%) were limited to cleared fire breaks, fence lines, tracks and other opportunistic exposures. It is noted here that where ground visibility was very low, adjacent cleared fence lines and fire breaks afforded excellent ground visibility at approximately >80%.

RESULTS

As a result of research undertaken at the Heritage and Culture Division, Department of Indigenous Affairs (WA) and a search of their Aboriginal Sites Database prior to the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, it was established that no registered Aboriginal archaeological sites or sites with an archaeological component are located within the survey area. However, it was established that one 'other heritage place' (Bunbury Bypass Archaeological Site 1 DIA 18884) has been recorded at a position that places it partially within the survey area (Figure 7).

The Bunbury Bypass Archaeological Site 1 (DIA 18884) was initially identified during an archaeological survey of the proposed Bunbury Bypass Road over fifteen years ago (Hammond and O'Reilly 1995). According to Hammond and O'Reilly (1995), the Bunbury Bypass Archaeological Site 1 (DIA 18884) is located approximately 30m to the southwest of the intersection of Hasties Road and Allenville Road. They described it as a very low density artefact scatter situated within a large dam structure which measures approximately 50m x 100m. They identified two discrete artefact clusters on the dam wall, one in the southwest corner and one in the southeast corner which combined contained a total of fourteen artefacts. Hammond and O'Reilly (1995:31) subsequently recorded these artefacts and identified four complete flakes (28.6%), nine flake fragments (64.3%) and one core fragment (7.1%), all of which had been manufactured on quartz.

During the course of fieldwork associated with the archaeological survey described in this report, the Bunbury Bypass Archaeological Site 1 (DIA 18884) was visited and re-recorded. Its precise location and extent was determined and its position recorded as accurately as possible using a Garmin GPSMAP 62 series hand held GPS. The associated spatial data was recorded in Map Grid of Australia (MGA) co-ordinates using the Geocentric Datum of Australia (GDA) 1994 and co-ordinates given below (Table 3) represent the approximate centre of the site. The extent of the site was also determined and clearly marked with pink flagging tape and a series of co-ordinates recorded which define its boundary. Details of the Bunbury Bypass Archaeological Site 1 (DIA 18884) are given in Table 4 and it is described and discussed below.

No other Aboriginal archaeological sites or material were identified as a result of the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area.

Table 3: Details of the Aboriginal archaeological heritage place identified within the survey area.

SITE ID.	Name	Location (Zone 50) East	North	Site Type	Site Extent	Estimated Number of Artefacts	Significance
18884	Bunbury Bypass Archaeological Site 1	375149	6302418	Artefact Scatter	100m x 200m	20	Very Low

Figure 7: Archaeological survey results, blue polygon showing actual extent of DIA 18884 Bunbury Bypass Archaeological Site 1, red polygon showing Survey Corridor and green polygon showing DIA buffered site extent.

SITE DESCRIPTION

DIA 18884 Bunbury Bypass Archaeological Site 1

MGA co-ordinates 375149mE and 6302418mN

The Bunbury Bypass Archaeological Site 1 site is a diffuse artefact scatter that is located on the south side of Hasties Road immediately west of the corner with Allenville Road. It was identified within what appears to have been a dam structure where an area of yellow sand has been excavated and either removed or used to construct the southern dam wall. Fences parallel the northern and eastern boundaries of the site (Figure 10). It appears that the area within the site has been universally disturbed in the past. Vegetation within this site was extremely open and low and dominated by low (<0.3m) grasses with some bushes to <1m at the western end of the site and several trees and bushes to 2m-3m at its eastern end. As a consequence, ground visibility in and around the Bunbury Bypass Archaeological Site 1 artefact scatter was excellent and averaged approximately 80% (Plate 1). The surface geology in and around this site can be characterised as yellow sand. The Bunbury Bypass Archaeological Site 1 artefact scatter has maximum dimensions of approximately 100m NS x 200m EW and its boundary is defined by the co-ordinates given in Table 4.

Table 4: MGA co-ordinates defining the boundary of the Bunbury Bypass Archaeological Site 1 artefact scatter.

EASTING (mE)	NORTHING (mN)	EASTING (mE)	NORTHING (mN)
375084	6302440	375170	6302392
375283	6302409	375201	6302467
375081	6302405	375204	6302397
375284	6302439	375168	6302467
375107	6302376	375239	6302388
375266	6302460	375135	6302467
375140	6302370	375280	6302378
375236	6302467	375105	6302466

It is estimated that the Bunbury Bypass Archaeological Site 1 artefact scatter contains less than twenty artefacts that have been manufactured exclusively on quartz. A single piece of quartz debris was identified at the western end of the site while one quartz backed blade (Plate 2), one quartz complete flake (Plate 3) and approximately fifteen pieces of quartz debris were identified at the eastern end of the site. Observations made at this site indicate that its artefact assemblage consists predominantly of small flaked pieces and flake fragments. On the basis of the above estimates, average artefact density has been calculated at approximately 0.001 artefacts/m^2 across the entire site. However, it is noted that artefacts are concentrated at the eastern end of the site. The distribution of the artefacts observed during the recording the Bunbury Bypass Archaeological Site 1 artefact scatter is probably a result of disturbance associated with the construction of the dam and not an internal feature of the site. An examination of exposed vertical sections at the eastern and western ends of the site did not reveal any cultural material *in situ* nor did it reveal any visible stratigraphy.

The Bunbury Bypass Archaeological Site 1 artefact scatter is interpreted as a camp site that was probably occupied on one or two occasions. While a single quartz backed blade was identified, no grinding material or other retouched/utilised artefacts were observed at this site and although artefacts may be present below the surface, there is little or no potential for it to contain stratified cultural deposits. The artefact assemblage at the Bunbury Bypass Archaeological Site 1 artefact scatter is very small, unremarkable and generally typical of other artefact scatters located in the wider region. As a result of its size, limited artefact assemblage and disturbed context, the Bunbury Bypass Archaeological Site 1 artefact scatter has little potential to address any of the research questions outlined above. Consequently, the Bunbury Bypass Archaeological Site 1 artefact scatter is assessed here as having very low archaeological significance.

Figure 8: Plate 1. Looking east from west end of the Bunbury Bypass Archaeological Site 1 artefact scatter.

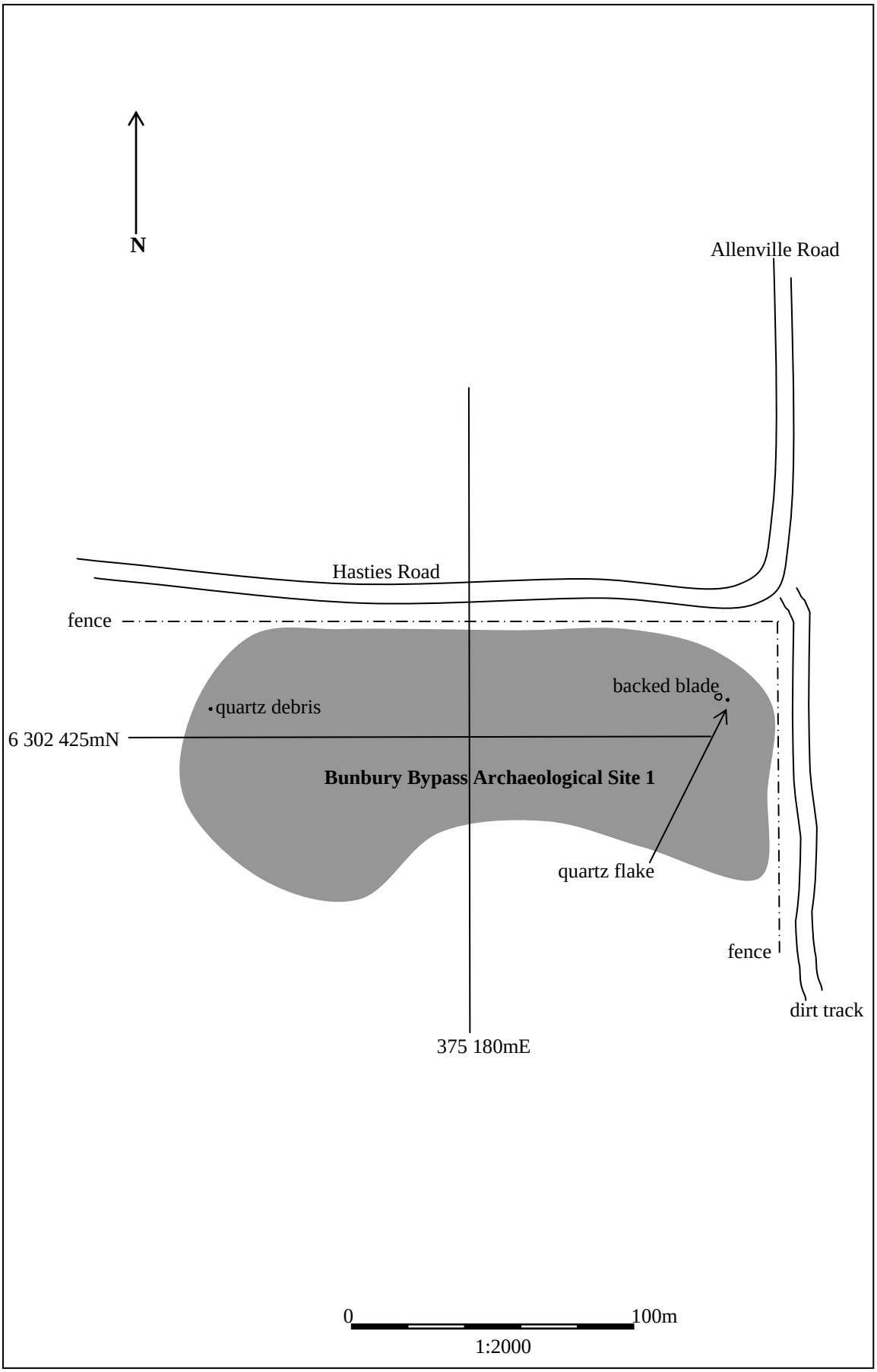

Figure 9: Sketch map showing location of the Bunbury Bypass Archaeological Site 1 artefact scatter.

Figure 10: Plate 2. Quartz backed blade *in situ* in the Bunbury Bypass Archaeological Site 1 artefact scatter.

Figure 11: Plate 3. Quartz flake *in situ* in the Bunbury Bypass Archaeological Site 1 artefact scatter.

CONCLUSIONS

DISCUSSION

An archaeological survey for Aboriginal archaeological sites within the Bunbury Outer Ring Road (Southern Section) Project Area, centred approximately 9km SSE of the Bunbury City centre, was undertaken on behalf of GHD Pty Ltd by archaeologists Thomas O'Reilly and Stuart Johnston in January 2012. The Bunbury Outer Ring Road (Southern Section) Project Area comprises a single discrete survey area that is irregularly shaped and which extends for approximately 9km from South Western Highway near the intersection of Centenary Road to Bussell Highway between Woods Road and Calinup Road. It varies in width form 50m to 150m and traverses an area that comprises cleared paddocks and road reserve corridors with some patches of remnant bush. In general, the majority of the survey area has been universally disturbed. GHD Pty Ltd on behalf of Main Roads Western Australia proposes to construct a dual carriageway and associated overpasses and service roads within the Bunbury Outer Ring Road (Southern Section) Project Area.

As a result of research undertaken at the Heritage and Culture Division, Department of Indigenous Affairs (WA) and a search of their Aboriginal Sites Database prior to the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, it was established that no registered Aboriginal archaeological sites or sites with an archaeological component are located within the survey area. However, it was established, on the basis of information given on the Department of Indigenous Affairs' Aboriginal Sites Database that one 'other heritage place' (Bunbury Bypass Archaeological Site 1) has been registered at a position that places it in a position that abuts and is encompassed by the survey area. As can be seen in Figures 5 and 6, the Bunbury Outer Ring Road (Southern Section) Project Area appears to encompass the Bunbury Bypass Archaeological Site 1 other heritage place.

It is noted here that information pertaining to the Bunbury Bypass Archaeological Site 1 (DIA 18884) 'other heritage place' has been reported to the Registrar of Aboriginal Sites and assessed by the Site Assessment Group. This is not the final assessment. The final assessment is yet to be determined by the Aboriginal Cultural Material Committee. Consequently, the Bunbury Bypass Archaeological Site 1 (DIA 18884) appears on the Department of Indigenous Affairs' Aboriginal Sites Database as 'Other Heritage Place'. Despite this, the provisions of the *Aboriginal Heritage Act 1972* still apply to this other heritage place until it is assessed as a place to which the *Aboriginal Heritage Act 1972* does not apply.

As previously stated, the Bunbury Bypass Archaeological Site 1 (DIA 18884) was initially identified during an archaeological survey of the proposed Bunbury Bypass Road over fifteen years ago (Hammond and O'Reilly 1995). During the course of the fieldwork associated with the archaeological survey described in this report, the Bunbury Bypass Archaeological Site 1 (DIA 18884) was visited and re-recorded (see Site Description in Results). As a result of this re-recording the Bunbury Bypass Archaeological Site 1 (DIA 18884) location, extent, artefact distribution and artefact assemblage were found to be consistent with the descriptions given by Hammond and O'Reilly (1995). Furthermore, it is noted here that Hammond and O'Reilly (1995) recorded all visible artefacts and identified four complete flakes (28.6%), nine flake fragments (64.3%) and one core fragment (7.1%), all of which had been manufactured on quartz.

In general, the artefact assemblage observed at the Bunbury Bypass Archaeological Site 1 (DIA 18884) artefact scatter appeared mundane and was dominated by flaked pieces and flake fragments that have been manufactured exclusively on quartz. Although a single backed blade was noted, no grinding material or other retouched and/or utilised artefacts were observed at this site and although artefacts may be present below the surface, there is little or no potential for it to contain stratified cultural deposits.

Given the features outlined above, the very small Bunbury Bypass Archaeological Site 1 (DIA 18884) artefact scatter is interpreted as a campsite that was probably visited on only one or two occasions. The artefact assemblage at this site is very small, generally unremarkable and has little potential to address the research questions outlined in 'Significance of Archaeological Sites.' Consequently, this site is assessed here as having very low archaeological or scientific significance.

It is noted here that the Aboriginal archaeological site identified within the survey area has been assessed on the basis of its archaeological or scientific significance only. It is pointed out that this site may also have cultural and/or social significance to Aboriginal people and that the opinion of the appropriate Aboriginal people should be sought before any planning decisions are made which may impact upon this site.

The entire length of the Bunbury Outer Ring Road (Southern Section) Project Area was surveyed and examined for the presence of Aboriginal archaeological sites and/or material using regularly spaced linear transects. The low surface visibility encountered in some parts the survey area can cause sites and archaeological material to be overlooked. A moderate to dense cover of grass and leaf litter in some parts of the survey area made it very difficult to see or find any Aboriginal archaeological material that may have been on the obscured ground surface. However, it should be noted that searches of fence lines, fire breaks and cleared tracks and their margins as well as other opportunistic exposures with high surface visibility adjacent to these parts of the survey also yielded no Aboriginal archaeological sites or material. Therefore, it is considered that the scarcity of Aboriginal archaeological sites and/or material within the low visibility parts of the survey area is real and not simply a product of poor visibility.

