Main Roads Western Australia

Mitchell Freeway Extension - Burns Beach Road to Romeo Road

Environmental Impact Assessment

May 2014

Abbreviations

ASRIS	Australian Soil Resource Information
ASS	Acid Sulfate Soil
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CWG	Community Working Group
DAA	Department of Aboriginal Affairs
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DER	Department of Environment Regulation
DotE	Department of the Environment
DoW	Department of Water
DPaW	Department of Parks and Wildlife
DRF	Declared Rare Flora
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
GHPD	Government Heritage Property Disposal
GPS	Global Positioning System
Ha	Hectare (100 m x 100 m)
HCWA	Heritage Council of Western Australia
IBRA	Interim Biogeographic Regionalisation of Australia
LGA	Local Government Association
Mbgl	Metres below ground level
MNES	Matters of national environmental significance
NEPM	National Environmental Protection Measure
OEPA	Office of the Environmental Protection Authority
PEC	Priority Ecological Community
RIWI Act	*Rights in Water and Irrigation Act 1914*
TEC	Threatened Ecological Community
WC Act	*Wildlife Conservation Act 1950*
WoNS	Weeds of National Significance

Executive Summary

GHD Pty Ltd (GHD) has been commissioned by Main Roads Western Australia (Main Roads) to undertake an Environmental Impact Assessment (EIA) for the proposed Mitchell Freeway Extension and associated works. The proposed project will be constructed in three stages located as follows:

- Stage 1: Freeway extension from Burns Beach Road to Hester Avenue and the connecting roads (Neerabup Road and Hester Avenue): Planned for 2015–2017. The total area for Stage 1 is 151.0 ha.
- Stage 2: Freeway extension from Hester Avenue to Romeo Road and connecting road (Romeo Road): Planned for 2017–2021. The total area for Stage 2 is 158.0 ha.
- Stage 3: Wanneroo Road duplication from Joondalup Drive to Hall Road: Planned for 2027–2029. The total area for Stage 3 is 95.2 ha.

This EIA details the existing environment for all three Stages, however, the potential impacts pertain to Stage 1 of the Project only. Currently, only Stage 1 of the Project has been given Government funding.

The primary impacts identified during the EIA are summarised below:

Table 1 Summary of primary impacts associated with Stage 1 of the Mitchell Freeway Extension

Environmental aspect	Potential impacts resulting from Stage 1 of the Mitchell Freeway Extension
Acid Sulfate Soils (ASS)	Risk mapping for these areas has identified a '*Low to nil risk of ASS occurring within 3 m of natural soil surface'*. However, excavation may be greater than 3 m in some areas of the Stage 1 Project Area.
Reserves and Conservation Areas	One DPaW managed reserve will be impacted in the Stage 1 Project Area: Neerabup National Park (1.52 ha) Bush Forever Site 383 'Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup' will be impacted by the clearing of 49.87 ha of the Bush Forever Site. Impacts associated with clearing within the two DPaW-managed reserves and Bush Forever Site include:
Vegetation Types	Stage 1 will require clearing of the following extents of the vegetation types mapped during the field assessment: 1. Banksia woodland (35.9 ha) 2. Jarrah–Banksia woodland (5.0 ha) 3. Tuart woodland (35.5 ha) 4. Mixed low heath on limestone (0.9 ha) 6. *Banksia sessilis* closed tall scrub (3.9 ha) 7. Mosaic of *Banksia* woodland and Mixed low heath on limestone (5.4 ha)

Environmental aspect	Potential impacts resulting from Stage 1 of the Mitchell Freeway Extension
	The clearing of vegetation for the Project will increase the fragmentation of vegetation within the local area. This effect is minimised for the majority of the length of Stage 1 of the Project, as the vegetation to be cleared occurs adjacent to existing developed areas, including subdivisions and existing cleared alignments, including the railway. However, clearing for Neerabup Road (east) will fragment vegetation within Neerabup National Park. This fragmentation may lead to community or species isolation, and edge effects (such as weed invasion). Clearing of vegetation along the Neerabup Road alignment will sever an area of contiguous vegetation, which may affect the vegetation integrity in this area.
Threatened and Priority Ecological Communities	Stage 1 of the Project will involve direct loss of 40.3 ha of the Priority 3 PEC 'Northern Spearwood Shrublands and Woodlands' (PEC equivalent to vegetation types 3, 4, 6 and sections of vegetation type 7 [mosaic]) and 35.9 ha of the Priority 3 PEC 'Banksia dominated woodlands on Swan Coastal Plain IBRA region' (PEC equivalent to vegetation type 1).
Flora species	Clearing for Stage 1 of this Project will require clearing of vegetation with high species diversity. One DPaW listed Priority species was identified in Stage 1: *Jacksonia sericea* (P4) – 706 individuals identified within Stage 1, predominantly within vegetation type 1, and often occurring in disturbed areas and along tracks The impact of Stage 1 of the Project on this species is high as it will impact on high numbers of individual plants of this species. However, *Jacksonia sericea* occurs along the tracks and disturbed areas of the Greater Project Area (Stage 1, 2 and 3), which indicates that this species generally responds well to disturbance. It currently occurs along disturbed and rehabilitated land adjacent to the railway which indicates its potential for regeneration in areas adjacent to the freeway following initial clearing and construction.
Dieback	Large areas of Stage 1 of the Project, particularly adjacent to Hester Avenue and Neerabup National Park have been mapped as Uninfested and Protectable. Dieback could potentially be spread to these areas during construction or operation of the Mitchell Freeway which has the potential to impact on the biodiversity of the area, including declines in vegetation structure and diversity. If Dieback is spread into these areas it could also spread and impact on the biodiversity values on adjacent areas of environmental value, such as Neerabup National Park. In addition, a number of areas within Stage 1 have been mapped as Unmappable and Unprotectable. While these areas are Unmappable there is still the potential for unrecorded Dieback infestations to occur in these areas and the construction of the Stage 1 Project may lead to the spread of Dieback from these areas to Uninfested areas both

Environmental aspect	Potential impacts resulting from Stage 1 of the Mitchell Freeway Extension
	within and outside of the Greater Project Area (Stage 1, 2 and 3).
Habitat linkages	Clearing of vegetation for Stage 1 of the Project is likely to exacerbate the existing fragmentation of the habitat and reduce the connectivity of habitat in the local area. This impact predominantly relates to the construction of the Neerabup Road Extension section of Stage 1, which will fragment the habitat within Neerabup National Park and the remnant bushland west of Wanneroo Road. Neerabup National Park and the surrounding Bush Forever Sites form a large contiguous tract of native vegetation that runs north-south between Wanneroo Road and the railway. This tract of vegetation forms a corridor for the movement of fauna species and a large area of habitat for a variety of fauna species. Therefore, clearing for the Neerabup Road Extension will sever this area of contiguous vegetation and create a barrier to the movement of fauna. The ongoing operation phase of Stage 1 of the Project also has the potential to substantially inhibit (e.g. reduce the number of movements across the road) or reduce the functionality of the habitat in the surrounding area, including foraging and potential breeding habitat.
Fauna	The potential impacts to fauna within Stage 1 as a result of the Project are associated with the impacts to flora and vegetation and direct loss of habitat. These impacts include: Loss of fauna habitat (86.5 ha of remnant vegetation) Disruptions to the movement of fauna, specifically relating to the construction and operational phases of the Neerabup Road Extension, including the barrier created by the road itself and increased frequency of vehicle strikes. During the Neerabup Road fauna movement survey (GHD 2013e) regular activity of a diverse range of fauna groups was recorded, with a high frequency of large terrestrial fauna species such as emus and kangaroos observed. These groups of species may be more susceptible to vehicle strike as a result of the construction of the new road. The Neerabup Road Extension will be fenced which will reduce the number of terrestrial fauna strikes. However, the fencing is not effective for all species and thus the increased traffic and new vehicle movements as a result of the Project (e.g. along the new Neerabup Road Extension) may increase the likelihood of death or injury of fauna species, in particular nocturnal birds.

Federal Approvals

On behalf of Main Roads, GHD submitted a referral to the DotE for Stage 1 for the loss of potential and known habitat for Black Cockatoos on 13 December 2013. The DotE responded to

this referral on 9 January 2014. The proposed action was deemed a controlled action and, as such, requires assessment and a decision on approval under the EPBC Act before it can proceed.

The residual impacts on the Black Cockatoos are considered to be significant. An offset package, which is tailored specifically to the attribute of the protected matter that is impacted, will be required for this Project and is currently in the process of being developed. Main Roads is currently in negotiations to acquire an area of land in the vicinity of GinGin that contains Black Cockatoo foraging and potential breeding habitat.

State Approvals

Significant proposals (e.g. subdivision and development applications) must be referred to the EPA under Section 38 of the *Environmental Protection Act 1986* (EP Act).

The MRS amendment 992/33 was referred to the EPA in March 2000 and was approved under Ministerial Statement 629 in 2003. Neerabup Road east was not approved pending deferred factors for impacts to fauna. The remaining areas were approved. Conditions were imposed and these conditions are currently being addressed.

Neerabup Road east and west will require referral under this Act given the project involves the construction of a new road. Additionally, the project will impact on the following environmental factors:

- Significant habitat for threatened fauna (Black Cockatoos)
- Bush Forever sites; and
- Neerabup National Park

An EPA referral is currently being prepared for Neerabup Road east and west by GHD

Further Studies

New road projects which may have an impact on local air quality require air quality modelling studies to be conducted to determine if traffic levels could lead to exceedences of the NEPM standards. An air quality assessment for the proposal would be required to estimate pollution generated by vehicles using projected traffic volumes and vehicle emission rates as inputs to an air dispersion model.

GHD recommend that further assessment is undertaken within areas of the Stage 1 Project Area where excavation is predominately below 3 m of the natural soil surface to confirm the ground conditions and assess the presence of ASS material prior to excavation and/or dewatering (if applicable).

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Appendices

1. Introduction

GHD Pty Ltd (GHD) has been commissioned by Main Roads Western Australia (Main Roads) to undertake an Environmental Impact Assessment (EIA) for the proposed Mitchell Freeway Extension and associated works. This assessment will be used to assess and manage the environmental impacts of the proposed Project.

1.1 Project background

The Mitchell Freeway provides the primary road access route from the City of Perth to the north-west corridor; however, the freeway currently terminates at Burns Beach Road. The freeway has been constructed in several stages since the 1960s, with further extensions and widening works planned. The Mitchell Freeway Extension has been the subject of a planning process undertaken by Main Roads.

Further development of the freeway is now required to provide a more direct route for traffic in the far northern suburbs, take pressure off smaller local roads and facilitate residential and business development in the area.

The Mitchell Freeway Extension Community Working Group (CWG) was formed by the State Government in March 2012 with the aim of working with the community and assisted by Main Roads to develop the "right transport" solution for the community in the northern corridor. The CWG prepared a Business Case which detailed the six options examined, associated costs and a recommended option. The scope of works for the recommended Value Engineered Option F (staged construction) is detailed below and shown in Figure 1 (Appendix A):

Stage 1 (2015 – 2017).

- Mitchell Freeway extension from Burns Beach Road to Hester Avenue.
- Grade separated interchanges (including road bridges) at Burns Beach Road, Neerabup Road and Hester Avenue.
- Principal Shared Path (PSP) on western side of the Mitchell Freeway extension from Burns Beach Road to Hester Avenue including a PSP bridge over Burns Beach Road.
- Underpasses at Currambine Station, Neerabup Road and Hester Avenue.
- Hester Avenue duplication from Hidden Valley Retreat to Wanneroo Road.
- Neerabup Road upgrade from Connolly Drive to Wanneroo Road connection to freeway.
- Wanneroo duplication from just south of relocated Flynn Drive to Hall Road.

Stage 2

- Extension of Mitchell Freeway from Hester Avenue to Romeo Road.
- Romeo Road East to Wanneroo Road.

Stage 3

- Wanneroo Road dual carriageway and safety improvements.
- Neerabup Road West.
- Connolly Drive dual carriageway (between Neerabup and Hester).

1.2 Project location

This EIA for the Mitchell Freeway Extension Project has been based on the proposed road design within the MRS boundary. The Greater Project Area (Stage 1, 2 and 3) includes all three stages proposed as part of the Mitchell Freeway Extension and upgrade areas and the proposed dual carriage way required between Burns Beach Road and Romeo Road. The Project is mostly located within the City of Wanneroo, with works on Joondalup Drive and Burns Beach Road located within the City of Joondalup.

The proposed project will be constructed in three stages located as follows:

- Stage 1: Freeway extension from Burns Beach Road to Hester Avenue and the connecting roads (Neerabup Road and Hester Avenue): Planned for 2015–2017. The total area for Stage 1 is 151.0 ha.
- Stage 2: Freeway extension from Hester Avenue to Romeo Road and connecting road (Romeo Road): Planned for 2017–2021. The total area for Stage 2 is 158.0 ha.
- Stage 3: Wanneroo Road duplication from Joondalup Drive to Hall Road: Planned for 2027–2029. The total area for Stage 3 is 95.2 ha.

The Greater Project Area boundary, detailing the three stages of the Project, is shown on Figure 1 (Appendix A). The total of the Greater Project Area is 404.2 ha.

This EIA details the existing environment for all three Stages, however, the potential impacts pertain to Stage 1 of the Project only. Currently, only Stage 1 of the Project has been given Government funding. The State has not committed funding for Stages 2 and 3 and a well-developed concept plan for these stages is not available. Therefore, detailed potential impacts for these future stages cannot be provided. However, the potential impacts detailed will hold some relevance for Stages 2 and 3 and these can be reviewed once the concept plans for these stages are available.

1.3 Key project characteristics for Stage 1

The extension of Mitchell Freeway from Burns Beach Road to Hester Avenue as a single Project will involve constructing dual two-lane carriageways in each direction, each to suit an ultimate three lane configuration. Associated works recommended as an integral part of this Project include:

- Extending Neerabup Road from Connolly Drive comprising dual two-lane carriageways to Wanneroo Road
- Upgrading Hester Avenue between Hidden Valley Retreat and Wanneroo Road from the current single carriageway to dual two-lane carriageways
- Constructing a pedestrian underpasses (east and west) at Currambine train station
- Constructing north bound and south bound freeway bridges over Burns Beach Road
- Constructing a Principal Shared Path (PSP) bridge over Burns Beach Road
- Constructing a bridge over the freeway at Neerabup Road and the PSP underpass at Neerabup Road.
- Constructing a bridge over the freeway at Hester Avenue and the PSP underpass at Hester Avenue
- Constructing a PSP on the western side of the freeway
- Services relocation

Project Objectives for Stage 1

The primary objectives of the Stage 1 Project are to:

- Provide a major efficient transport link between and to the rapidly growing northern suburbs of Perth
- Provide an alternative link to regional and industrial centres north of Perth via the Mitchell Freeway and future upgrades of east-west roads between the Mitchell Freeway and major north-south roads
- Transfer traffic from local distributor roads to a safer freeway environment
- Reduce traffic congestion, travel time and fuel consumption
- Reduce associated impacts on residential areas such as noise, vibration and pollution
- Achieve alignment with relevant corporate, state and national strategies, and
- Ensure the Project Works are appropriate and in sympathy with the existing environment.

2. Scope of works and methodology

This EIA has been undertaken using desktop investigations and includes findings from field work investigations, including:

- Level 2 flora and vegetation and Level 1 fauna survey (GHD 2013a).
- Black cockatoo assessment (GHD 2013b).
- Dieback survey (Glevan Consulting 2013).
- Preliminary site investigation (potentially contaminated site assessment) (GHD 2013c).
- Neerabup Road fauna trapping survey (GHD 2013d)
- Neerabup Road fauna movement survey (GHD 2013e)
- European heritage desktop assessment (Nayton 2013a).
- European heritage field assessment (Nayton 2013b)
- Indigenous heritage desktop assessment (O'Connor 2013).
- Ethnographic Aboriginal Heritage Survey (Brad Goode & Associates 2013)
- Mitchell Freeway Extension Noise Assessment (GHD 2014a)

2.1.1 Environmental impact assessment scope

This EIA has been prepared in accordance with the Main Roads Environmental Standard Brief: Environmental Impact Assessment and Environmental Management Plan for the Stage 1 Project only. Information gathered for the Greater Project Area (Stage 1, 2 and 3) has been used to provide environmental context, however, impacts have only been identified for the Stage 1 Project. Specifically, the scope of this EIA includes the following items:

- Determine the key environmental aspects to be considered and give particular attention to those matters/triggers/issues/factors which might warrant a statutory environmental impact assessment
- Environmental assessment to identify and define potentially significant environmental impacts
- Consult with the EPA and the Department of the Environment (formerly the Department of Sustainability, Environment, Water, Populations and Communities) to determine the scope of investigations required, including Main Roads in discussions.
- Accurately define 'the proposal' and include a key characteristics table and a road reserve figure
- Describe and asses the existing environment, including biological, physical, pollution and social surrounding
- Conduct field investigations that include at a minimum:
  - Level 1 flora and vegetation survey
  - Level 1 fauna survey
  - Black cockatoo habitat assessment
  - Dieback survey (including other diseases or pathogens)
  - Wetland field assessment
  - Contaminated sites assessment

  - Any other issues identified during the desktop assessment
- Conduct an impact assessment that describes the proposed works and their potential impact on the existing environment, with reference to all features of the project including road and bridgeworks. Please note the impact assessment details the potential impacts identified for Stage 1 of the Project only
- Assess the acceptability of environmental impacts against published Government environmental policy, standards, criteria and requirements
- Consult with other stakeholders to determine requirements
- Provide clear and auditable (specific and measureable) environmental management commitments demonstrating how significant impacts can be avoided, minimised, managed or mitigated (including who will do what, why, when and to whose satisfaction). A detailed Environmental Management Plan is not required.
- Provide all necessary information to obtain, and assist the Main Roads Project Manager to apply for clearances required under legislative provisions, including (but not limited to) those required under the following Acts:
  - *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*
  - *Conservation and Land Management Act 1984*
  - *Wildlife Conservation Act 1950*
  - *Heritage Act of Western Australia 1990*
- Provide an EIA report suitable for inclusion in the referral documentation for submission to the EPA and if necessary the commonwealth Minister for the Environment to meet the requirements of the EP Act and EPBC act respectively
- Provide a concise report on the results of environmental investigations and clearances obtained to provide all environmental information necessary to complete the EPA's referral form.

2.2 Limitations

This Report has been prepared by GHD for Main Roads and may only be used and relied on by Main Roads for the purpose agreed between GHD and the Main Roads as set out in section 2.1.1 of this Report, as provided in the project brief.

GHD otherwise disclaims responsibility to any person other than Main Roads arising in connection with this Report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in the Report and are subject to the scope limitations set out in the Report.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD described in this Report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this Report on the basis of information provided by Main Roads and Government authorities, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified

information, including errors and omissions in the Report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this Report are based, in part, on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points. Investigations undertaken in respect of this Report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this Report.

Site conditions (including the presence of species and communities of conservation significance) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this Report if the site conditions change.

2.2.1 Assumptions

This report assesses the Stage 1 Project Area only as defined in Section 1.2 and shown in Figure 1, Appendix A. Any change to the area of impact may change the results of this assessment. Should the Project Area change, GHD is not responsible for updating any parts of the report.

3. Legal framework & background information

3.1 Relevant legislation

Key Federal and State (WA) environmental legislation that may be relevant to the Project is outlined in Table 2.

Additional background and legal framework information are provided in further detail in Appendix B.

Table 2 Key environmental legislation relevant to the Project

Legislation	Responsible government agency	Aspect
Federal legislation		
Environment Protection and Biodiversity Conservation Act 1999	Department of the Environment; DotE (formerly Department of Sustainability, Environment, Water, Population and Communities; DSEWPaC)	Rare flora and fauna
Native Title Act 1993	National Native Title Tribunal	Native title
State legislation		
Aboriginal Heritage Act 1972	Department of Aboriginal Affairs (DAA)	Archaeological and ethnographic sites
Biosecurity and Agriculture Management Act 2007	Department of Agriculture and Food Western Australia (DAFWA)	Weeds and feral animals
Conservation and Land Management Act 1984	Department of Parks and Wildlife (DPaW)	Use, protection and management of public lands and waters and its flora and fauna.
Contaminated Sites Act 2003	Department of Environment Regulation (DER)	Management of contaminated sites
Environmental Protection Act 1986	Environmental Protection Authority (EPA)	Environmental impact assessment and management Acid Sulfate Soils
Environmental Protection (Noise) Regulations 1997	DER	Noise standards
Environmental Protection (Clearing of Native Vegetation) Regulations 2004	DER	Clearing of native vegetation
Heritage of Western Australia Act 1990	Heritage Council of Western Australia	European Heritage protection
Land Administration Act 1997	Department of Regional Development and Lands	Administration of State Land
Metropolitan Water Supply Sewage and Drainage Act 1909	Department of Water (DoW)	Provides for the establishment and control of the Metropolitan Water, Sewerage and Drainage Area. Authorisation to impact upon watercourse within water reserves and catchment areas.
Rights in Water and Irrigation Act 1914	Department of Water (DoW)	Access to and use of water resources; protection and management of river flows and drainage

Legislation	Responsible government agency	Aspect
Soil and Land Conservation Act 1945	DAFWA	Protection of soil and prevention/management of soil erosion
Wildlife Conservation Act 1950	DPaW	Protection of native wildlife
Planning Bulletin 64/2009	Western Australian Planning Commission	Acid Sulfate Soil

4. Existing environment & potential impacts

The key environmental aspects considered relevant to Stage 1 for this Project are outlined in this section. For each aspect, a baseline environmental description is included and, where appropriate, is followed by an assessment of potential environmental impacts from Stage 1 of the Project.

Where relevant, recommendations are provided for additional investigations. Management and mitigation measures to address the identified impacts are outlined in Table 23 and further detailed in the Environmental Management Plan. GHD has developed a separate Construction Environmental Management Plan for Stage 1 of the Project.

4.1 Climate

The Greater Project Area (Stage 1, 2 and 3) experiences a Mediterranean climate, with mild wet winters and hot dry summers. The closest Bureau of Meteorology (BoM) weather station to the Greater Project Area that provides climatic data is located 25 km north-east at Gingin Aero (station number 9178). A summary of the climatic data (BoM 2013) for this weather station is below and is graphed in Plate 1:

- Mean maximum temperature: 18.3 °C (July) to 33.3 °C (February)
- Mean minimum temperature: 6.1 °C (July) to 17.0 °C (February)
- Rainfall: 649.0 mm
- Mean number of days of rain ≥ 1 mm: 76.3

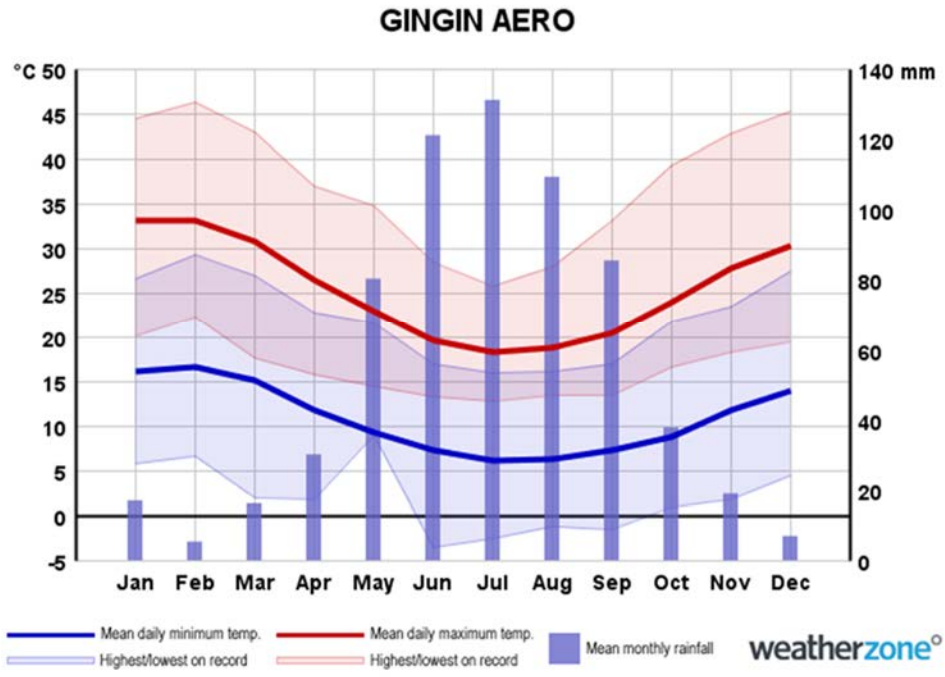

Plate 1 Climatic data for Gingin Aero (station 9178) (Weatherzone 2013)

4.1.1 Evaluation of potential impacts to climate for Stage 1

No impacts were identified or recommendations warranted for this environmental aspect.

4.2 Soils, geology & landforms

According to soils and landform mapping (McArthur and Bettenay 1960 and Playford et al. 1976; both cited in Government of Western Australia 2000), the Greater Project Area (Stage 1, 2 and 3) is situated on:

- Spearwood Dunes: Pleistocene Aeolian sands overlying Tamala Limestone. These sands have a less leached profile than the sands of the Bassendean Dunes falling from 40–80 m relief except where the Tamala Limestones are exposed. The exposed ridges of Tamala Limestone are the most prominent landforms on the Swan Coastal Plain.
- Quindalup Dunes: These calcareous coastal Holocene sands on the western margin of the Plain are the most recent Aeolian dunes. At times these overlie Tamala Limestone.

The Greater Project Area is situated on aeolian deposits of the Swan Coastal Plain. The geology of the area consists of Tamala Limestone, sands derived from Tamala Limestone, Safety Bay Sands and Holocene swamp deposits (Department of Mines 1978; cited in Government of Western Australia 2000).

The soils of the Tamala Limestone geological system consist of Limestone and associated light yellowish brown sands. The soils of the sands derived from the Tamala Limestone geological system consists of white to pale yellow sands. The soils of the Safety Bay Sands geological system consists of white calcareous sands, sometimes with Limestone deposits. The soils of the Wetlands within the Tamala Limestone geological system consist of peats associated with clays, sands and silts in various proportions (Government of Western Australia 2000).

4.2.1 Acid sulfate soils

The DER Acid Sulfate Soil (ASS) risk mapping indicates the site has 'No known risk of ASS occurring within 3 m of the natural soil surface' for the majority of the Greater Project Area (Stage 1, 2 and 3). However, it is noted that areas particularly to the south within the vicinity of Burns Beach Road and to the east of Wanneroo are considered to be 'High to moderate risk of ASS occurring within 3 m of the natural soil surface'. An ASS risk map is provided in Figure 2, Appendix A.

The ASS risk mapping is considered consistent with geological mapping and the assumed presence of lacustrine sediments due to the occurrence of historical geomorphic wetlands and Holocene swamp deposits associated with the chain of north-south trending wetlands in the region.

Although not presented on the ASS Risk Map, ASS may be present within the lower topographical regions. The lower lying areas are generally reflective of the north-south trending wetlands, but also in the intervening areas towards the coast, the lower lying areas may comprise coastal back swamp deposits (eg. Connolly Drive) (GHD 2013c).

The ASS assessment for Stage 1 of the Project has been based upon the DER risk mapping classifications, which is considered consistent with published geological information for the area. Accordingly, Stage 1 of the Project has been separated into three ASS assessment areas, taking into account the three major areas of excavation proposed for the extension route outlined below:

- Burns Beach Road intersection and adjacent area; excavations required expected to be approximately 5 meters below ground level (mbgl) for the freeway and up to 14 mbgl for ramps
- Neearbup Road intersection and adjacent areas; excavations required expected to be up to 7.2 mbgl for the freeway and up to 14.5 mbgl for ramps

- South of Hester Avenue and Hester Avenue intersection; excavations required expected to be up to 7.1 mbgl along the freeway and up to 6.5 mbgl for the ramps.

The desktop assessment below is undertaken from publically available information at the time of writing and the preponderance of information is based upon superficial geological deposits rather than surficial information in consideration of the maximum depth of proposed excavation.

A review of the DER ASS risk mapping available through the Landgate Shared Information Portal (SLIP) and the Australian Soil Resources Information System (ASRIS) was undertaken in April 2014 for the Stage 1 area of the Project.

The DER risk mapping indicates that Stage 1 of the Project Area is within an area of '*Low to nil risk of ASS occurring within 3 m of natural surface that could be disturbed by most land development activities (ASS not known to occur below 3 m).* This classification indicates that this risk category has not been assessed due to the absence of suitable geological and geochemical information (i.e. the DER has not collected and validated samples within these locations).

The ASRIS mapping indicates the site is classified '*C – Extremely low probability/confidence unknown'.* The ASS risk mapping is depicted on Figure 2.

The ASS risk mapping classifications are considered consistent with the geological information provided in Table 3 and discussed below. The published geological mapping is depicted on Figure 2.

Table 3 Summary of Acid Sulfate Soils risk mapping for Stage 1 of the Project Area

Intersection	ASS risk mapping	Lithological description
Burns Beach Road area	Low to nil risk of ASS occurring within 3 m of natural soil surface	S_7 – Sand – *pale and olive yellow, medium to coarse grained, sub-angular quartz and a trace of feldspar, moderately sorted, of residual origin.* LS1 – Limestone – light yellowish brown, fine to coarse grained, sub-angular to well rounded, quartz, a trace of feldspar, shell debris, variably lithified, surface kankar of eolian origin.
Neerabup Road area	Low to nil risk of ASS occurring within 3 m of natural soil surface	S_7 – Sand – *pale and olive yellow, medium to coarse grained, sub-angular quartz and a trace of feldspar, moderately sorted, of residual origin.* LS1 – Limestone – light yellowish brown, fine to coarse grained, sub-angular to well rounded, quartz, a trace of feldspar, shell debris, variably lithified, surface kankar of eolian origin.
Hester Avenue area	Low to nil risk of ASS occurring within 3 m of natural soil surface	S_7 – Sand – *pale and olive yellow, medium to coarse grained, sub-angular quartz and a trace of feldspar, moderately sorted, of residual origin.* LS1 – Limestone – light yellowish brown, fine to coarse grained, sub-angular to well rounded, quartz, a trace of feldspar, shell debris, variably lithified, surface kankar of eolian origin.

The '*Low to nil risk of ASS occurring within 3m of natural soil surface' classification* is consistent with the eolian deposits associated with the Tamala Sand deposits derived from Tamala Limestone.

Historical aerial images may provide information on historical wetland areas or swales that may have been historically in-filled and therefore not registered as ASS risk areas. The aerial photographs available have been used to identify further areas of potential ASS risk. Table 4

identifies the historical aerial photograph available from SLIP and any relevant information in regards to ASS.

Table 4 Historical aerial Acid Sulfate Soils assessment

Aerial photo	ASS risk mapping	Additional comments
1965 (earliest available)	No known risk	No additional swales or back-wash areas are noted within close proximity to Stage 1 of the Project Area.

ASS = acid sulfate soils

4.2.2 Evaluation of potential impacts to Acid Sulfate Soils for Stage 1

Stage 1 of the Project Area transverses an area classified as 'Low to nil risk of ASS occurring within 3 m of natural soil surface'. Typically ASS risk mapping is consistent with geological mapping information. Additionally no areas considered to be in-filled historical wetland areas and/or swales were identified in the historical photographs.

However, where excavation is predominantly below 3 m of the natural soil surface, ASS may be present. GHD note that excavation for a number of the on and off- ramps is anticipated to be extensive (maximum depth excavation 14.5 mbgl) with potentially a large volume of material to be excavated. It is possible that swales potentially containing ASS material will be excavated during construction works, particularly within the excavation of the Hester Avenue western abutment where natural elevation is approximately 25 m Australian Height Datum (AHD).

If ASS is present, this has the potential to cause significant environmental and economic impacts in the Stage 1 Project Area including:

- Contamination of groundwater resources by acid, arsenic, heavy metals and other contaminants
- Damage to infrastructure through the corrosion of concrete and steel pipes, bridges and other subsurface assets.

4.3 Reserves & conservation areas

The following two DPaW managed reserves occur within the boundaries of the Greater Project Area (Stage 1, 2 and 3) (Government of Western Australia 2012):

- Neerabup National Park (park has a total area of 937 ha).
- Neerabup Nature Reserve, east of Wanneroo Rd (park has a total area of 132 ha).

The Project will impact on 1.77 ha (0.19%) of Neerabup National Park (that is, 1.52 ha in Stage 1, 0.034 ha in Stage 2 and 0.21 ha in Stage 3) and 2.42 ha (1.83%) of Neerabup Nature Reserve (all in Stage 3).

The Greater Project Area is also surrounded by the following four DPaW managed reserves (Government of Western Australia 2012):

- Lake Joondalup Nature Reserve (approximately 500 m south of the Greater Project Area).
- Gnangara–Moore River State Forest (approximately 2.5 km east of the Stage 1 Project Area).
- Marmion Marine Park (approximately 5 km west of the Greater Project Area).
- Neerabup Lake and adjacent bushland (approximately 500 m north-east of the Stage 1 Project Area)

4.3.1 Bush Forever

The following two Bush Forever sites occur within the boundaries of the Greater Project Area (Government of Western Australia 2012):

- Site 299: Yellagonga Regional Park, Wanneroo/Woodvale/Kingsley.
- Site 383: Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup.

The Project will involve the total clearing of approximately 0.03 ha (0.008%) of Bush Forever Site 299 and 145.97 ha (8.41%) of Bush Forever Site 383. A description of these Bush Forever sites and total area impacted by the Project is listed in Table 5.

The locations of the Bush Forever sites are shown on Figure 3, Appendix A.

Bush Forever sites have been identified by the State Government as areas which should be protected for conservation purposes and any impacts on these sites are discouraged. Main Roads require a development approval for any works within a Bush Forever site.