Given the degree of surface visibility in general throughout the survey area and the intensity of coverage, it is considered that the archaeological survey was sufficient to locate any Aboriginal archaeological sites present on the surface. It should be noted that sites can be exposed and/or concealed as a result of both wind and water erosion. It is also possible that archaeological material lies below the surface and may be exposed as a result of environmental factors or work undertaken within the surveyed area. GHD Pty Ltd and Main Roads Western Australia should be aware of this when undertaking ground disturbing work or any other activities.

RECOMMENDATIONS

On the basis of the results of the archaeological survey of the Bunbury Outer Ring Road (Southern Section) Project Area, and the above discussion it is recommended that;

1) GHD Pty Ltd and/or Main Roads Western Australia be allowed to proceed with their proposal to construct a dual carriageway and associated overpasses and service roads within the Bunbury Outer Ring Road (Southern Section) Project Area, on the condition that they avoid any impact upon or disturbance to heritage place Bunbury Bypass Archaeological Site 1 (DIA 18884).

2) If it is necessary to disturb any part(s) of the heritage place Bunbury Bypass Archaeological Site 1 (DIA 18884), GHD Pty Ltd and/or Main Roads Western Australia, as required under section 18 of the Western Australian *Aboriginal Heritage Act 1972*, need to apply to the Minister for Indigenous Affairs for consent to proceed with activities that will disturb Aboriginal heritage sites.

3) If such an application is made, consent should be granted to proceed with activities that will disturb heritage place Bunbury Bypass Archaeological Site 1 (DIA 18884) unconditionally as this place and its artefact assemblage has been previously recorded in detail.

4) In the event of any artefactual material or skeletal material being discovered in the course of mineral exploration activities or any other activities, work should stop while the Department of Indigenous Affairs carry out an investigation of the site. In the case of skeletal material being uncovered, work must cease immediately and the Western Australian Police must be notified.

5) GHD Pty Ltd and/or Main Roads Western Australia personnel and contractors be advised of their obligations under section 15 of the *Aboriginal Heritage Act* 1972, to report the discovery of any Aboriginal cultural material which may be uncovered in the course of their work.

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APPENDIX 1: SITES REGISTER SEARCH

Search Criteria

1 sites in a search polygon. The polygon is formed by these points (in order):

MGA Zone 50	
Northing	Easting
6299057	371102
6300853	373679
6302457	374339
6303355	375203
6303376	375299
6304410	375886
6305077	377742
6304838	377835
6304812	377541
6300242	373672
6299004	371111
6299057	371102

Disclaimer

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

Copyright

Legend

Restriction

N	No restriction
M	Male access only
F	Female access

Access

C	Closed
O	Open
V	Vulnerable

Coordinate Accuracy

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

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

Status

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

Spatial Accuracy

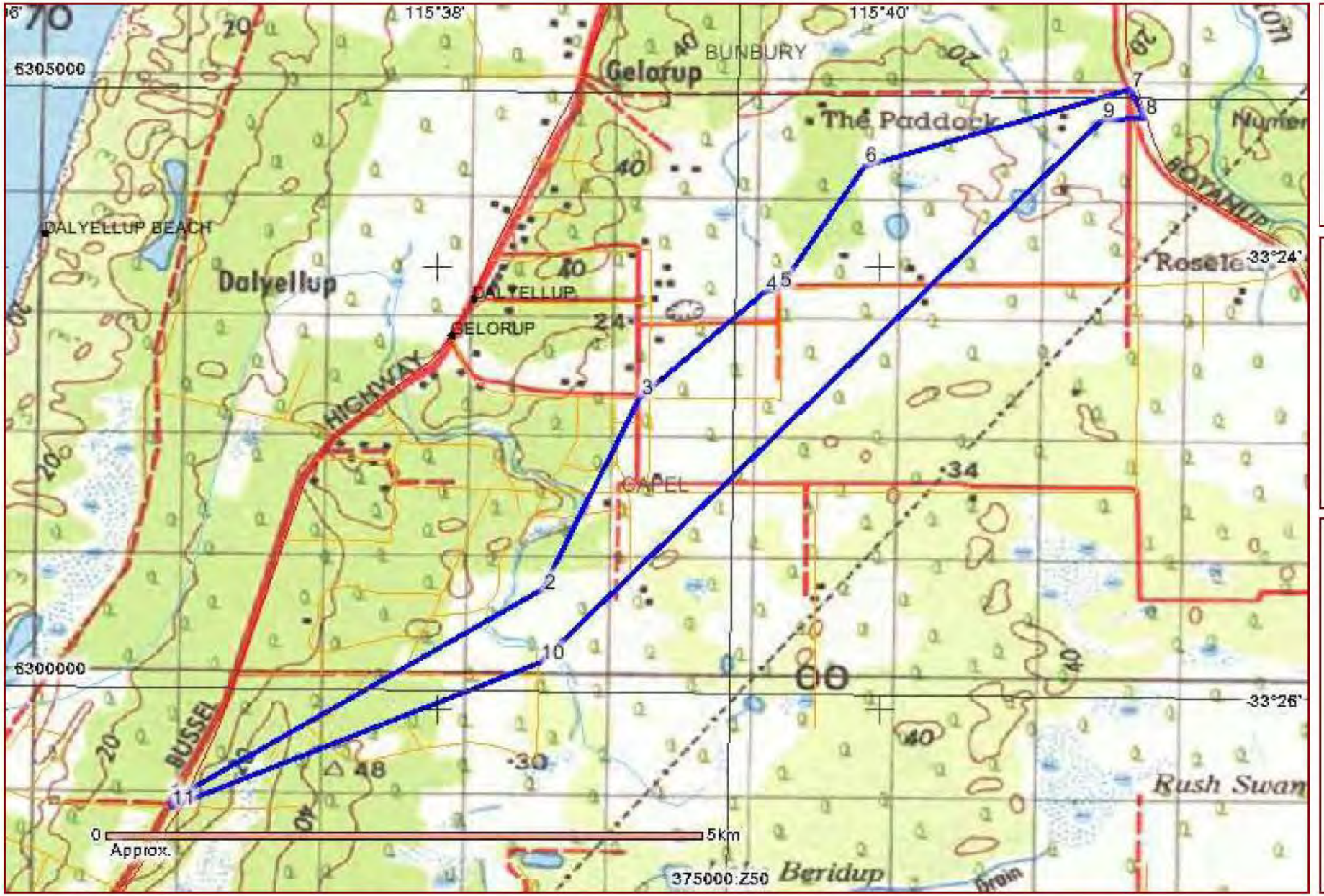
Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code “closed” or “vulnerable”. Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more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

Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of Registered Aboriginal Sites with Map

No results



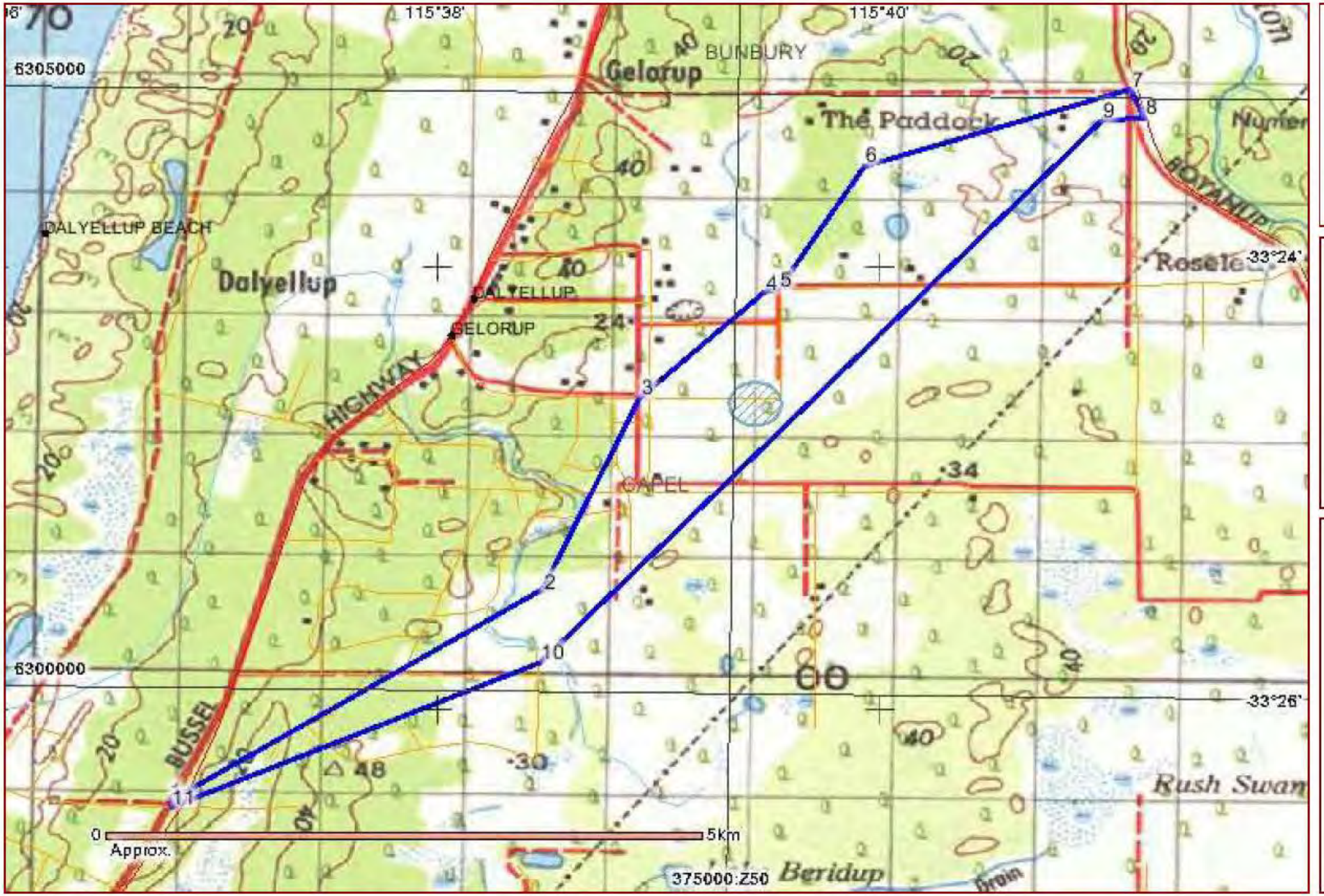
Legend

Selected Heritage Sites

- Registered Sites
- Town
- Map Area
- Search Area

List of 1 Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
18884	L	O	N	Bunbury Bypass Archaeological Site 1	Artefacts / Scatter			375149mE 6302418mN Zone 50 [Reliable]	



Legend

Selected Heritage Sites

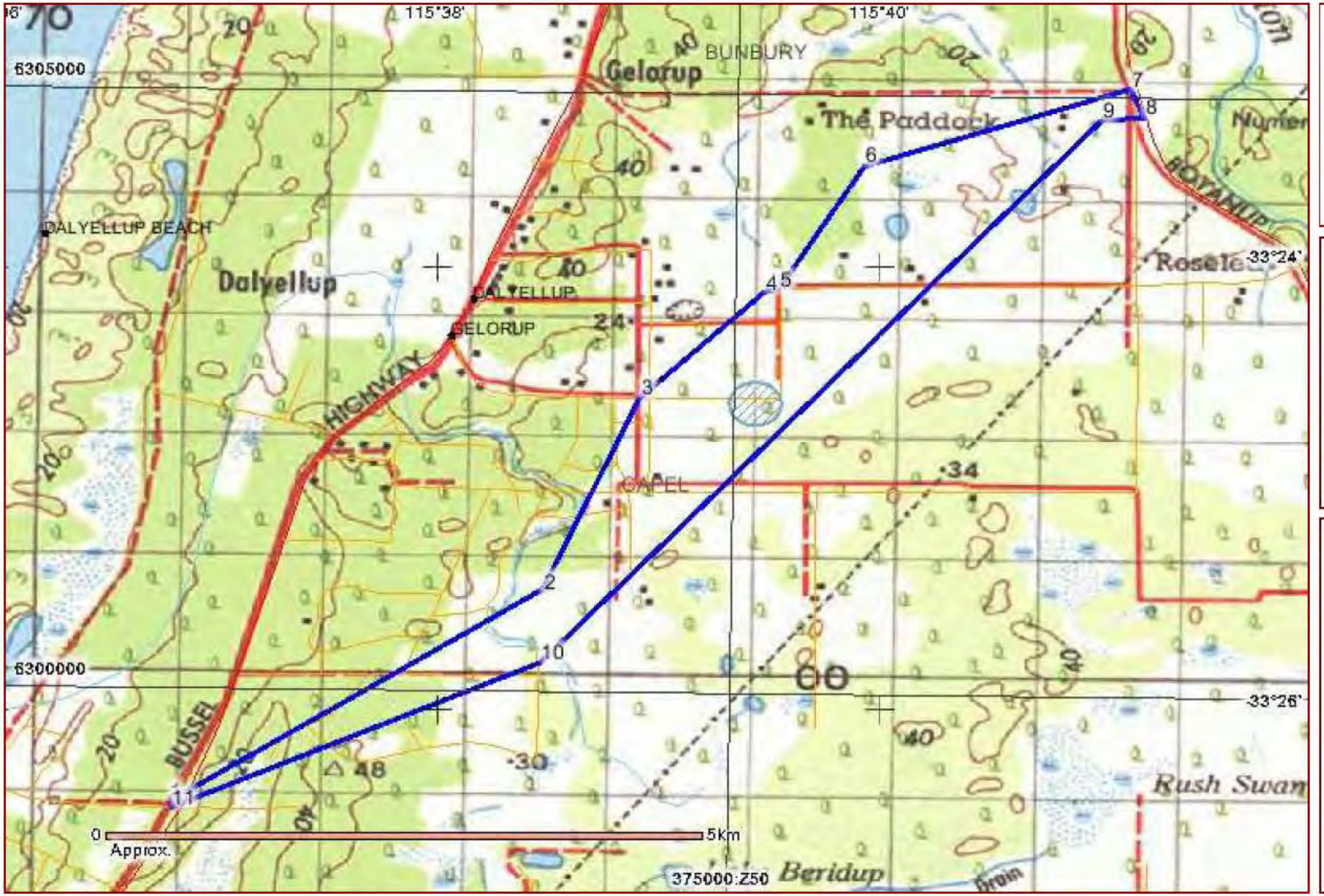
Other Heritage Places

Town

Map Area

Search Area

Map Showing Registered Aboriginal Sites and Other Heritage Places



Legend

Selected Heritage Sites

- Registered Sites
- Other Heritage Places
- Town
- Map Area
- Search Area

APPENDIX 2: LETTER OF ADVICE

Brad Goode & Associates Pty Ltd
Consulting Anthropologist
Heritage Assessments

79 Naturaliste Terrace
DUNSBOROUGH WA 6281
(08) 9755 3716
bradnlee@westnet.com.au
ACN: 134 732 040
ABN: 41 134 732 040

21st February 2012

We the undersigned have been consulted by Bradley Goode on behalf of Main Roads in regard to the Bunbury Outer Ring Road, Southern Section (Stage 2). We would like to make the following recommendations in relation to the Western Australian Aboriginal Heritage Act (1972)