Table 5 Details of the Bush Forever sites located within the Greater Project Area (Stage 1, 2 and 3) (Government of Western Australia 2000)

Site	Site name	Total size (ha)	Landscape features	Selection criteria met	Bush Forever recommendation	Linkagesi	Total within Greater Project Area (Stage 1, 2 and 3) (ha) (% of Bush Forever site within Greater Project Area)
299	Yellagonga Regional Park, Wanneroo/ Woodvale/ Kingsley	380.9	Open water, vegetated wetland, vegetated uplands	Representation of ecological communities, rarity, general criteria for the protection of wetland. Streamline and estuarine fringing and coastal vegetation.	Site with some existing protection; the care, control and management of this site for conservation purposes within Yellagonga Regional Park is endorsed.	Adjacent bushland to the north (Site 383, across road), east (Site 164, across road) and west; part of Greenways 4, 2, 5 (Tingay, Alana & Associates 1998); part of a regionally significant contiguous bushland/wetland linkage.	Stage 1: nil Stage 2: nil Stage 3: 0.03 ha (0.008%) Total: 0.03 ha (0.008%)
383	Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup	1736.1	Limestone ridge, open water, vegetated wetland, vegetated uplands	Representation of ecological communities, rarity, maintaining ecological processes or natural systems, general criteria for the protection of wetland, streamline and estuarine fringing and coastal vegetation.	Part A: Site with some existing protection; the existing purpose, care, control and management of Reserves 27575 and 24581 is endorsed. Part B: Proposed Parks and Recreation Reservation. Part C: Other Government Lands Mechanism.	Adjacent bushland to the north, south (Site 299, across road), east and west (Site 323, through bushland to Site 397); part Greenways 35, 2, 5 (Tingay, Alan & Associates 1998); part of a regionally significant contiguous bushland/wetland linkage.	Stage 1: 49.87 (2.87%) Stage 2: 79.75 (4.59%) Stage 3: 16.35 (0.94%) Total: 145.97 ha (8.41%)

4.3.2 Evaluation of potential impacts to reserves and conservation areas for Stage 1

One DPaW managed reserve will be impacted in Stage 1 of the Project:

- Neerabup National Park (1.52 ha)

Clearing for Stage 1 will involve direct loss of 49.87 ha of Bush Forever site 383 'Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup'. This impact is incongruent with the aim of Bush Forever to recognise areas of regional conservation value and provide some level of protection to these areas (Government of Western Australia 2000).

Impacts associated with clearing native vegetation within the two DPaW managed reserves and Bush Forever site include:

- Clearing of DPaW Priority-listed flora species and their habitat identified in the Stage 1 Project Area (and loss of habitat for conservation significant flora species that may possibly occur in Stage 1 of the Project)
- Loss of fauna habitat including habitat for conservation significant fauna species
- Fragmentation of remnant vegetation patches and habitat
- Disruptions to breeding cycles and movement of fauna
- Direct mortality to fauna from construction activities (vehicle strike)
- Increased erosion and runoff and changes to existing drainage and hydrology

The Project may also impact on the conservation reserves that are adjacent, or connected through vegetation, to Stage 1 of the Project (such as Neerabup National Park) through potential indirect impacts, including changes to hydrology, introduction of weeds and fragmentation of habitat. These potential impacts are discussed further in Sections 4.5, 4.7, 4.8 and 4.9.

4.4 Environmentally sensitive areas

A search of the DER Native Vegetation Viewer identified a large proportion of both the Stage 1 Project Area and Stages 2 and 3 as being within an Environmental Sensitive Area (ESA). The ESA is associated with TECs and Bush Forever Sites and may be associated with areas covered by the *Environmental Protection (Gnangara Mound Crown Land) Policy 1992*.

4.4.1 Evaluation of potential impacts to Environmentally Sensitive Areas for Stage 1

The potential impacts associated with the ESAs include impacts on:

- Flora and vegetation

These are discussed in detail in Section 4.7. It should be noted that the Main Roads statewide clearing permit does not apply within areas identified as ESAs.

4.5 Hydrology & water resources

Desktop searches of the DoW Geographic Data Atlas (2013) identified the water resource aspects present in the Greater Project Area (Stage 1, 2 and 3). These are detailed below in Table 6.

Table 6 Department of Water Geographic Data Atlas Queries (DoW 2013)

Aspect	Results
RIWI Groundwater Areas	Perth
RIWI Surface Water Areas	None present
RIWI Irrigation District	None present
RIWI Rivers	None present
Public Drinking Water Source Areas (PDWSA)	Perth Coastal Underground Water Pollution Control Area
Waterway Management Areas	None present

4.5.1 Surface water and wetlands

No Surface Water Areas including Rivers listed under the RIWI Act were identified in the Greater Project Area.

Four lakes were identified within 500 m of the Greater Project Area. Details of these lakes are provided in Table 7. These lakes form part of the north south rending chain of wetlands, which are a major topographical feature (low) of the region (GHD 2013c).

Table 7 Lakes present within 500 m of the Project Area

Lake name	Level	Hydrology type	Proximity to Project Area
Carabooda	Major tributary	Ephemeral lake	Approximately 200 m east of the Stage 3 of the Project (northern end)
Joondalup	Minor river	Perennial lake	Approximately 500 m south of Stage 3 of the Project (southern end). Approximately 2 km south east of Stage 1 of the Project (southern end).
Neerabup	Major tributary	Perennial lake	Approximately 300 m east of Stage 1 of the Project Area (east of Wanneroo Road)
Nowergup	Major tributary	Perennial lake	Approximately 150 m east of Stage 3 of the Project Area (northern end)

Ramsar & Nationally Important Wetlands

The EPBC Act Protected Matters Search Tool (PMST) (DotE 2013a) did not identify any Ramsar listed wetlands within 10 km of the Greater Project Area (Stage 1, 2 and 3). The search did, however, identify a Nationally Important Wetland (Joondalup Lake) located approximately 1.5 km south-east of the Stage 1 Project Area.

Lakes covered under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*

There are no EPP lakes within the Greater Project Area (Stage 1, 2 and 3). There are, however, seven EPP Lakes located within 500 m of the Greater Project Area (Government of Western Australia 2012). All EPP Lakes are approximately 100 m or more from the Greater Project Area.

Geomorphic wetlands

No geomorphic wetlands are located within the Greater Project Area. There are nine geomorphic wetlands located within 500 m of the Greater Project Area (Table 8). The location of these wetlands and their associated identification number is presented on Figure 4, Appendix A.

Table 8 Geomorphic wetlands present within 500 m of the Greater Project Area (Stage 1, 2 and 3) (Government of Western Australia 2013)

UFI	Wetland classification	Management category	Wetland name	Proximity to the Project Area
7954	Lake	Conservation	Lake Joondalup	Approximately 500 m south of Stage 3 of the Project Area (southern end)
8009	Sumpland	Resource Enhancement	Carabooda Lake	Approximately 200 m east of Stage 3 of the Project Area (northern end)
8017	Sumpland	Resource Enhancement	Unknown	Approximately 500 m east of Stage 1 of the Project Area
8018	Sumpland	Multiple Use	Unknown	Approximately 500 m east of Stage 1 of the Project Area
8019	Sumpland	Resource Enhancement	Neerabup Lake	Approximately 300 m east of Stage 1 of the Project Area (northern end)
8020	Sumpland	Resource Enhancement	Unknown	Approximately 200 m east of the Stage 3 of the Project Area (northern end)
8021	Lake	Conservation	Nowergup lake	Approximately 150 m east of Stage 1 of the Project Area (northern end)
8159	Sumpland	Conservation	Pauls Swamp	Approximately 150 m south-west of Stage 3 of Project Area (southern end of Wanneroo Road)
8160	Sumpland	Multiple Use	Pauls Swamp	Approximately 150 m south-west of Stage 3 of Project Area (southern end of Wanneroo Road)

4.5.2 Evaluation of potential impacts to Hydrology and water resources for Stage 1

Stage 1 of the Project will not directly impact on any wetlands, as the closest wetland, Neerabup Lake, is located approximately 150 m east of Wanneroo Road. There is a low risk of indirect impacts, such as changes to hydrology, discharge of contaminated water and the introduction of weeds to this wetland. However, the potential for these impacts is minimised as there is a buffer distance of at least 150 m to the wetland. Measures to manage potential changes to groundwater and surface water drainage patterns, erosion and sedimentation and weeds should be implemented that prevent any potential indirect impacts.

4.5.3 Groundwater

The Greater Project Area (Stage 1, 2 and 3) is located within the Gnangara Mound which is an important source of fresh groundwater in the Perth region, derived from the unconfined superficial aquifer. Abstraction from the superficial aquifer is subject to licensing under the RIWI Act. The superficial aquifer also supports a variety of significant environmental features such as wetlands, shallow cave streams, springs and seepages, and native vegetation dependent on groundwater (Western Australian Planning Commission 2001).

Groundwater in the region is inferred as flowing in a westerly direction beneath the Greater Project Area, discharging toward the Indian Ocean. Groundwater elevation in the vicinity of the Greater Project Area is approximately 0.3 to 47.85 mbgl (GHD 2013c).

The groundwater salinity in the Greater Project Area is relatively fresh, ranging from typically 200 to 1000 mg/L TDS (DoW 2013). A DoW bore database search indicated 1224 registered bores are located within a 5 km radius of the Greater Project Area (GHD 2013c). It is pertinent to note that unregistered bores may exist around the Greater Project Area which could potentially be used for domestic consumption.

4.5.4 Public drinking water source areas

A search of the DoW Geographic Data Atlas (2013) indicates that the majority of the Greater Project Area is within the Perth Coastal Underground Water Pollution Control Area Public Drinking Water Source Area (PDWSA) which is a Priority 3 Protection Zone.

Priority 3 (P3) classification areas are defined to manage the risk of pollution to the water source. P3 areas are declared over land where water supply sources need to coexist with other land uses such as residential, commercial and light industrial developments.

4.5.5 Evaluation of potential impacts to Groundwater and Public drinking water source areas for Stage 1

Stage 1 of the Project will require clearing on the Gnangara Mound and within the Perth Coastal Underground Water Pollution Control Area Public Drinking Water Source Area (PDWSA) which is a Priority 3 (P3) Protection Zone.

Potential impacts from clearing on the Gnangara Mound and a P3 Protection Zone include:

- Alteration of natural hydrological regimes (changes to groundwater hydrology)
- Changes to water quality (e.g. through chemical spills, erosion causing turbidity, disturbance of ASS, deposition of sediments, gross pollutants, heavy metals, hydrocarbons and solvents)
- Flooding of receiving water bodies
- Dewatering (if required)

These potential impacts require management through the implementation of mitigation measures prescribed in environmental management plans.

4.5.6 Drainage

The field survey confirmed no drainage lines are present within the Greater Project Area (Stage 1, 2 and 3).

4.5.7 Evaluation of potential impacts to drainage for Stage 1

No impacts are expected from this environmental aspect as no drainage lines are located within the Stage 1 Project Area.

4.6 Contaminated sites

The DER Contaminated Sites Database (available online) identified no known contaminated sites present within or immediately adjacent to the Greater Project Area.

A site visit of the Greater Project Area undertaken by GHD between May and June 2013 identified that potential asbestos containing building material (eight locations; two in Stage 1, one in Stage 2, and five in Stage 3) and empty fuel drums (1 location; Stage 2) were present in the Greater Project Area.

4.6.1 Evaluation of potential impacts from contaminated sites for Stage 1

There were no known contaminated sites identified within Stage 1 which means there is limited risk of contaminated sites being encountered during construction. However, if unidentified contaminated sites are encountered during work in Stage 1 these sites could potentially have adverse impacts on environmental and human health.

Potential asbestos containing material and general fly tipping (household waste, rusted car body, inert building material including possible asbestos containing material, concrete, wood,

pallets and empty fuel drums) were identified at four sites within Stage 1. If disturbed during the Project, these could potentially contaminate the nearby environment and may pose potential harm to construction staff. These should be removed and disposed of appropriately before commencing works.

4.7 Flora & vegetation

4.7.1 Bioregion

The Greater Project Area (Stage 1, 2 and 3) is located within the Swan Coastal Plain Interim Biogeographic Regionalisation of Australia (IBRA) Bioregion, Perth Sub-Region (SWA02). This sub-region is dominated by woodlands of *Banksia* and Tuart on sandy soils, sheoak on outwash plains, and paperbark in swampy areas. The colluvial and aeolian sand areas represent three phases of Quaternary marine sand dune development (which provide relief), and include a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestones and several off-shore islands. Younger sandy areas and limestones are dominated by heath and/or Tuart woodlands, while *Banksia* and Jarrah–*Banksia* woodlands are found on the older dune systems (Mitchell et al. 2002).

The Greater Project Area (404.2 ha) represents 0.035 percent of the total Perth Sub-Region (1,142,331.84 ha) (Government of Western Australia 2013).

4.7.2 Broad vegetation mapping

Broadscale vegetation mapping of the area (Beard 1979) identified the following four vegetation associations present within the Greater Project Area:

- Medium woodland; tuart & jarrah (association 6)
- Shrublands; tea tree thicket (association 37)
- Low woodland; banksia (association 949)
- Medium woodland; tuart (association 998) Spearwood

Heddle et al. (1980) mapped the Perth area at a finer scale than Beard (1979). The Heddle et al. (1980) mapping identified the following vegetation complexes on Aeolian Deposits of the Swan Coastal Plain within the Greater Project Area (Government of Western Australia 2000):

<u>Quindalup dunes</u>

- **Quindalup complex:** Coastal dune complex consisting mainly of two alliances – the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata* – *Callitris preissii* and the closed scrub of *Acacia rostellifera*.

<u>Spearwood Dunes</u>

- **Cottesloe complex – central and south:** Mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *E. gomphocephala* – *E. marginata* – *E. calophylla* [now *Corymbia calophylla*]; closed heath on the Limestone outcrops.
- **Karrakatta complex – central and south:** Predominantly open forest of *E. gomphocephala* – *E. marginata* – *C. calophylla* and woodland of *E. marginata* – *Banksia* species.

<u>Wetlands</u>

- **Herdsman complex:** Sedgelands and fringing woodland of *E. rudis* – *Melaleuca* species.

The extent of the mapped Beard (1979) vegetation associations and Heddle et al. (1980) vegetation complexes within each stage of the Greater Project Area is included in Table 9.

Table 9 Vegetation associations and complexes mapped within the Greater Project Area (Stage 1, 2 and 3)

Vegetation mapping	Project Stage	Vegetation association/complex (Beard, 1979; Heddle et al. 1980)	Mapped extent within each Project Stage (ha)
Vegetation Associations (Beard 1979)	Stage 1	Vegetation Association 949	45.08
		Vegetation Association 998	105.92
	Stage 2	Vegetation Association 949	144.54
		Vegetation Association 998	11.83
		Vegetation Association 1007	1.63
	Stage 3	Vegetation Association 6	0.52
		Vegetation Association 37	16.57
		Vegetation Association 949	20.22
		Vegetation Association 998	57.91
Vegetation Complexes (Heddle et al 1980)	Stage 1	Cottesloe complex – central and south	149.42
		Herdsman complex	1.58
	Stage 2	Cottesloe complex – central and south	154.51
		Quindalup complex	3.49
	Stage 3	Cottesloe complex – central and south	81.05
		Herdsman complex	4.05
		Karrakatta complex – central and south	10.11

The mapping of Beard (1979) and Heddle et al. (1980) is broad-scale and used for desktop assessment. The vegetation types present within the Greater Project Area do not necessarily reflect this broad-scale mapping. Vegetation types specific to the Greater Project Area have been determined from the field assessment (see below – Section 4.7.4).

4.7.3 Evaluation of potential impacts to Vegetation Extent and Status for Stage 1

The local and regional impacts on the loss of vegetation associations have been assessed using the remaining extents of the Beard (1979) vegetation associations and the vegetation complexes of Heddle et al. (1980) calculated by the Department of Environment and Conservation (latest update 2012 -Government of Western Australia 2013) and the EPA Guidance Statement No. 10 (EPA 2006a), respectively. The remaining extents have been calculated for following levels: the State, IBRA region (Swan Coastal Plain), IBRA subregion (Perth) and Local Government Areas (Cities of Joondalup and Wanneroo), as detailed in Table 10 and Table 11.

Based on the current extent of Beard's (1979) vegetation associations, association 6 has less than 30 percent (considered to be the threshold level - Commonwealth of Australia 2001; EPA 2000) remaining at all levels and associations 949 and 998 both have less than 30 percent remaining within the City of Joondalup (Government of Western Australia 2013). However, the Greater Project Area (Stage 1, 2 and 3) falls predominantly within the City of Wanneroo with impacts in the City of Joondalup likely to be restricted to cleared areas on existing roads, Burns

Beach Rd and Joondalup Drive. At all other levels, associations 949 and 998 have more than 30 percent remaining (Government of Western Australia 2013).

Table 11 presents the extent of Heddle et al. (1980) vegetation complexes currently present against predicted pre-European extents (EPA 2006a). Based on the current extent of these vegetation complexes, all vegetation complexes have more than 30 percent remaining in the System 6/part System 1 area except the Karrakatta complex - central and south, which has 29.5 percent remaining.

All of the Heddle et al. (1980) vegetation complexes that are mapped within the Greater Project Area have less than 15 percent of the pre-European extent protected in secure tenure and are thus below the JANIS criteria used as the threshold for the Regional Forest Agreement process (EPA 2006a).

The Greater Project Area is located within a constrained area (i.e. areas of urban development in cities and major towns) of the Swan Coastal Plain. All vegetation types listed in Table 10 and Table 11 have more than 10 percent of their pre-clearing extent remaining and are therefore not considered critical assets (EPA 2006b).

Clearing of Stage 1 will reduce the extent of mapped Beard (1979) vegetation associations (at the state level) by less than 0.6 percent of the current extent, and will not drop the extents below the threshold level of 30 percent of the pre-European extent. Clearing of the mapped Heddle et al (1980) vegetation complexes within Stage 1 will reduce the extents by less than 1 per cent of the remaining extent and will not reduce the mapped extents below the threshold level of 30 percent of the pre-European extent. However, the mapped vegetation complexes (Heddle et al 1980) within Stage 1 have less than 15 percent of the pre-European extent protected in secure tenure and are thus under the criteria considered by EPA as the target for reservation (EPA 2006a).

Table 10 Extent and status of Beard (1979) vegetation associations within the Stage 1 Project Area (Government of Western Australia 2013)

Vegetation association	Vegetation description	Region	Pre-European extent (ha)	Current extent (ha)	% remaining	% current extent protected (IUCN Class I-IV) for conservation (proportion of current extent)	Area cleared for Stage 1 (ha)	% of current extent that has been mapped within Stage 1 of the Project Area
IBRA Region – Swan Coastal Plain			1,501,221.92	586,975.23	39.1	10.14		
6	Medium woodland; tuart & jarrah	State	56343.01	14019.16	24.88	13.38	0	0
		IBRA region	56,343.01	14,019.16	24.88	13.38		
		IBRA sub-region	56343.01	14019.16	24.88	13.38		
		City of Joondalup	2,294.47	336.51	14.67	8.90		
		City of Wanneroo	12,662.15	3,040.28	24.01	0.00		
37	Shrublands; teatree thicket	State	39,296.52	24,960.64	63.52	18.65	0	0
		IBRA region	15,617.85	5,618.39	35.97	35.64		
		IBRA sub-region	14,018.45	4,913.63	35.05	40.44		
		City of Joondalup	113.79	58.78	51.65	38.37		
		City of Wanneroo	568.91	263.07	46.24	20.78		
949	Low woodland; banksia	State	218,193.94	124,116.74	56.88	24.20	45.08	0.036
		IBRA region	209,983.25	121,247.44	57.74	24.09		0.037
		IBRA sub-region	184,475.82	105,107.74	56.98	26.12		0.043
		City of Joondalup	1,209.87	133.04	11.00	0		33.88
		City of Wanneroo	37,138.47	17,641.75	47.50	18.01		0.26
998	Medium woodland; tuart (association)	State	51,015.33	19,373.13	37.98	31.56	105.92	0.55
		IBRA region	50,867.50	19,372.82	38.08	31.56		0.55
		IBRA sub-region	50,867.50	19,372.82	38.08	31.56		0.55
		City of Joondalup	2,841.12	287.94	10.13	5.90		36.79
		City of Wanneroo	4,635.30	2,852.72	61.54	51.77		3.71

Table 11 Extent and status of Heddle et al. (1980) within the Stage 1 Project Area (EPA 2006a)

Vegetation complex	Total pre-1750 extent (ha)	Present extent (1997/98) in the System 6/part System 1 area (ha)	% of each remaining (1997/98) in the System 6/part System 1 area (ha)	% of each remaining of pre-1750 extent in secure tenure (2002)	Area cleared for Stage 1	% of present extent (1997/98) of vegetation association within Stage 1
Quindalup dunes						
Quindalup complex	38,238	18,000	47.1	5.2	0	0
Spearwood dunes						
Cottesloe complex – central and south	44,995	18,474	41.1	8.8	149.42	0.81
Karrakatta complex – central and south	49,912	14,729	29.5	2.5	0	0
Wetlands						
Herdsman complex	8,309	2,875	34.6	11.5	1.58	0.05

4.7.4 Site vegetation types

A Level 2 flora and vegetation survey was undertaken within the Greater Project Area (Stage 1, 2 and 3) in May–July, 2013 and September-October by GHD (2013a). The survey was conducted to provide descriptions of the dominant vegetation types present, vegetation condition and flora species present at the time of the survey.

The majority of the Greater Project Area is located alongside established residential areas, roads, tracks and the Clarkson line railway. As such, more than half of the Greater Project Area (208.8 ha or 51.7 percent) has been highly disturbed and is cleared or has been revegetated with native or introduced plant species.

The remnant vegetation (195.4 ha or 48.3 percent) within the Greater Project Area consists of seven vegetation types (Table 12). In addition, the Greater Project Area is composed of a mosaic[1] of several vegetation types. This vegetation type is generally associated with the landforms upon which it lies, with tall woodlands to forests in lower-lying areas with deep soils, low shrublands and heaths on shallow soils on hilltops and ridges, and woodlands in intermediate landforms. The vegetation types identified in the Greater Project Area and total amount to be cleared are described in further detail in Table 12 and mapped in Figure 5, Appendix A.

The vegetation condition of the Greater Project Area ranges from *Excellent* (2) to *Completely Degraded* (6) (GHD 2013a) (Figure 6, Appendix A). Roads, roadside plantings, tracks, the train line and other cleared areas were considered to be *Completely Degraded*. Depending on the stage of regrowth, rehabilitated areas have been assigned conditions of *Degraded* to *Completely Degraded*. Remnant vegetation ranged in condition from *Excellent* to *Completely Degraded*. In general, the greater distance from roads and residential areas, the better condition of the vegetation. Large portions of vegetation adjacent to the train line were in *Excellent* condition, whereas areas alongside arterial roads were in *Completely Degraded* condition. The majority of the Neerabup Road portion bounded by Neerabup National Park was in *Excellent* condition, in part due to restricted access to the general public (GHD 2013a).

[1] Mosaics are vegetation/habitat units with more than one vegetation/habitat type within them. These mosaics are examples of "structurally and floristically different vegetation[/habitat] types within one map unit that are not uniquely tied together ecologically (e.g. are part of the patterning of the landscape)" (ESCAVI 2003). These mosaics occur because occurrences of each vegetation/habitat type are smaller than the scale of the minimum mapping unit (i.e. 1:10,000).

Table 12 Vegetation types and extent (by vegetation condition) of occurrence within each Stage of the Greater Project Area (GHD 2013a)

Broad vegetation type	Vegetation description	Potential corresponding Gibson et al. (1994) vegetation complex	Associated flora values	Area within Stage 1 (ha)	Area within Stage 2 (ha)	Area within Stage 3 (ha)	Total area (ha)
1: *Banksia* woodland	Woodland of *Banksia attenuata*/*B. menziesii* (with occasional *Eucalyptus*/*Corymbia* species and *Allocasuarina fraseriana*) over shrubland of *Hibbertia hypericoides*, *Xanthorrhoea preissii* and *Acacia pulchella* over dense understorey of *Mesomelaena pseudostygia*, weedy grasses and herbs and *Desmocladus flexuosus* on grey to brown sand.	FCT 28: Spearwood *Banksia attenuata* or *Banksia attenuata*/*Eucalyptus* woodlands Reservation status: well reserved Conservation risk: low risk	Habitat for *Jacksonia sericea* (DPaW Priority 4)	35.9	40.4	14.3	90.6
2: Jarrah–*Banksia* woodland	Woodland of *Eucalyptus marginata* and *Banksia attenuata*/*B. menziesii* over shrubland of *Hibbertia hypericoides*, *Xanthorrhoea preissii* and *Acacia pulchella* over dense understorey of *Mesomelaena pseudostygia*, weedy grasses and herbs and *Desmocladus flexuosus* on grey to brown sand.	FCT 28: Spearwood *Banksia attenuata* or *Banksia attenuata*/*Eucalyptus* woodlands Reservation status: well reserved Conservation risk: low risk		5.0	2.1	2.7	9.8
3: Tuart woodland	Woodland of *Eucalyptus gomphocephala* over sparse shrubland of *Xanthorrhoea preissii*, *Acacia saligna*, *Rhagodia baccata* and *Hakea lissocarpha* over sparse understorey of weedy grasses and herbs in	FCT 24: Northern Spearwood shrublands and woodlands (Priority 3 PEC)	Habitat for *Jacksonia sericea* (DPaW Priority 4)	35.5	5.5	10.6	51.6

Broad vegetation type	Vegetation description	Potential corresponding Gibson et al. (1994) vegetation complex	Associated flora values	Area within Stage 1 (ha)	Area within Stage 2 (ha)	Area within Stage 3 (ha)	Total area (ha)
	deep dark brown sand.	Reservation status: well reserved Conservation risk: susceptible					
4: Mixed low heath on limestone	Low heath of mixed species (dominated by *Melaleuca systena*, *Acacia lasiocarpa*, *Hibbertia hypericoides* and *Xanthorrhoea preissii*) over a dense mixed understorey (dominated by *Desmocladus flexuosus* and *Drosera erythrorhiza* and weedy grasses and herbs) on limestone.	FCT 24: Northern Spearwood shrublands and woodlands (Priority 3 PEC) Reservation status: well reserved Conservation risk: susceptible	Habitat for a number of conservation species including *Jacksonia sericea* (DPaW Priority 4), *Stylidium maritimum* (DPaW Priority 3) and *Pimelea calcicola* (DPaW Priority 3)	0.9	21.3	0.00	22.2
5: *Melaleuca huegelii–M. systena* shrubland on limestone	Shrubland of *Melaleuca huegelii*, *M. systena*, *Acacia pulchella* and *Grevillea preissii* subsp. *preissii* over a sparse understorey of *Desmocladus flexuosus*, *Lomandra* species and mixed weedy herbs and grasses on outcropping limestone.	FCT 26a: *Melaleuca systena/M. huegelii* shrublands on limestone ridges (Endangered TEC) Reservation status: unreserved Conservation risk: susceptible	Habitat for a number of conservation species including *Jacksonia sericea* (DPaW Priority 4), *Stylidium maritimum* (DPaW Priority 3) and	0.00	0.00	0.6	0.6

Broad vegetation type	Vegetation description	Potential corresponding Gibson et al. (1994) vegetation complex	Associated flora values	Area within Stage 1 (ha)	Area within Stage 2 (ha)	Area within Stage 3 (ha)	Total area (ha)
			Pimelea calcicola (DPaW Priority 3)				
6: *Banksia sessilis* closed tall scrub	Closed tall scrub of *Banksia sessilis* over a sparse understorey of mixed weedy herbs and grasses on grey sand.	This vegetation type may be a more disturbed form of the Priority 3 PEC FCT 24 (Northern Spearwood shrublands and woodlands) Reservation status: well reserved Conservation risk: susceptible	Habitat for *Jacksonia sericea* (DPaW Priority 4)	3.9	2.5	0.00	6.4
7: Mosaic of vegetation types 1 & 4		Combination of FCT 28 (Spearwood *Banksia attenuata* or *Banksia attenuata*/*Eucalyptus* woodlands) and FCT 24 (Northern Spearwood shrublands and woodlands – Priority 3 PEC)		5.4	9.1	0.00	14.5
8: Degraded/roads/tracks/railway				51.4	77.3	60.5	189.2
9: Planted				0.1	0.00	6.6	6.7
10: Rehabilitation				13.0	0.00	0.00	13.0

4.7.5 Evaluation of potential impacts to Vegetation Types for Stage 1

Stage 1 will require clearing of the following extents of the vegetation types mapped during the field assessment:

1.	Banksia woodland	35.9 ha
2.	Jarrah–Banksia woodland	5.0 ha
3.	Tuart woodland	35.5 ha
4.	Mixed low heath on limestone	0.9 ha
6.	*Banksia sessilis* closed tall scrub	3.9 ha
5.	Mosaic of *Banksia* woodland and Mixed low heath on limestone	5.4 ha

The clearing of vegetation for the Project will increase the fragmentation of vegetation within the local area. This effect is minimised for the majority of the length of Stage 1 of the Project, as the vegetation to be cleared occurs adjacent to existing developed areas, including subdivisions and existing cleared alignments, including the railway. However, clearing for Neerabup Road (east) will fragment vegetation within Neerabup National Park. This fragmentation may lead to community or species isolation, and edge effects (such as weed invasion). Clearing of vegetation along the Neerabup Road alignment will sever an area of contiguous vegetation, which may affect the vegetation integrity in this area.

4.7.6 Threatened & Priority Ecological Communities

Desktop investigations (DotE 2013a; DPaW 2013b; DPaW 2013c) and surveys by HGM (2001) identified four conservation significant communities that occur or are predicted to occur within the Greater Project Area (Stage 1, 2 and 3) (Figure 2, Appendix A). During the 2013 surveys GHD observed one TEC (*Mealeuca huegelii-M.acerosa* [now *M. systena*] shrublands on limestone ridges) within the Stage 2 Project Area and one Priority 3 PEC (Northern Spearwood Shrublands and Woodlands;) within all stages (Table 13 and Figure 7, Appendix A) (GHD 2013a).

Subsequent to these surveys a new PEC has been listed by DPaW '*Banksia* dominated woodlands on the Swan Coastal Plain IBRA region' (Priority 3) which has been determined as occurring within the Greater Project Area, and is equivalent to vegetation type 1 '*Banksia* woodland' (Table 13 and Figure 7, Appendix A). This PEC occurs within all stages of the Project.

GHD did not observe any DotE listed TECs within the Greater Project Area (Stage 1, 2 and 3).

Table 13 Conservation significant communities occurring and possibly occurring within each stage of the Project Area

Conservation significant community	Status (State WC Act/DPaW listing)	Federal (EPBC Act listing)	Description	Presence within Project Area **Desktop**	Presence within Project Area **GHD survey**
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Critically Endangered TEC	Endangered TEC	This community occurs in linear damplands and occasionally sumplands, between Holocene dunes. Typical and common native species are the shrubs *Acacia rostellifera*, *A. saligna, Xanthorrhoea preissii*, the sedges *Baumea juncea*, *Ficinia nodosa*, *Lepidosperma gladiatum* and the grass *Poa porphyroclados* (English et al. 2002). Corresponds to Gibson et al. (1994) SCPFCT19.	Previous mapping in the area for the MRS amendment has not identified vegetation types corresponding to this vegetation type.	Stage 1: Not present Stage 2: Not present Stage 3: Not present
Melaleuca huegelii–M. acerosa [now *M. systena*] shrublands on limestone ridges	Endangered TEC		Corresponds to Gibson et al. (1994) SCPFCT26a.	Corresponds to HGM (2001) vegetation type: Mixed Low Heath.	Stage 1: Not present Stage 2: Not present Stage 3: Present as vegetation type 5. Occurs in the freeway alignment north of Lukin Drive and on Wanneroo Rd south of Nowergup Road.
Northern Spearwood Shrublands and Woodlands	Priority 3 PEC		Heaths with scattered *Eucalyptus gomphocephala* occurring on deeper soils north from Woodman Point. Most sites occur on the Cottesloe unit of the Spearwood	This corresponds to HGM (2001) vegetation types Tuart Woodland and *Banksia* (*Dryandra*) *sessilis* Heath and occurs throughout the MRS	Present as vegetation types 3, 4 and 6 (total of 80.2 ha) Stage 1: Present as vegetation types 3 (35.5 ha), 4 (0.9 ha) and 6 (3.9 ha). Total: 40.3 ha. Occurs in southern

Conservation significant community	Status (State WC Act/DPaW listing)	Federal (EPBC Act listing)	Description	Presence within Project Area **Desktop**	Presence within Project Area **GHD survey**
			system. The heathlands in this group typically include *Dryandra sessilis* [now *Banksia sessilis*], *Calothamnus quadrifidus* and *Schoenus grandiflorus.* Corresponds to Gibson et al. (1994) SCPFCT24.	extent and it is expected to occur throughout Neerabup National Park.	section of freeway alignment and Neerabup Road Stage 2: Present as vegetation types 3 (5.5 ha), 4 (21.3 ha) and 6 (2.5 ha). Total: 29.3 ha. Isolated in the northern area. Occurs in freeway alignment north of Lukin Drive and western end of Romeo Road. Stage 3: Present as vegetation type 3 (10.6 ha). Total: 10.6 ha. Occurs in southern section of Wanneroo Road.
Banksia dominated woodlands on the Swan Coastal Plain IBRA region	Priority 3 PEC		*Banksia attenuata* and/or *B. menziesii* occurring on deep sands. The species commonly co-occur. The community occurs on the Quindalup, Spearwood and Bassendean dunes and rarely on the Pinjarra Plain landforms, that comprise the dominant landforms of the Swan Coastal Plain.		Present as vegetation type 1, total area: 90.6 ha Stage 1: Present as vegetation type 1 throughout Stage 1 (*Banksia* woodland; 35.9 ha) Stage 2: Present as vegetation type 1 throughout Stage 2 (*Banksia* woodland; 40.4 ha) Stage 3: Present as vegetation type 1 throughout Stage 3 (*Banksia* woodland; 14.3 ha)

DPaW Department of Parks and Wildlife
PEC Priority Ecological Community
TEC Threatened Ecological Community
SCPFCT Swan Coastal Plain Floristic Community Type
WC Act Wildlife Conservation Act 1950

4.7.7 Other significant vegetation

The vegetation types were also assessed to determine whether they were significant for reasons other than as a TEC or because the extent is below a threshold level, as defined by the EPA (2004a) (Table 14). This assessment determined that the vegetation types that have the potential to be considered as 'other significant vegetation' are those also likely to be either a TEC or PEC.

Table 14 Potential for vegetation types within the Greater Project Area (Stage 1, 2 and 3) to be considered as other significant vegetation

Vegetation Type	Comment	Area within each Stage of the Greater Project Area	Potential to be considered as 'other significant vegetation' (EPA 2004a)
1: Banksia woodland	Widespread on Spearwood Dunes and well-represented in the area	Stage 1: 35.9 ha Stage 2: 40.4 ha Stage 3: 14.3 ha	Unlikely – also likely to be a PEC
2: Jarrah–Banksia woodland	Widespread on Spearwood Dunes and well-represented in the area	Stage 1: 5.0 ha Stage 2: 2.1 ha Stage 3: 2.7 ha	Unlikely
3: Tuart woodland	Is representative of the range of the unit as it is in good condition and in an area where the majority of this vegetation has been cleared	Stage 1: 35.5 ha Stage 2: 5.5 ha Stage 3: 10.6 ha	Yes – also likely to be a PEC
4: Mixed low heath on limestone	This vegetation type appears to have a role as a refuge, as it contains a number of priority species	Stage 1: 0.9 ha Stage 2: 21.3 ha Stage 3: not present	Yes – also likely to be a PEC
5: *Melaleuca huegelii–M. systena* shrubland on limestone	Restricted distribution	Stage 1: not present Stage 2: not present Stage 3: 0.6 ha	Yes – also likely to be a TEC
6: *Banksia sessilis* closed tall scrub	Restricted distribution	Stage 1: 3.9 ha Stage 2: 2.5 ha Stage 3: not present	Yes – also likely to be a PEC

4.7.8 Evaluation of potential impacts to Conservation Significant Communities for Stage 1

No federal or state listed TECs were recorded within Stage 1 of the Project.

Stage 1 of the Project will involve direct loss of 40.3 ha of the Priority 3 PEC 'Northern Spearwood Shrublands and Woodlands' (PEC equivalent to vegetation types 3, 4, 6 and sections of vegetation type 7 [mosaic]) and 35.9 ha of the Priority 3 PEC 'Banksia dominated woodlands on Swan Coastal Plain IBRA region' (PEC equivalent to vegetation type 1).

Clearing of the PEC 'Northern Spearwood Shrublands and Woodland's within the Neerabup Road alignment may also have indirect impacts on the PEC adjacent to the Stage 1 Project Area (within Neerabup National Park) by fragmenting the vegetation which may lead to edge

effects, such as increased spread of weeds. The alignment may also impact these surrounding areas by changes to existing drainage and hydrology, increased erosion and runoff, introduction and/or spread of dieback, and increased risk of fire. Vegetation fragmentation is discussed further below.

4.7.9 Flora diversity

A NatureMap search identified 1023 plant taxa (including subspecies and varieties), representing 143 families and 483 genera, that have previously been recorded within 10 km of the Greater Project Area (Stage 1, 2 and 3). This total is comprised of 820 native species and 203 introduced (exotic) species. The GHD flora survey (GHD 2013a) identified a total of 392 flora species, representing 79 families and 234 genera within the Greater Project Area. This total comprised 246 native species and 146 introduced/planted species.

Dominant families recorded within the Greater Project Area during the survey were:

- Fabaceae: 49 taxa
- Asteraceae, Myrtaceae and Poaceae 32 taxa each
- Proteaceae 25 taxa

Information on the average species richness per quadrat (10 x 10 m) on the Swan Coastal Plain is provided by the Government of Western Australia (2000). This indicates that quadrats located on the Spearwood Dunes have an average species richness between 9.6 and 35 and quadrats located on the Quindalup Dunes have an average species richness between 37.3 and 55.1. The species richness of the GHD (2013a) quadrats ranges between 12 and 56 and can be considered to range from low to high species diversity.

4.7.10 Conservation significant flora

Searches of the DPaW Threatened Flora (2012) and the Western Australian Herbarium (WAHERB) databases, EPBC Act PMST (DotE 2013a) and Western Australian Museum/DPaW NatureMap records (DPaW 2007–) identified one vascular flora species of conservation significance (*Acacia benthamii*; Priority 2) previously recorded within the Greater Project Area. One non-vascular species (*Fabronia hampeana*; Priority 2; moss) has also previously been recorded within the Greater Project Area. An additional 36 species of conservation significance have been recorded or potentially occur within 10 km of the Greater Project Area (GHD 2013a). Species of conservation significance previously recorded within 10 km of the Greater Project Area are mapped in Figure 5 (Appendix A).

No species listed under the EPBC Act or Wildlife Conservation Act 1950 (WC Act) were recorded during the survey. However, five DPaW Priority species were recorded within the Greater Project Area (Stage 1, 2 and 3) (Figure 7, Appendix A):

- *Acacia benthamii* (Priority 2)
- *Eucalyptus caesia* (Priority 4)
- *Jacksonia sericea* (Priority 4)
- *Pimelea calcicola* (Priority 3)
- *Stylidium maritimum* (Priority 3)

Eucalyptus caesia was identified in roadside plantings. This species is widely grown as an ornamental plant. As a result, the individuals observed within the Greater Project Area (Stage 1, 2 and 3) are not considered to be wild, naturally occurring specimens. *Fabronia hampeana* was not recorded during the field survey.

Acacia benthamii (DPaW Priority 2)

One individual of this species were observed on sandy soils within a fenced off portion alongside the railway, approximately 1.5 km north of Hester Avenue within vegetation type 1 (*Banksia* woodland) (Stage 2 of the Project). The plant had been individually fenced off using chicken wire, indicating that they had previously been identified for protection by the landholder. Another individual was located nearby, but outside of the boundary of the Greater Project Area. As no adequate flowering or fruiting material was present at the time of the survey, it is not possible to verify these specimens.

No individuals were recorded within the Stage 1 area.

Jacksonia sericea (DPaW Priority 4)

Discussion with the WA Herbarium (pers. comm.) determined that within the Wanneroo region (near the Greater Project Area (Stage 1, 2 and 3)), *J. sericea* species intergrades with *J. calcicola* (Chappill et al. 2007), which is not listed under any legislation or as a Priority species. As a result, many individuals within the Wanneroo region possess intermediate characteristics or traits of both species.

Approximately 6,020 individuals of this species were observed, scattered predominantly throughout vegetation type 1 (*Banksia* woodland) and alongside disturbed areas of the Greater Project Area.

Approximately 706 individuals of *Jacksonia sericea* were recorded within Stage 1.

Pimelea calcicola (DPaW Priority 3)

Approximately 516 individuals of this species were observed within GHD vegetation types 4 (Mixed low heath on limestone) and 5 (*Melaleuca huegelii–M. systena* shrubland on limestone) (Stages 2 and 3).

No individuals were recorded within the Stage 1 area.

Stylidium maritimum (DPaW Priority 3)

Approximately 1,455 individuals of this species were observed within vegetation type 4 (Mixed low heath on limestone) (Stages 2 and 3).

No individuals were recorded within the Stage 1 area.

Local and regional context

Four naturally occurring priority flora species listed by DPaW were recorded within the Greater Project Area. The population extent of these species within the state has been determined through desktop searches and is included in Table 15. The estimation of populations and plants in the whole of Western Australia, as included in Table 15, is a conservative estimate as:

- FloraBase records do not always provide details on the number of plants present. Records often provide comments such as ‘scattered’ and ‘common’ for their frequency. However, where a count was not provided the record has only been included as one plant.
- Records on FloraBase only represent those lodged with the herbarium. There may be other populations in areas not surveyed or records may not have been lodged.

Table 15 Population size of priority flora species recorded within the Greater Project Area (Stage 1, 2 and 3) compared to known records for the state

Taxon	Status	Count in each Project Area	State-wide record frequency
Acacia benthamii	P2	Stage 1: nil Stage 2: 1 Stage 3: nil	34 records on Florabase which includes at least 53 individual plants recorded and 1 record identified as "locally common/abundant/frequent etc" (WA Herbarium 1998-).
Jacksonia sericea	P4	Stage 1: 706 Stage 2: 4824 Stage 3: 436	55 records on Florabase which includes at least 195 individual plants recorded and 4 records identified as "locally common/abundant/frequent etc" (WA Herbarium 1998-).
Pimelea calcicola	P3	Stage 1: nil Stage 2: 508 Stage 3: 7	26 records on Florabase which includes at least 75 individual plants recorded and 4 records identified as "locally common/abundant/frequent etc" (WA Herbarium 1998-).
Stylidium maritimum	P3	Stage 1: nil Stage 2: 806 Stage 3: 59	37 records on Florabase which includes at least 362 individual plants recorded and 4 records identified as "locally common/abundant/frequent etc" (WA Herbarium 1998-).

4.7.11 Other significant flora

Aside from the priority flora taxa listed by the DPaW, the survey also identified six flora taxa within the Greater Project Area (Stage 1, 2 and 3) that are considered of particular interest on the Swan Coastal Plain as they are rare, poorly known, restricted in distribution or have some other distinctive feature (Government of Western Australia 2000) (Table 16). Of these, one is not considered to be naturally occurring as it has been used in roadside plantings (Table 16).

Table 16 Other significant flora identified within the Greater Project Area (Stage 1, 2 and 3)

Species	Status (Government of Western Australia, 2000)					
	r	d	p	s	E	Planted
Agonis flexuosa	×			×		
Astroloma microcalyx				×		
Callitris preissii				×	×	×
Conospermum triplinervium	×			×		
Lechenaultia linarioides			×			
Melaleuca lanceolata		×		×		

Significant flora codes (Government of Western Australia, 2000)

Geographical variation significance

r	Populations at the northern or southern limit of their known geographic range
d	Populations disjunct from their known geographic range
p	Considered to be poorly reserved (applies to all Threatened and Priority taxa)
s	Significant populations (applies to all Threatened and Priority taxa)

Regional ecological preferences

E	Taxa endemic to the Swan Coastal Plain in the Perth Metropolitan Region

4.7.12 Evaluation of potential impacts to flora species for Stage 1

Surveys of the Greater Project Area indicated that the area supports a high floral diversity with large numbers of native plant species. Clearing for Stage 1 of this Project will require clearing of vegetation with high species diversity.

No flora species listed under the EPBC Act or the WC Act have been recorded within Stage 1. One DPaW listed Priority species was identified in Stage 1:

- *Jacksonia sericea* (P4) – 706 individuals identified within Stage 1, predominantly within vegetation type 1, and often occurring in disturbed areas and along tracks

The impact of Stage 1 of the Project on this species is high as it will impact on high numbers of individual plants of this species. However, *Jacksonia sericea* occurs along the tracks and disturbed areas of the Greater Project Area (Stage 1, 2 and 3), which indicates that this species generally responds well to disturbance. It currently occurs along disturbed and rehabilitated land adjacent to the railway which indicates its potential for regeneration in areas adjacent to the freeway following initial clearing and construction. Management measures, such as seed collection and revegetation with this species, should be implemented to reduce the potential impacts on this species.

Clearing for the Project will also reduce the extents of five naturally occurring flora species considered to be species of conservation significance on the Swan Coastal Plain (Government of Western Australia 2000).

4.7.13 Introduced plants (weeds)

A total of 146 introduced (exotic) and planted species were recorded within the Greater Project Area (Stage 1, 2 and 3) during the GHD flora survey (GHD 2013a). Of these, three species are listed as Declared Pests under Section 22 of the *Biosecurity and Agriculture Management Act 2007*:

- *Asparagus asparagoides* (bridal creeper) – Approximately 12 individuals scattered throughout the Greater Project Area (Stage 1 contained six bridal creeper individuals located on the eastern end of Hester Ave and on Wanneroo Road)
- *Solanum linnaeanum* (apple of sodum) – Approximately 13 individuals within the Tuart woodland (vegetation type 3). (Stage 1 contained six apple of sodum individuals in total, five on Neerabup Road west and one on Neerabup road east)
- *Zantedeschia aethiopica* (arum lily) – Approximately 100 individuals at the intersection of Romeo Road and Wanneroo Roads (Does not occur in Stage 1)

Bridal creeper is also listed as a Weed of National Significance (WoNS) (Australian Weeds Committee 2010). The locations of these species recorded within the Greater Project Area (Stage 1, 2 and 3) are provided in Figure 6 (Appendix A)

4.7.14 Evaluation of potential impacts to Introduced Plants (weeds) for Stage 1

Stage 1 of the Project has the potential to introduce and spread weeds, including declared weeds, into surrounding areas during both the construction and operation phase. These weeds have the potential to impact on areas of native vegetation by competing with native species for habitat. In particular, the Stage 1 Project has the potential to spread weeds into the adjacent Neerabup National Park and Bush Forever sites which may impact on the environmental values of these areas.

4.8 Dieback

Dieback (*Phytophthora cinnamomi*) is spread by the movement of infected soil, plant material or water. The disease spreads naturally in sloping areas where surface water movements may result in contamination of areas downslope of an infected area. Dieback is also commonly spread via human activities, such as earth moving, vehicle movement and movement on foot.

Glevan Consulting undertook an assessment of the vegetation within the Greater Project Area (Stage 1, 2 and 3) in July 2013 for the presence of Phytophthora Dieback (Glevan Consulting 2013). The Greater Project Area was determined to be a mosaic of Infested, Uninfested, and Unmappable vegetation. Table 17 presents the relevant areas of each hygiene category within the Greater Project Area.

Table 17 Occurrence category summary for the Greater Project Area (Stage 1, 2 and 3) and adjacent areas.

Category	Area (hectares)	% of total area
Infested (with *P. cinnamomi*)	2.6 ha	0.6%
Uninfested	171.8 ha	39.3%
Unmappable	262.9 ha	60.1%
Total	437.3 ha	

The Greater Project Area lies predominantly within the Spearwood and Quindalup dune systems which is a landform where the effect of *P. cinnamomi* on the vegetation would be minimal. During the assessment it was observed that the vegetation was generally overlaying calcareous soils with surface limestone in many places. Some isolated sites did, however, appear to have a Bassendean dune structure which is more suited to the presence and spread of *P. cinnamomi* (Glevan Consulting 2013).

Due to the limited expected Phytophthora disease expression on the calcareous soils, the vegetation in these areas could be uninterpretable for the disease. These areas should be managed as being Uninfested. This conclusion is drawn from the results of the samples from this assessment and previous assessments undertaken in the area (Glevan Consulting 2013).

One site of vegetation that is suspected to be infested with *P. cinnamomi* was observed in the extension to Romeo Road portion of the Greater Project Area. A sample of soil and root material taken from the site did not prove the presence of *P. cinnamomi*, however, it is considered that the area should be treated and managed as being Infested (Glevan Consulting 2013).

Many sites within the Greater Project Area are suffering from a decline in the vegetation, with some areas displaying an ulcer effect on the vegetation, with many deaths in Dieback susceptible species in a localised area. In particular, these sites were near the proposed Neerabup Road extension and adjacent to the rail alignment between Burns Beach Road and Carramar Road. Samples were taken at these sites, and all returned negative results which supported the field decision. The Neerabup Management Plan also mentions that 'monitoring has revealed signs of long-term decline in the vigour and distribution of some wetland and terrestrial species in response to declining groundwater levels' (Glevan Consulting 2013).

All sections of the Greater Project Area to the west of the rail alignment are considered Unmappable, with the vegetation either disturbed or non-existent. These areas are considered Unprotectable. The vegetation adjacent to Burns Beach Road and on the eastern side of

Wanneroo Road is also considered Unmappable and Unprotectable. Deaths of Phytophthora susceptible species, particularly *Banksia attenuata* and *Xanthorrhoea preissii* were noted along the edge of the road and representative samples were taken. All vegetation within the existing rail easement has been disturbed to a degree to warrant it being Unmappable and Unprotectable (Glevan Consulting 2013).

The vegetation on the western side of Wanneroo Road, although Unmappable is considered Protectable as it abuts Neerabup National Park. All vegetation adjacent to Hester Avenue and the proposed Neerabup Road extension is Uninfested and Protectable. The vegetation within the Greater Project Area on the eastern side of the rail alignment, and the proposed extension of the alignment to Romeo Road is generally Uninfested with small patches of Unmappable areas. This area should be managed as Protectable (Glevan Consulting 2013).

4.8.1 Evaluation of potential impacts from Dieback for Stage 1

Large areas of Stage 1 of the Project, particularly adjacent to Hester Avenue and Neerabup National Park have been mapped as Uinfested and Protectable. Dieback could potentially be spread to these areas during construction or operation of the Mitchell Freeway which has the potential to impact on the biodiversity of the area, including declines in vegetation structure and diversity. If Dieback is spread into these areas it could also spread and impact on the biodiversity values on adjacent areas of environmental value, such as Neerabup National Park.

In addition, a number of areas within Stage 1 have been mapped as Unmappable and Unprotectable. While these areas are Unmappable there is still the potential for unrecorded Dieback infestations to occur in these areas and the construction of the Stage 1 Project may lead to the spread of Dieback from these areas to Uninfested areas both within and outside of the Greater Project Area (Stage 1, 2 and 3).

4.9 Fauna

4.9.1 Fauna habitat

During the Level 1 fauna survey undertaken by GHD (2013a), six broad fauna habitat types (excluding Planted/Highly degraded/Cleared) were identified in the Greater Project Area (Stage 1, 2 and 3) based on the predominant landforms, soil and vegetation structure in the area. A description of these habitat types, their corresponding vegetation types and an assessment on their value within the Greater Project Area are listed in Table 18.

The native vegetation within the Greater Project Area consists predominantly of a combination of mixed eucalypt woodlands and *Banksia* woodlands. These habitat types consist of a dominant overstorey of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah), *Corymbia calophylla* (marri), *Banksia attenuata* and *B. menziesii* and were generally associated with grey sandy soils on plains or low undulating dune systems.

The fauna habitat types were originally mapped during the Level 1 fauna survey (GHD 2013a). However, the vegetation mapping was further refined during the Spring flora survey and for the purposes of this impact assessment, the vegetation type mapping has been used to determine the impacts to the corresponding fauna habitats (associated with areas of remnant vegetation) and to quantify the specific impacts to fauna.

Table 18 Habitat types, corresponding vegetation types and value within the Greater Project Area (Stage 1, 2 and 3)

Habitat type	Corresponding vegetation types (see Table 12)	Habitat value
Low heathland on limestone outcrops	4: Mixed low heath on limestone 5: *Melaleuca huegelii–M. systena* shrubland on limestone	Moderate habitat value. Limestone outcrops and surrounding sands provide suitable habitat for small reptile species. Low heathlands provide excellent cover and feeding habitat for a number of bird species, particularly honeyeaters.
Banksia woodland on grey/brown sand	1: *Banksia* woodland	High habitat value given the presence of a variety of microhabitats and various resource niches available (i.e. fallen logs, hollows, leaf litter and loose sandy soil). Provides for a high diversity of birds species, in particular provides suitable foraging habitat for threatened Black Cockatoo s. Loose sands are particularly suitable for burrowing reptile species.
Tuart (*Eucalyptus gomphocephala*) woodland in deep dark brown sand	3: Tuart woodland	High habitat value given the presence of a variety of microhabitats and various resource niches available (i.e. fallen logs, hollows, leaf litter and loose sandy soil). Provides for a high diversity of birds species and contains potential breeding and roosting habitat as well as suitable foraging habitat for threatened Black Cockatoo s.
Banksia sessilis tall shrubland on grey sand and limestone outcropping	6: *Banksia sessilis* closed tall scrub	High habitat value as *B. sessilis* is a key foraging species for threatened Black Cockatoo s. The density of shrubs within this habitat type provides good protection for small birds, mammals and reptile species although somewhat limited due to the fragmentation of this habitat type.
Jarrah (*E. marginata*)–*Banksia* woodland on grey/brown sand	2: Jarrah–*Banksia* woodland	High habitat value given the presence of a variety of microhabitats and various resource niches available (i.e. fallen logs, hollows, leaf litter and loose sandy soil). Provides for a high diversity of bird species, in particular provides suitable foraging habitat for threatened black cockatoos. Loose sands are particularly suitable for burrowing reptile species.
Mosaic of Banksia woodland and low heathland	7: Mosaic of vegetation types 1 & 4	See details above
Highly degraded/cleared/ planted roadside vegetation	8: Degraded/roads/ tracks/railway 9: Planted 10: Rehabilitation	Little to no habitat value given that these areas are partially or completely devoid of native vegetation. Planted roadside vegetation may provide some shelter and opportunistic food for some bird species, but only contribute a small percentage of the overall area of this habitat type. These areas provide limited connectivity between larger patches of remnant vegetation.

4.9.2 Evaluation of potential impacts to Fauna Habitats for Stage 1

Construction for the Stage 1 Project Area will require clearing of up to 86.5 ha of fauna habitat, associated with remnant vegetation. This will result in a loss the habitat available to fauna

species. The specific impacts to fauna species as a result of this loss are discussed further in sections 4.9.4, 4.9.6 and 4.9.8.

4.9.3 Habitat linkages

Locally, the habitat within the Greater Project Area (Stage 1, 2 and 3) east and north of the railway and connected to habitat is immediately adjacent Neerabup National Park and associated Bush Forever sites. The vegetation within the PTA rail boundary is currently fenced off with 2.5 m high chain mesh fencing which presents a barrier to movement of ground dwelling fauna between remnant vegetation to the east and west of the existing railway. The majority of the Greater Project Area west of the railway has been cleared or is currently being cleared for urban development, with only small patches of remnant vegetation remaining.

Within the Stage 1 Project Area, the areas of remnant vegetation in and immediately surrounding the Greater Project Area are part of a regionally significant contiguous bushland/wetland linkage (Government of Western Australia 2000), with a large proportion of this vegetation currently included as national park and a series of Bush Forever sites (Government of Western Australia 2000). There are several surrounding linkages and the habitat within Neerabup National Park (Bush Forever site 383) is linked to bushland to the north in Yanchep National Park, to the south to Bush Forever site 299 (across Wanneroo road) and to the east and west to Bush Forever Site 323 and through bushland to Bush Forever Site 397. The vegetation within Stage 1 of the Project also is part of Greenways 35, 2, 5 (Tingay, Alan and Associates 1998). Neerabup National Park provides a narrow corridor to allow movement of animals along the coastal plain and associated wetlands.

4.9.4 Evaluation of potential impacts to Habitat Linkages for Stage 1

Clearing of vegetation for Stage 1 of the Project is likely to exacerbate the existing fragmentation of the habitat and reduce the connectivity of habitat in the local area.

This impact predominantly relates to the construction of the Neerabup Road Extension section of Stage 1, which will fragment the habitat within Neerabup National Park and the remnant bushland west of Wanneroo Road. Neerabup National Park and the surrounding Bush Forever Sites form a large contiguous tract of native vegetation that runs north-south between Wanneroo Road and the railway. This tract of vegetation forms a corridor for the movement of fauna species and a large area of habitat for a variety of fauna species. Therefore, clearing for the Neerabup Road Extension will sever this area of contiguous vegetation and create a barrier to the movement of fauna.

Clearing for the other sections of Stage 1, including the freeway extension, road duplications, construction of interchanges and the Principal Shared Path will also increase the existing fragmentation of habitat within the local area. The majority of these areas occur adjacent to existing developed areas, including subdivisions and existing cleared alignments (such as the railway). Clearing of the vegetation in these areas will reduce the overall area of remnant vegetation within the larger vegetated corridor. This will further reduce the availability of habitat for fauna in the local area and decrease the connectivity of habitat linkages to surrounding bushland areas.

The ongoing operation phase of Stage 1 of the Project also has the potential to substantially inhibit (e.g. reduce the number of movements across the road) or reduce the functionality of the habitat in the surrounding area, including foraging and potential breeding habitat. Increased traffic and new vehicle movements as a result of the Project (e.g. along the new Neerabup Road Extension) may also increase the likelihood of death or injury fauna species in the remaining remnant vegetation in the surrounding area (predominantly Neerabup National Park).

4.9.5 Fauna diversity

A NatureMap search (DPaW 2007–) identified 456 fauna species as previously recorded within 10 km of the Greater Project Area (Stage 1, 2 and 3), of which 438 species are native and 18 are pest (introduced) species. These results consisted of 216 bird, 37 mammal, 65 reptile, 7 amphibian, 54 fish and 77 invertebrate species (GHD 2013a).

During the Level 1 field survey undertaken by GHD (2013a), a total of 61 fauna species, consisting of 47 birds, seven reptiles and seven mammals were recorded within the Greater Project Area (Stage 1, 2 and 3). Of these, nine are introduced (feral) species.

GHD also undertook a fauna trapping survey for the Neerabup Road Extension (GHD 2013d) located within Stage 1 of the Project. A total of 114 vertebrate fauna species comprising 1485 individuals from both opportunistic and trapping survey results was recorded. This included 70 birds, 29 reptiles, one amphibian, eight native mammals (including bats) and six introduced mammals.

4.9.6 Evaluation of potential impacts to Fauna diversity for Stage 1

The potential impacts to fauna within Stage 1 as a result of the Project are associated with the impacts to flora and vegetation and direct loss of habitat. These impacts include:

- Loss of fauna habitat (86.5 ha of remnant vegetation)
- Fragmentation of fauna habitat within the Neerabup National Park due to the Neerabup Road Extension, and loss of connectivity and linkages as discussed in 4.9.4.
- Disruptions to the movement of fauna, specifically relating to the construction and operational phases of the Neerabup Road Extension, including the barrier created by the road itself and increased frequency of vehicle strikes. During the Neerabup Road fauna movement survey (GHD 2013e) regular activity of a diverse range of fauna groups was recorded, with a high frequency of large terrestrial fauna species such as emus and kangaroos observed. These groups of species may be more susceptible to vehicle strike as a result of the construction of the new road.

4.9.7 Conservation significant fauna

Searches of the EPBC Act PMST (DotE 2013a) and Western Australian Museum/DPaW NatureMap records (DPaW, 2007–) identified the presence or potential presence of the following:

- 20 Threatened fauna listed under the EPBC Act
- 28 Migratory birds listed under the EPBC Act
- 24 Threatened or other specially protected species listed under the WC Act
- 13 Priority fauna species listed by the DPaW

In addition to these, the desktop searches identified a number of marine mammal, shark, reptile and bird species. These species have been excluded from this assessment as no marine habitat is present within the Greater Project Area or will be impacted as a result of the Stage 1 Project.

Field results

The combined results of the field assessments including the Level 1 fauna survey (GHD, 2013a, Black Cockatoo Assessment (GHD 2013b), Neerabup Road fauna trapping survey (GHD 2013d) and Neerabup Road fauna movement survey (GHD 2013e) recorded seven

conservation significant fauna species within the Greater Project Area. All of these species were also recorded within Stage 1 of the Project, and include:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered (EPBC Act) Schedule 1 (WC Act)
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) – Vulnerable (EPBC Act) Schedule 1 (WC Act)
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) – Vulnerable (EPBC Act) Schedule 1 (WC Act)
- Carpet Python (*Morelia spilota imbricata*) – Schedule 4 (WC Act)
- Rainbow Bee Eater (*Merops ornatus*) – Marine/Migratory (EPBC Act), Schedule 3 (WC Act)
- Western Brush Wallaby (*Macropus irma*) – Priority 4
- Quenda/Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) – Priority 5

The results of the Neerabup Road fauna trapping survey indicate that the Carnaby's Black Cockatoo, Baudin's Black Cockatoo, Forest Red-tailed Black Cockatoo, Carpet Python, Southern Brown Bandicoot and Western Brush Wallaby rely on the habitat types within the Stage 1 Project Area to persist (GHD 2013d). Additionally Western Brush Wallabys on the Swan Coastal Plain are only known to persist in large remnant areas (Bush Forever 2000).

Likelihood of occurrence

In addition to the fauna species recorded during the field surveys, a number of conservation significant fauna species were initially identified as part of the desktop investigation for the fauna assessment (GHD 2013a) as potentially occurring within the Project Area. An assessment on the likelihood of these species occurring in the Project Area was undertaken as part of the Level 1 fauna assessment, based on species biology, habitat requirements, the quality and availability of suitable habitat and records of the species in the area. This assessment has been updated for this EIA to incorporate the results of the targeted Black Cockatoo assessment (GHD 2013b), Neerabup Road fauna trapping survey (GHD 2013d) and Neerabup Road fauna movement survey (GHD 2013e).

The revised assessment found that three species previously considered as potentially occurring; the Fork-tailed Swift, Shield-backed Trapdoor Spider and Graceful Sun Moth, are now considered to be unlikely to occur and are therefore not included in the assessment of impacts for Stage 1 of the Project.

The assessment concluded that seven species are known to occur, six species are likely to occur, and one species could possibly occur within the Greater Project Area (Stage 1, 2 and 3). This assessment also applies to the Stage 1 Project Area only. The species determined as present, likely to occur or could possibly occur within the Greater Project Area are listed in Table 19.

Table 19 Summary of likelihood of occurrence of conservation significant fauna species identified as present, likely to occur and possibly occurring within the Greater Project Area (Stage 1, 2 and 3)

Taxa	Common name	Status		Likelihood of occurrence
		State (WC Act/DPaW listing)	Federal (EPBC Act listing)	
Birds				

Taxa	Common name	Status		Likelihood of occurrence
		State (WC Act/DPaW listing)	Federal (EPBC Act listing)	
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	Threatened	Endangered	Present
Calyptorhynchus baudinii	Baudin's Black Cockatoo	Vulnerable	Threatened, Schedule 1	Present
Calyptorhynchus banksii subsp. *naso*	Forest Red-tailed Black Cockatoo	Vulnerable	Vulnerable	Present
Falco peregrinus	Peregrine Falcon	Schedule 4		Likely
Merops ornatus	Rainbow Bee-eater	Schedule 3	Migratory	Present
Mammals				
Isoodon obesulus fusciventer	Quenda / Southern Brown Bandicoot	Priority 5		Present
Dasyurus geoffroii	Chuditch/Western Quoll	Schedule 1	Vulnerable	Possible
Macropus irma	Western Brush Wallaby	Priority 4		Present
Reptiles				
Ctenotus gemmula (Swan Coastal Plain subspecies)	Jewelled Ctenotus	Priority 3		Likely
Morelia spilota imbricata	Carpet Python	Schedule 4		Present
Neelaps calonotos	Black-striped Snake	Priority 3		Likely
Invertebrates				
Austrosaga spinifer	A cricket	Priority 3		Likely
Hylaeus globuliferus	A bee	Priority 3		Likely
Leioproctus contrarius	A bee	Priority 3		Likely

A discussion of each of the species known to, likely to and that could possibly occur in Stage 1 of the Project is presented below.

Species known to occur

Black Cockatoos

All three species of Black Cockatoos were recorded within the Greater Project Area (Stage 1, 2 and 3) during the field assessments. The most commonly recorded species was the Carnaby's Black Cockatoo, which was recorded multiple times on multiple occasions in Stage 1 during the field surveys. The numbers of birds recorded at each sighting ranged from a pair of birds to flocks of over 100 individuals. Stage 1 of the Project is:

- Located within the known breeding range for the Carnaby's Black Cockatoo.
- Located within the area where the Forest Red-tailed Black Cockatoo is known to occur (however located outside currently documented distribution) (DSEWPaC 2012).
- Not located within the recognised range for the Baudin's Black Cockatoo, however the species was recorded in the Project Area and is known to be utilising recourses and areas outside those currently recognised in its documented distribution (DSEWPaC 2012).

Each of the three Black Cockatoo species are discussed individually below and a summary of the amount of each habitat type present within the Greater Project Area and its suitability as

Black Cockatoo habitat is provided in Table 20. A summary of the extent of Black Cockatoo foraging, potential breeding and roosting habitat within Stage 1 is provided in Table 21.

Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)

The Carnaby's Black Cockatoo is listed Endangered under the EPBC Act and Threatened (Schedule 1) under the WC Act. It is distributed across the south-west of Western Australia in uncleared or remnant areas of *Eucalyptus* woodland and shrubland of kwongan heath. During the survey, the Carnaby's Black Cockatoo was recorded multiple times in the Greater Project Area (Stage 1, 2 and 3). Numbers of birds recorded at each sighting ranged from a pair of birds to flocks of over 100 individuals. Additionally, evidence of feeding was recorded throughout the Greater Project Area in areas of suitable foraging habitat (GHD 2013a).

Foraging habitat

Generally, all the areas containing remnant native vegetation within the Greater Project Area are considered to represent suitable foraging habitat as they all contain plant species documented as foraging habitat. The most dominant/obvious species include *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah), *E. todtiana* (coastal blackbutt), *Corymbia calophylla* (marri), *Banksia grandis, B. menziesii, B. attenuata, B. sessilis* and *Allocasuarina fraseriana* (sheoak). Based on the data collected during the flora and vegetation survey (GHD 2013a), the areas of best-quality foraging habitat can be regarded as those areas having the highest density and widest range of documented foraging plant species. Areas which had been cleared or contained planted species (both native and introduced) along the road verges generally did not contain suitable foraging species. In total, there is approximately 195.4 ha (86.5 ha in Stage 1, 80.7 ha in Stage 2 and 28.1 ha in Stage 3) of suitable foraging habitat within the Greater Project Area. Suitable foraging habitat is mapped by GHD (2013b; Figure 2).

Foraging habitat within Stage 1: All of the areas containing remnant native vegetation provide suitable foraging habitat as they contain suitable plant foraging species for Carnaby's Black Cockatoo (86.5 ha).

Breeding habitat

The Greater Project Area is partially located within the known breeding range for the Carnaby's Black Cockatoo (DSEWPaC, 2012). It nests in hollows in live or dead trees of *E. salmonophloia* (salmon gum), *E. wandoo* (wandoo), tuart, jarrah, *E. rudis* (flooded gum), *E. loxophleba* subsp. *loxophleba* (York gum), *E. accedens* (powderbark), *E. diversicolor* (karri) and marri. Of these species, tuart, jarrah, and marri were all recorded from the Greater Project Area. The Tuart woodlands and to a lesser extent, the Jarrah-*Banksia* woodlands are considered to be the most valuable habitat types in terms of providing potential breeding habitat for black cockatoos within the Greater Project Area.

A significant tree assessment undertaken by GHD (2013b) identified a total of 833 trees with a diameter at breast height (DBH) of >500 mm within or immediately adjacent to the Greater Project Area. This consisted of 546 tuart (*E. gomphacephala*), 196 jarrah (*E. marginata*), 61 marri (*Corymbia calophylla*) and 30 stags (dead trees). The majority (570, 68%) of the trees were observed to not contain hollows of any size. A total of 60 (7%) of the trees contained one or more "small" hollows (<5 cm entrance size), these hollows are not currently considered to be suitable for black cockatoos to use for nesting purposes but may be in the future. A total of 153 (18%) trees contained at least one medium and/or large sized hollow (>5 cm) which may provide suitable breeding habitat now, or in the near future. A total of 45 trees contained hollows which were considered to provide suitable nesting habitat (>20 cm entrance size). None of the trees containing large hollows showed evidence of current or past use by black cockatoos. However, of the 45 identified, suitability for breeding is high (GHD, 2013b).

Of the trees with hollows recorded, 13 were currently occupied by feral bees. During the early July surveys, a number of galahs and Australian ringneck parrots were observed occupying a number of the hollows in the Greater Project Area as their breeding season begins. Additionally one hollow was observed being prepared by western long-billed corella. Feral bees, galahs, corella and parrots are known threats to black cockatoos as they face competition for hollows to nest in. The location of significant trees recorded in the Greater Project Area was mapped by GHD (2013b; Figure 3).

Breeding habitat within Stage 1: A total of 40.5 ha of Tuart woodland and Jarrah/Banksia woodland provides potential breeding habitat. Overall, 589 trees with diameter at breast height (DBH) of >500 mm occur within Stage 1, 31 of which contain hollows which were considered to provide suitable breeding habitat (with an entrance diameter greater than 20 cm).

Roosting habitat

A roost is an area or site with a roost tree or a number of roost trees where black cockatoos congregate at dusk to rest overnight. A night roost can include tall trees (>8 m height) within 1 km of the central roosting area of larger roost sites (>150 cockatoos) and within 500 m for smaller roost sites (<150 cockatoos) (Glossop et al. 2011). Typically, night roost sites have a standing water source nearby for drinking which may be a natural waterway or lake but constructed lakes, farm dams and stock water troughs are also used (Glossop et al. 2011).