* No sites of sig as defined by section 5 of the AHA of Heritage
* Monitor Arch site Hasta Act
* Request dual naming of Bridges

Gnaala Karla Booja WC98/58 Native Title Claim Group		
Joe Northover	21.2.2012	
Peter Michael	21.2.2012	
James Khan	21.2.2012	
Marie Khan	21.2.2012	
Violet Bennell	21.2.2012	
Ritchie Bennell	21.2.2012	
Les Wallam	21.2.2012	
Denis Hill	21.2.2012	
Dorothy Winmar	21.2.2012	

APPENDIX 3: MAPS OF THE PROJECT AREA IN RELATION TO ABORIGINAL HERITAGE SITES

SiteID:- 4879 BUNBURY 18

SiteID:- 24507 Bunbury 01-05-07/ISO-001 - ISO-005

SiteID:- 24507 Bunbury 01-05-07/ISO-001 - ISO-005

SiteID:- 18965 Woodcrest Rise Development Marked Tree

SiteID:- 4881 BUNBURY 24

SiteID:- 18884 Bunbury Bypass Archaeological Site 1

SiteID:- 5688 STIRLING BEACH DALYELLUP

SiteID:- 19795 Preston River

KEARNEY
SARAH
LARSSON
CHADD
CARR
BRAND
LIAM
GILLMAN
YARDLEY
MEREDITH
OCEAN
POSSUM
PEPPERMINT
CENTENARY
TIMBER MILL
NAME UNIDENTIFIED
BUSHER
MOORE
PARADE
HOLLYHILL
DUNMOW
BERTL
KIWEL
KARDIL
WANDOO
PUNGURA
MOORT
DALYELLUP
HUTT
AGRA
SEQUE
GERS
MAY
TOBAR
ZEDOR
HOPE
MAIDMENT
NORTON
LORETTA
DAWES
HASTIES
SWAN
POOLE
HOWITT
DAMPIER
JANSZ
COYDER
MACKAY
EVA
PODONDO
THETIS
SEPIA
NICOLAY
SEWELL
CASSON
MELBA
BATMAN
WALTON
ONSLOW
JULL
DRIVER
DIAMOND
LONGBOW
ADALE
MORONY
FRANCES
ALLEN
JULES
HAWKINS
SPEED
TEATREE
PALMER
HASTIES
ALLENVILLE
RAY
RUSSELL
SHEOAK
JOANNE
HAREWOODS
TURNER
ZINNIA
GREENDALE
CROWD
SERENE
DUCANE
RIDGE
JILLEY
ZANADU
TARROCK
WATKINS
GELORUP
BUSSELL
MARCHETTI
BANKSIA
BROCKWAY
WOODS
ST CLAIR
COWELUP
MANEA
LAKES
QUAMBI
TAMRA
CALINUP
MINNINUP
RAMSAY
LILLYDALE
QUEELUP
ROSELEA
SOUTHWESTERN
FORD
SKIPPINGS
HAIR
KILPATRICK
PEPPERMINT

369000 370000 371000 372000 373000 374000 375000 376000 377000 378000 379000 380000

6306000 6305000 6304000 6303000 6302000 6301000 6300000 6299000

BUNBURY OUTER RING ROAD STAGE TWO JAN 2012

Legend
- DIA Site Extents Jan 2012
- BORR SURVEY CORRIDOR
- roads

DATE
30th Jan 2012

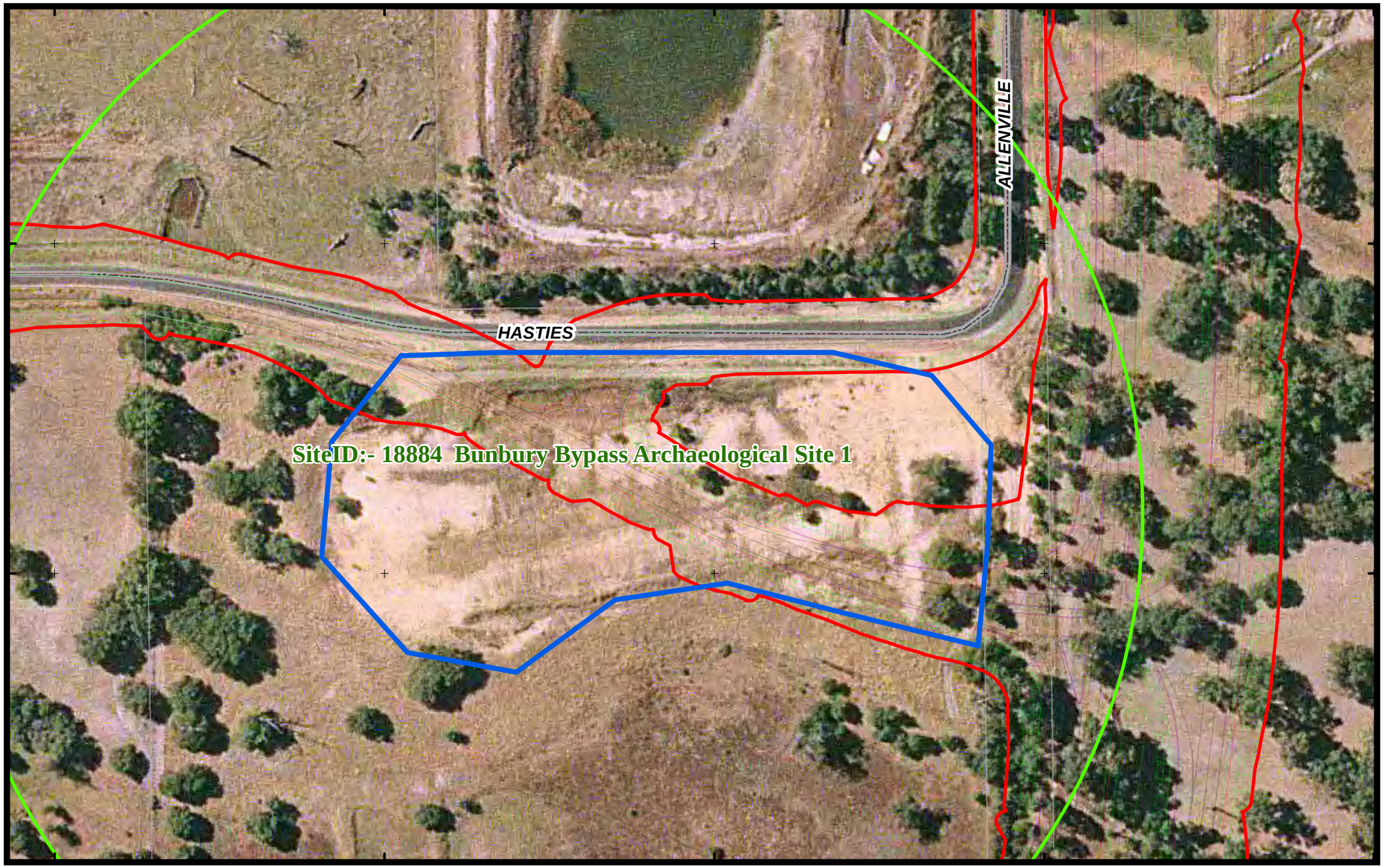
SCALE - at A4
1:15,000

0 70 140 280 420 560 700 840
Meters

N

GDA 1994 MGA Zone 50

Survey conducted by
BRAD GOODE & ASSOCIATES PTY LTD.
Mapping provided by
WARPSPEED GIS - P.O. BOX 147, VASSE WA 6280



BUNBURY OUTER RING ROAD STAGE TWO JAN 2012

Site ID 18584 Bunbury Bypass Archaeological Site 1

Legend
- DIA Site Extents Jan 2012
- BORR SURVEY CORRIDOR
- roads
- SiteID 18884 Bunbury Bypass Archaeological Site 1

DATE 30th Jan 2012

SCALE - at A4 1:1,500

Meters

N

GDA 1994 MGA Zone 50

Survey conducted by
BRAD GOODE & ASSOCIATES PTY LTD.
Mapping provided by
WARPSPEED GIS - P.O. BOX 147, VASSE WA 6280

Appendix G – Noise Management Plan

Noise Management Plan

Bunbury Outer Ring Road – Southern Section

South Western Highway to Bussell Highway

PRELIMINARY ONLY

Prepared For

GHD Bunbury

November 2012

Reference: 11081916-01a.docx

LLOYD GEORGE Acoustics

Report: 11081916-01a.docx

Lloyd George Acoustics Pty Ltd
ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923

Offices:	Ocean Reef	Padbury	Scarborough	Waterford
Phone:	9300 4188	9401 7770	9245 3223	9313 3655
Fax:	9300 4199	9401 7770	9300 4199	9300 4199
Email:	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	mike@lgacoustics.com.au	rebecca@lgacoustics.com.au
Mobile:	0439 032 844	0400 414 197	0438 201 071	0427 388 876

Member of the Association of Australian Acoustical Consultants – (AAAC)

Prepared By:	Terry George 
Position:	Project Director
Date:	7 November 2012

CONTENTS

APPENDICES

1 INTRODUCTION

The Bunbury Outer Ring Road (BORR) will be constructed as a four-lane dual carriageway with a combination of grade separated interchanges and at-grade intersections, with the capacity to be upgraded to freeway status in the long term. This report relates to the southern section, being between South Western Highway and Bussell Highway. The overall project is shown in *Figure 1.1* with *Figure 1.2* relating specifically to the southern section.