One potential roosting site was recorded during the GHD survey (GHD 2013b). This roosting site is located approximately 1 km south of Neerabup Road. This site showed evidence of roosting by black cockatoos, including presence of cut debris (leaves and small branches) on the ground and large amounts of faecal material.

The Greater Project Area provides suitable roosting habitat based on the presence of suitable roosting trees, close proximity of known roosting sites (Department of Planning 2011) and presence of suitable foraging habitat. Although there is no standing water within the Greater Project Area, there are a number of lake systems in the nearby area, including Lake Joondalup to the south and Neerabup and Nowergup lakes to the east.

Roosting habitat within Stage 1: A total of 40.5 ha of Tuart woodland and Jarrah/Banksia woodland provides potential roosting habitat. One potential roosting site was also identified during the survey, near the Clarkson rail line approximately 1 km south of Neerabup Road. This site showed evidence of roosting by Black Cockatoos, including presence of cut debris (leaves and small branches) on the ground and large amounts of faecal material.

Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)

The Baudin's Black Cockatoo is listed Vulnerable under the EPBC Act and Threatened (Schedule 1) under the WC Act. Baudin's Black Cockatoo was observed flying over and foraging in the Neerabup National Park area and along the proposed Neerabup Road Extension during the targeted Black Cockatoo breeding assessment (GHD 2013b).

Foraging habitat

The Baudin's Black Cockatoo forages on eucalypt woodlands and forest, and proteaceous woodland and heath. During the breeding season they feed primarily on native vegetation, particularly marri. Outside the breeding season, they may feed in fruit orchards (mostly apple and pear, but also persimmon) and tips of *Pinus* spp. (DSEWPaC 2013). Common food items include mostly marri (seeds, flowers, nectar and grubs) and proteaceous trees and shrubs. Also other native seeds and introduced fruits; insects and insect larvae; pith of kangaroo paw *Anigozanthos flavidus*; juice of ripe persimmons; tips of *Pinus* spp. and seeds of apples and pears (DSEWPaC 2012).

As detailed above, generally, all the areas containing remnant native vegetation within the Greater Project Area (Stage 1, 2 and 3) are considered to represent suitable foraging habitat as they all contain plant species documented as suitable for foraging.

Foraging habitat within Stage 1: All of the areas containing remnant native vegetation provide suitable foraging habitat as they contain suitable plant foraging species for Baudin's Black Cockatoo (86.5 ha).

Breeding habitat

The Baudin's Black Cockatoo generally breeds in woodland or forest, but may also breed in former woodland or forest now present as isolated trees. They nest in hollows in live or dead trees of karri, marri, wandoo and tuart (DSEWPaC 2012).

Breeding habitat within Stage 1: Stage 1 is located outside the known breeding range of Baudin's Black Cockatoo, and therefore no potential breeding habitat is present.

Roosting habitat

The Baudin's Black Cockatoo generally roosts in or near riparian environments or other permanent water sources. Suitable roosting tree species include jarrah, marri, flooded gum, blackbutt, tuart, and introduced eucalypts including blue gum and lemon scented gum (*Corymbia citriodora*). (DSEWPaC 2012).

Roosting habitat within Stage 1: A total of 40.5 ha of Tuart woodland and Jarrah/Banksia woodland provides potential roosting habitat.

Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso*)

The Baudin's Black Cockatoo is listed Vulnerable under the EPBC Act and Threatened (Schedule 1) under the WC Act. The Forest Red-tailed Cockatoo was observed flying over and foraging in the Neerabup National Park area and along the proposed Neerabup Road Extension during the targeted Black Cockatoo breeding assessment (GHD 2013b).

Foraging habitat

The Forest Red-tailed Cockatoo feeds on Jarrah and marri woodlands and forest, and edges of karri forests including wandoo and blackbutt, within the range of the subspecies. Common food items include mostly seeds of marri and jarrah, also *Eucalyptus caesia*, *illyarrie E. erythrocorys* and some introduced eucalypts such as river red gum (*E. camaldulensis*) and flooded gum (*E. grandis)*, *Allocasuarina* cones, fruits of snottygobble (*Persoonia longifolia)* and mountain marri (*Corymbia haematoxylon*). On the Swan Coastal Plain, they often feed on introduced cape lilac (*Melia azedarach)*. (DSEWPaC 2012).

Foraging habitat within Stage 1: All of the areas containing remnant native vegetation provide suitable foraging habitat as they contain suitable plant foraging species for the Forest Red-tailed Cockatoo (86.5 ha).

Breeding habitat

Breeding habitat generally includes woodland or forest, but species may also breed in former woodland or forest now present as isolated trees. The Forest Red-tailed Cockatoo nests in hollows in live or dead trees of marri, karri, wandoo, bullich, *E. megacarpa*, blackbutt, *E. patens*, tuart and jarrah. (DSEWPaC 2012).

Breeding habitat within Stage 1: Stage 1 is located outside the known breeding range of Forest Red-tailed Cockatoo, and therefore no potential breeding habitat is present.

Roosting habitat

The Forest Red-tailed Cockatoo roosts in tall jarrah, marri, blackbutt, tuart and introduced eucalypt trees within or on the edges of forests. (DSEWPaC 2012).

Roosting habitat within Stage 1: A total of 40.5 ha of Tuart woodland and Jarrah/Banksia woodland provides potential roosting habitat.

Table 20 Summary of vegetation types within the Greater Project Area (Stage 1, 2 and 3) and their suitability as Black Cockatoo habitat

Vegetation type	Potential food species	Density of food species	Present of breeding habitat	Presence of roosting habitat	Area within Stage 1 (ha)	Area within Stage 2 (ha)	Area within Stage 3 (ha)	Total area within Greater Project Area (ha)
Mixed low heath on limestone	*Banksia sessilis, B. attenuata, Grevillea* spp. and *Hakea* spp.	Scattered/ patchy	None	None	0.9	21.3	Not present	22.2
Banksia woodland	*B. menziesii, B. attenuata, B. grandis, B. sessilis, Eucalyptus todtiana, Allocasuarina fraseriana, Eucalyptus* spp., and *Grevillea* spp.	Dominant species	None	None	35.9	40.4	14.3	90.6
Tuart woodland	*E. gomphocephala, Banksia spp., Allocasuarina fraseriana, Hakea lissocarpha, Grevillea* spp. and occasional *E. marginata* and *C. calophylla*.	Dominant species	Potential	Potential	35.5	5.5	10.6	51.6
Banksia sessilis closed tall scrub	*B. sessilis* and *Hakea trifurcata*.	Dominant species	None	None	3.9	2.5	Not present	6.4
Jarrah–*Banksia* woodland	*E. marginata, B. attenuata, B. menziesii* and *Allocasuarina fraseriana.*	Dominant species	Potential	Potential	5.0	2.1	2.7	9.8
Mosaic of *Banksia* woodland and mixed low heath on limestone and	*B. menziesii, B. attenuata, B. grandis, B. sessilis, Eucalyptus todtiana, Allocasuarina fraseriana, Eucalyptus* spp., *Hakea* spp. and *Grevillea* spp.	Dominant species	None	None	5.4	9.1	Not present	14.5
Planted roadside vegetation/rehabilitation/ highly disturbed/cleared	Planted eucalypts.	None to very scattered	None	None	64.5	77.3	67.1	208.9
				Total	**151.0**	**158.0**	**92.2**	

Table 21 Summary of the type and extent of Black Cockatoo habitat within Stage 1 of the Project Area

Black Cockatoo habitat type	Total area of habitat within Stage 1 (ha)	Summary of habitat value
Foraging	86.5 ha All vegetation types excluding Planted roadside vegetation/rehabilitation/ highly disturbed/cleared	Provides known and potential foraging habitat for Carnaby's Black Cockatoo, Baudin's Black Cockatoo and Forest Red-tailed Black Cockatoo. All of the areas containing remnant native vegetation provide suitable foraging habitat as they contain plant species documented as foraging species. The most dominant/obvious species include *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah), *E. todtiana* (coastal blackbutt), *Corymbia calophylla* (marri), *Banksia grandis*, *B. menziesii*, *B. attenuata*, *B. sessilis* and *Allocasuarina fraseriana* (sheoak).
Breeding	40.5 ha Tuart woodland and Jarrah/*Banksia* woodland	Provides potential breeding habitat for Carnaby's Black Cockatoo. Total of 589 trees with diameter at breast height (DBH) of >500 mm. 31 trees (contained hollows which were considered to provide suitable breeding habitat (with an entrance diameter greater than 20 cm). 100 trees with at least one medium and/or large sized hollow, which are not currently considered suitable for Black Cockatoo nesting, but may provide suitable breeding habitat in the near future. 458 younger age class trees with a DBH of >500 mm (not containing hollows currently suitable for breeding)
Roosting	40.5 ha Tuart woodland and Jarrah/*Banksia* woodland	Provides potential breeding habitat for Carnaby's Black Cockatoo, Baudin's Black Cockatoo and Forest Red-tailed Black Cockatoo. Most likely to provide potential roosting habitat for Carnaby's Black Cockatoo. One potential roosting site was identified during the survey, near the Clarkson rail line approximately 1 km south of Neerabup Road. This site showed evidence of roosting by Black Cockatoos, including presence of cut debris (leaves and small branches) on the ground and large amounts of faecal material. Suitability based on the presence of suitable roosting trees, close proximity of known roosting sites and presence of suitable foraging habitat.

Carpet Python (*Morelia spilota imbricata*)

The Carpet Python is listed as Schedule 4 (other specially protected fauna) under the WC Act. This subspecies inhabits temperate climatic areas with good winter rains and dry summers. It

occurs in south-west Western Australia, from Northampton, south to Albany and eastwards to Kalgoorlie, including undisturbed remnant bushland near Perth and the Darling Ranges, Yanchep National Park, and Garden Island. It has been recorded in semi-arid coastal and inland habitats consisting of *Banksia* woodland, eucalypt woodlands, and grasslands (DEC 2012a).

This species was identified in the Greater Project Area (Stage 1, 2 and 3) from a snake dropping within a tree hollow during the field survey (GHD 2013a). A sub-adult was also identified within the Neerabup Road Extension area of Stage 1 during the fauna trapping survey (GHD 2013d). The majority of the Project Area containing remnant native vegetation provides suitable habitat for this species. It is likely that this species would generally inhabit the larger areas of contiguous native vegetation within and adjacent to the Greater Project Area (Stage 1, 2 and 3).

Habitat within Stage 1: All fauna habitats (86.5 ha) provide opportunity for foraging, breeding and dispersal.

Quenda/Southern Brown Bandicoot (*Isoodon obesulus fusciventer*)

The Quenda, or Southern Brown Bandicoot, is listed as a Priority 5 species by the DPaW. This species is widely distributed near the south-west from Guilderton north of Perth to east of Esperance. They are patchily distributed throughout the Swan Coastal Plain where they are often associated with wetlands. Quenda inhabit scrubby, often swampy, vegetation with dense cover up to 1 m high and often feed in adjacent forest and woodland (Van Dyck and Strahan 2008).

Two distinctive conical diggings were observed in the Greater Project Area (Stage 1, 2 and 3) during the fauna survey (GHD 2013a). Although there are no wetlands or wetland associated vegetation within the Greater Project Area, the eucalypt and *Banksia* woodlands provide some suitable habitat for Quenda, particularly areas with a dense understorey.

Habitat within Stage 1: All fauna habitats (86.5 ha) provide opportunity for foraging, breeding and dispersal.

Rainbow Bee Eater (*Merops ornatus*)

The Rainbow Bee Eater is listed as Schedule 3 (protected fauna under international agreement) under the WC Act and marine/migratory under the EPBC Act. The species is widespread across Australia and migrates north over the winter period, returning in spring and their breeding season.

The species prefers open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It also inhabits sand dune systems in coastal areas and at inland sites that are in close proximity to water (DotE 2013c). Breeding occurs in burrows dug by parent birds on flat open areas preferably in raised spoils, banks or other man made soil deposits. During the survey, a pair of Rainbow Bee Eaters were observed within the Tuart Woodland of the Neerabup Road Extension. Additionally DPaW also recorded the species in other areas of the Neerabup National Park. The Neerabup Road extension Survey Area (inclusive of *Banksia* woodland, Tuart woodland and Jarrah-*Banksia* woodland) is considered to be of high value to Rainbow Bee-eaters.

Habitat within Stage 1: All fauna habitats (86.5 ha) provide opportunity for foraging, breeding and dispersal.

Western Brush Wallaby (*Macropus irma*)

The Western Brush Wallaby is listed as a Priority 4 species by the DPaW. This species is widely distributed in the south west of the state from about Kalbarri to east of Esperance, excluding the

extreme south west wet forests. They are patchily distributed through the Swan Coastal Plain where they now only persist in large remnant areas of natural vegetation. Habitat includes open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets. The species is also found in some areas of mallee and heathland, and is uncommon in Karri forest (Van Dyck and Strahan 2008).

One report of this species was recorded by DPaW on a camera trap. As is the case with the Quenda (discussed above) the limited number of records for this species is likely to be associated with the large numbers of feral predators reported within the National Park.

The Greater Project Area (Stage 1, 2 and 3) (inclusive of *Banksia* woodland, Tuart woodland and Jarrah-*Banksia* woodland) is considered to be of high value to the Western Brush Wallaby.

Habitat within Stage 1: All fauna habitats (86.5 ha) provide opportunity for foraging, breeding and dispersal.

Species likely or possibly occurring

Chuditch

The Chuditch is listed Vulnerable under the EPBC Act and Threatened (Schedule 1) under the WC Act. The Chuditch or Western Quoll formerly ranged over nearly 70 % of Australia but now retains only a patchy distribution through Eucalypt forest (especially Jarrah, *Eucalyptus marginata*), dry woodland and mallee shrublands in Western Australia. In the Jarrah forest, Chuditch populations occur in both moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest (Orell and Morris, 1994). Most diurnal resting sites in sclerophyll forest consist of hollow logs or earth burrows (Van Dyke & Strahan, 2008). The species can travel large distances, has a large home range (15 km^2 for males =1500 ha and 4 km^2 for females = 400 ha) and is sparsely populated through a large portion of its range (Orell and Morris, 1994).

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).

More recently (from 2006) the species is also known to occur in Julimar Nature Reserve (near Bindoon) and Kalbarri area (both via a reintroduction program) and Forestonia area east of Hyden (natural population). On the Swan Coastal Plain Chuditch have been recorded in the Byford area and adjoining areas of the Darling Range, more recently the species was captured in Paganoni Reserve south of Perth. The species is known to move large distances where habitat is available and predation is reduced or managed via predator control programs such as baiting.

No Chuditch were recorded during the survey however a specimen was recorded as a road fatality on Wanneroo Road just north of the Study Area. Chuditch require very large areas of habitat to persist and the Neerabup National Park size (1069 ha, excluding the proposed extensions) may only support a small population.

The Study Area (all three habitat types) is considered high value to Chuditch, however due to the size of the Neerabup National Park the carry capacity of a population would be limited and a long term population may not be viable.

Habitat within Stage 1: All fauna habitats (86.5 ha) provide opportunity for dispersal and potential foraging.

Peregrine Falcon

The Peregrine Falcon is listed as Schedule 4 under the WC Act. This species is known to be uncommon but wide-ranging across Australia. Habitat is extremely diverse, from rainforest to

arid scrub, from coastal heath to alpine. The Peregrine Falcon nests primarily on ledges of cliffs, shallow tree hollows, and ledges of buildings in cities (Morcombe 2004).

The Peregrine Falcon was not observed during the survey however the species is known to be in the region. Breeding habitat is present in hollows of large Tuarts and all of the alignment would be used as foraging area.

The Greater Project Area (Stage 1, 2 and 3) is considered high value to Peregrine Falcon.

Habitat within Stage 1: All fauna habitats (86.5 ha) for aerial foraging and 35.5 ha of Tuart woodland for potential breeding.

Jewelled Ctenotus

The Jewelled Ctenotus (Swan Coastal Plain population) is listed as Priority 3 by DPaW. This species has scattered populations:

- Along the lower west coastal plain from Cataby and south to Perth.
- Along the south coast and adjacent interior, from Rocky Gully east to the beginning of the Great Australian Bight, and inland to Lake Magenta (Maryan and Shea 2010).

The northern population is the only population listed and is likely to be a different species to the southern population. The Jewelled Ctenotus occurs on pale sandplains supporting heaths in association with Banksia or Mallee woodlands on the Swan Coastal Plain (Wilson and Swan, 2013). The closest known records to the Study Area are records from Ellenbrook and Melaleuca Park along Neaves Road approximately 10 kilometres east of the Study Area. Habitat is present for this species within the Study Area particularly in the Banksia Woodland in the western portion of the proposed road alignment. No specimens were captured during this study, however due to the shy nature of the species and scattered distribution of its populations, the species may be present.

The Greater Project Area (Stage 1, 2 and 3) is considered high value to the Jewelled Ctenotus.

Habitat within Stage 1: The Banksia woodland, low heathland on limestone outcrops, and the mosaic of both of these habitats (42.2 ha) for potential habitat.

Black-striped Snake

The Black-striped Snake is listed as Priority 3 by Department of Parks and Wildlife. This species is restricted to the sandy coastal strip, between Mandurah and Dongara. It occurs on dunes and sand-plains vegetated with heaths and eucalypt/banksia woodlands. This species is seriously threatened by increasing development and habitat loss within its restricted distribution (Wilson and Swan, 2013).

No specimens were collected during the survey however DPaW records (reported in the NatureMap search) show specimens captured approximately four kilometres west, seven kilometres south and 5.5 kilometres south east of the Study Area. Habitat is present for this species particularly in the Banksia Woodland in the western portion of the proposed road alignment. Given the surrounding records of occurrence and the suitability of habitat within the Study Area the Black-striped Snake is expected to occur in the Study Area.

The Greater Project Area (Stage 1, 2 and 3) (particularly the Banksia Woodland) is considered high value to Black-striped Snake. The Tuart Woodland and Banksia-Jarrah Woodland are considered moderate value to the Black-striped Snake.

Habitat within Stage 1: All fauna habitats (86.5 ha) provide potential habitat.

Austrosaga spinifer, Hylaeus globuliferus and Leioproctus contrarius

There is suitable habitat within Stage 1 of the Project Area for three conservation significant invertebrate species, including the two native bees (*Hylaeus globuliferus* and *Leioproctus contrarius*) and the native cricket (*Austrosaga spinifer*). Both of the native bees inhabit vegetation dominated by proteaceous species, therefore the Banksia woodland, Tuart woodland, *Banskia sessilis* scrub and Jarrah/Banksia woodland provide 85.7 ha of potential habitat for these species. The native cricket species, *Austrosaga spinifer*, has a limited distribution and there is limited information known on its preferred habitat. As a result all of the habitats present in Stage 1 may provide potential habitat for *Austrosaga spinifer*..

Habitat within Stage 1: All fauna habitats (86.5 ha) provide potential habitat to the bee and cricket species.

4.9.8 Evaluation of potential impacts to Conservation Significant Fauna for Stage 1

Fourteen conservation significant fauna species are known, likely to or may possibly occur within the Stage 1 Project Area. The potential impacts to each of these species are discussed further below.

As outlined in section 4.9.2, for the purposes of this impact assessment, the areas of remnant vegetation identified in section 4.7.5 have been used to quantify the specific impacts to fauna.

Carnaby's Black Cockatoo, Baudin's Black Cockatoo and Forest Red-tailed Black Cockatoo

The key potential impact to the three species of Black Cockatoos for Stage 1 of the Project is the loss of habitat, including:

- Loss of up to 86.5 ha of known foraging habitat for all three species of Black Cockatoos.
- Loss of one potential night roosting site, located near the Clarkson rail line approximately 1 km south of Neerabup Road.
- Loss of 40.5 ha of potential diurnal and night roosting habitat for all three species of Black Cockatoos.
- Loss of 40.5 ha of potential breeding habitat for Carnaby's Black Cockatoo, including:
  - Loss of 31 habitat trees with suitable hollows for Carnaby's Black Cockatoo breeding (contained a hollow with an entrance diameter greater than 20 cm).
  - Loss of up to 558 younger age class trees with a diameter at breast height (DBH) of >500 mm (100 contain at least one medium and/or large sized hollow and 458 not containing hollows currently suitable for Black Cockatoo nesting).

In addition, the other impacts to Black Cockatoos for Stage 1 of the Project include:

- Exacerbation of existing fragmentation and reduction in connectivity of foraging habitat within the City of Wanneroo locality, in particular Neerabup National Park.
- Reduction in the availability of foraging habitat in close proximity to known roosting sites (two known Carnaby's Black Cockatoo roost sites located east of Wanneroo Road less than 2 km Stage 1).
- Death or injury when hit by cars or trucks during both the construction phase and operation phase of the Project.
- Localised temporary disturbance to Black Cockatoos from increased light, noise, emissions and vibrations from the construction of the Project. In particular, undertaking construction activities at night has the potential to add additional light disturbance to the

birds. This light disturbance may deter Black Cockatoos from night roosting within the adjacent areas, and is considered to be a temporary disturbance during the construction period.

Peregrine Falcon

The Peregrine Falcon is a wide-ranging species that inhabits a diverse range of habitats and may utilise the Stage 1 Project Area for aerial foraging and breeding. This species diet predominantly consists of other birds, and to a lesser extent small mammals, which it hunts from the air and therefore clearing of all of the habitats within the Stage 1 Project Area (86.5 ha) will reduce the availability of foraging habitat for the falcon in the local region.

In addition the Tuart woodland (35.5 ha) within the Stage 1 Project Area also provides potential breeding habitat for the Peregrine Falcon, due to the presence of suitable nesting resources. In the south-west of Western Australia this species is known to typically nest in the shallow hollows of hollow-bearing trees (Nevill 2013), which are scattered throughout the Tuart woodland habitat. As a result, Stage 1 of the Project is likely to result is the loss of up to 35.5 ha of potential breeding habitat for the Peregrine Falcon.

Rainbow Bee-eater

Stage 1 of the Project Area provides known habitat for the Rainbow Bee-eater, and the majority of the habitats present provide potential breeding habitat for the species. The Project Area is located on the Spearwood dunes system, which consist of low undulating dunes and loose soils and provides suitable nesting habitat for the Bee-eater. In the south-west of Western Australia, Rainbow Bee-eaters will utilise a wide-range of habitats to nest, and within the Stage 1 Project Area any areas with loose soils, banks or spoil provide potential breeding habitat for the species. In particular these areas more frequently occur in the more open woodland habitats of Stage 1 (the Tuart woodland provides fewer suitable areas). Therefore clearing of the habitats within Stage 1 will result in a loss of potential habitat (including potential breeding habitat) for the Rainbow Bee-eater (86.5 ha).

Chuditch

The Chuditch is a wide ranging species that has a very large home range and requires very large areas of remnant vegetation to persist. Due to the size of Neerabup National Park and the larger tract of remnant vegetation, it is likely that the local area would only support a small population of Chuditch. The key potential impact to the Chuditch for Stage 1 is the clearing for the Neerabup Road Extension, which will result in fragmentation of the larger linear area of contiguous vegetation. This may reduce the area of dispersal habitat for Chuditch within the local area. However, the species is unlikely to rely on the habitats present within Stage 1.

Quenda and Western Brush Wallaby

Both the Quenda and the Western Brush Wallaby rely on the habitats present in Stage 1 of the Project. On the Swan Coastal Plain, the Western Brush Wallaby's are only known to persist in large remnant areas (Bush Forever 2000), and therefore clearing of all of the vegetation in Stage 1 will result in loss of habitat for the species (including the Tuart woodland, Jarrah/Banksia woodland, Banksia woodland and heathland, 86.5 ha). The fragmentation of habitats resulting from Stage 1 is also likely to impact on both the Quenda and Western Brush Wallaby, due the severing the larger linear area of contiguous vegetation and an important corridor for movement for both species.

Both species are also susceptible to the increased risk of death or injury due to vehicle strike during both construction phase and operation phase of Stage 1, particularly for the Neerabup Road Extension.

Jewelled Ctenotus and Black-striped Snake

The Jewelled Ctenotus and Black-striped Snake are both species which are restricted to the lower west coastal plain, and are typically restricted to sandplains and dunes with heaths, eucalypt and banksia woodlands. The habitats within Stage 1 of the Project that are likely to support the Jewelled Ctenotus include the Banksia woodland and low heathland on limestone outcrops, as well as the mosaic of both of these habitats (42.2 ha). All of the habitats within Stage 1 are considered likely to support the Black-striped Snake (86.5 ha). Therefore, clearing of these habitats for Stage will result in the loss of 42.2 ha and 86.5 ha of potential habitat for the Jewelled Ctenotus and Black-striped Snake, respectively.

Carpet Python

The Carpet Python is known to persist in undisturbed remnant bushland areas in the Perth region, and both the Tuart woodland and Jarrah/Banksia woodland habitats provide particularly suitable habitat for this species in the Stage 1 Project Area. All of the habitats present in Stage 1 provide suitable habitat for the Carpet Python (86.5 ha). During the Neerabup Road Extension fauna trapping survey (GHD 2013d), a sub-adult Carpet Python was recorded within Tuart woodland, indicating that the species breeds in the area. Therefore, clearing of the 86.5 ha remnant vegetation Stage 1 will result in loss of known habitat (dispersal, foraging and breeding) for the Carpet Python.

The Carpet Python also requires relatively large areas of contiguous native vegetation to persist, and therefore the habitat fragmentation resulting from the Neerabup Road Extension is likely to reduce the connectivity of habitat for the species.

Austrosaga spinifer, Hylaeus globuliferus and Leioproctus contrarius

There is suitable habitat within Stage 1 of the Project Area for three conservation significant invertebrate species, including the two native bees (*Hylaeus globuliferus* and *Leioproctus contrarius*) and the native cricket (*Austrosaga spinifer*). Both of the native bees inhabit vegetation dominated by proteaceous species, therefore clearing of the Banksia woodland, Tuart woodland, *Banskia sessilis* scrub and Jarrah/Banksia woodland within Stage 1 will result in a loss of 85.7 ha of potential habitat for these species. The native cricket species, *Austrosaga spinifer*, has a limited distribution and there is limited information known on its preferred habitat. As a result all of the habitats present in Stage 1 may provide potential habitat for *Austrosaga spinifer*, and clearing for Stage 1 will result in the loss of 86.5 ha of potential habitat for this species.

4.10 Noise & vibration

GHD was commissioned by Main Roads to undertake a road traffic noise assessment for Stage 1 of the Project (GHD 2014a). Predicted traffic noise impacts on receptors were modelled using CadnaA, a computer program for the calculation, assessment and prognosis of noise exposure. Noise levels were predict for five scenarios, based on existing and predicted future road traffic volumes and routes:

- Scenario 1: Baseline current network (year 2013 traffic flows)
- Scenario 2: No build (year 2031 traffic flows)
- Scenario 3: Stage 1 built (year 2021 traffic flows)
- Scenario 4: Stage 1 built (year 2031 traffic flows)
- Scenario 5: Stage 1 built, with rail (year 2031 traffic flows)

The final scenario, which also considered noise emissions from rail traffic during 2031 was assessed to predict the cumulative impact of rail and road noise on sensitive receptors. The following sensitive receptors occur within the Stage 1 Project Area:

- Currambine and Joondalup residential areas
- Kinross residential area
- Urban development land (Catalina)
- Clarkson residential area
- Ridgewood residential area.

Sensitive receptors are largely concentrated to the west of the Stage 1 Project Area. This is because Crown Land, with no significant dwellings or businesses, is located to the east of the proposed alignment. It is important to note that even without the proposed extension of the Mitchell Freeway; the sensitive receptors considered for this assessment would typically receive impacts from:

- Local vehicle traffic
- Vehicle traffic from nearby main roads, including:
  - The existing freeway alignment at southern receptors
  - Other major north/south or east/west roads such as Connolly Drive, Burns Beach Road and Hester Avenue
- The Joondalup train line runs along the current and planned extension to the Mitchell Freeway, and this will also have a noise impact on receptors
- Sounds of nature may be audible in some locations. Residential properties to the north are currently flanked by crown reserve land to the east of the planned freeway extension. Sound of nature can include the wind through the trees, birds and insects
- Residential noise, such as music, leisure and/or sporting activities

Existing ground levels can provide some barrier protection to nearby sensitive receptors. The impact of topography (both existing and design contours) and existing noise walls located near the southern end of Stage 1 were factored into all scenarios.

Predict noise levels at selected sensitive receptors for scenarios 1 (baseline) and 2 (no build 2031) were below the relevant noise limit, but above the noise targets. Although there were more exceedances of the noise target for scenario 2 (no build 2031), there were still no exceedances of the limit predicted for any of the sensitive receptor locations considered in the model. Predicted noise levels for the build scenarios 3 and 4 included road noise impacts based on no new mitigation measures and then the addition of sound walls to meet noise limits and targets, respectively. Without any additional mitigation measures, noise levels were predicted to exceed the target and limit at a number of sensitive receptor locations for both build scenarios. However, the modelling predicts it would be readily achievable to meet noise limits and attainable to meet noise targets at these sensitive receptors with the installation of noise walls.

4.10.1 Evaluation of potential impacts from Noise & Vibration for Stage 1

Although not included in the noise modelling assessment, construction activities will result in increased noise levels due to earth works, construction activities and vehicle and machinery movement and operation. The proposed alignment is located within close proximity to residential premises which may be impacted by nuisance noise during construction.

Noise associated with vehicle movements during the operational phase of the proposed road network is anticipated to increase above current noise levels and will impact on nearby

residential dwellings and local business, even without the Stage 1 extension to the Mitchell Freeway. The development of Stage 1 of the Project is predicted to result in exceedances of the noise target and limits at a number of sensitive receptor locations, without mitigation measures incorporated into the design.

For the majority of the sensitive receptors, mitigation requirements to meet noise limits are predicted to be relatively straight forward, involving use of noise walls of 2.4, 3.0, or 3.6 m height adjacent to the residential area and along the overpass. However, to reach noise targets, far more significant noise mitigation is required, with noise walls as high as 4.8 m. Sensitive receptors located adjacent to the current Mitchel Freeway are more complex, as it is predicted the freeway extension will allow an additional 50,000 vehicles to use the freeway by 2031. As such, a moderate level of mitigation is required to reach noise limits, however the addition of a number of noise walls at 4.8 m height was unable to bring predicted noise levels to below noise targets.

4.11 Ambient air quality

The increase of urban development in the surrounding area has put pressure on the existing freeway and surrounding network of roads which has resulted in increased traffic. There is currently moderate to high traffic use in the area along the existing Mitchell Freeway, Burns Beach Road, Connolly Drive, Wanneroo Road and Marmion Avenue, particularly during peak-time. Sensitive receptors surrounding the Greater Project Area (Stage 1, 2 and 3) include residential dwellings, a school and local businesses.

Major vehicle pollutants include products of combustion, such as CO, PM10, NOx and VOCs. The human health effects of these air pollutants range from mild airway irritations to major organ damage. Repeated exposure can also cause soiling to buildings and other objects. Many of the emissions from motor vehicles react together and with pollutants from other sources to form secondary pollutants, such as photochemical oxidants (ozone), which can also have significant effects.

The National Environmental Protection Measure (NEPM) sets standards for Ambient Air Quality in Australia. The NEPM specifies standards for carbon monoxide, nitrogen dioxide, photochemical oxidants, sulfur dioxide, lead and small airborne particles (known as criteria pollutants). New road projects which may have an impact on local air quality require air quality modelling studies to be conducted to determine if traffic levels could lead to exceedences of the NEPM standards.

An air quality assessment for the proposal would be required to estimate pollution generated by vehicles using projected traffic volumes and vehicle emission rates as inputs to an air dispersion model.

4.11.1 Evaluation of potential impacts to Ambient Air Quality for Stage 1

The construction of the Project has the potential to generate dust as a result of vegetation clearing, earthworks, spillage of soil material and vehicle movement, which may be a nuisance to nearby residents and impact adjacent vegetation. The majority of the soil type in the area is loose sand with fine organic matter, which has potential for movement in strong breezes. Excessive dust emissions have the potential to impact on the health of the local community and surrounding vegetation. Amenity issues may occur in the localised area during construction activities.

The extension of the Mitchell Freeway is expected to redistribute traffic flow within the broader region. The potential air quality impacts from criteria pollutant emissions during the operation phase have not been estimated.

4.12 Visual amenity

The existing amenity of the Greater Project Area (Stage 1, 2 and 3) includes native bushland, existing roads and railway, urban development/residential dwellings, market gardens and cleared land. At the highest point within the proposed Mitchell Freeway extension, north of Hester Avenue, there are views over the suburbs to the west, as far as the ocean. The proposed Mitchell Freeway extension is likely to be visible to a number of neighbouring properties.

The sections of Wanneroo Road proposed for the dual carriageway traverses residential dwellings, market gardens and National Park. Wanneroo Road is currently an important tourist road to northern attractions such as Yanchep National Park and Lancelin and its visual appeal should be considered. The undulating landscape combined with the significant vegetation of the tuart woodland provides an attractive drive which could be significantly altered due to clearing and cut and fill works. There are currently no views to any wetlands from existing or proposed roads within the Greater Project Area.

4.12.1 Evaluation of potential impacts to Visual Amenity for Stage 1

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

- Vegetation clearing, particularly within Neerabup National Park and adjacent reserves.
- Construction of underpasses within Neerabup National park, impacting on bush walk trails
- Changes to the natural land contours (areas of cut and fill)
- Traffic noise exposure
- Changes to local road systems
- Visibility of the freeway

Measures such as traffic noise management, solid fencing, rehabilitation and site landscaping will reduce these impacts to some extent but residual amenity impacts can be expected in the long term.

4.13 Public safety & risk

Increased traffic volumes arising from the movement of construction and transport vehicles may result in some localised short-term adverse impacts on local traffic movements. Provided traffic management and signage to Main Roads standards is employed, none of the proposed works present any significant hazards to public safety.

The proposed freeway extension and associated works will serve to enhance public safety by improving local road conditions.

4.13.1 Evaluation of potential impacts to Public Safety & Risk for Stage 1

Increased traffic volumes arising from the movement of construction and transport vehicles may result in some localised short-term adverse impacts on local and regional traffic movements. The following potential impacts have been identified:

- Risk of injury to road users due to construction vehicles and trucks operating within the local area.
- Potential damage to roads and spillage of carted materials, particularly sand.

4.14 Waste & hazardous substances

Demolition and construction works are likely to generate considerable waste materials. Waste management pertains to the controlled disposal of products that cannot be used onsite, and may include construction waste, general office waste, and hazardous waste. Poor management of waste materials may lead to litter or contamination of the Stage 1 Project Area and surrounds. This in turn may impact on the aesthetics of the area (e.g. visual amenity) and the health of terrestrial ecosystems.