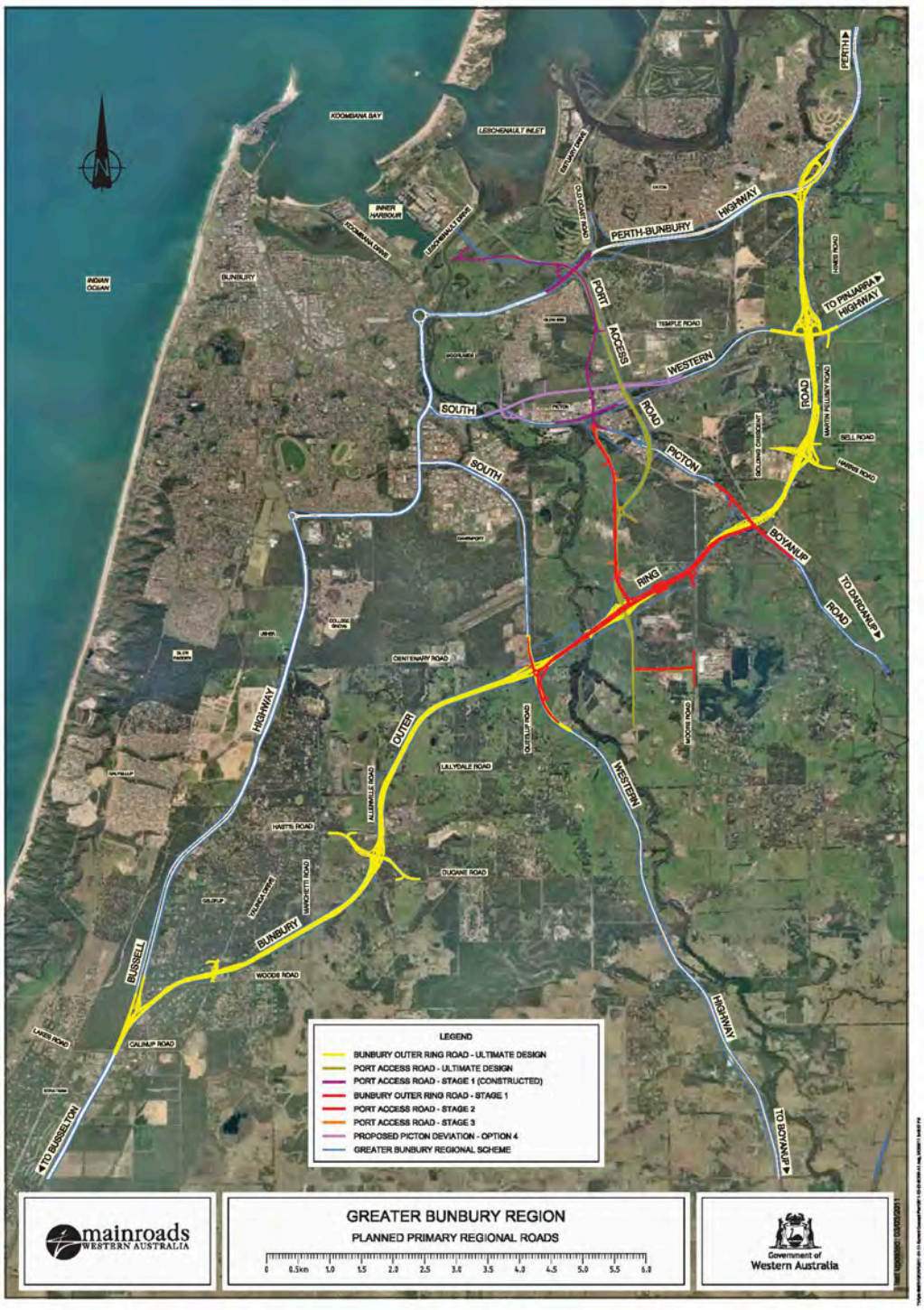


Figure 1.1 – Bunbury Outer Ring Road Project

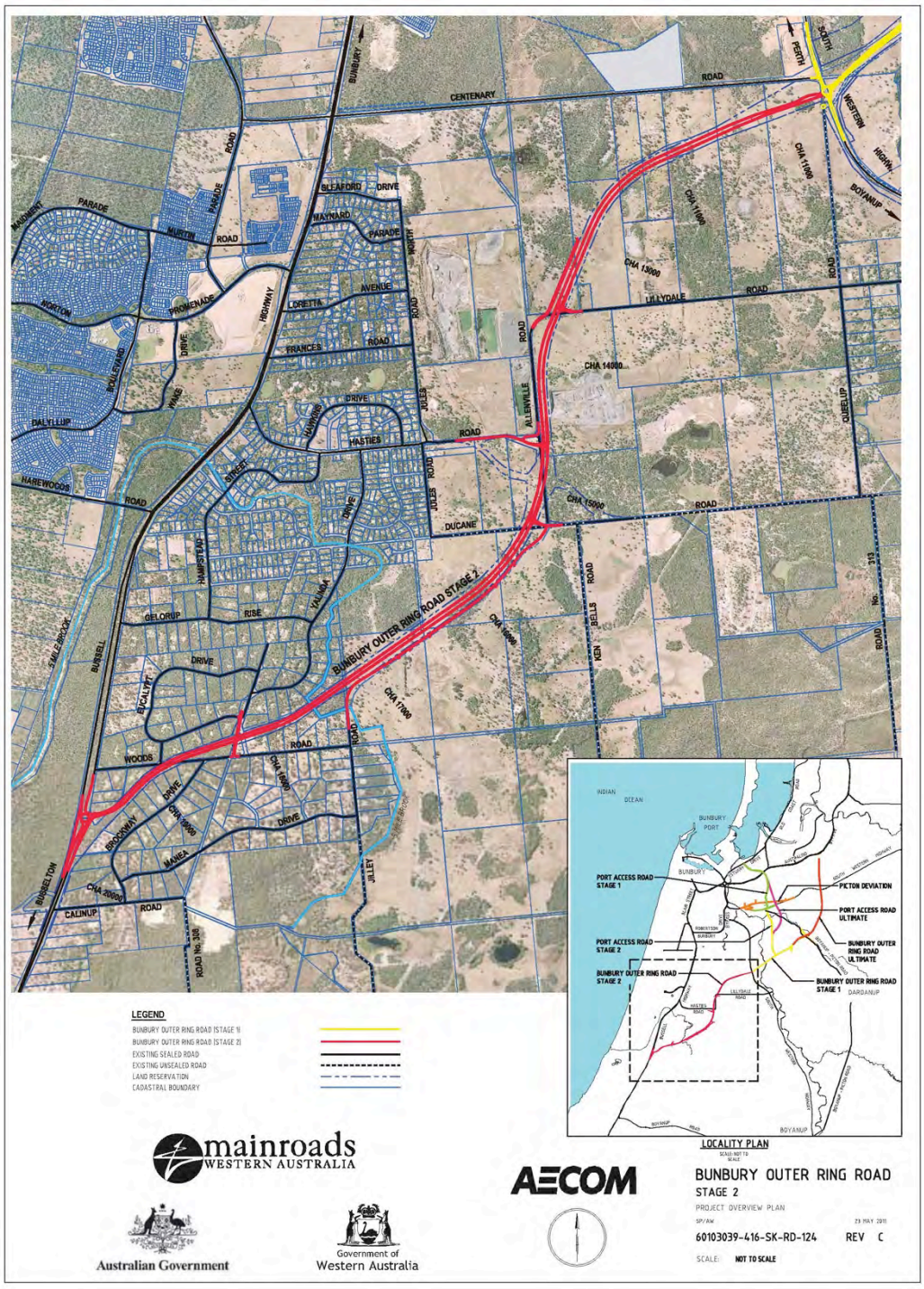


Figure 1.2 – BORR Southern Section

The southern section consists of 9 km of dual carriageway and:

- Proposed intersections at Lillydale Road, Hastie Road and Ducane Road;
- A major roundabout at the Bussell Highway intersection;
- An overpass at Yalinda Drive; and
- A proposed service road between Ducane Road and Jilley Road to provide access to adjacent properties.

As with any new road project, noise from road traffic is a consideration and part of the environmental assessments. This preliminary Noise Management Plan (NMP) has been prepared to describe how traffic noise impacts at nearby existing noise sensitive receptors will be modelled and managed during the design and subsequent construction of the BORR in accordance with the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (WAPC, 2009).

The NMP considers noise through to the year 2041. Assessment is made to existing residential areas and does not consider the management of transportation noise at undeveloped future residential areas. It is the responsibility of the relevant land developers to ensure compliance with the WAPC criteria.

This preliminary NMP also does not consider the impact and management of noise (and vibration) related to the construction of the road. Construction noise is managed under the provisions of the *Environmental Protection (Noise) Regulations 1997*.

2 NOISE CRITERIA

The WAPC has prepared the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning*. The objectives in the Policy are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; and
- Facilitate the strategic co-location of freight handling facilities.

The Policy's outdoor noise criteria are shown in *Table 2.1* and are expected to give consideration to a 15-20 year transport planning horizon. These criteria applying at any point 1-metre from a habitable façade of a noise sensitive premises and in one outdoor living area.

Table 2.1 – Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(\textbf{Day})}$	60 dB $L_{Aeq(\textbf{Day})}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

The 5 dB difference between the *target* and *limit* is referred to as the *margin*.

In the application of the noise criteria to new major road or rail infrastructure projects, the objectives of this Policy is that the new infrastructure be designed and constructed so that the noise emissions are at levels that -

- Provides an acceptable level of acoustic amenity for existing noise sensitive land uses and for the planning of new noise sensitive developments;
- Is consistent with other planning policies and community expectations; and
- Is practicably achievable.

If a transport infrastructure project will emit transport noise levels that meet the noise *target*, no further measures are required under this policy. Otherwise, transport infrastructure providers should design mitigation measures to achieve the noise *limit* of 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$, when assessed at 1-metre from the façade at ground floor level.

Transport infrastructure providers are also required to consider design measures to meet the noise *target* of 55 dB $L_{Aeq(Day)}$ and 50 dB $L_{Aeq(Night)}$, and to implement these measures where reasonable and practicable.

3 METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of the Policy as described in *Sections 3.1 and 3.2*.

3.1 Background Noise Measurements Methodology

Noise monitoring was undertaken at five (3) locations in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18hour}$, $L_{Aeq\ (Day)}$ and $L_{Aeq\ (Night)}$); and
- Calibrate the noise model for existing conditions.

The instruments used were ARL Type 316 noise data logger (pictured in *Figure 3.1*) or Ngara noise loggers. The loggers were programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

Figure 3.1 – Automatic Noise Data Logger

The measurement locations are shown in *Figure 3.2* being:

1. 3 Crowd Road, Gelorup;
2. 187 Woods Road, Gelorup; and
3. 11 Zinnia Road, Gelorup.

Noise loggers were set-up to obtain at least 3 full weekdays, in this case from 22 February to 29 February 2012.

Sound pressure levels were measured in accordance with Australian Standard 2702-1984: *Acoustics - Method For Measurement of Road Traffic Noise*, with the logger positioned at one metre from the façade of interest. The logger was placed at least one metre from any corner of the building and the microphone height was 1.4 metres above ground floor level.

From the hourly measurements, the $L_{A10,18\ hour}$, $L_{Aeq,24\ hour}$, $L_{Aeq\ (Day)}$ and $L_{Aeq\ (Night)}$ values were determined for each complete measurement day. These results were averaged and the mean level reported.

The noise data collected was verified by inspection and professional judgement. Where hourly data was considered atypical, an estimated value was inserted and highlighted by bold italic lettering.

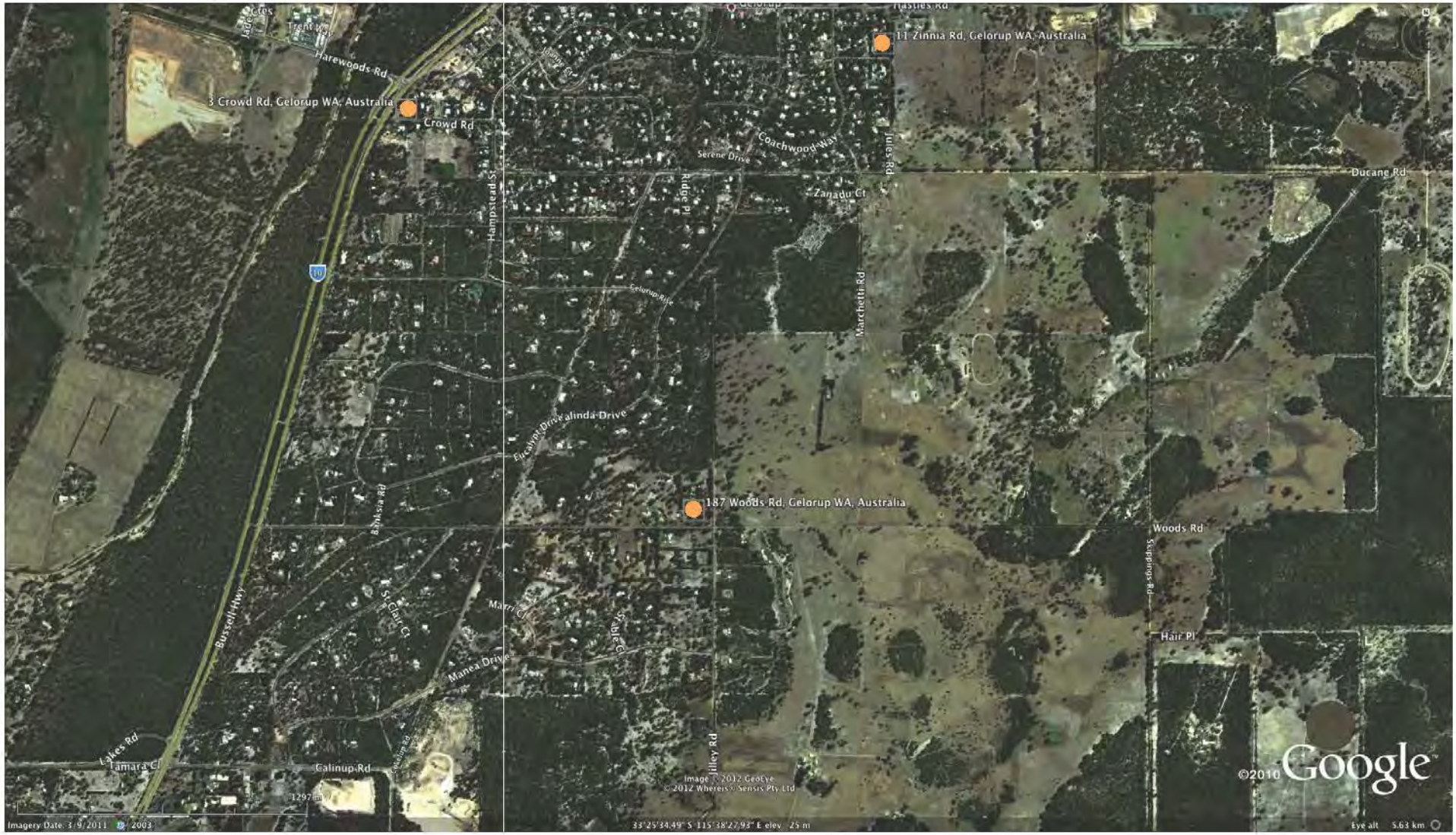


Figure 3.2 – Noise Logger Locations

3.2 Road Traffic Modelling Methodology

The computer programme *SoundPLAN 7.1* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered. Note that corrections are applied to the exhaust of –8.0 dB (based on *Transportation Noise Reference Book, Paul Nelson, 1987*) and to the engine source of –0.8 dB, so as to provide consistent results with the CoRTN algorithms for the no barrier scenario.

- An adjustment of –1.7 dB has been applied to the predicted levels based on the findings of *An Evaluation of the U.K. DoE Traffic Noise Prediction*; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group 1982.

Predictions are made at heights of 1.4 metres (single storey residence) above ground floor level and at 1.0 metre from an assumed building façade (resulting in a + 2.5 dB correction due to reflected noise).

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc and these are discussed in *Sections 3.2.1 to 3.2.3*.

3.2.1 Ground Topography, Road Design & Cadastral Data

Some topographical data was already on file from a previous project. This data was from Landgate and has the ground contours at 5-metre intervals. This was supplemented with more detailed survey data in the vicinity of the road project.

The Landgate data also provided locations of buildings, however the information is at a low resolution so Landgate simply provide a square for a building, irrespective of the actual shape of the building. Many of these remain in the model as they are, however houses closest to the road have been manually digitised based on *GoogleEarth* imagery.

The road design was provided in 3D digital format by AECOM and incorporated in the model.

3.2.2 Traffic Data

Traffic data includes:

- Road Surface –

  The noise relationships between different road surface types are shown in *Table 3.1*.

Table 3.1 – Noise Relationship Between Different Road Surfaces

Road Surfaces						
Chip Seal			Asphalt			
14mm	10mm	5mm	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	0.0 dB	-0.2 dB	-1.0 dB	-2.5 dB

  The existing road surfaces (Bussell Highway and South Western Highway) are 14mm chip seal.

  The future road surfaces are also assumed to be 14mm chip seal.

- Vehicle Speed –

  Existing and future posted speeds are assumed to be 110km/hr, slowing to 80km/hr near intersections

- Traffic Volumes –

  Traffic volume data used in the modelling was provided by MRWA and is summarised in *Table 3.2*.

Table 3.2 – Traffic Volumes Used in the Modelling

Description	Period		
	24-Hour	16-Hour	8-Hour
Existing (2011)			
Bussell Highway	14,154 (9.8%)	13,514 (9.3%)	640 (20.2%)
South Western Highway	6,288 (12.9%)	6,018 (12.4%)	270 (24.8%)
Hasties Road	1,200 (5%)	1,164 (4.8%)	36 (11.1%)
Future (Opening - 2016)			
Bussell Highway			
North of BORR	14,100 (10%)	13,395 (10%)	705 (15%)
South of BORR	19,800 (14%)	18,810 (13%)	990 (25%)
South Western Highway			
North of BORR	7,700 (10%)	7,469 (10%)	385 (15%)
South of BORR	7,200 (14%)	6,984 (14%)	360 (30%)
BORR			
North of Hasties Rd	9,100 (16%)	8,645 (14%)	455 (35%)
South of Hasties Rd	6,200 (22%)	5,890 (19%)	310 (45%)
Hasties Road	2,000 (5%)	1,940 (4.8%)	60 (11.1%)
Future (2031)			
Bussell Highway			
North of BORR	14,200 (8%)	13,490 (8%)	710 (15%)
South of BORR	27,800 (14%)	26,410 (13%)	1390 (25%)
South Western Highway			
North of BORR	8,100 (10%)	7,857 (10%)	405 (15%)
South of BORR	8,400 (14%)	8,148 (14%)	420 (30%)
BORR			
North of Hasties Rd	17,800 (17%)	16,910 (15%)	890 (30%)
South of Hasties Rd	14,000 (20%)	13,300 (18%)	700 (35%)
Hasties Road	4,000 (5%)	3,880 (4.8%)	120 (11.1%)
Future (2041)			
Bussell Highway			
North of BORR	20,000 (8%)	19,000 (8%)	1,000 (15%)
South of BORR	40,000 (14%)	38,000 (13%)	2,000 (25%)
South Western Highway			
North of BORR	12,000 (10%)	11,640 (10%)	600 (15%)
South of BORR	10,000 (14%)	9,700 (14%)	500 (30%)
BORR			
North of Hasties Rd	25,000 (17%)	23,750 (15%)	1,250 (30%)
South of Hasties Rd	20,000 (20%)	19,000 (18%)	1,000 (35%)
Hasties Road	4,900 (5%)	4,753 (4.8%)	147 (11.1)

Note: numbers shown in brackets are the percentage heavy vehicles.

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.25 (25%) within the road reserves and 1.00 elsewhere, where 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised in *Tables 4.1 to 4.3* and shown graphically in *Figures 4.1 to 4.3*.