4.14.1 Evaluation of potential impacts from Waste and hazardous substances for Stage 1

The construction of the Project is unlikely to require the use of hazardous substances other than fuels and oils for machinery. The storage and use of hazardous substances for Stage 1 of the Project has the potential, if not carefully managed, to:

- Decrease the health of terrestrial ecosystems, in particular Neerabup National Park and the surrounding nature reserves and Bush Forever sites.
- Pollute groundwater and cause site contamination that may require remediation.
- Adverse impacts on human health if handled inappropriately.

Standard management procedures which minimise the risk of hazardous substances storage and use have been included in the Construction Environmental Management Plan.

4.15 Indigenous Heritage

An Aboriginal heritage desktop assessment for the Project was conducted by R. & E. O'Connor Pty Ltd in May 2013. Searches of the Register of Aboriginal Sites at the Department of Aboriginal Affairs (DAA) have established that there are no previously-recorded Aboriginal sites within the areas of proposed road works (O'Connor 2013). An ethnographic survey of the Greater Project Area was undertaken in December 2013 (Goode 2013). Three previous Aboriginal heritage survey reports are of central relevance to these works, as follows:

- R. O'Connor, C. Bodney and G. Quatermaine, February 1989. Report on a Survey for Aboriginal Sites on the Proposed Mitchell Freeway Extension from Shenton Avenue to Romeo Road.
- R. O'Connor, April 1996. Addendum to the Above 1989 Report.
- McDonald Hales and Associates, 1998. Report on an Aboriginal Heritage of Proposed Wanneroo Road Improvement Project.

The first two documents have established that there are no archaeological sites within a 200 m wide corridor centred upon the Mitchell Freeway Reserve and that there are no known ethnographic sites within a similar 1 km wide corridor (O'Connor 2013). O'Connor (2013) therefore recommends that Aboriginal Heritage considerations should not be deemed an impediment to the proposed Mitchell Freeway extension from Burns Beach Road to Romeo Road.

The third report has established that there are no Aboriginal sites of any type within the areas of the then proposed works centred upon Wanneroo Road. O'Connor (2013) therefore recommends that Aboriginal Heritage considerations should not be deemed an impediment to the proposed upgrade of Wanneroo Road.

The section of Mitchell Freeway to the south of Burns Beach Road and the section of Burns Beach Road to the west of Mitchell Freeway were included in the 1989 and 1996 reports.

O'Connor (2013) recommends that Aboriginal heritage considerations should not be deemed an impediment to the works.

The works will take place in areas already disturbed by previous construction:

- Joondalup Drive-Burns Beach Road junction
- Connolly Drive from Neerabup Road to Hester Avenue
- Hester Avenue through Mitchell Freeway Reserve to Wanneroo Road.

O'Connor (2013) states that it would be difficult to justify any further Aboriginal heritage surveys in these already disturbed areas.

O'Connor (2013) did not uncover any previous Aboriginal heritage surveys which included the proposed Neerabup Road in their scope. O'Connor (2013) recommends that Aboriginal heritage surveys of this proposed road corridor are carried out before construction there commences. This survey should be carried out in accordance with Paragraph 2.18 of the *Due Diligence Guidelines* issued by the Department of Indigenous Affairs (now DAA) as to which persons or groups should be included in Aboriginal heritage surveys and consultations:

Similarly, with the exception of the proposed Butler to Yanchep railway corridor, which was the subject of an Aboriginal heritage survey carried out by O'Connor Pty Ltd in 2012, the proposed realignment of Romeo Road from Marmion Avenue, through the Mitchell Freeway Reserve, to Wanneroo Road does not appear to have been considered in previous Aboriginal heritage surveys. O'Connor therefore recommends that Aboriginal heritage surveys of this proposed road corridor should be carried out before construction there commences (O'Connor 2013).

The ethnographic survey of the Greater Project Area by Brad Goode (Goode 2013) was undertaken as Site ID 3504 Joondalup Waugal Egg and Place ID 20598 Butler-FS03 were not sufficiently defined and could possibly be affected by works to adjoining roads. The desktop assessment confirmed the results of O'Connor (2013). The site consultations with the named DAA site informant and native title claimant's provided no further information with regards to the location and extent of Site ID 3504 Joondalup Waugal Egg. During the consultation it was confirmed that Place ID 20598 Butler-FS03 no longer has any current heritage values as the scar trees and associated evidence of former Aboriginal camping have been destroyed by urbanisation (Goode 2013).

Main Roads staff met with representatives from DAA and South West Aboriginal Land and Sea Council (SWALSC) on 21 August 2013 to discuss the Project. The parties met at the beginning of the 10th Light Horse Heritage Trail, where the past Aboriginal heritage surveys were discussed. All parties travelled to the general area of the proposed Neerabup connecting road and inspected the terrain through which it would pass. Although the preliminary concerns expressed by SWALSC were acknowledged, DAA were of the opinion that both the Hester and Neerabup connecting roads have been adequately surveyed and there is a low risk that a place which would be considered as a site under section 5a of the *Aboriginal Heritage Act 1972* (AH Act) may be located in the area. Additionally, Romeo Road connecter was surveyed in a general 1990 survey. Although this general survey addressed housing developments in the region, it is noted from historical aerial photography that the general area of Romeo Road appears to have previously been grazing land. As such, DAA considers it unlikely that any significant archaeological material finds would occur during a survey of the area.

Based on advice from DAA, the risk of damaging an Aboriginal heritage site as defined by section 5 of the AH Act is considered low and it is anticipated no approval under this Act would be required prior to works proceeding.

4.15.1 Evaluation of potential impacts to Indigenous Heritage for Stage 1

Although unlikely, the Project may impact unidentified Aboriginal heritage sites or skeletal/Indigenous materials within the Stage 1 Project.

4.16 Native Title

The Project is covered by two applications for determination of native title; namely the Swan River People #2 (Number WC 2011/002) and the Whadjuk People (Number WC 2011/009). The latter has satisfied the requirements of Section 190A of the *Native Title Act 1993* (NT Act) and is therefore entered on the Register of Native Title Claims. The Swan River #2 application is unregistered (O'Connor 2013).

The Project is therefore covered by the Whadjuk People (Number WC 2011/009) registered Native Title claim which is one of the six registered claimants being presented the South West Land Settlement by the Western Australian Government as a final offer to resolve native title claims across the South West of Western Australia . The NT Act allows provisions under section 24 (namely 24KA) for the State Government to construct, operate, use, maintain or repair public facilities within the Whadjuk claim, with these claimants having the Right to be Notified and the Right to Comment on the proposed public works.

4.16.1 Evaluation of potential impacts to Native Title for Stage 1

Native title impacts will need to be progressed consistent with the requirements of section 24 of the NT Act.

4.17 European Heritage

A desktop assessment of non-Indigenous heritage places within the Greater Project Area (Stage 1, 2 and 3) was undertaken by Gaye Nayton in August, 2013 (Nayton 2013a). The desktop assessment found a total of 12 known heritage places considered likely to be within the Greater Project Area (Stage 1, 2 and 3). Details of these are summarised in Table 22.

Most of the identified heritage places are located within Neerabup National Park which is crown land. Place 70 is also on crown land. A Government Heritage Property Disposal (GHPD) referral form will need to be completed for those heritage places on crown land.

In many cases the exact location or extent of heritage places could not be determined from the available information. Therefore Nayton (2013b) undertook an archaeological field survey to identify if any archaeological evidence associated with identified listed heritage places would be impacted by the Stage 1 construction phase of the Mitchell Freeway extension from Burns Beach Road to Hester Avenue. Sites identified in the Stage 1 section of the Greater Project Area as containing heritage places were Site 1, Site 54, Site 69 and Site 73. Nayton (2013b) recommended the following actions for the four sites:

- Site 1 – No action required
- Site 54: - No action required
- Site 69 – Include archival record with local government planning approval documentation. Complete GHPD Form and include archival record with documentation
- Site 73 (HCWA 15873) – Section off bush camp and associated single artefact as an exclusion area during Neerabup Road construction. Include mitigation procedures and a copy of the survey report with local government and Heritage Council of Western Australia (HCWA) planning approval documentation

4.17.1 Evaluation of potential impacts to European Heritage for Stage 1

No direct impacts to European Heritage sites are expected if the areas are sectioned off and an exclusion area created. Although unlikely, the Project may impact unidentified European Heritage sites within the Stage 1 Project Area.

Table 22 Summary of non-Indigenous heritage sites located within the Greater Project Area (Stage 1, 2 and 3), the potential impact, and recommendations.

MI Number HCWA Number	Listing Status	Place Name	Ownership	Impact	Recommendations
MI 1 HCWA 15726	MI & MI group	10th Light Horse camp & heritage trail	Crown	On archaeological sites at southern extent of trail.	Site inspection with metal detector to determine extent of impact within project boundary. If impact likely GHPD referral form to be completed and mitigation measures proposed for GHPD and LGA heritage policy purposes.
MI 53 HCWA 9476	MI Possible later inclusion HCWA nomination	Lime Kiln - Lunder (5)	Crown	Possible impact on associated archaeology of workers accommodation, possible impact on kiln.	General area contains three sets kilns (one nominated) and workers accommodation (nominated) the location of all of which is not pinpointed. Recommend this general area of activity covering sites 53, 63 and 64 is accurately surveyed to locate all remains of built heritage fabric and surveyed with a metal detector to determine extent of associated deposits for mitigation purposes under GHPD, LGA heritage policy and HCWA development referral purposes. GHPD referral form to be completed.
MI 54 HCWA 17936	MI	Lime Kiln - Pappas No 1 (6)	Private	Road widening will not impact kiln but may impact any associated historic activities/accommodation areas near the former Wanneroo road and now within the road reserve.	Recommended road reserve is inspected to determine level of impact as part of mitigation planning for LGA heritage policy purposes.
MI 63 HCWA 17929	MI & HCWA Group Nomination	Lime Kilns (22, 23)	Crown	Possible impact on associated archaeology of workers' accommodation, possible impact on kiln.	General area contains three sets kilns (one nominated) and workers' accommodation (nominated), the location of all of which is not pinpointed. Recommend this general area of activity covering sites 53, 63 and 64 is accurately surveyed to locate all remains of built heritage fabric and surveyed with a metal detector to determine extent of associated deposits for mitigation purposes under GHPD, LGA heritage policy and HCWA development referral purposes. GHPD referral form to be completed.

MI Number HCWA Number	Listing Status	Place Name	Ownership	Impact	Recommendations
MI 64 HCWA 17930	MI Possible later inclusion HCWA nomination	Lime Kilns (24,25)	Crown	Possible impact on associated archaeology of workers' accommodation, possible impact on kiln.	General area contains three sets kilns (one nominated) and workers' accommodation (nominated), the location of all of which is not pinpointed. Recommend this general area of activity covering sites 53, 63 and 64 is accurately surveyed to locate all remains of built heritage fabric and surveyed with a metal detector to determine extent of associated deposits for mitigation purposes under GHPD, LGA heritage policy and HCWA development referral purposes. GHPD referral form to be completed.
MI 69 HCWA 9488	MI & MI group	Market Picnic Area	Crown	Area directly impacted, site likely to be destroyed.	MI only, low archaeological values. Recommend place photographed to create archival record under LGA heritage policy and for GHPD processes. LGA permission required for demolition. GHPD referral form needs to be completed.
MI 70 HCWA 14284	MI	Mindarie Pastoral Company Homestead ruins	Crown	Impact in road reserve will not affect ruins. May impact heritage listed trees.	Recommend road reserve is inspected to determine if any heritage trees will be impacted and if impact GHPD referral form required. Compile archival record of any threatened trees for GHPD and LGA heritage policy purposes.
MI 71 HCWA 14291	MI & Register of National Estate	71: Neerabup Lake Caves 14291 Neerabup National Park	Crown	Park contains several heritage places see individual listing for impacts. Desktop could not pinpoint location/depth of cave so impact unknown	Recommend information on location and depth of caves is sought to determine level of impact for GHPD and LGA heritage policy purposes. GHPD referral form required for all listed places on Crown land.
MI 73 HCWA 15873	Route on Register but this section not assessed	North West Stock Route	Crown	Original Wanneroo Rd followed N/W route. Route reserve half mile wide. Widening will affect any surviving evidence of this place	GHPD referral form will need to be completed as this section of place not yet on Register but recommended for assessment. HCWA approval required for adverse impact. Recommend 1890 route overlaid accurately on project plans and stock reserve surveyed for any surviving evidence and evidence mapped to determine level of impact as part of mitigation processes for GHPD and HCWA purposes.

MI = City of Wanneroo Municipal Inventory
HCWA = Heritage Council of Western Australia
GHPD = Government Heritage Property Disposal

5. Summary of impacts & potential management measures

Table 23 Summary of Stage 1 impacts and management measures

Environmental aspect	Potential impact	Management measures
Acid Sulfate Soils (ASS)	Excavation is to be undertaken in three areas of the Stage 1 Project Area: • Burns Beach Road area • Neerabup Road area • Hester Avenue area Risk mapping for these areas has identified a '*Low to nil risk of ASS occurring within 3 m of natural soil surface'*. However, excavation may be greater than 3 m in some areas of the Stage 1 Project Area. Identifying the presence/absence of ASS within the Stage 1 Project Area prior to commencing any earthworks is essential as ASS has the potential to cause significant environmental and economic impacts including: • Contamination of groundwater resources by acid, arsenic, heavy metals and other contaminants • Damage to infrastructure through the corrosion of concrete and steel pipes, bridges and other subsurface assets	GHD recommend that further assessment is undertaken within areas of the Project Area where excavation is predominantly below 3 m of the natural soil surface to confirm the ground conditions and assess the presence of ASS material prior to excavation and/or dewatering (if required). Stage 1 of the Project Area has been separated into three ASS assessment areas, taking into account the three major areas of excavation proposed for the extension route. These areas should be assessed for the presence/absence of ASS: • Burns Beach Road intersection and adjacent area; excavations required expected to be approximately 5 mbgl for the freeway and up to 14 mbgl for ramps • Neerabup Road intersection and adjacent areas; excavations required expected to be up to 7.2 mbgl for the freeway and up to 14.5 mbgl for ramps • South of Hester Avenue and Hester Avenue intersection; excavations required expected to be up to 7.1 mbgl along the freeway and up to 6.5 mbgl for the ramps. In addition, once construction work has commenced the following management measures should be followed: • Contractor should be aware of and

Environmental aspect	Potential impact	Management measures
		trained in the identification of potential ASS. This may be included within the pre-start Tool Box meeting and/or short presentation • Visual checking of material excavated for potential ASS. ASS assessment will be based on material type, colour and consistency. Typically dark grey and black, very soft to soft, occasionally firm clays and sandy and dark grey to grey clayey sands and sands (mud) may be classified as suspected ASS. Additionally brown to dark brown sands (often silty and gravelly) are also suspected ASS material and can contain pyrite and therefore acidify upon exposure. • Contractors should visually assess for jarosite staining, and field pH testing should be carried out if jarosite is evident • Materials encountered during construction works that are suspected of being ASS should be stockpiled separately and advice from a suitably qualified environmental consultant should be sought prior to re-use and/or disposal
Reserves and Conservation Areas	One DPaW managed reserves will be impacted in the Stage 1 Project Area: Neerabup National Park (1.52 ha) Bush Forever Site 383 'Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup' will be impacted by the clearing of 49.87 ha of the Bush Forever Site. Impacts associated with	To avoid and minimise impacts on reserves and conservation areas (and associated flora and fauna species), the following management measures should be implemented: • The design should be modified where possible to minimise the number of trees and extent of vegetation to be cleared • All trees that have been identified as having hollow suitable for Black Cockatoo breeding will be checked to remove any birds in hollows • Clearing should be limited to the area required for the safe

Environmental aspect	Potential impact	Management measures
	clearing within the two DPaW-managed reserves and Bush Forever Site include: Clearing of DPaW Priority-listed flora species and their habitat identified in the Stage 1 Project Area (and loss of habitat for conservation significant flora species that may possibly occur in Stage 1 of the Project) Loss of fauna habitat including habitat for conservation significant fauna species Fragmentation of remnant vegetation patches and habitat Disruptions to breeding cycles and movement of fauna Direct mortality to fauna from construction activities (vehicle strike) Increased erosion and runoff and changes to existing drainage and hydrology The Project may also impact on the conservation reserves that are adjacent, or connected through vegetation, to Stage 1 of the Project (such as Neerabup National Park) through potential indirect impacts, including changes to hydrology, introduction of weeds and fragmentation of habitat.	construction and operation of the road, in line with Main Roads standards • For five consecutive days immediately prior to logging or vegetation clearing activities the areas should be trapped and surveyed by an appropriately licenced and experienced ecologist to remove and relocate any fauna that may be directly impacted by logging and clearing activities • The induction program should include relevant vegetation, flora and fauna information • A clearing line should clearly marked onsite by a surveyor to avoid any unnecessary clearing • Trees of significance should be retained, where possible, and clearly marked on site • Prior to clearing commencement, an internal clearing permit should be approved by the Environmental Coordinator and the Stakeholder Relationships Manager to ensure the applicable environmental and social aspects of the clearing are considered and managed • Prior to the commencement of clearing, the area should be searched for fauna and any fauna relocated into the neighbouring vegetation. Searches should include ground searches for fauna, tree hollow inspections, including the use of a cherry picker if required, with the purpose to remove any possums or birds (including eggs) from the trees
Environmentally Sensitive Areas	The potential impacts associated with the ESAs include impacts on: Flora and vegetation	Management measures to minimise the impacts on the environmental aspect 'Environmentally Sensitive Areas' are discussed in 'Reserves and Conservation Areas'
Hydrology and	Stage 1 of the Project will not directly impact on any	Measures to manage potential changes to groundwater and

Environmental aspect	Potential impact	Management measures
water resources	wetlands, as the closest wetland, Neerabup Lake, is located approximately 150 m east of Wanneroo Road. There is a low risk of indirect impacts, such as changes to hydrology, discharge of contaminated water and the introduction of weeds to this wetland. However, the potential for these impacts is minimised as there is a buffer distance of at least 150 m to the wetland.	surface water drainage patterns, erosion and sedimentation and weeds should be implemented that prevent any potential indirect impacts including • Final drainage designs should be provided to the Department of Water for their information • Drainage structures should be constructed in accordance with design drawings and specifications, conducted by suitably qualified personnel and subsequently approved by DOW • Erosion control measures should be designed and constructed at discharge points. • Water diversion bunds or levees should be established around potentially contaminated areas to prevent the cross-contamination of clean water. • Any evidence of erosion, disturbance to natural drainage flow or impact on vegetation should be reported to the Site Supervisor and be remediated as required • The workforce induction should include information on surface water and groundwater protection during construction • Effective erosion and sediment control measures shall be implemented during construction to mitigate runoff from site. Controls may include mulch sausages, sand bags, silt fences, hay bales and geotextile placement • Construction material should not obstruct drainage lines (flow pathways) • Drainage pathways should be vegetated to reduce scour and slow flows • Hygiene management measures will be observed during the basin constructions, with particular attention to those basins located within dieback uninterpretable areas and Dieback protectable • A Spill Response Procedure shall be prepared and implemented for an oil, chemical or hazardous material spill event to make sure the spill is contained effectively and

Environmental aspect	Potential impact	Management measures
		cleaned up appropriately and efficiently with approved materials. • All fuel storage shall comply with the relevant regulations and legislation. • All chemicals on site will be stored in purpose built containers/tanks in accordance with the MSDS. • Re-fuelling on site shall be undertaken on a sealed/bunded surface or using a catch tray • No re-fuelling of equipment (with the exception of stationary plant) shall be conducted within 50 m of a watercourse • Vehicles shall not be left unattended when re-fuelling • All hydrocarbon spills shall be cleaned up immediately and recorded using the internal project incident reporting tool • Appropriate permits/approvals should be acquired for the taking or discharging of surface and groundwater, and any approval conditions should be implemented Management measures for weeds are discussed in the environmental aspect 'Introduced plants (weeds)'
Groundwater and Public drinking water source areas	Potential impacts from clearing on the Gnangara Mound and a P3 Protection Zone include: Alteration of natural hydrological regimes (changes to groundwater hydrology) Changes to water quality (e.g. through chemical spills, erosion causing turbidity, disturbance of ASS, deposition of sediments, gross pollutants, heavy metals, hydrocarbons and solvents) Flooding of receiving water bodies Dewatering (if required)	Management measures to minimise impacts to groundwater and Public Drinking Water Source Areas are discussed above in the environmental aspect 'Hydrology and Water Resources'
Contaminated	There were no known contaminated sites identified	Potential asbestos containing material and general fly tipping

Environmental aspect	Potential impact	Management measures
Sites	within Stage 1 which means there is limited risk of contaminated sites being encountered during construction. However, if unidentified contaminated sites are encountered during work in Stage 1 these sites could potentially have adverse impacts on environmental and human health. Potential asbestos containing material and general fly tipping (household waste, rusted car body, inert building material including possible asbestos containing material, concrete, wood, pallets and empty fuel drums) were identified at four sites within Stage 1. If disturbed during the Project, these could potentially contaminate the nearby environment and may pose potential harm to construction staff.	waste should be removed and disposed of appropriately before commencing works. The induction program should include training to make sure all personnel are aware of visual and olfactory observations which suggest potential contamination. During intrusive works such as excavations, if visual and or olfactory evidence suggests potential for contamination (e.g. fill material, building rubble, odours, soil staining), works should cease, the site supervisor should be notified, and the material sampled and analysed. Works should commence once the status of the material has been confirmed and corrective actions implemented (if required) Determination of contamination and requirements for remediation should be undertaken on advice from the Environmental Coordinator. The site of potential contamination should be contained (i.e. bunded) to prevent any spread of contaminates, and should be fenced to prevent any unauthorised access.
Vegetation extent and status	Clearing of Stage 1 will reduce the extent of mapped Beard (1979) vegetation associations (at the state level) by less than 0.6 percent of the current extent, and will not drop the extents below the threshold level of 30 percent of the pre-European extent. Clearing of the mapped Heddle et al (1980) vegetation complexes within Stage 1 will reduce the extents by less than 1 per cent of the remaining extent and will not reduce the mapped extents below the threshold	Management measures to minimise the impacts on the environmental aspect 'Vegetation extent and status' are discussed in 'Reserves and Conservation Areas'

Environmental aspect	Potential impact	Management measures
	level of 30 percent of the pre-European extent. However, the mapped vegetation complexes (Heddle et al 1980) within Stage 1 have less than 15 percent of the pre-European extent protected in secure tenure and are thus under the criteria considered by EPA as the target for reservation (EPA 2006a).	
Vegetation Types	Stage 1 will require clearing of the following extents of the vegetation types mapped during the field assessment: 6. Banksia woodland (35.9 ha) 7. Jarrah–Banksia woodland (5.0 ha) 8. Tuart woodland (35.5 ha) 9. Mixed low heath on limestone (0.9 ha) 6. *Banksia sessilis* closed tall scrub (3.9 ha) 10. Mosaic of *Banksia* woodland and Mixed low heath on limestone (5.4 ha) The clearing of vegetation for the Project will increase the fragmentation of vegetation within the local area. This effect is minimised for the majority of the length of Stage 1 of the Project, as the vegetation to be cleared occurs adjacent to existing developed areas, including subdivisions and existing cleared alignments, including the railway. However, clearing for Neerabup Road (east) will fragment vegetation within Neerabup National Park. This fragmentation may lead to community or species isolation, and edge effects	Management measures to minimise the impacts on the environmental aspect 'Vegetation Types' are discussed in 'Reserves and Conservation Areas'

Environmental aspect	Potential impact	Management measures
	(such as weed invasion). Clearing of vegetation along the Neerabup Road alignment will sever an area of contiguous vegetation, which may affect the vegetation integrity in this area.	
Threatened and Priority Ecological Communities	Stage 1 of the Project will involve direct loss of 40.3 ha of the Priority 3 PEC 'Northern Spearwood Shrublands and Woodlands' (PEC equivalent to vegetation types 3, 4, 6 and sections of vegetation type 7 [mosaic]) and 35.9 ha of the Priority 3 PEC 'Banksia dominated woodlands on Swan Coastal Plain IBRA region' (PEC equivalent to vegetation type 1). Clearing of the PEC 'Northern Spearwood Shrublands and Woodland's within the Neerabup Road alignment may also have indirect impacts on the PEC adjacent to the Stage 1 Project Area (within Neerabup National Park) by fragmenting the vegetation which may lead to edge effects, such as increased spread of weeds. The alignment may also impact these surrounding areas by changes to existing drainage and hydrology, increased erosion and runoff, introduction and/or spread of dieback, and increased risk of fire.	Management measures to minimise the impacts on the environmental aspect 'Threatened and Priority Ecological Communities' are discussed in 'Reserves and Conservation Areas'

Environmental aspect	Potential impact	Management measures
Flora species	Clearing for Stage 1 of this Project will require clearing of vegetation with high species diversity. One DPaW listed Priority species was identified in Stage 1: *Jacksonia sericea* (P4) – 706 individuals identified within Stage 1, predominantly within vegetation type 1, and often occurring in disturbed areas and along tracks The impact of Stage 1 of the Project on this species is high as it will impact on high numbers of individual plants of this species. However, *Jacksonia sericea* occurs along the tracks and disturbed areas of the Greater Project Area (Stage 1, 2 and 3), which indicates that this species generally responds well to disturbance. It currently occurs along disturbed and rehabilitated land adjacent to the railway which indicates its potential for regeneration in areas adjacent to the freeway following initial clearing and construction. Management measures, such as seed collection and revegetation with this species, should be implemented to reduce the potential impacts on this species. Clearing for the Project will also reduce the extents of five naturally occurring flora species considered to be species of conservation significance on the Swan Coastal Plain (Government of Western Australia 2000).	Management measures to minimise the impacts on the environmental aspect 'Flora species' are discussed in 'Reserves and Conservation Areas', and 'Introduced Plants (weeds).

Environmental aspect	Potential impact	Management measures
Introduced plants (weeds)	Stage 1 of the Project has the potential to introduce and spread weeds, including declared weeds, into surrounding areas during both the construction and operation phase. These weeds have the potential to impact on areas of native vegetation by competing with native species for habitat. In particular, the Stage 1 Project has the potential to spread weeds into the adjacent Neerabup National Park and Bush Forever sites which may impact on the environmental values of these areas.	Management measures to minimise the impact of introduced plants (weeds) include: • The site induction program should include hygiene training to ensure all staff and sub-contractors are aware of the requirements to avoid the spread and introduction of weeds. • Plant, machinery, equipment, tools and footwear should be cleaned down prior to arrival and prior to departure from the site. Clean down will consist of brushing, gouging, scraping and/or water blasting to remove any compacted soil or plant matter. • All declared category P1 plants under the BAM Act should be managed in accordance with legislated requirements. • Weed infested topsoil should be disposed of at an approved site, which may include within the road reserve, under noise walls or buried beneath 1 m of material (in accordance with Main Roads specifications). Alternatively topsoil may be disposed of at a licensed landfill facility. • Imported fill will be weed free. • Prior to any new seeding or planting, weed control measures should be implemented. • Any revegetation works along and within the Neerabup National Park should only include plant species which are indigenous to the local area. • Revegetation species, in areas other than that within the Neerabup National Park, should be as agreed with Main Roads representative. • Mulch shall be acquired from site works and approved commercial suppliers • Source plant material should be obtained from certified suppliers with appropriate *Phytophthora cinnamomi* and weed control measures.
Dieback	Large areas of Stage 1 of the Project, particularly adjacent	Management measures to minimise the impact of dieback

Environmental aspect	Potential impact	Management measures
	to Hester Avenue and Neerabup National Park have been mapped as Uninfested and Protectable. Dieback could potentially be spread to these areas during construction or operation of the Mitchell Freeway which has the potential to impact on the biodiversity of the area, including declines in vegetation structure and diversity. If Dieback is spread into these areas it could also spread and impact on the biodiversity values on adjacent areas of environmental value, such as Neerabup National Park. In addition, a number of areas within Stage 1 have been mapped as Unmappable and Unprotectable. While these areas are Unmappable there is still the potential for unrecorded Dieback infestations to occur in these areas and the construction of the Stage 1 Project may lead to the spread of Dieback from these areas to Uninfested areas both within and outside of the Greater Project Area (Stage 1, 2 and 3).	include: • Strictly avoid the movement of soils and plant material into the Uninfected and Unmappable areas within Stage 1 of the Project Area • Reduce vehicle and plant movement into and within the site as much as possible- particularly during wet conditions. • Restrict access to public into the Project Area. • Clearly demarcate the areas of the site that are infested and un-infested. The boundaries between the management zones will be clearly marked in the field prior to earthworks commencing. • All site personnel and contractors should be educated with regard to Dieback and their obligations to follow the CEMP and the Dieback management plan • Dieback hygiene procedure to be prepared for use by contractors including the provision of training to all vehicle operators on site in the effective use of clean down stations and the environmental implications of the spread of the pathogen • Ensure the effluent from the clean down stations, leachate from contaminated soil stockpiles and drainage lines from contaminated areas are contained and not able to drain into adjacent dieback free or uninterpretable areas or Neerabup National Park. • As far as practical, time the clearing phase of the operation to occur during the dry months to reduce the risk of spreading the disease
Fauna habitat	Construction for the Stage 1 Project Area will require clearing of up to 86.5 ha of vegetation and the loss of associated fauna habitat. The remaining 64.5 ha of the Stage 1 Project Area consists of planted roadside vegetation, highly disturbed areas and previously cleared areas, which provide little to	Management measures to minimise the impact on the environmental aspect 'Fauna habitat' are detailed in 'Reserves and Conservation Areas'

Environmental aspect	Potential impact	Management measures
	no habitat value given these areas are partially or completely devoid of native vegetation.	
Habitat linkages	Clearing of vegetation for Stage 1 of the Project is likely to exacerbate the existing fragmentation of the habitat and reduce the connectivity of habitat in the local area. This impact predominantly relates to the construction of the Neerabup Road Extension section of Stage 1, which will fragment the habitat within Neerabup National Park and the remnant bushland west of Wanneroo Road. Neerabup National Park and the surrounding Bush Forever Sites form a large contiguous tract of native vegetation that runs north-south between Wanneroo Road and the railway. This tract of vegetation forms a corridor for the movement of fauna species and a large area of habitat for a variety of fauna species. Therefore, clearing for the Neerabup Road Extension will sever this area of contiguous vegetation and create a barrier to the movement of fauna. Clearing for the other sections of Stage 1, including the freeway extension, road duplications, construction of interchanges and the Principal Shared Path will also increase the existing fragmentation of habitat within the local area. The majority of these areas occur adjacent to existing developed areas, including subdivisions and existing	Management measures to minimise the impact on the environmental aspect 'Habitat linkages' are detailed in 'Reserves and Conservation Areas'

Environmental aspect	Potential impact	Management measures
	cleared alignments (such as the railway). Clearing of the vegetation in these areas will reduce the overall area of remnant vegetation within the larger vegetated corridor. This will further reduce the availability of habitat for fauna in the local area and decrease the connectivity of habitat linkages to surrounding bushland areas. The ongoing operation phase of Stage 1 of the Project also has the potential to substantially inhibit (e.g. reduce the number of movements across the road) or reduce the functionality of the habitat in the surrounding area, including foraging and potential breeding habitat. Increased traffic and new vehicle movements as a result of the Project (e.g. along the new Neerabup Road Extension) may also increase the likelihood of death or injury fauna species in the remaining remnant vegetation in the surrounding area (predominantly Neerabup National Park).	
Fauna	The potential impacts to fauna within Stage 1 as a result of the Project are associated with the impacts to flora and vegetation and direct loss of habitat. These impacts include: Loss of fauna habitat (86.5 ha of remnant vegetation) Fragmentation of fauna habitat within the Neerabup National Park due to the Neerabup Road Extension, and loss of	Management measures to minimise the impact on the environmental aspect 'Fauna' are detailed in 'Reserves and Conservation Areas'

Environmental aspect	Potential impact	Management measures
	connectivity and linkages. Disruptions to the movement of fauna, specifically relating to the construction and operational phases of the Neerabup Road Extension, including the barrier created by the road itself and increased frequency of vehicle strikes. During the Neerabup Road fauna movement survey (GHD 2013e) regular activity of a diverse range of fauna groups was recorded, with a high frequency of large terrestrial fauna species such as emus and kangaroos observed. These groups of species may be more susceptible to vehicle strike as a result of the construction of the new road.	
Noise and vibration	Although not included the noise modelling assessment, construction activities will result in increased noise levels due to earth works, construction activities and vehicle and machinery movement and operation. The proposed alignment is located within close proximity to residential premises which may be impacted by nuisance noise during construction. Noise associated with vehicle movements during the operational phase of the proposed road network is anticipated to increase above current noise levels and will impact on nearby residential dwellings and local business, even without the Stage 1 extension to the Mitchell Freeway. The development of Stage 1 of the Project is	For the majority of the sensitive receptors, mitigation requirements to meet noise limits are predicted to be relatively straight forward, involving use of noise walls of 2.4, 3.0, or 3.6 m height adjacent to the residential area and along the overpass. However, to reach noise targets, much more significant noise mitigation is required, with noise walls as high as 4.8 m. Sensitive receptors located adjacent to the current Mitchel Freeway are more complex, as it is predicted the freeway extension will allow an additional 50,000 vehicles to use the freeway by 2031. As such, a moderate level of mitigation is required to reach noise limit, however, the addition of a number of noise walls at 4.8 m height was unable to bring predicted noise levels to below noise targets.