Table 4.1 – Measured Average Noise Levels – 3 Crowd Street

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Thursday 23 February 2012	64.6	60.8	61.9	57.1
Friday 24 February 2012	65.6	61.9	63.1	57.5
Monday 27 February 2012	63.2	59.9	61.0	56.4
Tuesday 28 February 2012	62.5	59.0	60.1	55.1
Average	**64.0**	**60.4**	**61.5**	**56.5**

Table 4.2 – Measured Average Noise Levels – 187 Woods Road

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Thursday 23 February 2012	43.7	43.3	44.9	33.8
Friday 24 February 2012	44.3	44.8	46.3	37.2
Monday 27 February 2012	43.8	44.2	45.7	37.0
Tuesday 28 February 2012	46.3	44.3	45.8	36.4
Average	**44.5**	**44.1**	**45.7**	**36.1**

Figure 4.1 - Noise Monitoring: 3 Crowd Street, Gelorup

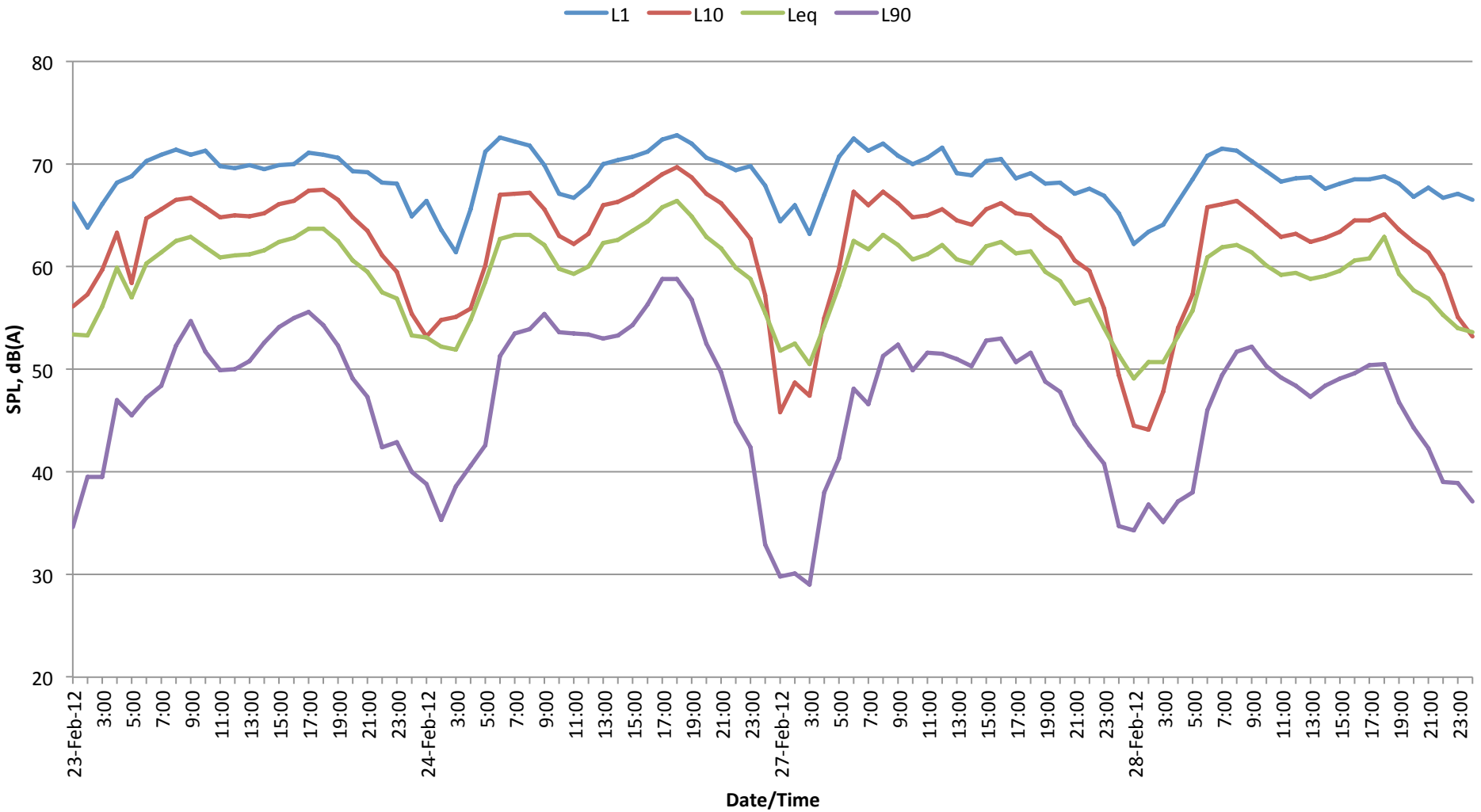


Figure 4.2 - Noise Monitoring: 187 Woods Road, Gelorup

Figure 4.3 - Noise Monitoring: 11 Zinnia Road, Gelorup

Table 4.3 – Measured Average Noise Levels – 11 Zinnia Rd

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
Thursday 23 February 2012	48.3	47.4	48.6	42.9
Friday 24 February 2012	48.4	47.8	49.3	40.1
Monday 27 February 2012	48.7	46.8	48.0	42.5
Tuesday 28 February 2012	52.4	49.5	50.6	45.6
Average	**49.5**	**47.9**	**49.1**	**42.8**

Location 1 at 3 Crowd Street provides the relationship for Bussell Highway, between the different parameters. Guidance can then be taken from this logger to establish the relationships for the other roads. In all cases it has been assumed that the $L_{Aeq(Night)}$ is at least 5 dB less than the $L_{Aeq(Day)}$ and therefore the $L_{Aeq(Day)}$ will be the determining parameter for compliance. Along BORR, it is expected the $L_{Aeq(Night)}$ will be 6 dB less than the $L_{Aeq(Day)}$.

4.2 Noise Modelling

Table 4.4 provides the predicted noise levels for the existing, future (at opening) and future (at 2031) noise levels at the nearest residences. The receiver numbers are shown in *Appendix A*, with noise contour plots for the future (at 2031) scenario shown in *Figures 4.4 to 4.8*.

The *Table 4.4* results represent the noise levels based on standard MRWA road design. It can be seen that for the most part, noise levels at residences are currently less than the *target*. At opening there will be 10 residences above the *limit* with the majority within the *margin*. In the future year 2031, the number of residences above the *limit* is calculated to increase to 22 with the distance to the *limit* being around 200 metres and to the *target* approximately 450 metres.

Table 4.4 – Predicted Noise Levels With 14mm Chip Seal (No Walls), dB $L_{Aeq(Day)}$

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$		
		Existing	At Opening	Future 2031
1	S	38	53	56
2	S	37	52	55
3	N	46	52	55
4	W	35	64	67
5	E	44	53	56
5	N	49	53	55
6	E	43	48	51
6	S	41	47	49
7	E	37	55	58
7	S	37	55	58
8	W	38	55	58
9	SE	38	50	53
10	S	39	51	54
10	E	37	50	53
11	S	39	50	53
12	N	39	56	59
13	W	37	51	55
13	N	37	52	56
14	E	38	52	55
15	E	37	53	57
16	E	37	56	59
17	E	37	56	60
18	SE	37	60	63
19	SE	38	60	64
20	SE	38	61	64
21	S	39	55	59
22	S	42	55	59
23	S	45	53	56
24	E	39	58	62
24	S	46	61	64
25	N	41	57	60
26	N	41	54	57
27	N	41	55	58
28	N	41	57	60
29	N	41	63	66
30	N	41	57	60
31	NW	43	58	61

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$		
		Existing	At Opening	Future 2031
31	NE	42	61	65
32	N	43	60	63
32	W	44	59	63
32	E	41	55	58
33	N	45	53	56
34	S	44	58	62
35	S	44	60	63
36	S	46	60	64
37	S	48	67	70
38	S	50	57	60
38	SE	45	57	60
39	S	52	57	60
40	S	50	62	65
40	E	46	61	64
41	S	54	59	62
42	E	51	61	64
42	S	54	61	64
43	NE	47	55	58
43	NW	48	57	60
44	NW	47	55	58
44	NE	46	54	57
45	N	48	60	63
46	N	49	59	62
47	N	50	58	61
48	NW	51	59	62
49	NW	52	59	62
50	NW	51	61	64
51	NW	55	62	65
52	NW	56	58	60
53	W	56	56	58
54	W	57	57	58

It should be noted that the predicted noise levels are for major road traffic only. That is, they do not include local noises from fauna, wind or local traffic. This is why the predicted noise levels at some locations for the existing scenario are relatively low.

Figure 4.4

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - 14mm Chip Seal / 110 km/hr

Noise levels
LAeq,day dB

55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

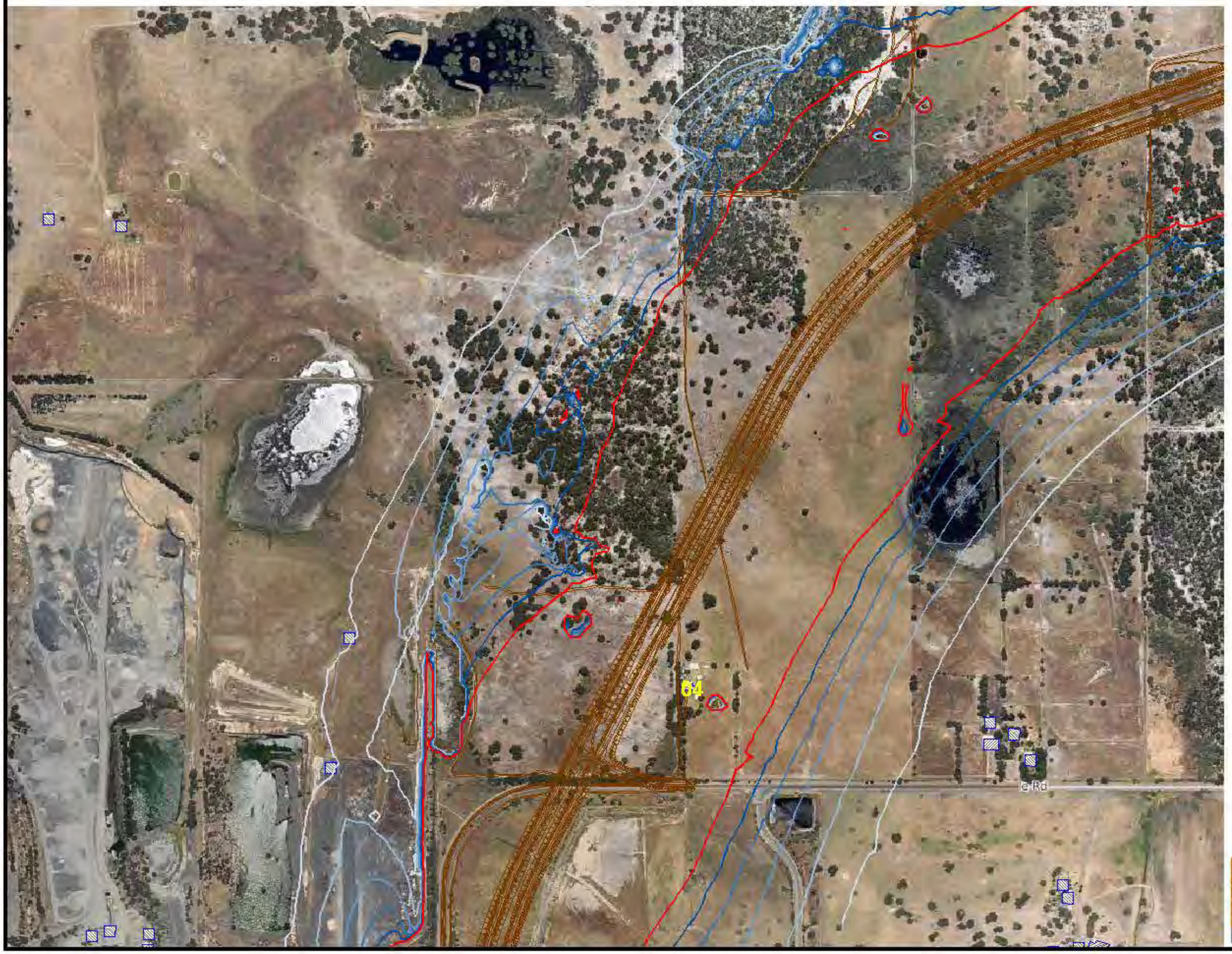
0 50 100 200 300 400 m

Lloyd George Acoustics
by Terry George
terry@lgacoustics.com.au
(08) 9401 7770

Figure 4.5

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - 14mm Chip Seal / 110 km/hr



Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - 14mm Chip Seal / 110 km/hr

Figure 4.6

Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

Lloyd George Acoustics
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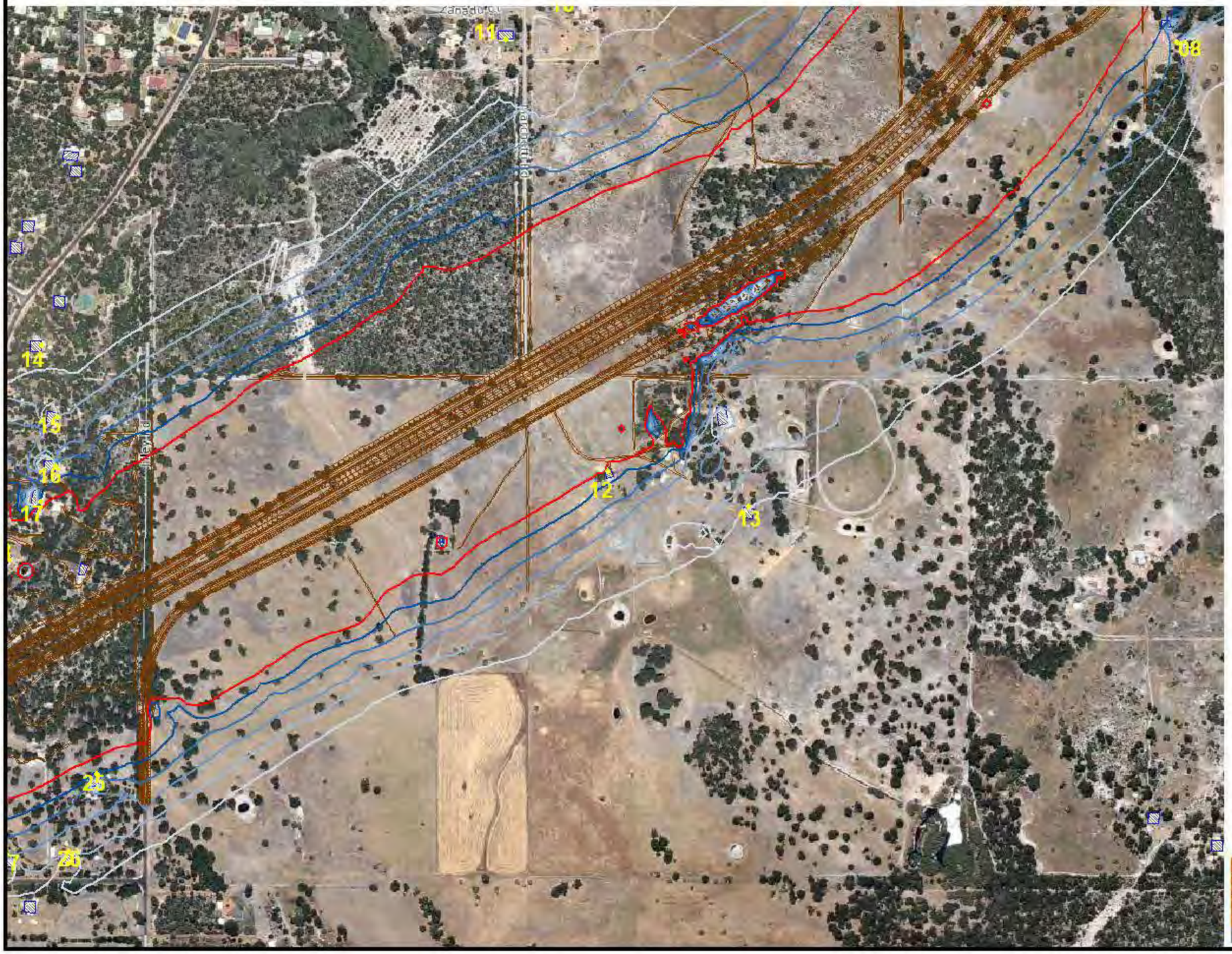
Figure 4.7

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - 14mm Chip Seal / 110 km/hr



Noise levels
LAeq,day dB

55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

- Building
- Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - 14mm Chip Seal / 110 km/hr

Figure 4.8

Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

- Building
- Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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5 NOISE CONTROL STRATEGY

The requirements of the WAPC Policy are for road traffic noise not to exceed 60 dB $L_{Aeq(Day)}$ or 55 dB $L_{Aeq(Night)}$. Assuming no noise management, at opening (2016) there are 10 residences predicted to be above the *limit* with this increasing to 22 by the year 2031 as a result of a 3 dB increase between opening and future.