Environmental aspect	Potential impact	Management measures
	predicted to result in exceedances of the noise target and limit at a number of sensitive receptor locations, without mitigation measures incorporated into the design.	
Ambient Air Quality	The construction of the Project has the potential to generate dust as a result of vegetation clearing, earthworks, spillage of soil material and vehicle movement, which may be a nuisance to nearby residents and impact adjacent vegetation. The majority of the soil type in the area is loose sand with fine organic matter, which has potential for movement in strong breezes. Excessive dust emissions have the potential to impact on the health of the local community and surrounding vegetation. Amenity issues may occur in the localised area during construction activities. The extension of the Mitchell Freeway is expected to redistribute traffic flow within the broader region. The potential air quality impacts from criteria pollutant emissions during the operation phase have not been estimated.	Management measures to minimise the impact on the environmental aspect Ambient air quality include: • Workforce inductions should include education in relation to the minimisation of dust. • The Guidelines for the Prevention of Dust and Smoke Pollution from Land Development Sites in Western Australia 1996 should be complied with during construction. • Dust generation should be controlled/mitigated through appropriate measures where practicable including hydro mulch, water application through water carts and chemical dust suppressants. This applies to the entire construction site and includes, but is not limited to haul roads, cleared areas, batters and stockpiles. • Appropriate licenses from the Department of Water should be obtained if required to supply water for dust suppression and other construction purposes. • A complaints register for any issues of concern shall be established • The extent of cleared and other disturbed areas will be minimised as far as is practicable for construction requirements. • When within 5 m of residential boundary, stockpiles shall be kept to below fence height. • All vehicles carrying dusty loads will be covered through the use of tarpaulins etc. if travelling outside of the Project Area where practicable. • The construction site will be kept clean to minimise dust accumulation within and surrounding the site. • Soil surfaces will be rehabilitated

Environmental aspect	Potential impact	Management measures
		and/or stabilised to minimise dust lift. • Regular maintenance of all heavy vehicles. Those owned by a sub-contractor will be inspected prior to entering the site to ensure vehicles are operating effectively, and documented in a maintenance register. • If required and practicable, construction material shall be dampened by sprinkling water prior to transportation, especially during dry and windy weather conditions.
Visual Amenity	Construction and operation of the Project will have a significant impact on the amenity of the local area as a consequence of: Vegetation clearing, particularly within Neerabup National Park and adjacent reserves. Construction of underpasses within Neerabup National park, impacting on bush walk trails Changes to the natural land contours (areas of cut and fill) Traffic noise exposure Changes to local road systems Visibility of the freeway	Measures such as traffic noise management, solid fencing, rehabilitation and site landscaping will reduce these impacts to some extent but residual amenity impacts can be expected in the long term.
Public Safety and Risk	Increased traffic volumes arising from the movement of construction and transport vehicles may result in some localised short-term adverse impacts on local and regional traffic movements. The following potential impacts have been identified: Risk of injury to road users due to construction vehicles and trucks operating within the local area.	Management measures to minimise the impact on Public Safety and Risk include: • All construction staff to be appropriately trained in safe work practices when working around traffic to avoid impacts to the public and environment • The general public should be well informed on the works taking place and appropriate signage should advise the road users and the public of any risks

Environmental aspect	Potential impact	Management measures
	Potential damage to roads and spillage of carted materials, particularly sand.	
Waste and Hazardous Substances	The construction of the Project is unlikely to require the use of hazardous substances other than fuels and oils for machinery. The storage and use of hazardous substances for Stage 1 of the Project has the potential, if not carefully managed, to: Decrease the health of terrestrial ecosystems, in particular Neerabup National Parkand the surrounding nature reserves and Bush Forever sites. Pollute groundwater and cause site contamination that may require remediation. Adverse impacts on human health if handled inappropriately.	Management measures to minimise the impact of waste and hazardous substances include: • The workforce induction shall outline the requirements for waste minimisation and management practices. All workers will be encouraged to minimise waste production and to make sure that any wastes produced are disposed of appropriately. • The Project Area will be kept clean and tidy with litter and waste placed in appropriate disposal / recycle bins • The Project Area will be secured (by security personnel) to reduce the frequency of illegal dumping of rubbish. • Litter and recycle bins shall be placed (and regularly emptied) in appropriate areas. • Waste chemicals shall be disposed of as per the corresponding MSDS sheet. • Any asbestos waste from existing structures shall be removed and disposed of by a suitably qualified demolition contractor • Littered asbestos waste will be removed according to Main Roads and the construction contractor's internal Occupational Health and Safety Procedure • All waste will be disposed of at an appropriate licensed facility.
Indigenous Heritage	Potential impacts include: Loss or damage to potentially unidentified Aboriginal heritage sites within the proposed Neerabup Road alignment and the Romeo Road from Marmion Avenue, through the Mitchell Freeway Reserve, to Wanneroo Road if Aboriginal archaeological surveys of these areas are not undertaken prior to	The Goode report (2013) provided the following recommendations with regards to Stage 1 of the Project: • That the new link road from Wanneroo Road to the Mitchell Freeway (Neerabup Road East) should be monitored for archaeological material. That Main Roads provide for interpretation of the cultural landscape in the form of signage at

Environmental aspect	Potential impact	Management measures
	construction. Disturbance of skeletal material or Indigenous materials if surveys of the proposed Neerabup Road alignment and the Romeo Road from Marmion Avenue, through the Mitchell Freeway Reserve, to Wanneroo Road if Aboriginal heritage surveys of these areas are not undertaken prior to construction.	an information bay that could be positioned along new link road from Wanneroo Road to the Mitchell Freeway (Neerabup Road East). That the new link road from Wanneroo Road to the Mitchell Freeway (Neerabup Road East) be named with a Nyungar name, with the suggestion that 'Mooro' would be appropriate to signify that the land was Yellagonga's country. It is further recommended that Main Roads avoid impacting upon the potential scarified large dead Jarrah located southwest of the Hester Avenue and Wanneroo Road. Should avoidance not be possible an inspection by an archaeologist with expertise in scar tree identification should be considered.
European Heritage	No direct impacts to European Heritage sites are expected if the areas are sectioned off and an exclusion area created. Although unlikely, the Project may impact unidentified European Heritage sites within the Stage 1 Project Area.	Areas containing European Heritage sites should be sectioned off and an exclusion area created.

6. Consultation

The Mitchell Freeway extension has been the subject of a planning process undertaken by Main Roads. The Mitchell Freeway Extension CWG was formed by the State Government in March 2012 with the aim of working with the community and assisted by Main Roads to develop the “right transport” solution for the community in the northern corridor. The CWG closely examined six options and associated costs and then prepared a Strategic Business Case, recommending Value Engineered Option F (staged construction) as the preferred transport solution.

Main Roads has established a Community Reference Group (CRG) to provide input to the preliminary design for the Mitchell Freeway Extension. It is intended the CRG will include key stakeholders from eight suburbs: Joondalup, Currambine, Kinross, Clarkson, Merriwa, Ridgewood, Butler and Alkimos. Also included will be some members of the CWG.

The CRG will be a non-decision making group that will assist Main Roads throughout the project development including the preliminary design process.

During the delivery stage of the project Main Roads will establish a Construction Reference Group (mainly members from the CRG) to assist Main Roads and the contractor providing valuable input during the detailed design, environmental management and local traffic management issues of the project.

7. Approvals

7.1 Federal approvals

Referral to DotE under the EPBC Act is triggered if a proposed action has/or potentially has a significant impact on any Matter of National Environmental Significance (MNES), including National Heritage values. An assessment of the Project against each of these issues is provided in Table 24.

Table 24 Assessment of the Project against Matters of National Environmental Significance (MNES)

Matters of National Environmental Significance	Present	Impact
World Heritage Places	No	None
National Heritage Places	No	None
Ramsar Wetlands	No	None
Nationally Threatened Species and Ecological Communities	Yes	Removal of up to 86.5 ha of known and potential foraging habitat for the three Black Cockatoo species. Removal of up to 40.5 ha of potential breeding habitat for Carnaby's Black Cockatoo. Removal of up to 40.5 ha of potential roosting habitat for the three Black Cockatoo species. Removal of potential breeding habitat for the Rainbow Bee-eater and potential dispersal habitat for the Chuditch.
Listed Migratory Species	May be present	No significant impacts
Commonwealth Marine Areas	No	None
The Great Barrier Reef Marine Park	No	None
Nuclear Actions	No	None
A water resource (in relation to coal seam gas and/or large coal mining development)	No	None

7.1.1 Black Cockatoos

On behalf of Main Roads, GHD submitted a referral to the DotE for Stage 1 for the loss of potential and known habitat for Black Cockatoos on 13 December 2013. The DotE responded to this referral on 9 January 2014. The proposed action was deemed a controlled action and, as such, requires assessment and a decision on approval under the EPBC Act before it can proceed. In addition it was determined that the Project will need to be assessed through preliminary documentation and that further information is required to be able to assess the relevant impacts. Further information on potential offset sites is currently being sought.

The potential impacts on Black Cockatoo species have been discussed in detailed in section 4.9.7 and 4.9.8.

7.1.2 Chuditch

The key potential impact to the Chuditch for Stage 1 is the clearing for the Neerabup Road Extension, which will result in fragmentation of the larger linear area of contiguous vegetation.

The Chuditch is not known to occur within Stage 1 of the Project Area, however there is the potential for small population of the species to occur in the Neerabup National Park. Stage 1 of the Project will remove up to 86.5 ha of potential habitat for this species. In the absence of species specific guidelines the DotE Significant impact guidelines 1.1 (DotE 2013d) were consulted to decide whether or not a referral under the EPBC Act may be required for the Chuditch with regard to this Project.

This assessment found that the Project is unlikely to have a significant impact on the Chuditch, primarily because Chuditch have large home-ranges and the clearing required for Stage 1 of the Project is unlikely to significantly reduce the availability of potential habitat for the species in the local area to extent where the species is likely to decline. Chuditch require very large areas of habitat to persist and have large home ranges (1500 ha for males and 400 ha for females), and the area of Neerabup National Park size (1069 ha, excluding the proposed extensions), and in turn Stage 1 of the Project Area may only support a small population. Therefore, the species is unlikely to rely on the habitats present within Stage 1, and clearing of 86.5 ha of potential habitat for the species is unlikely to substantially reduce the area of occupancy of the species overall.

7.1.3 Rainbow Bee-eater

The Rainbow Bee-eater is known to range over vast areas and utilise a wide variety of habitats throughout most of Australia (Morcombe, 2004). A pair of Rainbow Bee Eaters were observed within the Tuart Woodland of the Neerabup Road within Stage 1 and the species is known to occur throughout Neerabup National Park. Stage 1 of the Project will remove up to 86.5 ha of habitat for this species including potential breeding habitat. In the absence of species specific guidelines the DotE Significant impact guidelines 1.1 (DotE 2013d) were consulted to decide whether or not a referral under the EPBC Act may be required for the Rainbow Bee-eater with regard to this Project. This assessment found that the Project is unlikely to have a significant impact on the Rainbow Bee-eater, as discussed below.

The highly mobile, wide ranging behaviour of this bird means that Stage 1 of the Project is highly unlikely to lead to a long-term decrease in the size of a population of Rainbow Bee-eater. This species utilises a wide variety of habitats and there is a large area of suitable habitat for the species within the local surrounding area (including habitat suitable for breeding). For example, Neerabup National Park is 937 ha in area and provides habitat with suitable nesting resources for Rainbow Bee-eaters. Therefore, the loss of 86.5 ha of potential breeding habitat for Stage 1 of the Project is unlikely to significantly reduce the availability of suitable breeding habitat at a local and regional scale to the extent that the species is likely to decline. The 86.5 ha of habitat is also not considered to be critical habitat for the Rainbow Bee-eater as it is known to utilise a broad range of habitat types and traverse extensive areas.

Furthermore, clearing of 86.5 ha of potential habitat for Stage 1 is unlikely to significantly reduce the area of occupancy of the Rainbow Bee-eater, due to the size of the proposed clearing in relation to the vast areas occupied by individuals and the species overall. Stage 1 of the Project is also unlikely to fragment the existing population given the mobility of the bird and regional habitat connectivity. There is the potential for clearing activities for the construction of Stage 1 of the Project to disrupt the breeding cycle of individual birds during the breeding season (between November and January), however this is unlikely to impact on the species.

7.1.4 Offsets

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures are implemented. These remaining,

unavoidable impacts are termed ‘residual impacts’. For assessments under the EPBC Act, offsets are only required if residual impacts are significant (DSEWPaC 2012a).

Based on this assessment, the residual impacts on the Black Cockatoos are considered to be significant. An offset package, which is tailored specifically to the attribute of the protected matter that is impacted, will be required for this Project and is currently in the process of being developed. Main Roads is currently in negotiations to acquire an area of land in the vicinity of GinGin that contains Black Cockatoo foraging and potential breeding habitat.

7.2 State approvals

7.2.1 Referral to Environmental Protection Authority (EPA)

Significant proposals (e.g. subdivision and development applications) must be referred to the EPA under Section 38 of the *Environmental Protection Act 1986* (EP Act).

In deciding whether a proposal will be subject to the formal environmental impact assessment process, the EPA takes into account the environmental significance of any potential impacts that may result from the implementation of the scheme or proposal.

Regardless of these factors, Main Roads must refer a project if it triggers the following:

- It is likely to have a significant effect on the environment
- There is a high level of public interest
- A new road or a major realignment is involved

The MRS amendment 992/33 was referred to the EPA in March 2000 and was approved under Ministerial Statement 629 in 2003. Neerabup Road east was not approved pending deferred factors for impacts to fauna. The remaining areas were approved. Conditions were imposed and these conditions are currently being addressed (Table 25).

Neerabup Road east and west will require referral under this Act given the project involves the construction of a new road. Additionally, the project will impact on the following environmental factors:

- Significant habitat for threatened fauna (Black Cockatoos)
- Bush Forever sites; and
- Neerabup National Park

An EPA referral is currently being prepared for Neerabup Road east and west by GHD.

Table 25 MRS amendment 992/33 conditions and outcomes for Stage 1 Project Area

Conditions imposed by EPA			Where addressed
Preparation of a Vegetation and Fauna Management Plan, including the following elements	**For: Reservation of the two East-West Roads**	**For: Alignment for Mitchell Freeway and part of the Northern Suburbs Rail System**	**On behalf of Main Roads, GHD completed a vegetation and fauna management plan in March 2014. This plan addressed the conditions of the EPA.** **Additional studies or management plans where the conditions have been addressed are included below**
	• Provision for revegetation	• Provision for revegetation of cleared or degraded areas within and adjacent to the amendment area.	
	• Weed control program	• Weed control program.	*Also addressed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*
	• Dieback management plan including dieback survey within the proposed alignments.	• Dieback management plan including dieback survey within the proposed alignment.	*Dieback management plan. On behalf of GHD, Glevan Consulting (2013) undertook an assessment of the vegetation within the Greater Project Area (Stage 1, 2 and 3). This assessment includes dieback management measures*
	• Fire management plan	• N/A	*Also addressed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*
	• Fauna survey to be undertaken along and adjoining the proposed alignments to delineate usage and movement patterns within the Project Area.	• Fauna survey for scheduled and priority fauna species, to be undertaken along and adjacent to the proposed alignment to delineate usage of sites within the Project Area.	*GHD undertook a Fauna Movement Study for the Neerabup Road Extension in February 2014. Fauna survey for scheduled and priority fauna species. GHD completed a Fauna Trapping Survey for Neerabup Road Extension in March 2014*.
	• Relocation of individual scheduled and priority fauna if their ranges lie within or overlap the area of the proposed alignment.	• Relocation of individual scheduled and priority fauna species, to be undertaken along and adjacent to the proposed alignment to	*Also addressed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*

Conditions imposed by EPA			Where addressed
		delineate usage of sites within the Project Area.	
	• N/A	• Further flora survey work in relation to the Mitchell Freeway alignment between Burns Beach Road and Hester Avenue to identify populations of Declared rare Flora or Priority taxa.	*Comprehensive spring survey for Declared Rare Flora, Priority and other significant taxa. GHD completed a Level 2 flora and vegetation survey which included a spring flora survey, targeted orchid survey, targeted TEC/PEC, Threatened and Priority flora survey*.
	• N/A	• Targeted flora survey for *Acacia benthamii* and *Eucalyptus argutifolia* within Neerabup National Park and designation of appropriate management measures.	*As above.*
	• Investigations into the alternatives for facilitation of fauna movement across each alignment	• Investigations into the alternatives for facilitation of fauna movement across each alignment	*Also addressed in Fauna Movement Study for the Neerabup Road Extension completed by GHD in February 2014 and Construction Environmental Management Plan (CEMP) by GHD (2014b).*
	• Investigation into measures that will reduce pressures, such as introduced species, disease and increased road deaths, on fauna populations within Neerabup National Park.	• N/A	*Also addressed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*
	• Identification of design and construction elements required to minimise impacts on fauna and park management.	• N/A	*Also addressed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*
	• Monitoring of fauna movement	• Monitoring of fauna	*GHD undertook a Fauna Movement Study for the Neerabup*

Conditions imposed by EPA			Where addressed
	across each alignment.	movement across each alignment.	*Road Extension in February 2014.*
	• The use of lighting along the roads to assist in the reduction of road deaths of nocturnal terrestrial fauna species	• Control of the use of lighting along the alignment to assist in the reduction of deaths of nocturnal terrestrial fauna species.	*Detailed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*
	• Allocation of responsibilities and timing for the implementation.	• Allocation and responsibilities and timing for implementation of the Vegetation and Fauna Management Plan.	*Also detailed in the Construction Environmental Management Plan (CEMP) by GHD (2014b).*
Preparation of a Construction Management Plan	**For: Reservation of the two East-West Roads**	**For: Alignment for Mitchell Freeway and part of the Northern Suburbs Rail System**	**On behalf of Main Roads, GHD completed a vegetation and fauna management plan in March 2014. This plan addressed the conditions of the EPA.** **Additional areas where the conditions have been addressed are included below**
	• Management of drainage incorporating best practice Water-Sensitive Design principles, in consultation with the Waters and Rivers Commission, which considers the implications to existing vegetation and groundwater quality from both sumps and altered surface hydrology to minimise potential for waterlogging and infiltration of pollutants to groundwater.	• Management of drainage incorporating best practice Water-Sensitive Design principles, in consultation with the Waters and Rivers Commission, which considers the implications to existing vegetation and groundwater quality from both sumps and altered surface hydrology to minimise potential for waterlogging and infiltration	

Conditions imposed by EPA			Where addressed
		of pollutants to groundwater.	
	• Investigation for the presence of caves prior to and during clearing for construction, and management of discovery.	• Investigation for the presence of caves before and during clearing for construction, and management of discovery.	*Main Roads has completed a geotechnical survey.*
	• Investigation of the potential impacts on any cave or karst system encountered in areas cleared or cut during construction, and designation of appropriate management measures.	• N/A	
	• The erection of exclusion fencing of the alignment area as designated by the 'extent-of-works' prior to any clearing for construction.	• The erection of exclusion fencing of the alignment area as designated by the 'extent-of-works' prior to any clearing for construction, paying particular attention to retaining as many mature trees as possible.	
	• Provision for meeting the requirements of the *Wildlife Conservation Act*	• N/A	
	• Summary of the management measures identified in the Vegetation and Fauna	• N/A	

Conditions imposed by EPA			Where addressed
	Management Plan which require action during construction.		
	• N/A	• Investigation for the presence of subterranean fauna within any cave or karst system encountered in areas cleared or cut during construction, and designation of appropriate management measures on advice of the Department of Environmental Protection.	
	• N/A	• Control of the use of lighting along the alignment to assist in the reduction of deaths of nocturnal terrestrial fauna species.	
	• N/A	• Compliance with appropriate dust, noise, vibration, and light standards and guidelines during construction.	
	• Allocation of responsibilities and timing for implementation	• Allocation of responsibilities and timing for implementation.	

Conditions imposed by EPA			Where addressed
Preparation of Noise, Vibration and Light Management Plan			**On behalf of Main Roads, GHD (2014b) completed a CEMP that broadly addresses noise, vibration and light management, with detailed plans to be developed by the Design and Construction contractor.**
		Predictions of noise levels from vehicles and trains along the length of the alignment, but focussing primarily on urban areas.	*GHD (2014a) completed a noise assessment for Main Roads which considered both road and rail related noise emissions.*
		Details of noise management measures to ensure compliance with current Main Roads WA and Western Australian Government railways Commission standards.	
		Procedures for monitoring the effectiveness of noise management measures once implemented.	
		Further investigation to determine the potential level of vibration in adjacent urban areas and designation of appropriate controls to comply with Australian Standard 2670.2-1990: Evaluation of human exposure to whole-body vibration-Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz).	
		A complaints response procedure.	
		Management measures to ensure that light overspill meets	

Conditions imposed by EPA			Where addressed
		the requirements of Australian Standards.	
		Allocation of responsibilities and timing for implementation.	

7.2.2 Department of Environment and Regulation (DER)

The clearing of vegetation in Western Australia is regulated by the DER and requires a permit under the EP Act, unless covered by an exemption. Main Roads has been granted a Statewide vegetation clearing permit (Purpose Permit CPS 818-11), granted under section 51E of the EP Act, from the DER. The Purpose Permit allows Main Roads to clear native vegetation for road realignment projects and associated construction activities (including preconstruction activities). Any clearing of native vegetation must be assessed against the "Ten Clearing Principles" outlined in the permit. The Permit does not authorise the clearance of native vegetation for project activities where:

- The clearing may be seriously at variance with the clearing principles
- Those project activities are incorporated in any proposal that is referred to and assessed under Part IV of the EP Act by the EPA.

Stage 1 of this Project is not likely to require a clearing permit as it is likely to be assessed by the EPA. However, if there are any areas of clearing required that will not have been assessed by the EPA then a clearing permit may be required.

An assessment of the Project against the 10 Clearing Principles is provided in Table 26. The Project is considered to be seriously at variance to principle (a), (b) and (h), and may be at variance with principle (g). Based on this assessment it is unlikely the required clearing could be undertaken via the Main Roads' Statewide vegetation clearing permit. If the EPA does not assess Stage 1, then a separate native vegetation clearing application will be required.

7.2.3 Referral to Department of Water (DoW))

The RIWI Act covers the regulation, management, use and protection of water resources and irrigation in Western Australia. A DoW 5C licence, as issued under the RIWI Act, will be required for this Project if groundwater abstraction or dewatering is undertaken as a result of Project works.

7.2.4 Referral to Department of Aboriginal Affairs (DAA)

As no Registered aboriginal heritage sites were identified within the Disturbance area, there currently appears to be no legislative requirement to submit a Section 18 application to the DAA under the AH Act.

If Aboriginal artefacts or remains are uncovered during the Project works, Main Roads should cease works immediately and consult with the DAA.

Table 26 Assessment of the Project against the Ten Clearing Principles for Stage 1

Clearing Principle		Assessment	Outcome
(a)	Native vegetation should not be cleared if it comprises a high level of biological diversity.	Clearing for Stage 1 will involve direct loss of 49.87 ha of Bush Forever site 383 'Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup'. One DPaW-managed reserve occurs within the boundaries of the Stage 1 Project Area: • Neerabup National Park (1.52 ha within Stage 1) Nearly half of Stage 1 (64.5 ha or 43 percent) has been highly disturbed and is cleared or has been revegetated with native or introduced plant species. The remnant vegetation (86.5 ha or 57 percent) within Stage 1 consists of six vegetation types: • Banksia woodland (35.9 ha) • Jarrah–*Banksia* woodland (5.0 ha) • Tuart woodland (35.5 ha) • Mixed low heath on limestone (0.9 ha) • *Banksia sessilis* closed tall scrub (3.9 ha) • Mosaic of vegetation types 1 & 4 (5.4 ha) Stage 1 of the Project will involve clearing of 45.7 ha of the Priority 3 PEC 'Northern Spearwood Shrublands and Woodlands' (PEC equivalent to vegetation types 3, 4, 6 and sections of vegetation type 7 [mosaic]) and 35.9 ha of the Priority 3 PEC 'Banksia dominated woodlands on Swan Coastal Plain IBRA region' (PEC equivalent to vegetation type 1). Vegetation condition (Keighery 1994) of Stage 1 ranges from Excellent (2) to Completely Degraded (6): • Excellent (41.2 ha) • Excellent to Very Good (1.8 ha) • Very Good (5.9 ha) • Good (16.2 ha) • Good to Degraded (15.1 ha) • Degraded (8.1 ha) • Degraded to Completely Degraded (10.5 ha) • Completely Degraded (52.2 ha)	The Project is seriously at variance with this principle.

Clearing Principle		Assessment	Outcome
		Clearing of Stage 1 will reduce the extent of mapped Beard (1979) vegetation associations (at the state level) by less than 0.6 percent of the current extent, and will not drop the extents below the threshold level of 30 percent of the pre-European extent. Clearing of the mapped Heddle et al (1980) vegetation complexes within Stage 1 will reduce the extents by less than 1 percent of the remaining extent and will not reduce the mapped extents below the threshold level of 30 percent of the pre-European extent. However, the mapped vegetation complexes (Heddle et al 1980) within Stage 1 have less than 15 percent of the pre-European extent protected in secure tenure and are thus under the criteria considered by EPA as the target for reservation (EPA 2006a). A NatureMap search identified 1023 plant taxa (including subspecies and varieties) representing 143 families and 483 genera, that have previously been recorded within 10 km of the Greater Project Area (Stage 1, 2 and 3) (820 native species and 203 introduced exotic species). The GHD flora survey identified a total of 392 flora species, representing 79 families and 234 genera within the Greater Project Area. This total comprised 246 native species and 146 introduced/planted species. Dominant families recorded within the Greater Project Area were: Fabaceae (49 taxa), Asteraceae, Myrtaceae and Poaceae (32 taxa each) and Proteaceae (25 taxa). Surveys of the Greater Project Area indicated that the area supports a high floral diversity with large numbers of native plant species. Clearing for Stage 1 of this Project will require clearing of vegetation with high species diversity. No flora species listed under the EPBC Act or the WC Act have been recorded within Stage 1. One DPaW listed Priority species was identified in Stage 1: • *Jacksonia sericea* (P4) – 706 individuals identified within Stage 1, predominantly within vegetation type 1, and often occurring in disturbed areas and along tracks Clearing for the Project will also reduce the extents of five naturally occurring flora species considered to be species of conservation significance on the Swan Coastal Plain (Government of Western Australia 2000). A NatureMap search identified 456 fauna species as previously recorded within 10 km of the Greater Project Area (Stage 1, 2 and 3), of which 438 species are native and 18 are pest (introduced) species. During the Level 1 field survey undertaken by GHD (2013a), a total of 61 fauna species, consisting of 47 birds, seven reptiles and seven mammals were recorded within the Greater Project Area (Stage 1, 2 and 3). Of these, nine are introduced (feral) species. GHD also undertook a fauna trapping survey for the Neerabup Road Extension (GHD 2013d) located within Stage 1 of the Project. A total of 114 vertebrate fauna species comprising 1485	

Clearing Principle		Assessment	Outcome
		individuals from both opportunistic and trapping survey results was recorded. This included 70 birds, 29 reptiles, one amphibian, eight native mammals (including bats) and six introduced mammals. Fourteen conservation significant fauna species are known, likely to or may possibly occur within the Stage 1 Project Area. Clearing for Stage 1 of the Project Area will impact on five mapped habitat types for fauna: • *Banksia* woodland on grey/brown sand • Tuart (*Eucalyptus gomphocephala)* woodland in deep dark brown sand • *Banksia sessilis* tall shrubland on grey sand and limestone outcropping • Jarrah (*E. marginata*)–*Banksia* woodland on grey/brown sand • Mosaic of *Banksia* woodland and low heathland Stage 1 of the Project supports substantial areas of native vegetation that contains PECs, DPaW priority listed flora, other conservation significant flora and habitat for conservation significant fauna. Stage 1 of the Project Area is considered to contain high biodiversity, particularly in relation to its position on the Swan Coastal Plain where large scale clearing of adjacent vegetation has occurred. Stage 1 of the Project is likely to be seriously at variance within this 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 to Western Australia.	The desktop assessment identified the presence or potential presence of 20 Threatened fauna listed under the EPBC Act, 28 Migratory birds listed under the EPBC Act, 24 Threatened or other specially protected species listed under the WC Act and 13 Priority fauna species listed by the DPaW. Seven conservation species are known to occur, six species are likely to occur, and one species could possibly occur within Stage 1 of the Project. The seven species known to occur within Stage 1 of the Project (i.e. were identified during the field surveys) include: • Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered (EPBC Act) Schedule 1 (WC Act). Present in Stage 1 • Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) – Vulnerable (EPBC Act), Threatened (Schedule 1 WC Act). Present in Stage 1	The Project is seriously at variance with this principle

Clearing Principle		Assessment	Outcome
		• Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso*) – Vulnerable (EPBC Act), Vulnerable (WC Act). Present in Stage 1 • Carpet Python (*Morelia spilota imbricata*) – Schedule 4 (WC Act) • Rainbow Bee Eater (*Merops ornatus*) – Marine/Migratory (EPBC Act), Schedule 3 (WC Act) • Western Brush Wallaby (*Macropus irma*) – Priority 4 • Quenda/Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) – Priority 5 The conservation significant species considered likely to occur include the Peregrine Falcon, Jewelled Ctenotus, Black-striped Snake, two native bee species (*Leioproctus contrarius* and *Hylaeus globuliferus*) and one native cricket species (*Austrosaga spinifer*). The Chuditch may possibly occur in Stage 1 of the Project, however given the species large home range and the size of the larger Neerabup National Park the population that may occur is likely to be small. Stage 1 of the Project Area consists of five fauna habitat types, all associated with native remnant vegetation, including: • *Banksia* woodland on grey/brown sand • Tuart (*Eucalyptus gomphocephala)* woodland in deep dark brown sand • *Banksia sessilis* tall shrubland on grey sand and limestone outcropping • Jarrah (*E. marginata*)–*Banksia* woodland on grey/brown sand • Mosaic of *Banksia* woodland and low heathland There is also 51.4 ha of planted roadside vegetation/highly degraded/cleared areas. These areas provide little to no habitat value given that these areas are partially or completely devoid of native vegetation. <u>Black Cockatoos</u> Stage 1 of the Project Area provides known habitat for all three species of Black Cockatoos. The type and extent of Black Cockatoo habitat is described below. • All areas containing remnant native vegetation within Stage 1 can be considered to	

Clearing Principle		Assessment	Outcome
		represent suitable Black Cockatoo foraging habitat. All three species of Black Cockatoo were observed foraging within Stage 1 of the Project, and therefore the remnant vegetation represents known habitat. In total there is 86.5 ha of foraging habitat for Black Cockatoos in Stage 1. • There is 40.5 ha of potential Tuart woodland and Jarrah/*Banksia* woodland breeding habitat for Carnaby's Black Cockatoo within Stage 1 of the Project. A total of 589 trees with DBH of >500 mm were recorded within Stage 1 and 31 of these trees contained hollows which were considered to provide suitable breeding habitat for Carnaby's Black Cockatoo (with an entrance diameter greater than 20 cm). • There is 40.5 ha of potential Tuart woodland and Jarrah/*Banksia* woodland habitat for all three species within Stage 1 of the Project. In addition, one potential roosting site was identified during the survey, near the Clarkson rail line approximately 1 km south of Neerabup Road. This site showed evidence of roosting by Black Cockatoos, including presence of cut debris (leaves and small branches) on the ground and large amounts of faecal material. Overall, Stage 1 of the Project will involve clearing of 86.5 ha of known and potential foraging habitat and 40.5 ha of potential breeding and roosting habitat for Black Cockatoos. This loss of habitat is considered likely to have a significant impact on Carnaby's Black Cockatoo due to the loss of potential breeding habitat, as well as the loss of a large area of foraging habitat within the local area.	
(c)	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	The GHD desktop search, field survey and likelihood of occurrence assessment identified two Threatened flora species as possibly occurring within the Greater Project Area (Stage 1, 2 and 3): • *Caladenia huegelii* (Threatened; State and Endangered; Federal) – Possible • *Drakaea micrantha* (Threatened; State and Vulnerable; Federal) – Possible A Level 2 flora assessment was undertaken in Autumn and Spring 2013. Neither of these species were identified during this survey.	The Project is not likely to be at variance within this principle.