Following discussions with MRWA, the noise mitigation treatment is to consist of using open graded asphalt road surface between Hasties Road and Bussell Highway. Construction of either walls or bunds will then be considered to achieve the *limit* and *target* (where practicable) based on the 2031 traffic volumes. Depending on the outcomes of the two barrier designs (one to achieve the *limit* and the other to achieve the *target*), MRWA will then adopt a rationalised design.

Table 5.1 presents the results of the 2031 noise levels with open graded asphalt between Hasties Road and Bussell Highway. With the inclusion of this road surface, the number of residences above the *limit* in 2031 reduces to 3.

Table 5.1 – Predicted 2031 Noise Levels With Open Graded Asphalt Between Hasties Road and Bussell Highway, dB $L_{Aeq(Day)}$

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$	Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$
1	S	56	29	N	60
2	S	55	30	N	54
3	N	54	31	NW	59
4	W	67	31	NE	55
5	E	54	32	N	57
5	N	55	32	W	57
6	E	49	32	E	52
6	S	46	33	N	51
7	E	53	34	S	56
7	S	53	35	S	57
8	W	53	36	S	58
9	SE	48	37	S	64
10	S	49	38	S	55
10	E	49	38	SE	55
11	S	48	39	S	56
12	N	53	40	S	60
13	W	49	40	E	58
13	N	50	41	S	57

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$	Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$
14	E	50	42	E	60
15	E	51	42	S	59
16	E	53	43	NE	53
17	E	54	43	NW	55
18	SE	57	44	NW	53
19	SE	58	44	NE	52
20	SE	58	45	N	57
21	S	53	46	N	57
22	S	53	47	N	56
23	S	51	48	NW	58
24	E	56	49	NW	58
24	S	59	50	NW	60
25	N	54	51	NW	61
26	N	52	52	NW	58
27	N	53	53	W	57
28	N	54	54	W	58

Figures 5.1 to 5.2 present the barrier design in order to achieve the *limit*.

Assuming a maximum barrier height of 5.0 metres (relative to the ground level at the barrier location), it is not practicable to achieve the *target* at all residences. At Receiver 4, a 5-metre high bund is required to achieve the *limit* (refer *Figure 5.1*) and lengthening the bund makes negligible difference to the noise level. At Receivers 24, 51, 52 & 54, noise levels of 56-57 dB $L_{Aeq(Day)}$ can be achieved with a maximum barrier height of 5 metres. As such, the barrier design shown on *Figures 5.3 to 5.5* generally achieves the *target*, with the exception of Receiver 04 (60 dB $L_{Aeq(Day)}$) and Receivers 24, 51, 52 & 54 where levels may be up to 57 dB $L_{Aeq(Day)}$.

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Noise Wall Design to Achieve Limit - 14mm Chip Seal / 110 km/hr

Figure 5.1

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Noise Wall Design to Achieve Limit - Open Graded Asphalt / 110 km/hr

Figure 5.2

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Figure 5.3

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Barrier Design to Achieve Target - 14mm Chip Seal / 110km/hr

N

Signs and symbols

- Building
- Point receiver
- Barrier
- Bund

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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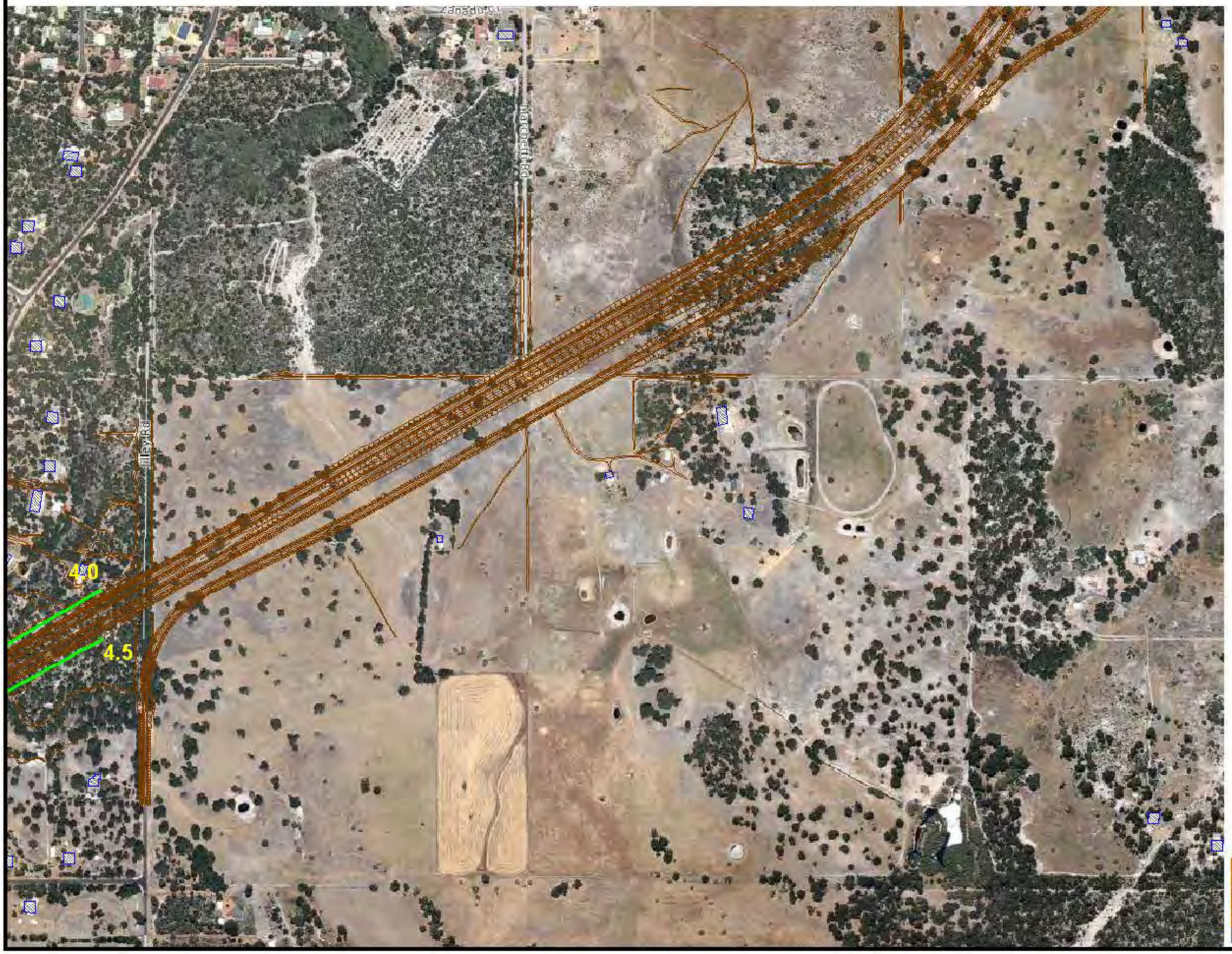
Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Noise Wall Design to Achieve Target - Open Graded Asphalt / 110 km/hr

Figure 5.4



N

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Noise Wall Design to Achieve Target - Open Graded Asphalt / 110 km/hr

Figure 5.5

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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The two barrier designs have been discussed with MRWA and a final design adopted for the purposes of this report, as shown in *Figures 5.7 to 5.9* (referred to as the rationalised design). *Table 5.2* provides the predicted 2031 noise levels with the noise control of open graded asphalt from Hasties Road to Bussell Highway and *Figures 5.7 to 5.9* noise walls. Noise contour plots of the rationalised design are provided in *Figures 5.10 to 5.13*.

Table 5.2 – Predicted 2031 Noise Levels With Open Graded Asphalt Between Hasties Road and Bussell Highway and Rationalised Barrier Design, dB $L_{Aeq(Day)}$

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$	Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$
1	S	56	29	N	58
2	S	55	30	N	53
3	N	54	31	NW	56
4	W	60	31	NE	52
5	E	54	32	N	53
5	N	55	32	W	53
6	E	49	32	E	51
6	S	46	33	N	51
7	E	53	34	S	53
7	S	53	35	S	52
8	W	53	36	S	53
9	SE	48	37	S	54
10	S	49	38	S	53
10	E	49	38	SE	52
11	S	48	39	S	53
12	N	53	40	S	54
13	W	49	40	E	52
13	N	50	41	S	55
14	E	49	42	E	56
15	E	51	42	S	56
16	E	53	43	NE	53
17	E	53	43	NW	54
18	SE	55	44	NW	52
19	SE	56	44	NE	51
20	SE	56	45	N	55
21	S	52	46	N	55
22	S	53	47	N	55
23	S	51	48	NW	56
24	E	53	49	NW	55
24	S	56	50	NW	55

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$	Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$
25	N	54	51	NW	58
26	N	51	52	NW	57
27	N	52	53	W	57
28	N	54	54	W	57

Table 5.3 provides a comparison between the no treatment scenario (*Table 4.4*) with the recommended treatment (*Table 5.2*).

Table 5.3 – Comparison Between No Treatment and Recommended Treatment Scenarios in 2031, dB $L_{Aeq(Day)}$

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$		Noise Level Difference, dB	Treatment Description
		No Treatment	With Recommended Treatment		
1	S	56	56	0	-
2	S	55	55	0	-
3	N	55	54	0	-
4	W	67	60	7	Bund
5	E	56	54	2	OGA
5	N	55	55	0	OGA
6	E	51	49	2	OGA
6	S	49	46	3	OGA
7	E	58	53	5	OGA
7	S	58	53	6	OGA
8	W	58	53	5	OGA
9	SE	53	48	5	OGA
10	S	54	49	5	OGA
10	E	53	49	5	OGA
11	S	53	48	5	OGA
12	N	59	53	6	OGA
13	W	55	49	6	OGA
13	N	56	50	5	OGA
14	E	55	49	6	OGA & Walls
15	E	57	51	6	OGA & Walls
16	E	59	53	7	OGA & Walls
17	E	60	53	7	OGA & Walls
18	SE	63	55	8	OGA & Walls
19	SE	64	56	8	OGA & Walls

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$		Noise Level Difference, dB	Treatment Description
		No Treatment	With Recommended Treatment		
20	SE	64	56	8	OGA & Walls
21	S	59	52	7	OGA & Walls
22	S	59	53	6	OGA & Walls
23	S	56	51	5	OGA & Walls
24	E	62	53	9	OGA & Walls
24	S	64	56	8	OGA & Walls
25	N	60	54	6	OGA & Walls
26	N	57	51	6	OGA & Walls
27	N	58	52	6	OGA & Walls
28	N	60	54	7	OGA & Walls
29	N	66	58	9	OGA & Walls
30	N	60	53	7	OGA & Walls
31	NW	61	56	5	OGA & Walls
31	NE	65	52	13	OGA & Walls
32	N	63	53	10	OGA & Walls
32	W	63	53	10	OGA & Walls
32	E	58	51	7	OGA & Walls
33	N	56	51	5	OGA & Walls
34	S	62	53	9	OGA & Walls
35	S	63	52	11	OGA & Walls
36	S	64	53	11	OGA & Walls
37	S	70	54	16	OGA & Walls
38	S	60	53	7	OGA & Walls
38	SE	60	52	8	OGA & Walls
39	S	60	53	7	OGA & Walls
40	S	65	54	11	OGA & Walls
40	E	64	52	12	OGA & Walls
41	S	62	55	7	OGA & Walls
42	E	64	56	9	OGA & Walls
42	S	64	56	9	OGA & Walls
43	NE	58	53	5	OGA & Walls
43	NW	60	54	6	OGA & Walls
44	NW	58	52	6	OGA & Walls
44	NE	57	51	6	OGA & Walls
45	N	63	55	8	OGA & Walls

Receiver Number	Façade Direction	Predicted $L_{Aeq(Day)}$		Noise Level Difference, dB	Treatment Description
		No Treatment	With Recommended Treatment		
46	N	62	55	7	OGA & Walls
47	N	61	55	7	OGA & Walls
48	NW	62	56	7	OGA & Walls
49	NW	62	55	7	OGA & Walls
50	NW	64	55	9	OGA & Walls
51	NW	65	58	7	OGA & Walls
52	NW	60	57	3	OGA & Walls
53	W	58	57	1	OGA & Walls
54	W	58	57	1	OGA & Walls

The results of the modelling with the proposed noise control shows that the majority of residences will have noise levels of no more than the *target* at 2031.

In 2041, forecast traffic volumes are likely to result in a 1.5-2.0 dB increase. Thus, those houses shown as being within 1-2 dB of the *target*, may be within the *margin* at 2041. Only Receiver 04 may be above the *limit* by 2041 as the 2031 calculated noise levels with the incorporation of a 5.0 metre high bund is 60 dB $L_{Aeq(Day)}$. It is recommended that this location be subject to noise monitoring after road opening to further assess the noise impact and possibly give consideration to architectural treatments to the dwelling.

6 NOISE MONITORING AND REMEDIAL ACTIONS

Prior to the selected contractor commencing construction on site, noise monitoring is to be undertaken at selected residences. The locations and number of monitoring positions is to be determined in consultation with MRWA.

At an agreed time with MRWA following practical completion (typically 6 months after opening), noise monitoring is to be undertaken at selected residences. Again, the locations and number of monitoring positions is to be determined in consultation with MRWA, however Receiver 4 must be monitored. Noise issues raised by residents may also affect the locations. The results of the monitoring are to be extrapolated to the design year (2031), to ensure noise levels will be no more than the *limit* of the WAPC Policy. Where it is determined the *limit* will be exceeded, remedial works are to be implemented to achieve compliance.

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Rationalised Noise Wall Design

Figure 5.7

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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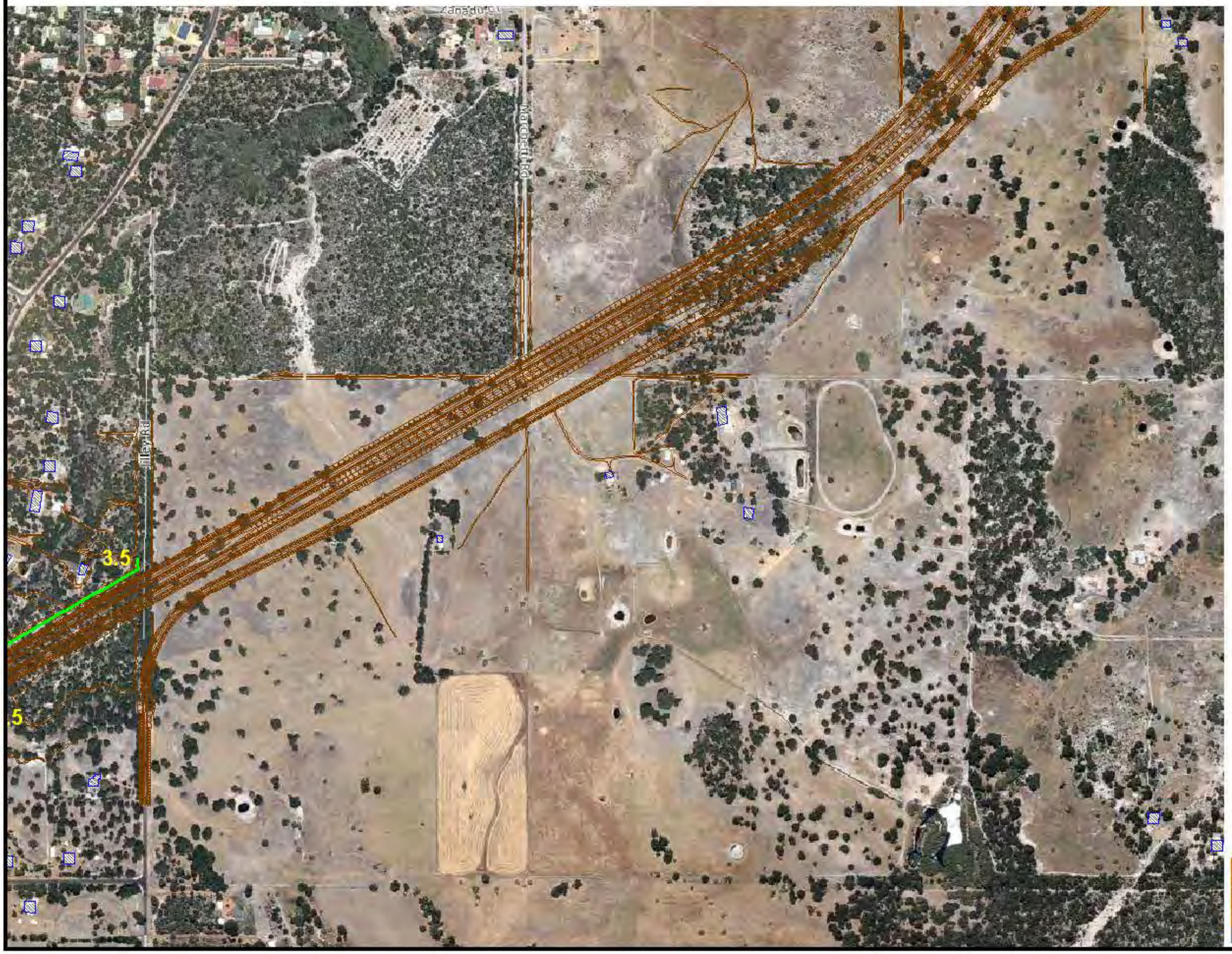
Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Rationalised Noise Barrier Design

Figure 5.8



N

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

13 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Rationalised Noise Barrier Design

Figure 5.9

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

13 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Figure 5.10

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - Rationalised Noise mitigation

Noise levels
LAeq,day dB

55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

- Building
- Point receiver
- Bund
- Wall

14 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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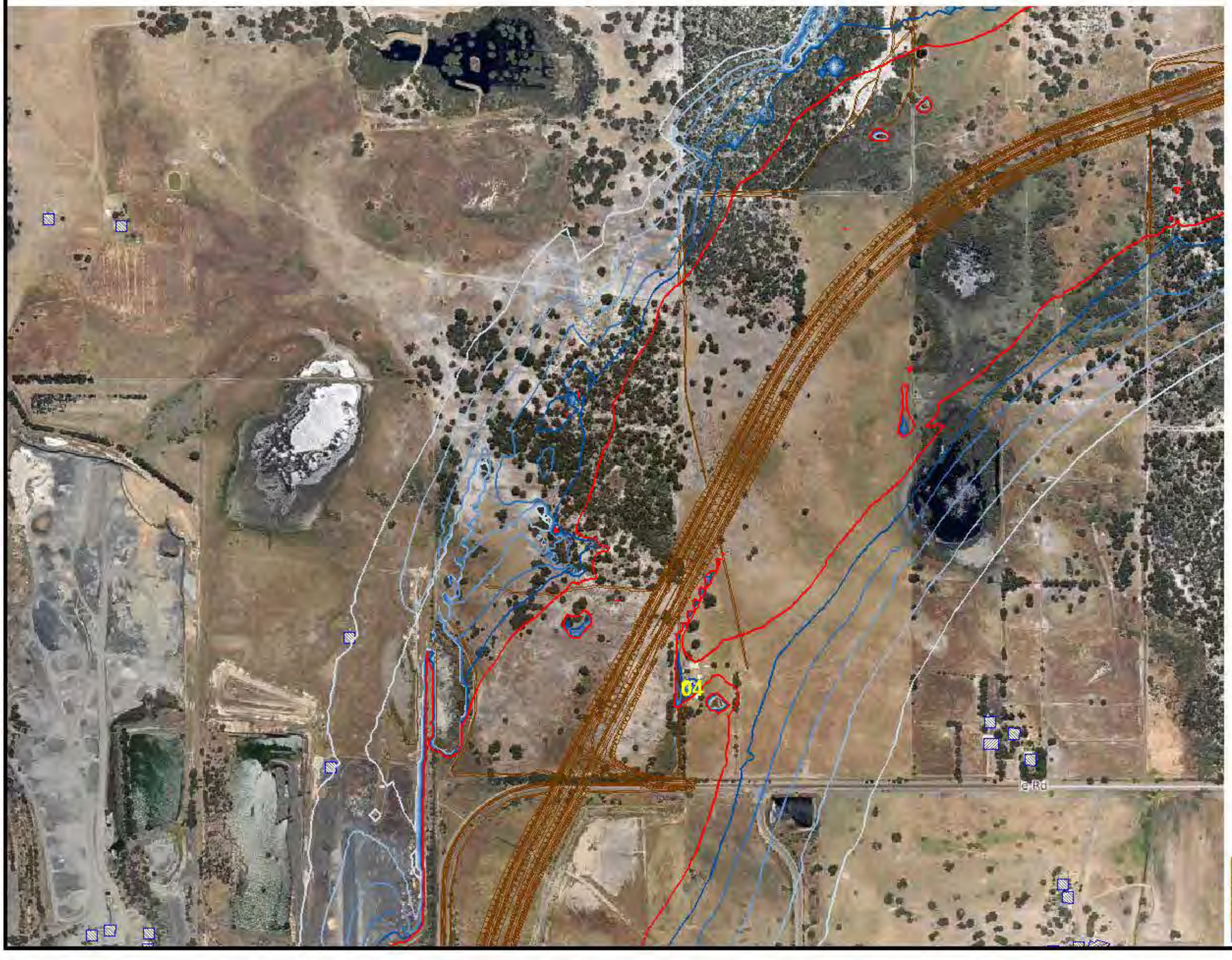
Figure 5.11

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - Rationalised Noise Mitigation



Noise levels
LAeq,day dB

55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

Building

Point receiver

14 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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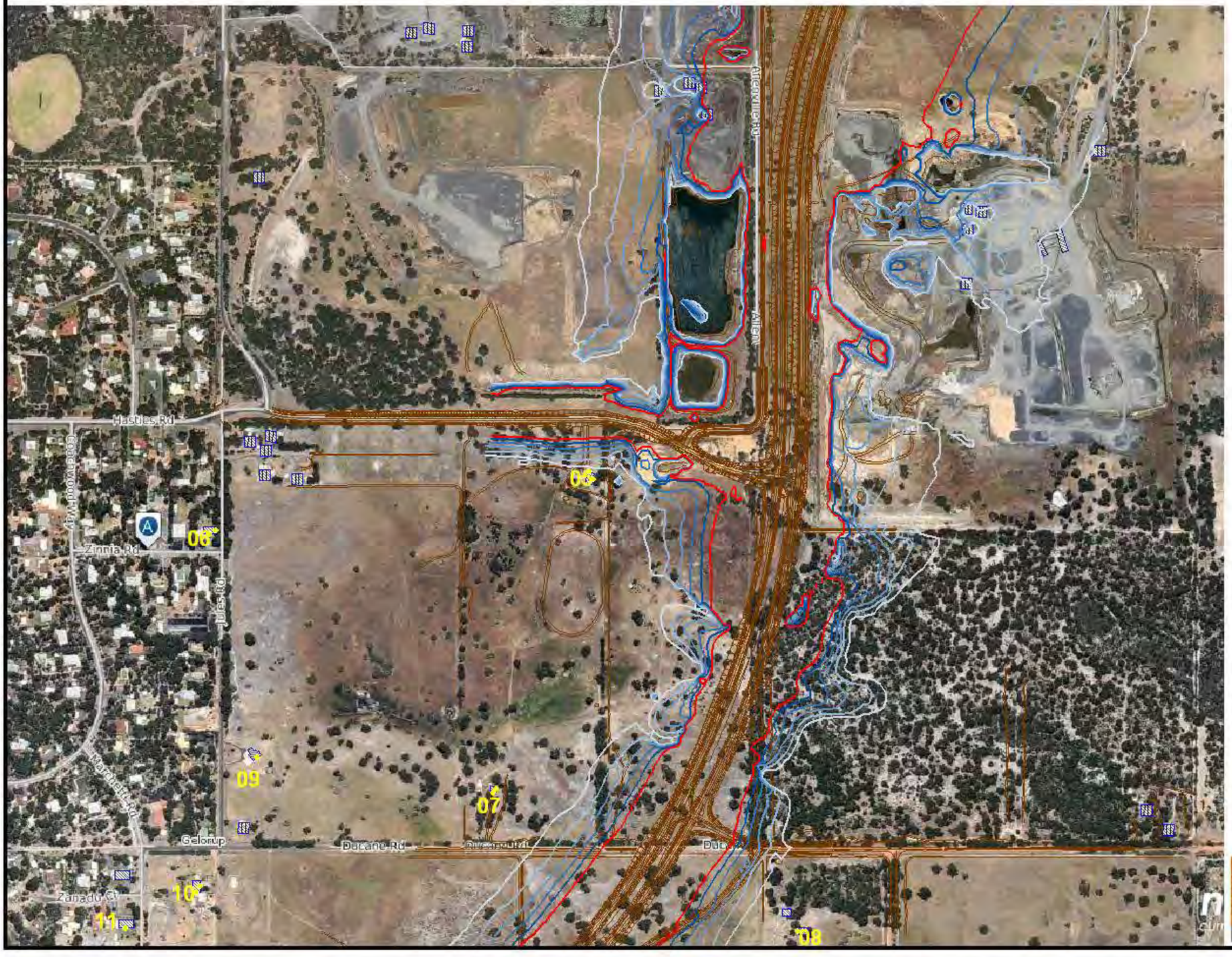
Figure 5.12

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - Rationalised Noise Mitigation



Noise levels
LAeq,day dB

55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

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Length Scale 1:10000

0 50 100 200 300 400 m

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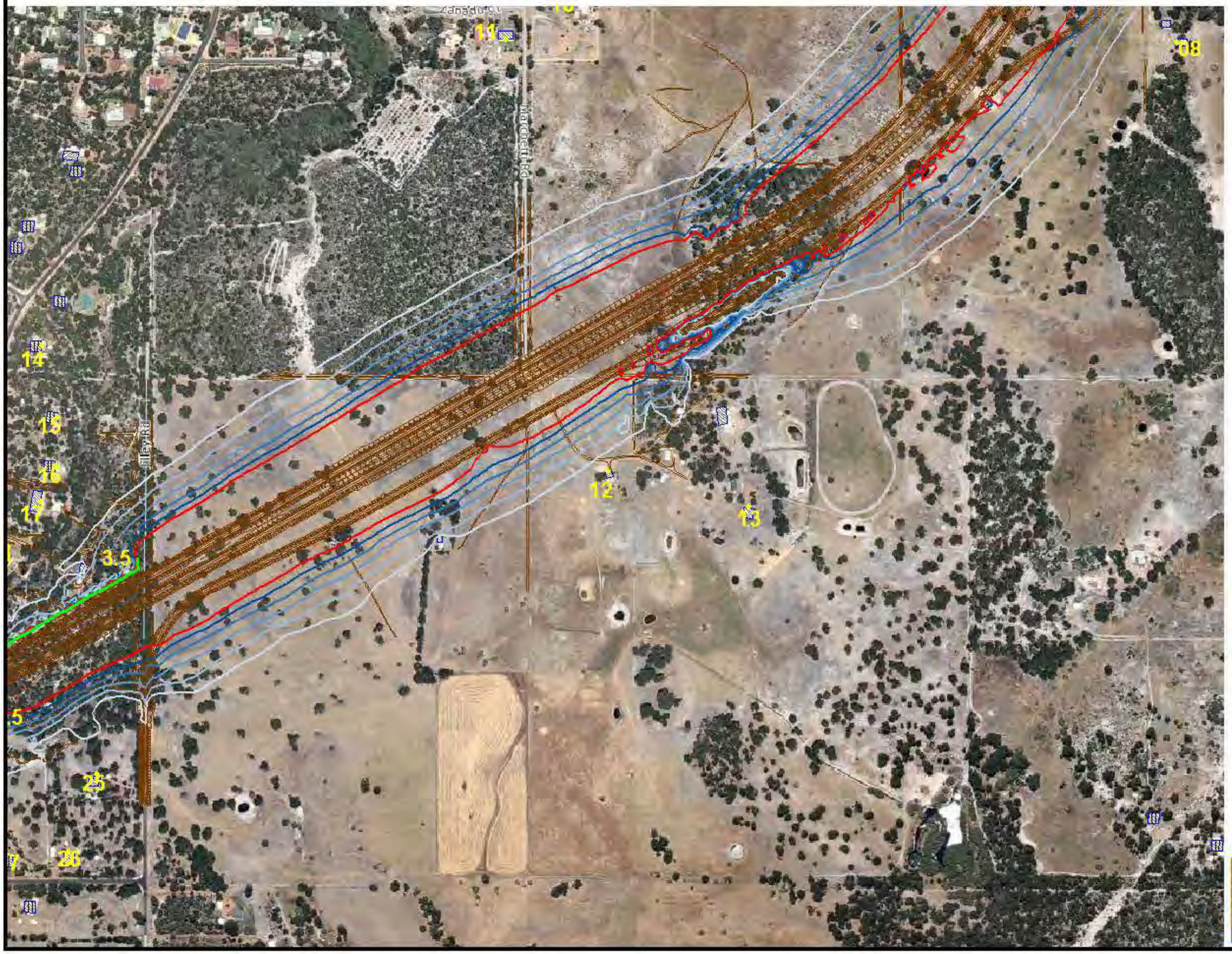
Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - Rationalised Noise Mitigation