Clearing Principle		Assessment	Outcome
(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.	No Threatened Ecological Communities were identified within the Stage 1 Project Area within the desktop and field surveys.	The Project is not likely to be at variance with this 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.	Broadscale vegetation mapping of the area (Beard 1979) identified two vegetation associations present within the Stage 1 Project Area: • Low woodland; banksia [*Banksia* spp.] (association 949; 45.1 ha) • Medium woodland; tuart [*E. gomphocephala*] (association 998; 105.9 ha) The Heddle et al. (1980) mapping identified two vegetation complexes within the Stage 1 Project Area: • Spearwood dunes – Cottesloe complex (central and south; 149.4 ha) • Wetlands – Herdsman complex (1.6 ha) Clearing of Stage 1 will reduce the extent of mapped Beard (1979) vegetation associations (at the state level) by less than 0.6 percent of the current extent, and will not drop the extents below the threshold level of 30 percent of the pre-European extent. Clearing of the mapped Heddle et al (1980) vegetation complexes within Stage 1 will reduce the extents by less than 1 percent of the remaining extent and will not reduce the mapped extents below the threshold level of 30 percent of the pre-European extent. However, the mapped vegetation complexes (Heddle et al 1980) within Stage 1 have less than 15 percent of the pre-European extent protected in secure tenure and are thus under the criteria considered by EPA as the target for reservation (EPA 2006a).	The Project is not likely to be at variance with this principle.
(f)	Native vegetation should not be cleared if it is growing in or in association with a watercourse or wetland.	No Surface Water Areas including Rivers listed under the RIWI Act were identified in Stage 1. The EPBC Act Protected Matters Search did not identify any Ramsar listed wetlands within 10 km of Stage 1. There are no EPP lakes or geomorphic wetlands within Stage 1. No vegetation associated with watercourses or wetlands was recorded in Stage 1 of the Project during the field survey.	The Project is not likely to be at variance with this principle
(g)	Native vegetation should not be cleared if the clearing of the	The groundwater salinity in Stage 1 is relatively fresh, ranging from typically 200 to 1000 mg/L TDS. The Natural Resource Management Shared Land Information Platform (SLIP) has mapped	The Project may be at

Clearing Principle		Assessment	Outcome
	vegetation is likely to cause appreciable land degradation.	the salinity risk as '0-2% high to extreme hazard of salinity risk'. Native vegetation clearing in Stage 1 is unlikely to increase salinity in Stage 1 and surrounding areas. Stage 1 is located within the Gnangara Mound which is an important source of fresh groundwater in the Perth region, derived from the unconfined superficial aquifer. The Natural Resource Management SLIP has mapped the waterlogging risk as '0-2% moderate to very high hazard' and flooding risk as '0-2% Moderate to high hazard'. It is unlikely that clearing of native vegetation in Stage 1 will increase waterlogging and flooding within and surrounding Stage 1. The risk of water erosion was mapped as '3-9% high to extreme hazard' for the majority of Stage 1. Stage 1 consists of Spearwood Dunes and Quindalup Dunes. The Natural Resource Management SLIP has mapped wind erosion risk as '70-100% high to extreme hazard' for the majority of Stage 1 and '30-49% high to extreme hazard' for the remaining areas. The high sand content of the soils and ease with which these materials can be transported by the wind means there is a high risk of wind erosion in this area.. The sands within Stage 1 of the Project Area are relatively porous and well drained and therefore there is little overland surface water flow, which minimises the risk of water erosion. The site has '*No known risk of ASS occurring within 3 m of the natural soil surface'* for the Stage 1 Project Area. Native vegetation clearing in Stage 1 is unlikely to result in ASS; however any excavations below 3 may result in ASS and an increase in subsurface acidification in Stage 1 and the surrounding areas and will require further investigation. Due to the risk of an increase in wind erosion and runoff the Project may be at variance to this principle. However, standard management measures will be implemented to minimise the potential for land degradation to occur.	variance with this principle
(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.	One DPaW-managed reserve occurs within the boundaries of the Stage 1 Project Area: • Neerabup National Park The Project will involve the total clearing of 1.52 ha of Neerabup National Park in Stage 1. One Bush Forever site occurs within Stage 1: • Site 383 – Neerabup National Park, Lake Nowergup Nature Reserve and adjacent bushland, Neerabup The Project will involve the total clearing of approximately 49.87 ha or 2.87% in Stage 1 of Bush Forever Site 383. Stage 1 is surrounded by four other DPaW managed reserves:	The Project is seriously at variance with this principle

Clearing Principle		Assessment	Outcome
		• Lake Joondalup Nature Reserve (approximately 500 m south of the Stage 1 Project Area). • Gnangara–Moore River State Forest (approximately 2.5 km east of the Stage 1 Project Area). • Marmion Marine Park (approximately 5 km west of the Greater Project Area (Stage 1, 2 and 3)). • Neerabup Lake and adjacent bushland (approximately 500 m north-east of the Stage 1 Project Area). Within the Stage 1 Project Area, the areas of remnant vegetation in and immediately surrounding the Greater Project Area are part of a regionally significant contiguous bushland/wetland linkage (Government of Western Australia 2000), with a large proportion of this vegetation currently protected as national park and a series of Bush Forever sites (Government of Western Australia 2000). There are several surrounding linkages and the habitat within Neerabup National Park (Bush Forever site 383) is linked to bushland to the north in Yanchep National Park, to the south to Bush Forever site 299 (across Wanneroo road) and to the east and west to Bush Forever Site 323 and through bushland to Bush Forever Site 397. The vegetation within Stage 1 of the Project also is part of Greenways 35, 2, 5 (Tingay, Alan and Associates 1998). Neerabup National Park provides a narrow corridor to allow movement of animals along the coastal plain and associated wetlands. Stage 1 of the Project contains areas of national park, nature reserve and Bush Forever as well as providing a linkage between conservation areas. Clearing of this area will result in direct loss of conservation areas, fragmentation of linkages between conservation areas as well as potential impacts on conservation areas through indirect measures, such as introduction of weeds and diseases.	
(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 Greater Project Area (Stage 1, 2 and 3) is situated on: • Spearwood Dunes: Pleistocene Aeolian sands overlying Tamala Limestone. These sands have a less leached profile than the sands of the Bassendean Dunes falling from 40–80 m relief except where the Tamala Limestones are exposed. • Quindalup Dunes: These calcareous coastal Holocene sands on the western margin of the Plain are the most recent Aeolian dunes. At times these overlie Tamala Limestone No RIWI Surface Water Areas, RIWI Irrigation Districts, RIWI Rivers or Waterway Management Areas are present within the Greater Project Area (Stage 1, 2 and 3). Four lakes, which form part of the north south rending chain of wetlands, were identified within 500 m of the Greater Project	The Project may be at variance with this principle

Clearing Principle		Assessment	Outcome
		Area (Stage 1, 2 and 3). However, no direct impacts are expected to occur on these lakes as a result of the proposed Project. No Ramsar wetlands occur within 10 km of the Greater Project Area (Stage 1, 2 and 3). A Nationally Important Wetland (Joondalup Lake) is located approximately 500 m south of the Greater Project Area (Stage 1, 2 and 3), however, no direct impacts are expected to occur on Joondalup Lake as a result of the proposed Project. There are no EPP lakes within the Greater Project Area (Stage 1, 2 and 3), however, there are seven EPP Lakes located within 500 m of the Greater Project Area (Stage 1, 2 and 3). All EPP Lakes are at least 100 m from the Greater Project Area (Stage 1, 2 and 3) and therefore no direct impacts are expected to occur on these lakes as a result of the proposed Project. No geomorphic wetlands are located within the Greater Project Area (Stage 1, 2 and 3). There are nine geomorphic wetlands located within 500 m of the Greater Project Area (Stage 1, 2 and 3). All geomorphic wetlands are at least 100 m from the Greater Project Area (Stage 1, 2 and 3) and therefore no direct impacts are expected to occur on these wetlands as a result of the proposed Project. The site has '*No known risk of ASS occurring within 3 m of the natural soil surface'* for the Stage 1 Project Area. Native vegetation clearing in Stage 1 is unlikely to result in ASS; however any excavations below 3 may result in ASS and an increase in subsurface acidification in Stage 1 and the surrounding areas and will require further investigation. No known contaminated sites are present within or immediately adjacent to the Greater Project Area (Stage 1, 2 and 3), however, potential asbestos containing material and general fly tipping (household waste, rusted car body, inert building material including possible asbestos containing material, concrete, wood, pallets and empty fuel drums) were identified at four sites within Stage 1. The Natural Resource Management SLIP mapped the salinity risk as '0-2% high to extreme hazard of salinity risk'. Native vegetation clearing in the Greater Project Area (Stage 1, 2 and 3) is unlikely to increase salinity in surface or underground water. The Natural Resource Management SLIP mapped the phosphorus export risk as '3-9% high to extreme hazard' for the majority of the Greater Project Area (Stage 1, 2 and 3) and '10-29% high to extreme hazard' in the areas near the lakes. The quality of surface and underground water in areas surrounding the lakes may deteriorate as a result of native vegetation clearing in the Greater Project Area (Stage 1, 2 and 3).	

Clearing Principle		Assessment	Outcome
		Clearing is not likely to significantly increase surface water runoff due to the porosity of the soils in the area. There are no watercourses or wetlands within the Greater Project Area; with the closest wetland, Neerabup Lake, located approximately 150 m east of Wanneroo Road. There is a low risk of indirect impacts, such as changes to hydrology and changes to surface water flows to this wetland. The potential for any impacts to Neerabup Lake is minimised as there is a buffer distance of at least 150 m to the wetland. In addition Wanneroo Road is an existing road and so potential impacts to Neerabup Lake from Wanneroo Road are pre-existing. Groundwater in the region is inferred as flowing in a westerly direction beneath the Greater Project Area (Stage 1, 2 and 3). Groundwater elevation in the vicinity of the Greater Project Area (Stage 1, 2 and 3) is approximately 0.3 to 47.85 m below ground level. Stage 1 of the Project is within the Perth Coastal Underground Water Pollution Control Area Public Drinking Water Source Area (PDSWA) which is a Priority 3 Protection Zone. As clearing is not likely to significantly increase surface water runoff and there is a buffer of at least 150 m between the clearing and nearby wetlands, the Project is not likely to cause deterioration in the quality of surface or groundwater.	
(j)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause, or exacerbate, the intensity of flooding.	The soils of the Stage 1 Project area are sandy and porous and the area is generally well-drained. No wetlands, watercourses or areas subject to inundation area location within Stage 1. In addition the clearing area is relatively small compared to the size of the catchment zone. The clearing proposed for this Project is not likely to increase incidence or intensity of flooding or lead to waterlogging.	The Project is not likely to be at variance with this principle

7.3 Further Studies

7.3.1 Air Quality

New road projects which may have an impact on local air quality require air quality modelling studies to be conducted to determine if traffic levels could lead to exceedences of the NEPM standards.

An air quality assessment for the proposal would be required to estimate pollution generated by vehicles using projected traffic volumes and vehicle emission rates as inputs to an air dispersion model.

7.3.2 Acid Sulfate Soils

GHD recommend that further assessment is undertaken within areas of the Stage 1 Project Area where excavation is predominately below 3 m of the natural soil surface to confirm the ground conditions and assess the presence of ASS material prior to excavation and/or dewatering (if applicable).

GHD has separated Stage 1 of the Project Area into three ASS assessment areas, taking into account the three major areas of excavation proposed for the extension route outlined below:

- Burns Beach Road intersection and adjacent area; excavations required expected to be approximately 5 meters below ground level (mbgl) for the freeway and up to 14 mbgl for ramps
- Neearbup Road intersection and adjacent areas; excavations required expected to be up to 7.2 mbgl for the freeway and up to 14.5 mbgl for ramps
- South of Hester Avenue and Hester Avenue intersection; excavations required expected to be up to 7.1 mbgl along the freeway and up to 6.5 mbgl for the ramps.

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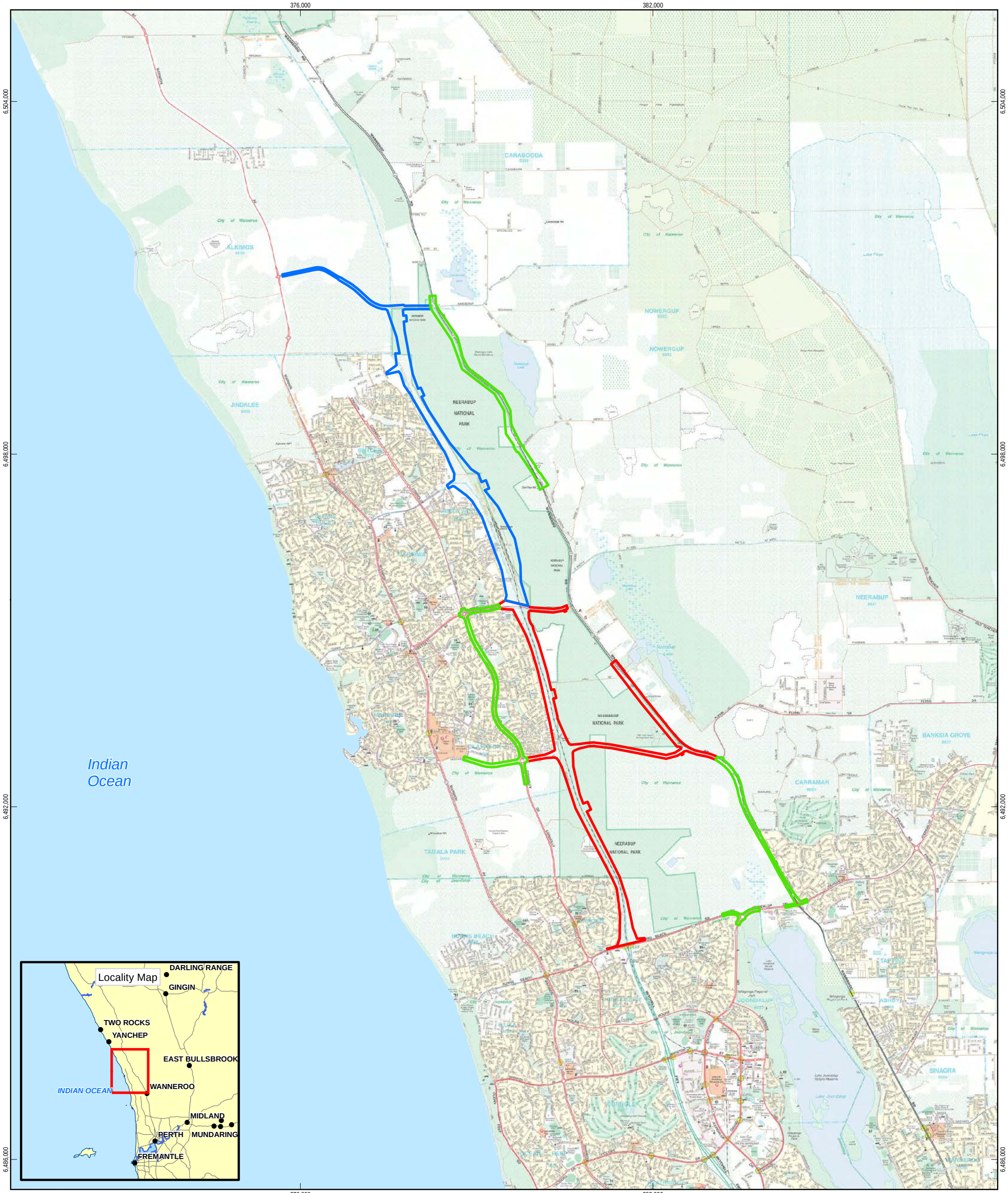
Appendices

Appendix A - Figures



LEGEND

Stage

- Stage 1
- Stage 2
- Stage 3

1: 60,000 (at A3)

0 0.25 0.5 1 1.5 2 2.5 3

Kilometres

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

N

Main Roads Western Australia
Mitchell Freeway - Environmental Impact Assessment

Job Number	61-2943503
Revision	0
Date	02 Apr 2014

Locality

Figure 1

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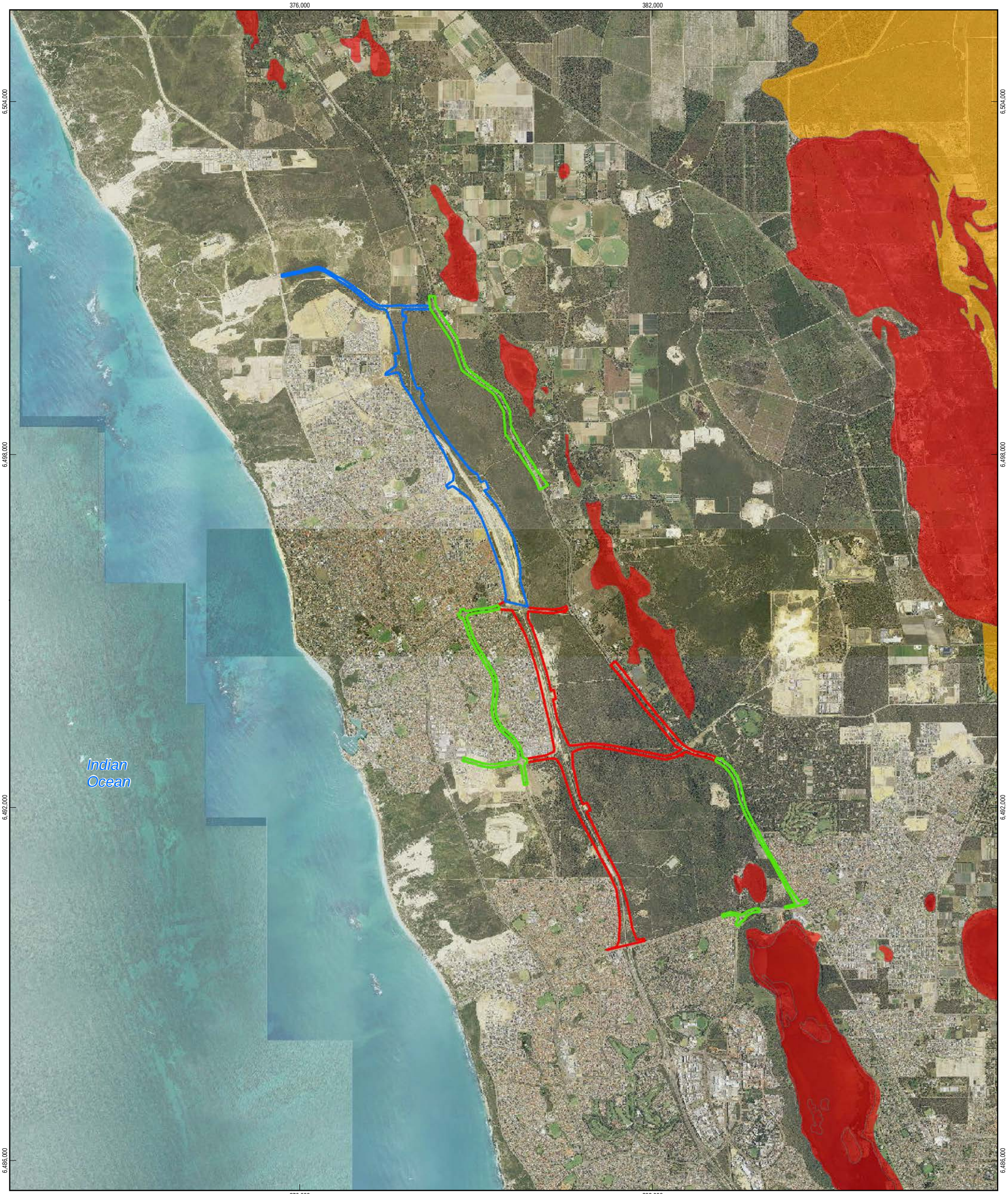
Data source: GA: Topo 250k Series 3 - 2006; GHD: Stage - 20130905; Landgate: Street Smart - 2011. Created by: slee2, vdinh, erice



LEGEND

Stage		ASS Risk Map	
	Stage 1		High to moderate ASS disturbance risk (<3m from surface)
	Stage 2		Moderate to low ASS disturbance risk (<3m from surface)
	Stage 3		

1: 60,000 (at A3)

0 0.25 0.5 1 1.5 2 2.5 3

Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Acid Sulphate Soils Risk Mapping

Figure 2

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Data source: GA: Topo 250k Series 3 - 2006; DPaW: ASS Risk Mapping - 20140321; GHD: Stage - 20130905; Landgate: Metro Moasic - 20140321. Created by: jrutherford

376,000 380,000 384,000

6,500,000 6,496,000 6,492,000

51 51 51

1007 949 949 998 998

Indian Ocean

1007 129 6 37

949 126

LEGEND

Roads
Stage
Stage 1
Stage 2
Stage 3
Bush Forever Sites
Environmental Sensitive Area
Threatened Ecological Community
Priority Ecological Community
DPaW-managed estates

Heddle et al.(1980) vegetation complexes
Cottesloe complex - central and south
Herdsman Complex
Karrakatta complex - central and south
Pinjar complex
Quindalup complex

Pre-European vegetation (Beard, 1979)
Medium woodland; tuart & jarrah (association 6)
Shrublands; teatree thicket (association 37)
Sedgeland; reed swamps, occasionally with heath (association 51)
Bare areas; freshwater lakes (association 126)
Bare areas; rock outcrops (association 129)
Low woodland; banksia (association 949)
Medium woodland; tuart (association 998)
Mosaic: Shrublands; Acacia lasiocarpa & Melaleuca acerosaheath / Shrublands; Acacia rostellifera & Acacia cyclops thicket (association 1007)

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Kilometres

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

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Environmental Context: Biological

Figure 3

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Data source: GA: Topo 250k Series 3 - 2006; GHD: Stage - 20130905; DPaW: Environmentall Sensitive Areas - 20130513, Threatened Ecological Community & Priority Ecological Community - 201306, DPaW managed estates - 20130513, Heddle et al. (1980) vegegattion complex - 20130513; Landgate: Roads - 20130513; DOP: Bush Forever Sites - 20130626; DAFWA: Pre-European Vegetation - 20130513. Created by: slee2, jrutherford

376,000
382,000
6,504,000
6,498,000
6,492,000
6,486,000
Indian Ocean

LEGEND

Stage
- Stage 1
- Stage 2
- Stage 3

- EPP Lakes
- Nationally Important Wetland

Geomorphic Wetlands
- Conservation
- Multiple Use
- Resource Enhancement

1: 60,000 (at A3)
0 0.25 0.5 1 1.5 2 2.5 3
Kilometres

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

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Environmental Context: Wetlands

Figure 4

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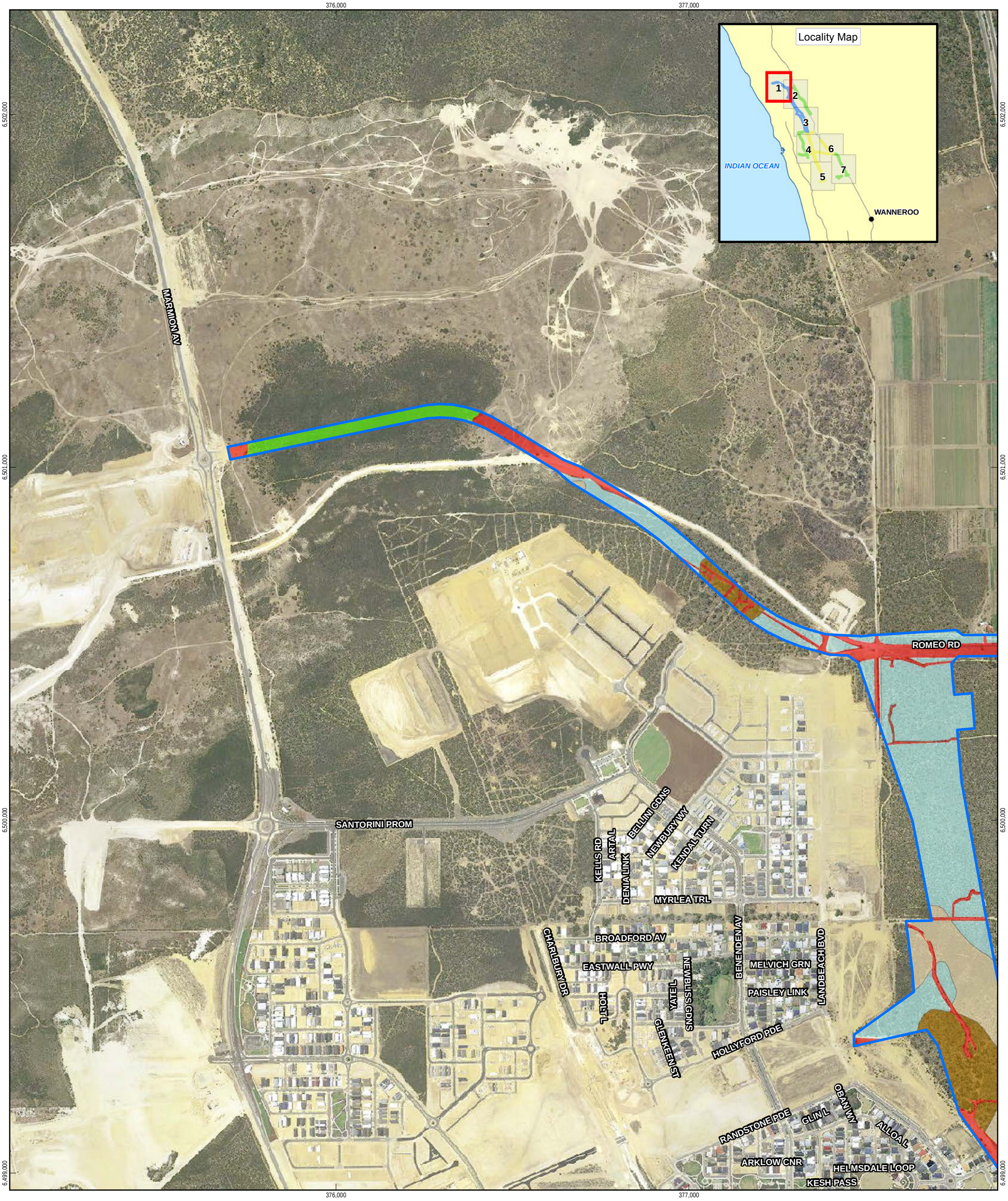
Data source: GA: Topo 250k Series 3 - 2006; EPA: EPP Lakes - 20130513: Department of the Environment - 2014; DEC: Geomorphic Wetlands - 20140321; GHD: Stage - 20130905; Landgate: Metro Moasic - 20140321. Created by: jrutherford



LEGEND

- 5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

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

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation Type (Number - Description)

- 1 - *Banksia* woodland
- 2 - Jarrah–*Banksia* woodland
- 3 - Tuart woodland
- 4 - Mixed low heath on limestone
- 5 - *Melaleuca huegelii – M. systena* shrubland on limestone
- 6 - *Banksia sessilis* closed tall scrub
- 7 - Mosaic of vegetation types 1 & 4
- 8 - Degraded/roads/ tracks / railway
- 9 - Planted
- 10 - Rehabilitation

1: 10,000 (at A3)

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Kilometres

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

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Vegetation types & previously recorded significant flora locations

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Map Sheet 1 of 7

Figure 5

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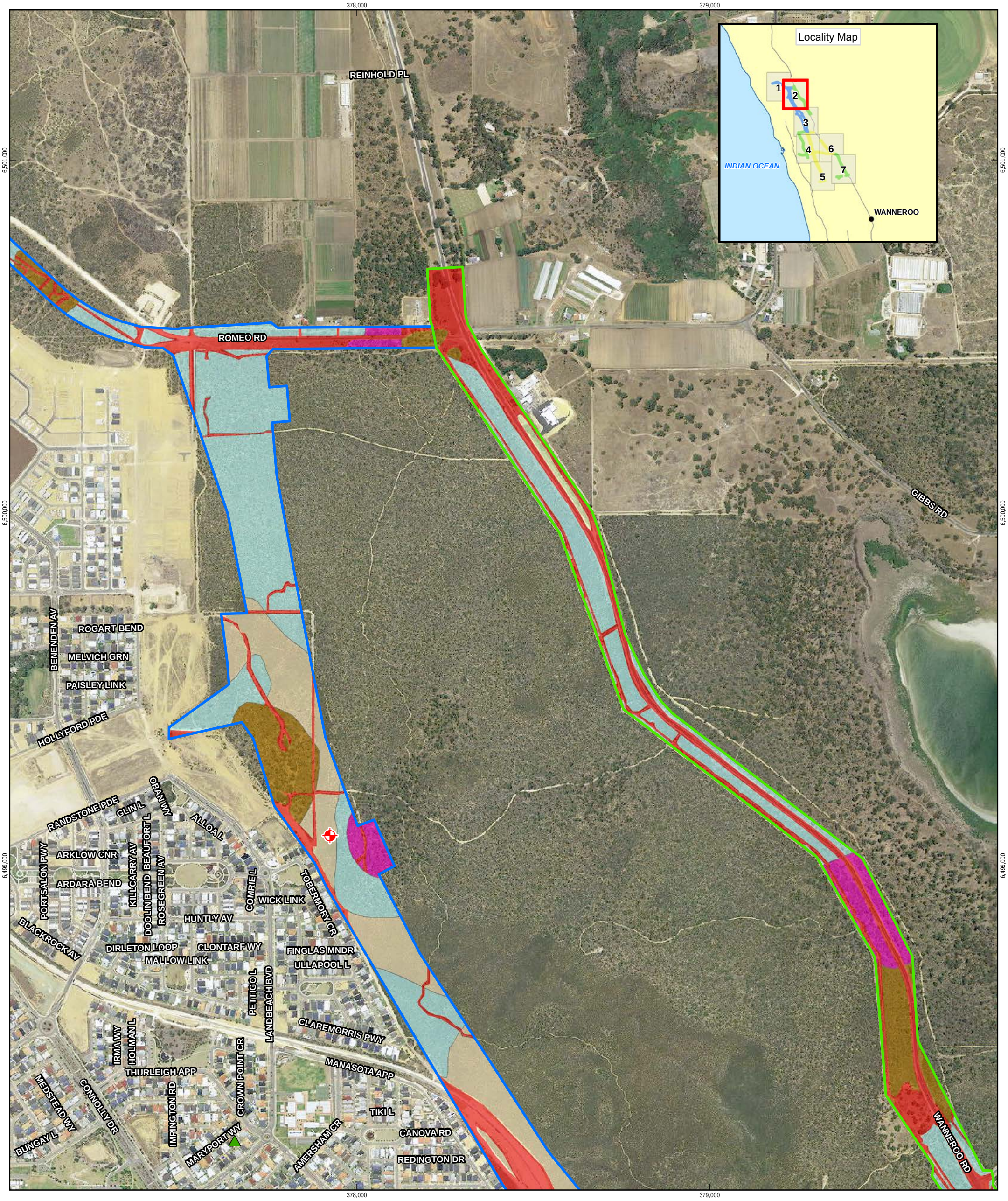
Data source: GA: Topo 250k Series 3 - 2006; GHD:Stage - 20130905, Sampling Points - 20131101,5 - <ita> Melaleuca huegelii - M. systena</ita> shrubland on limestone - 20130731; Vegetation Type - 20131122; Landgate: Metro Central Mosaic - 2013; MRWA: Roads - 2013; DPAW: Threatened (Declared Rare) & Priority Taxa - 20130520. Created by: erice



LEGEND

- 5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

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

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation Type (Number - Description)

- 1 - *Banksia* woodland
- 2 - Jarrah–*Banksia* woodland
- 3 - Tuart woodland
- 4 - Mixed low heath on limestone
- 5 - *Melaleuca huegelii* – *M. systena* shrubland on limestone
- 6 - *Banksia sessilis* closed tall scrub
- 7 - Mosaic of vegetation types 1 & 4
- 8 - Degraded/roads/ tracks / railway
- 9 - Planted
- 10 - Rehabilitation

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5

Kilometres

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

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Map Sheet 2 of 7

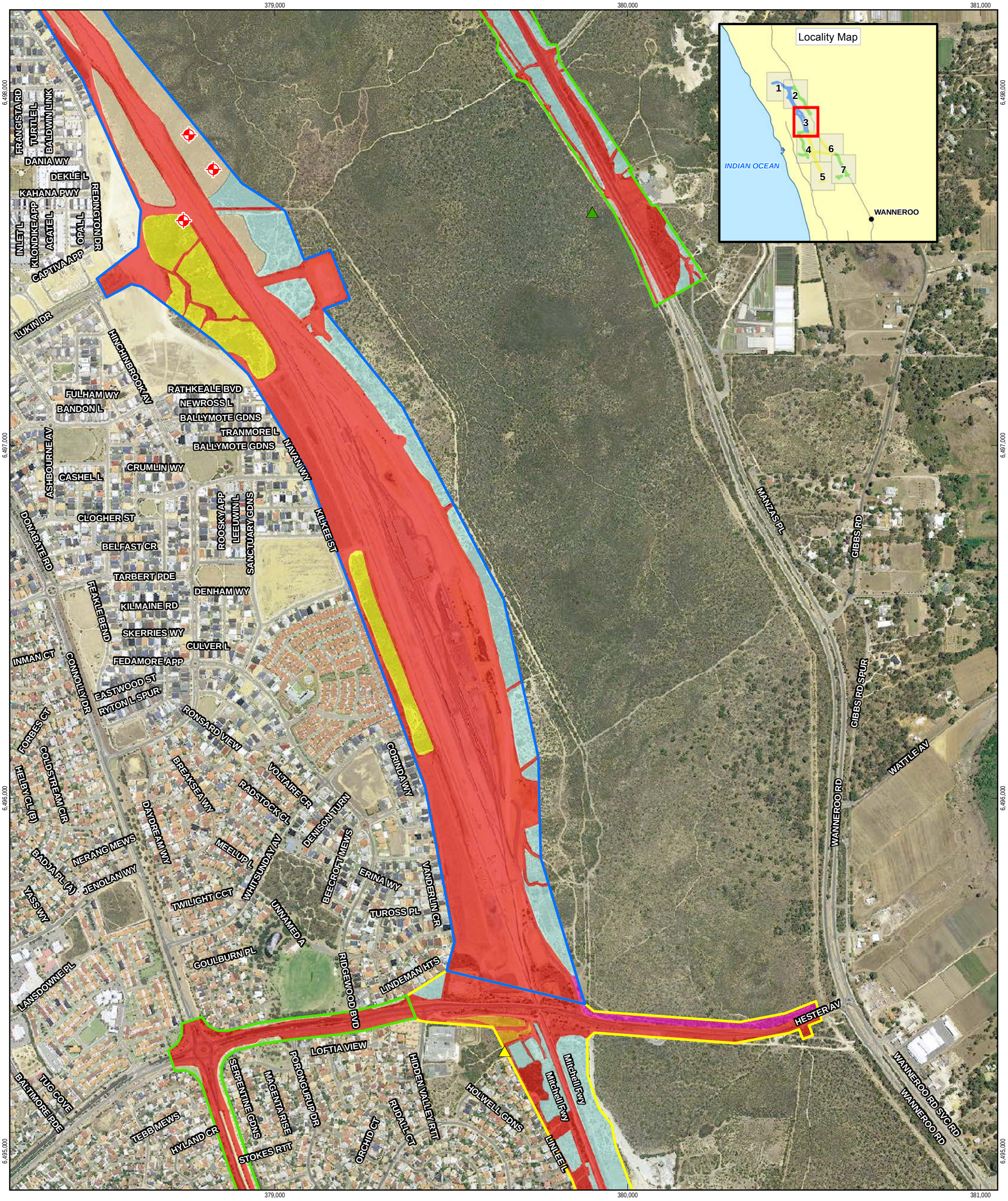
Vegetation types & previously recorded significant flora locations

Figure 5

G:\61\29435\GIS\Maps\MXD\612943503_G027_Fig05_Rev0.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: GA: Topo 250k Series 3 - 2006; GHD:Stage - 20130905, Sampling Points - 20131101,5 - <ita> Melaleuca huegelii - M. systena</ita> shrubland on limestone - 20130731; Vegetation Type - 20131122; Landgate: Metro Central Mosaic - 2013; MRWA: Roads - 2013; DPAW: Threatened (Declared Rare) & Priority Taxa - 20130520. Created by: erice



LEGEND

5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

(T) Threatened Rare Flora - Extant Taxa

Priority 1 - Poorly Known Taxa

Priority 2 - Poorly Known Taxa

Priority 3 - Poorly Known Taxa

Priority 4 - Rare Taxa

Priority 5 - Conservation Dependent Taxa

Stage

Stage 1

Stage 2

Stage 3

Vegetation Type (Number - Description)

1 - *Banksia* woodland

2 - Jarrah–*Banksia* woodland

3 - Tuart woodland

4 - Mixed low heath on limestone

5 - *Melaleuca huegelii* – *M. systena* shrubland on limestone

6 - *Banksia sessilis* closed tall scrub

7 - Mosaic of vegetation types 1 & 4

8 - Degraded/roads/ tracks / railway

9 - Planted

10 - Rehabilitation

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5

Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Vegetation types & previously recorded significant flora locations