Figure 5.13



Noise levels
LAeq,day dB

55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	< 55

N

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

14 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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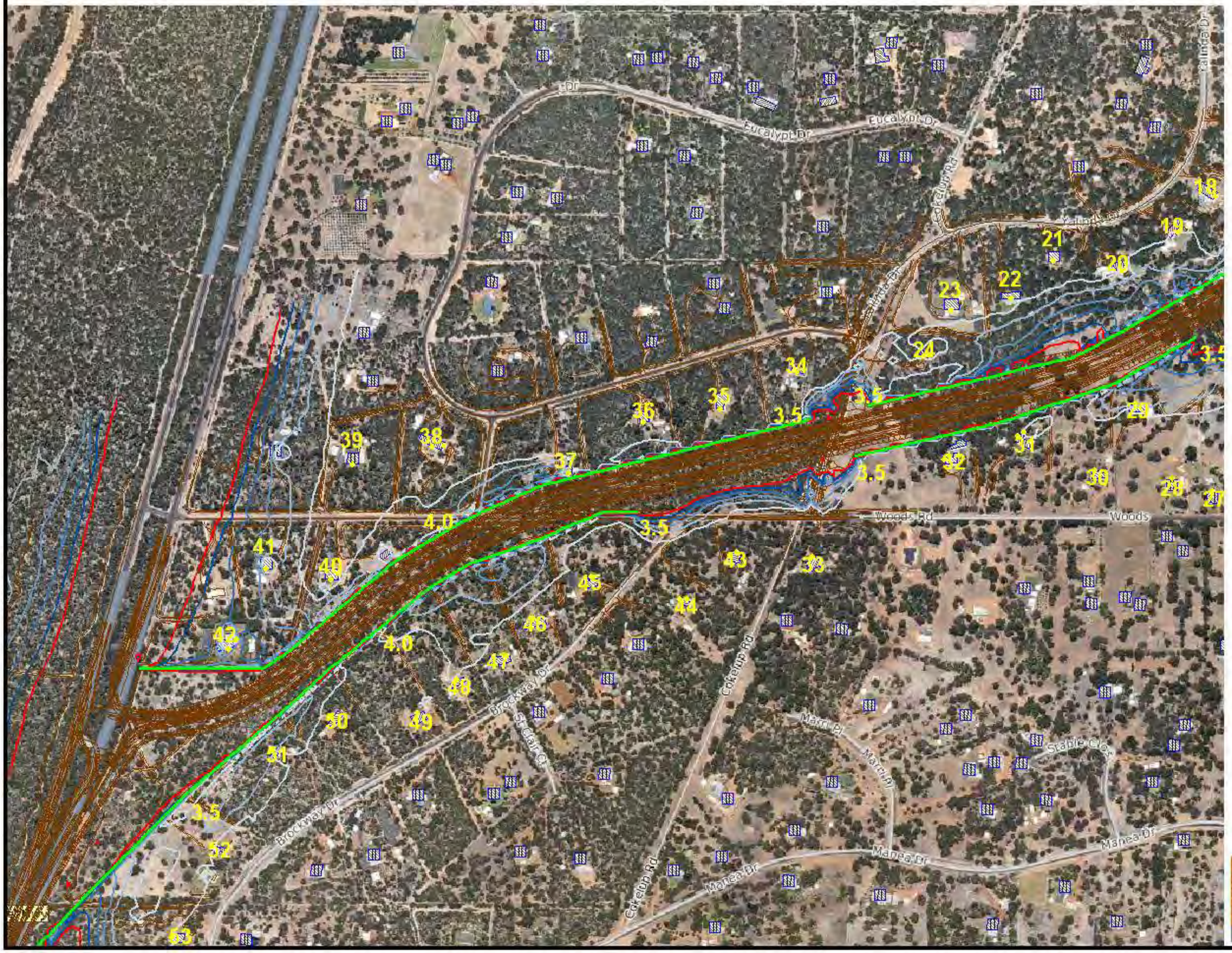
Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

2031 LAeq,Day Noise Level Contours - Rationalised Noise Mitigation

Figure 5.14



Noise levels
LAeq,day dB

	< 55
55 <=	< 56
56 <=	< 57
57 <=	< 58
58 <=	< 59
59 <=	< 60
60 <=	

N

Signs and symbols

- Building
- Point receiver
- Wall
- Bund

14 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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APPENDIX A

Receiver Locations

Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Receiver Names

Figure A1

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Receiver Names

Figure A2

N

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Receiver Names

Figure A3

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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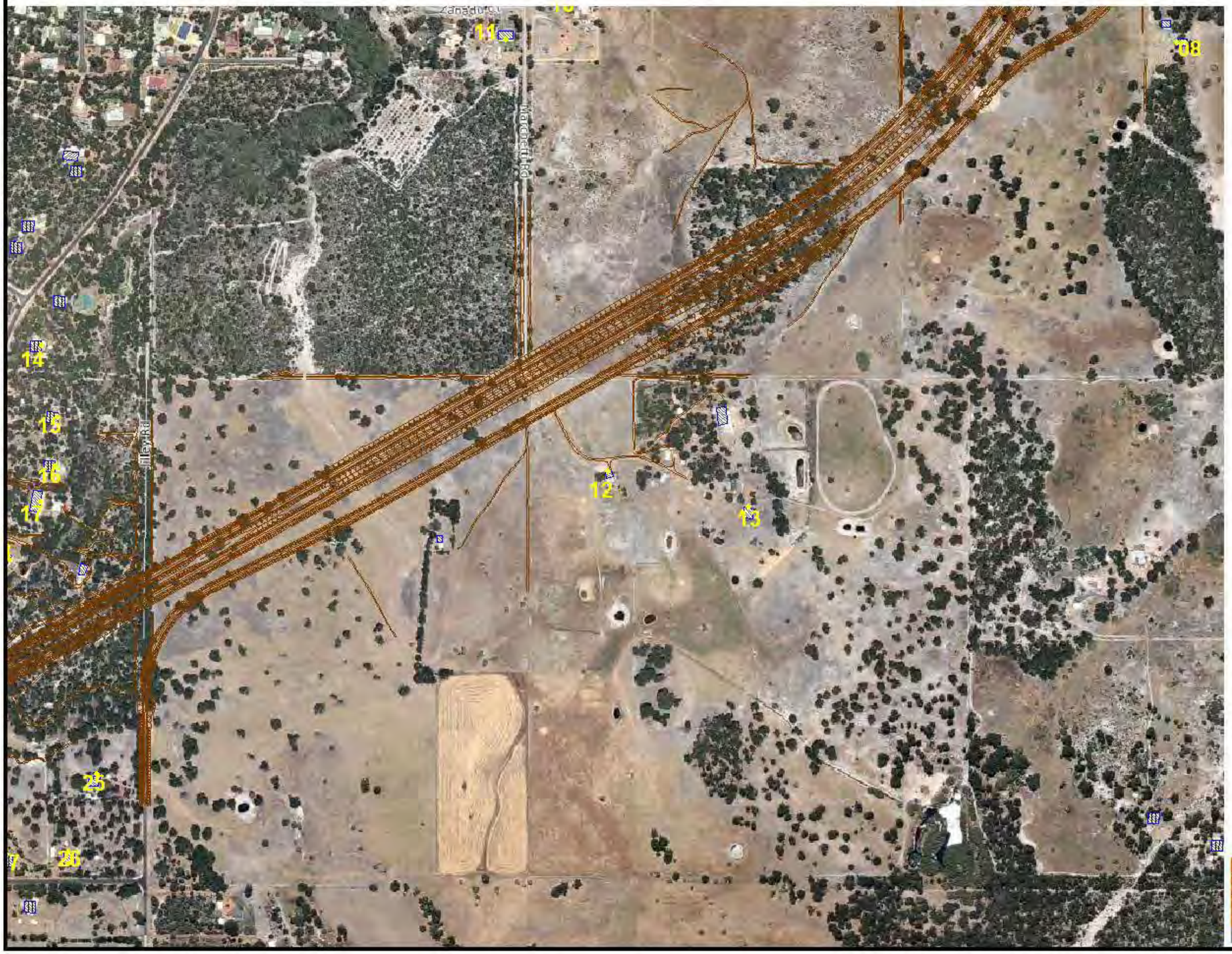
Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Receiver Names

Figure A4



N

Signs and symbols

Building

Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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Bunbury Outer Ring Road - Southwest Highway to Bussell Highway

Receiver Names

Figure A5

Signs and symbols

- Building
- Point receiver

12 June 2012

Length Scale 1:10000

0 50 100 200 300 400 m

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APPENDIX B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)

The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1

An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}

An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}

An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}

The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$

The $L_{A10,18\ hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$

The $L_{Aeq,24\ hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq\ (Night)}$

The $L_{Aeq\ (Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\ (Day)}$

The $L_{Aeq\ (Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

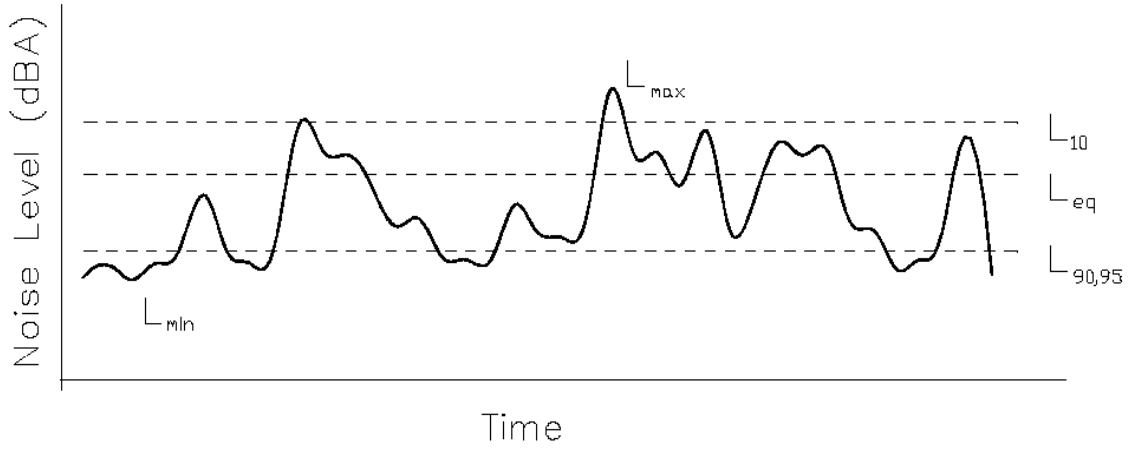
Satisfactory Design Sound Level

The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level

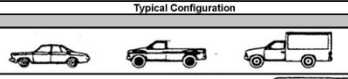
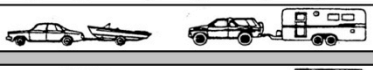
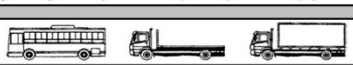
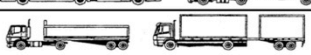
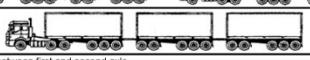
The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austroads Vehicle Class

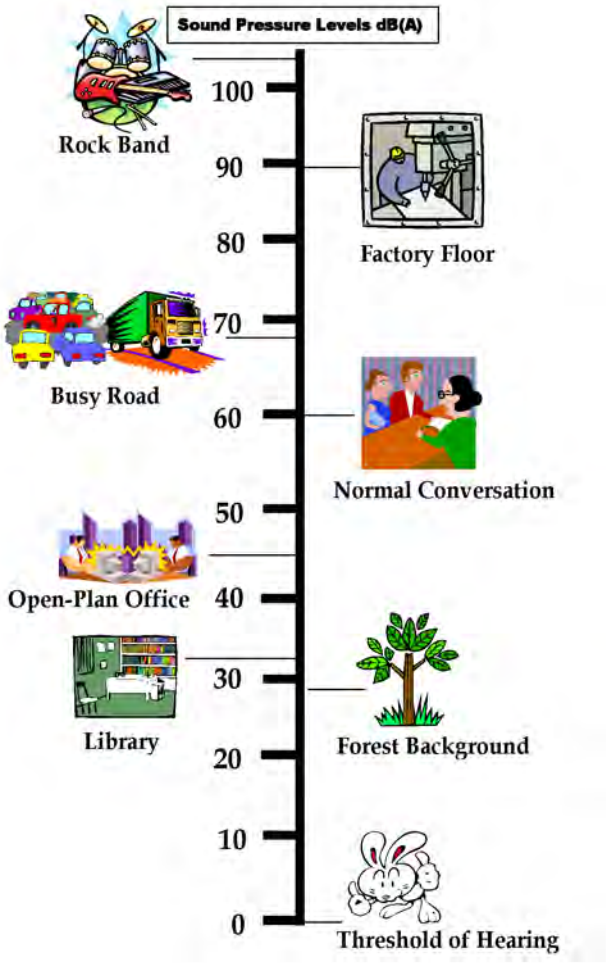
AUSTROADS Vehicle Classification System

Level 1 Length (indicative)	Level 2 Axles and Axle Groups		Level 3 Vehicle Type	AUSTROADS Classification		
Type	**Axles**	**Groups**	**Typical Description**	**Class**	**Parameters**	**Typical Configuration**
	LIGHT VEHICLES					
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	$d(1) \leq 3.2$m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	2	groups = 3 $d(1) \geq 2.1$m, $d(1) \leq 3.2$m, $d(2) \geq 2.1$m and axles = 3, 4 or 5	
	HEAVY VEHICLES					
	2	2	**Two Axle Truck or Bus**	3	$d(1) > 3.2$m and axles = 2	
	3	2	**Three Axle Truck or Bus**	4	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	6	$d(1) > 3.2$m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	7	$d(2) < 2.1$m or $d(1) < 2.1$m or $d(1) > 3.2$m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	8	$d(2) < 2.1$m or $d(1) < 2.1$m or $d(1) > 3.2$m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions: Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)

d(1): Distance between first and second axle
d(2): Distance between second and third axle

Typical Noise Levels



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