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 3 of 7

Figure 5

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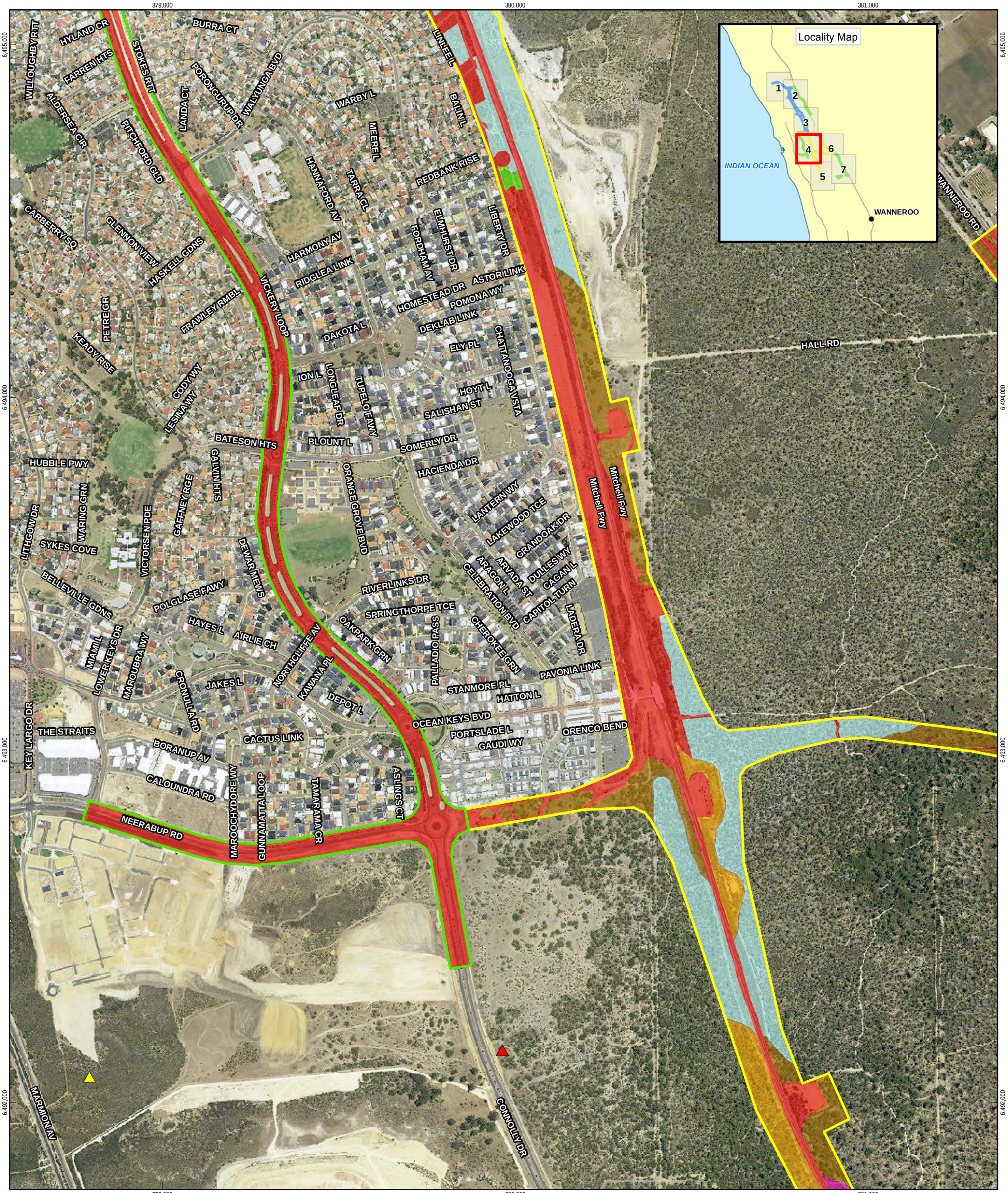
239 Adelaide Terrace Perth WA 6004 Australia **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: GA: Topo 250k Series 3 - 2006; GHD:Stage - 20130905, Sampling Points - 20131101,5 - <ita> Melaleuca huegelii - M. systena</ita> shrubland on limestone - 20130731; Vegetation Type - 20131122; Landgate: Metro Central Mosaic - 2013; MRWA: Roads - 2013; DPAW: Threatened (Declared Rare) & Priority Taxa - 20130520. Created by: erice



LEGEND

- 5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

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

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation Type (Number - Description)

- 1 - *Banksia* woodland
- 2 - Jarrah–*Banksia* woodland
- 3 - Tuart woodland
- 4 - Mixed low heath on limestone
- 5 - *Melaleuca huegelii* – *M. systena* shrubland on limestone
- 6 - *Banksia sessilis* closed tall scrub
- 7 - Mosaic of vegetation types 1 & 4
- 8 - Degraded/roads/ tracks / railway
- 9 - Planted
- 10 - Rehabilitation

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5

Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Vegetation types & previously recorded significant flora locations

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 4 of 7

Figure 5

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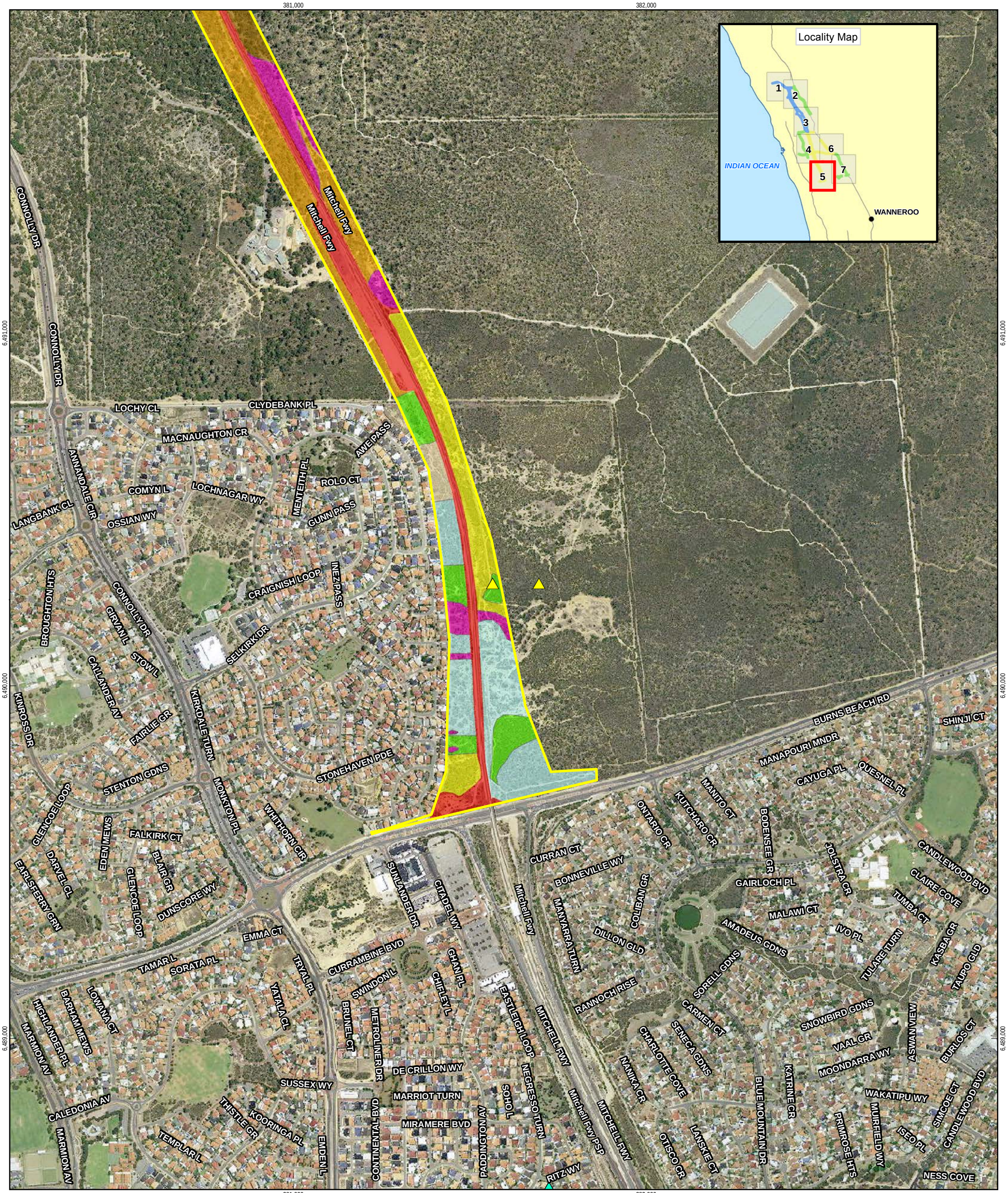
239 Adelaide Terrace Perth WA 6004 Australia **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: GA: Topo 250k Series 3 - 2006; GHD:Stage - 20130905, Sampling Points - 20131101,5 - <ita> Melaleuca huegelii - M. systena</ita> shrubland on limestone - 20130731; Vegetation Type - 20131122; Landgate: Metro Central Mosaic - 2013; MRWA: Roads - 2013; DPAW: Threatened (Declared Rare) & Priority Taxa - 20130520. Created by: erice



LEGEND

5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

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

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation Type (Number - Description)

- 1 - *Banksia* woodland
- 2 - Jarrah–*Banksia* woodland
- 3 - Tuart woodland
- 4 - Mixed low heath on limestone
- 5 - *Melaleuca huegelii* – *M. systena* shrubland on limestone
- 6 - *Banksia sessilis* closed tall scrub
- 7 - Mosaic of vegetation types 1 & 4
- 8 - Degraded/roads/ tracks / railway
- 9 - Planted
- 10 - Rehabilitation

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5

Kilometres

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

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Mitchell Freeway - Environmental Impact Assessment

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Map Sheet 5 of 7

Vegetation types & previously recorded significant flora locations

Figure 5

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

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382,000 383,000 384,000

6,495,000 6,494,000 6,493,000 6,492,000

HALL RD

WANNEROO RD

FLYNN DR

BUSHLAND RTT

LEGEND

5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

(T) Threatened Rare Flora - Extant Taxa

Priority 1 - Poorly Known Taxa

Priority 2 - Poorly Known Taxa

Priority 3 - Poorly Known Taxa

Priority 4 - Rare Taxa

Priority 5 - Conservation Dependent Taxa

Stage

Stage 1

Stage 2

Stage 3

Vegetation Type (Number - Description)

1 - *Banksia* woodland

2 - Jarrah–*Banksia* woodland

3 - Tuart woodland

4 - Mixed low heath on limestone

5 - *Melaleuca huegelii – M. systena* shrubland on limestone

6 - *Banksia sessilis* closed tall scrub

7 - Mosaic of vegetation types 1 & 4

8 - Degraded/roads/ tracks / railway

9 - Planted

10 - Rehabilitation

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5

Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Vegetation types & previously recorded significant flora locations

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 6 of 7

Figure 5

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

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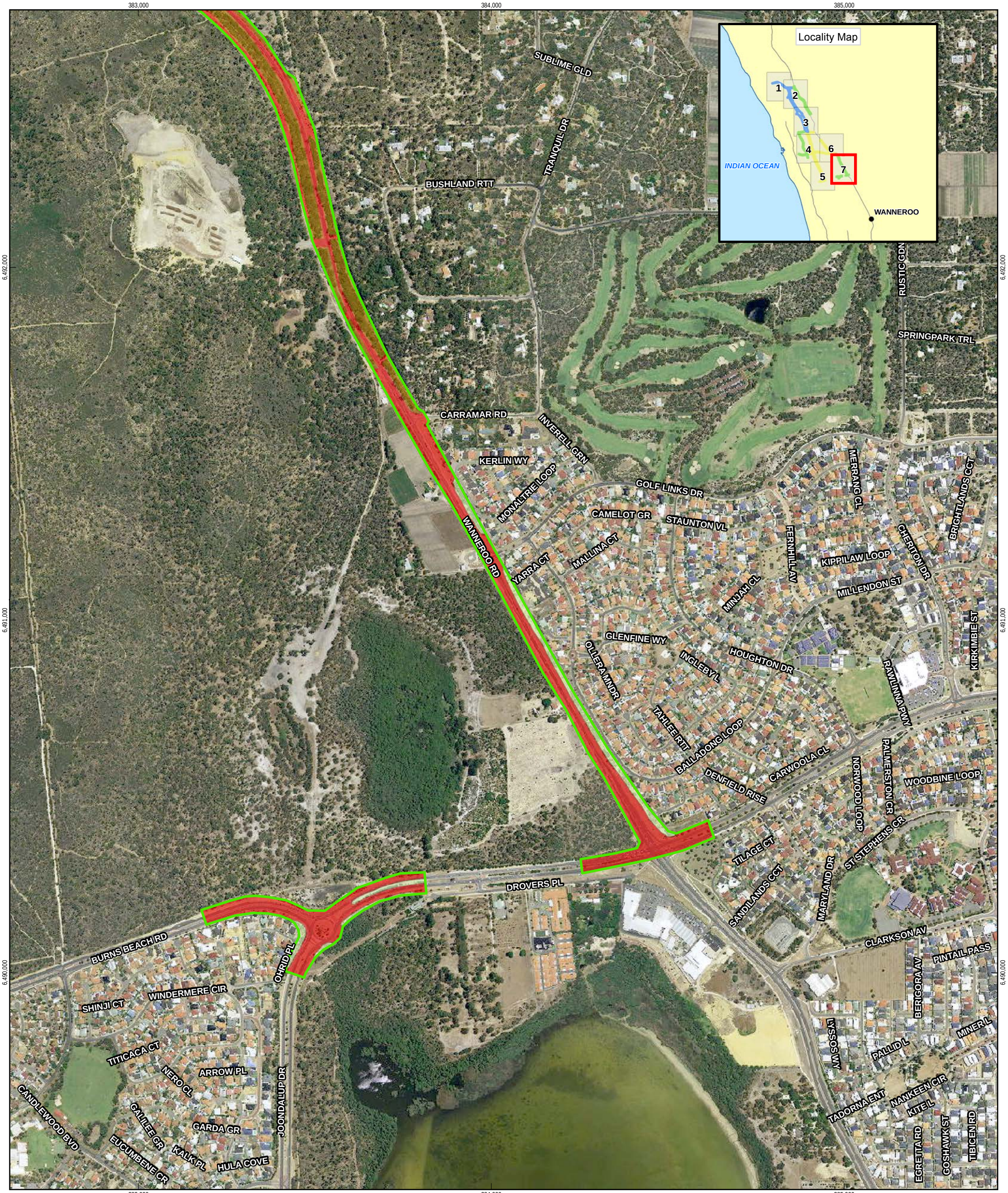

LEGEND

5 - *Melaleuca huegelii - M. systena* shrubland on limestone

Threatened (Declared Rare) & Priority Flora

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

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation Type (Number - Description)

- 1 - *Banksia* woodland
- 2 - Jarrah–*Banksia* woodland
- 3 - Tuart woodland
- 4 - Mixed low heath on limestone
- 5 - *Melaleuca huegelii* – *M. systena* shrubland on limestone
- 6 - *Banksia sessilis* closed tall scrub
- 7 - Mosaic of vegetation types 1 & 4
- 8 - Degraded/roads/ tracks / railway
- 9 - Planted
- 10 - Rehabilitation

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5 Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Vegetation types & previously recorded significant flora locations

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 7 of 7

Figure 5

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

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376,000 377,000

6,502,000 6,501,000 6,500,000 6,499,000

MARMION AV
SANTORINI PROM
ROMEO RD
KEILS RD
ARTAL
DENIA LINK
BELLINI GDNS
NEWBURY WY
SANMARIA WY
KENDAL TURN
MYRLEA TRL
CHARLBURY DR
BROADFORD AV
ELGIN WY
EASTWALL PWY
ALVA L
YATE L
HOIT L
NEWBUSS GDNS
BENENDEN AV
MELVICH GRN
PAISLEY LINK
LANDBEACH BVD
BRETTON GRA
GLENKEEN ST
REDHILL L
SORAN WY
HOLLYFORD PDE
RANDSTONE PDE
MALDON L
GLINL
OBANN WY
ALLOA L
ARKLOW CNR
LOCKERBIE TURN
KILLCARRY AV
BEAUFORT L
ROSEGREEN AV
COSTELLOE GDNS
TOBERMORY CR

Locality Map
1 2 3 4 5 6 7
INDIAN OCEAN

Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010)

- **Asparagus asparagoides* (bridal creeper) (Declared Pest C3 Management for the Whole of the State, WoNS)
- **Solanum linnaeanum* (apple of Sodom) (Declared Pest C3 Management for the South West Land Division)
- **Zantedeschia aethiopica* (arum lily) (Declared Pest C3 Management for the Whole of the State)

Roads

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation condition (Keighery, 1994)

- *Pristine* (1)
- *Excellent* (2)
- *Excellent - Very Good* (2 - 3)
- *Very Good* (3)
- *Very Good - Good* (3 - 4)
- *Good* (4)
- *Good - Degraded* (3)
- *Degraded* (5)
- *Degraded - Completely Degraded* (5 - 6)
- *Completely Degraded* (6)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5 Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 1 of 7

Vegetation condition & weed locations

Figure 6

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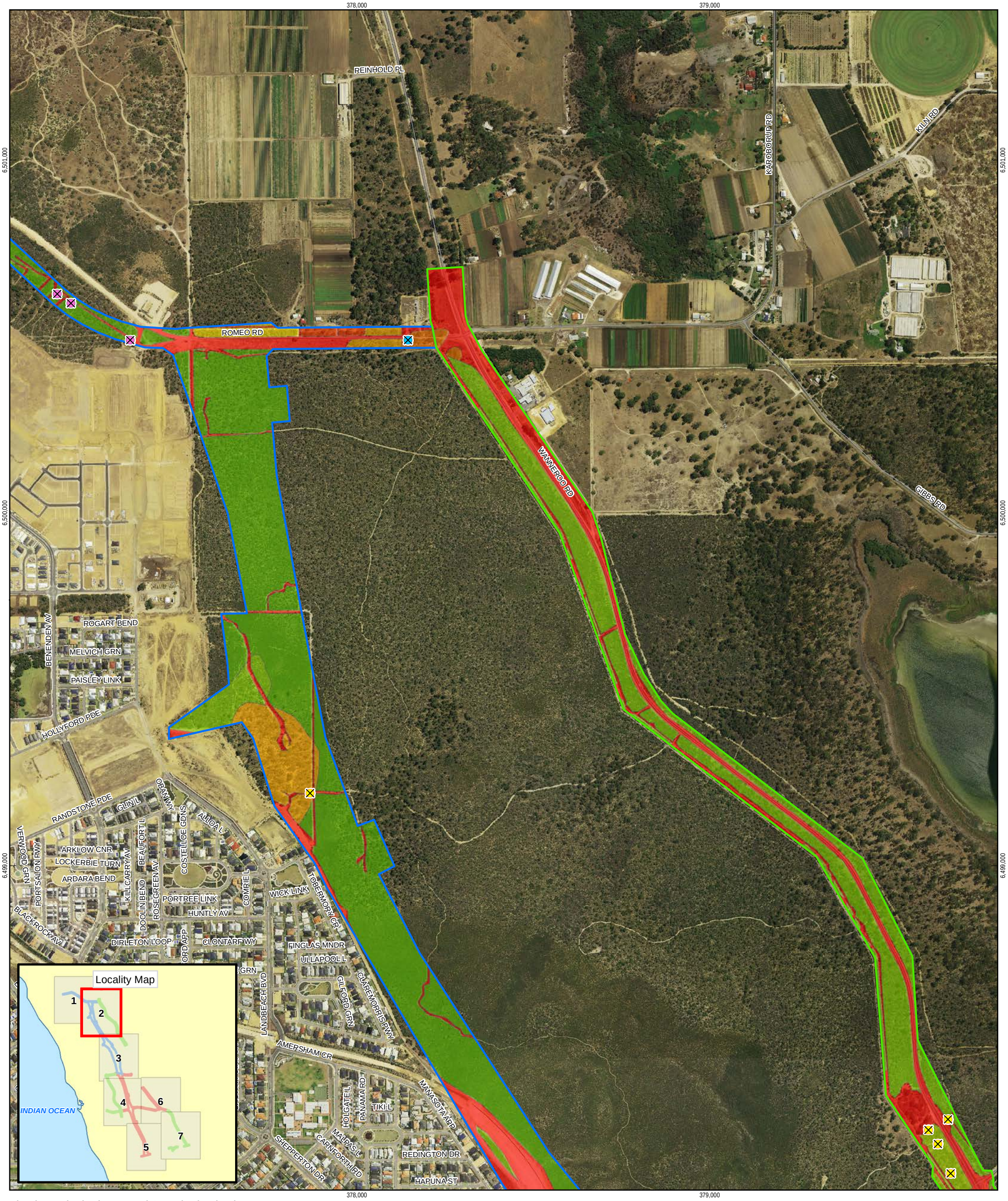
239 Adelaide Terrace Perth WA 6004 Australia T 61 8 6222 8222 F 61 8 6222 8555 E permail@ghd.com.au W www.ghd.com.au

Data source: GA: Topo 250k Series 3 - 2006; GHD: Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010) - 20130726, Stage - 20130905, Vegetation Condition - 20131101; MRWA: Metro Central Mosaic - 20130615, IRIS Roads - 201305. Created by: slee2, erice



Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010)

- **Asparagus asparagoides* (bridal creeper) (Declared Pest C3 Management for the Whole of the State, WoNS)
- **Solanum linnaeanum* (apple of Sodom) (Declared Pest C3 Management for the South West Land Division)
- **Zantedeschia aethiopica* (arum lily) (Declared Pest C3 Management for the Whole of the State)

Roads

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation condition (Keighery, 1994)

- *Pristine* (1)
- *Excellent* (2)
- *Excellent - Very Good* (2 - 3)
- *Very Good* (3)
- *Very Good - Good* (3 - 4)
- *Good* (4)
- *Good - Degraded* (3)
- *Degraded* (5)
- *Degraded - Completely Degraded* (5 - 6)
- *Completely Degraded* (6)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5 Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 2 of 7

Vegetation condition & weed locations

Figure 6

G:\61\29435\GIS\Maps\MXD\612943503_G031_Fig06_Rev0.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

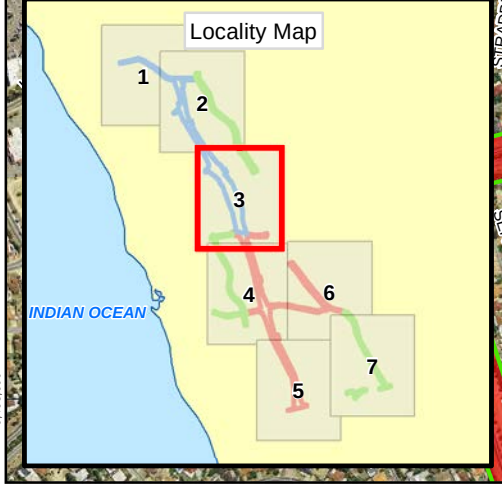
Data source: GA: Topo 250k Series 3 - 2006; GHD: Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010) - 20130726, Stage - 20130905, Vegetation Condition - 20131101; MRWA: Metro Central Mosaic - 20130615, IRIS Roads - 201305. Created by: slee2, erice

379,000 380,000 381,000

6,498,000 6,497,000 6,496,000 6,495,000

NOWERGUP RD
DUNSTAN RD
REDINGTON DR
TURRILE L
BALDWIN LINK
DANIA WY
IDEKLE L
KAHANA PWY
KLONDIKE APP
AGATE L
OPAL L
CAPTIVA APP
LUKIN DR
BRIGSLEY WY
CLAXTON L
FULHAM WY
BANDON L
RATHKEALE BVD
RUSH L
NEWROSS L
BALLYMOTE GDNS
TRANMORE L
SAINTFIELD CNR
BALLYMOTE GDNS
NAVAN WY
KILKEE ST
CRUMLIN WY
CASHEL L
ASHBOURNE AV
BOYLE RD
DONABATE RD
CLOGHER ST
ROOSKY APP
LEEUWIN L
PORTLAND WY
SANCTUARY GDNS
MUSGRAVE PROM
BELFAST CR
TARBERT PDE
DENHAM WY
FEAKLE BEND
KILMAINE RD
SKERRIES WY
HINCHINBROOK AV
INMAN CT
FEDAMORE APP
CONNOLLY DR
EASTWOOD ST
RYTON L SPUR
WESTALL LINK
RONSARD VIEW
FORBES CT
HARCUS RTT
LEVEQUE RMBL
COLDSTREAM CIR
HELBY CL (B)
BREAKSEA WY
PRUDHOE MEWS
DAYDREAM WY
TWILIGHT CCT
MEELUP L
NERANG MEWS
BADJA PL (A)
YASS WY
JENOLAN WY
WHITSUNDAY AV
VOLTAIRE CR
RADSTOCK CL
DENISON TURN
CORINDA WY
BEECROFT MEWS
ERINA WY
VANDERLIN CR
PASCAL MEWS
UNNAMED A
RIDGEWOOD BVD
LINDEMAN HTS
SIRADBROKE GDNS
PORONGURUP DR
LOFTIA VIEW
PENOLA CT
WALPOLE PL
HIDDEN VALLEY RTT
HEMMINGS CL
HOLWELL GDNS
Mitchell Fwy
SERPENTINE GDNS
MAGENTA RISE
BURRA CT
ORCHID CT
RUDALL CT
WALYUNGA BVD
STOKES RTT
TATHRA WY
LENSWOOD RTT
LINLEE L
HESTER AV
MANZAS RL
GIBBS RD
GIBBS RD SPUR
WATTLE AV
WANNEROO RD SVC RD
WANNEROO RD
WANNEROO RD

Locality Map



Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010)

- **Asparagus asparagoides* (bridal creeper) (Declared Pest C3 Management for the Whole of the State, WoNS)
- **Solanum linnaeanum* (apple of Sodom) (Declared Pest C3 Management for the South West Land Division)
- **Zantedeschia aethiopica* (arum lily) (Declared Pest C3 Management for the Whole of the State)

Roads

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation condition (Keighery, 1994)

- *Pristine* (1)
- *Excellent* (2)
- *Excellent - Very Good* (2 - 3)
- *Very Good* (3)
- *Very Good - Good* (3 - 4)
- *Good* (4)
- *Good - Degraded* (3)
- *Degraded* (5)
- *Degraded - Completely Degraded* (5 - 6)
- *Completely Degraded* (6)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5 Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 3 of 7

Vegetation condition & weed locations

Figure 6

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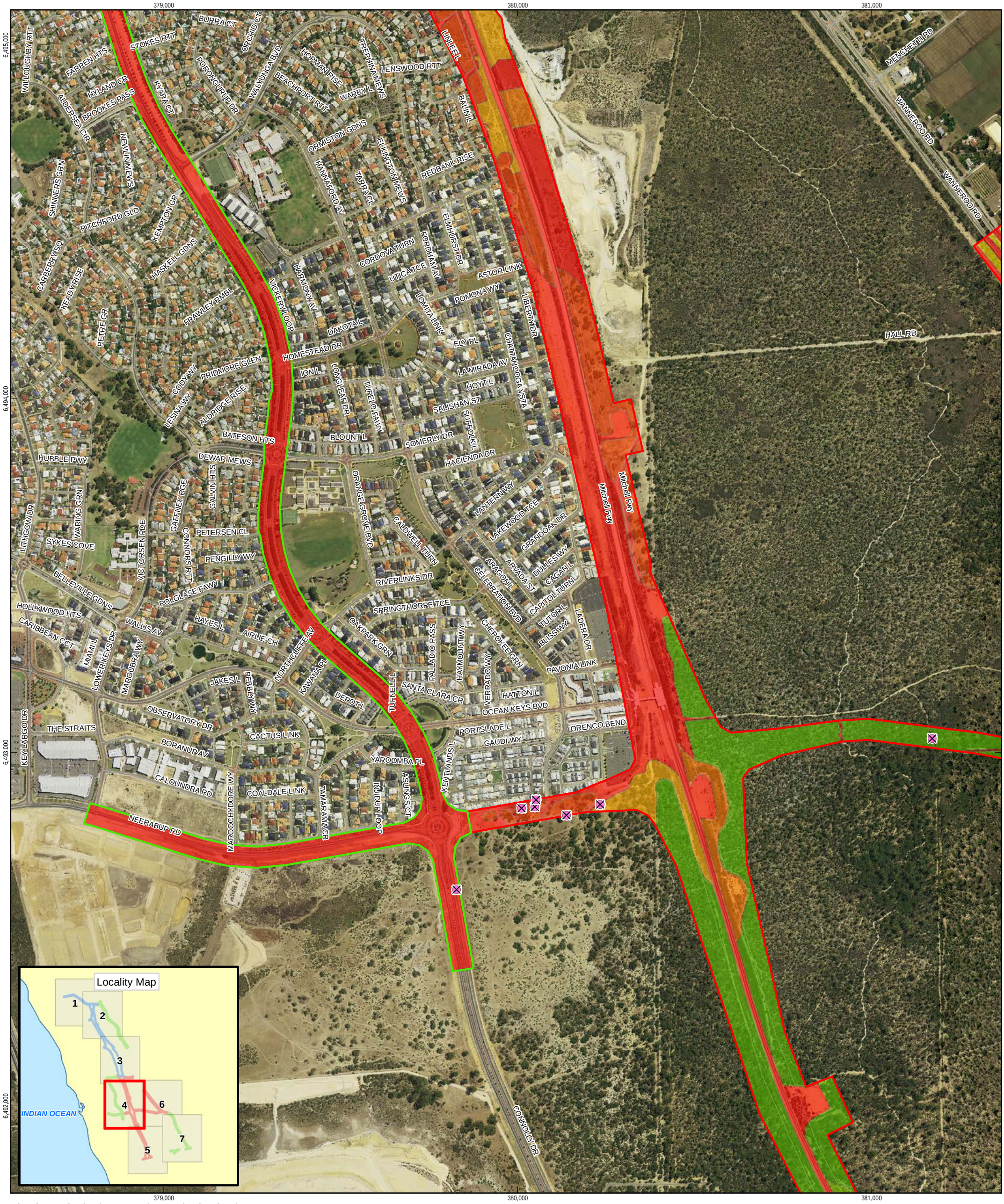
239 Adelaide Terrace Perth WA 6004 Australia **T** 61 8 6222 8222 **F** 61 8 6222 8555 **E** permail@ghd.com.au **W** www.ghd.com.au

Data source: GA: Topo 250k Series 3 - 2006; GHD: Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010) - 20130726, Stage - 20130905, Vegetation Condition - 20131101; MRWA: Metro Central Mosaic - 20130615, IRIS Roads - 201305. Created by: slee2, erice



Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010)

- **Asparagus asparagoides* (bridal creeper) (Declared Pest C3 Management for the Whole of the State, WoNS)
- **Solanum linnaeanum* (apple of Sodom) (Declared Pest C3 Management for the South West Land Division)
- **Zantedeschia aethiopica* (arum lily) (Declared Pest C3 Management for the Whole of the State)

Roads

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation condition (Keighery, 1994)

- *Pristine* (1)
- *Excellent* (2)
- *Excellent - Very Good* (2 - 3)
- *Very Good* (3)
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- *Good* (4)
- *Good - Degraded* (3)
- *Degraded* (5)
- *Degraded - Completely Degraded* (5 - 6)
- *Completely Degraded* (6)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5 Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Job Number 61-2943503
Revision 0
Date 03 Apr 2014

Map Sheet 4 of 7

Vegetation condition & weed locations

Figure 6

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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: GA: Topo 250k Series 3 - 2006; GHD: Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010) - 20130726, Stage - 20130905, Vegetation Condition - 20131101; MRWA: Metro Central Mosaic - 20130615, IRIS Roads - 201305. Created by: slee2, erice

381,000 382,000

6,491,000 6,490,000 6,489,000

Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010)

- **Asparagus asparagoides* (bridal creeper)
  (Declared Pest C3 Management for the Whole of the State, WoNS)
- **Solanum linnaeanum* (apple of Sodom)
  (Declared Pest C3 Management for the South West Land Division)
- **Zantedeschia aethiopica* (arum lily)
  (Declared Pest C3 Management for the Whole of the State)

Roads

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation condition (Keighery, 1994)

- *Pristine* (1)
- *Excellent* (2)
- *Excellent - Very Good* (2 - 3)
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- *Very Good - Good* (3 - 4)
- *Good* (4)
- *Good - Degraded* (3)
- *Degraded* (5)
- *Degraded - Completely Degraded* (5 - 6)
- *Completely Degraded* (6)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5
Kilometres

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
Mitchell Freeway - Environmental Impact Assessment

Job Number	61-2943503
Revision	0
Date	03 Apr 2014

Map Sheet 5 of 7

Vegetation condition & weed locations

Figure 6

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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: GA: Topo 250k Series 3 - 2006; GHD: Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010) - 20130726, Stage - 20130905, Vegetation Condition - 20131101; MRWA: Metro Central Mosaic - 20130615, IRIS Roads - 201305. Created by: slee2, erice

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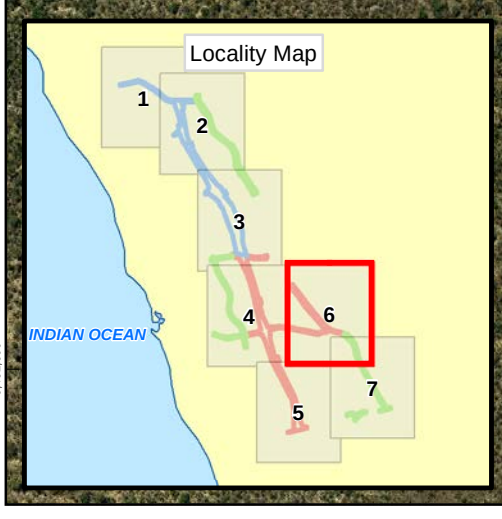
WANNEROO RD

FLYNN DR

BUSHLAND RTT



Declared Pests (under the BAM Act) & Weeds of National Significance (WoNS) (Australian Weeds Committee, 2010)

- **Asparagus asparagoides* (bridal creeper) (Declared Pest C3 Management for the Whole of the State, WoNS)
- **Solanum linnaeanum* (apple of Sodom) (Declared Pest C3 Management for the South West Land Division)
- **Zantedeschia aethiopica* (arum lily) (Declared Pest C3 Management for the Whole of the State)

Roads

Stage

- Stage 1
- Stage 2
- Stage 3

Vegetation condition (Keighery, 1994)

- *Pristine* (1)
- *Excellent* (2)
- *Excellent - Very Good* (2 - 3)
- *Very Good* (3)
- *Very Good - Good* (3 - 4)
- *Good* (4)
- *Good - Degraded* (3)
- *Degraded* (5)
- *Degraded - Completely Degraded* (5 - 6)
- *Completely Degraded* (6)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5 Kilometres

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

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Vegetation condition & weed locations

Figure 6

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- Stage 2
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Vegetation condition & weed locations

Figure 6

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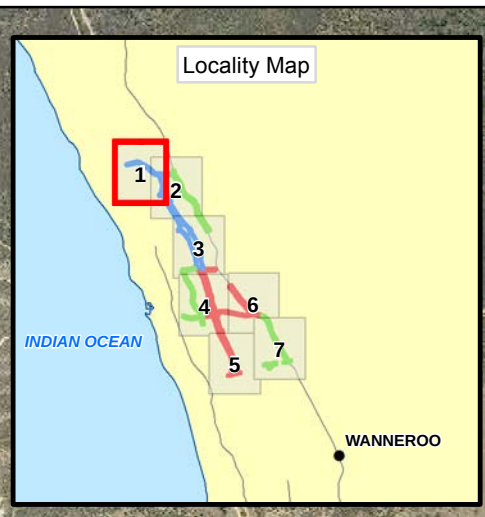

LEGEND

Melaleuca huegelii–M. acerosa [now *M. systena*] shrublands on limestone ridges (DPaW Endangered TEC)

Priority Flora

Acacia ?benthamii (DPaW Priority 2)

Jacksonia sericea (DPaW Priority 4)

Pimelea calcicola (DPaW Priority 3)

Stylidium maritimum (DPaW Priority 3)

Stage

Stage 1

Stage 2

Stage 3

Priority Species Area

Jacksonia sericea (DPaW Priority 4)

Stylidium maritimum (DPaW Priority 3)

Banksia dominated woodlands of the Swan Coastal Plain IBRA region (DPaW Priority 3 PEC)

Melaleuca huegelii–M. systena shrubland on limestone

Northern Spearwood Shrublands and Woodland (DPaW Priority 3 PEC)

1: 10,000 (at A3)

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
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Main Roads Western Australia
Mitchell Freeway - Environmental Impact Assessment

Conservation significant vegetation & flora

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Map Sheet 1 of 7

Figure 7

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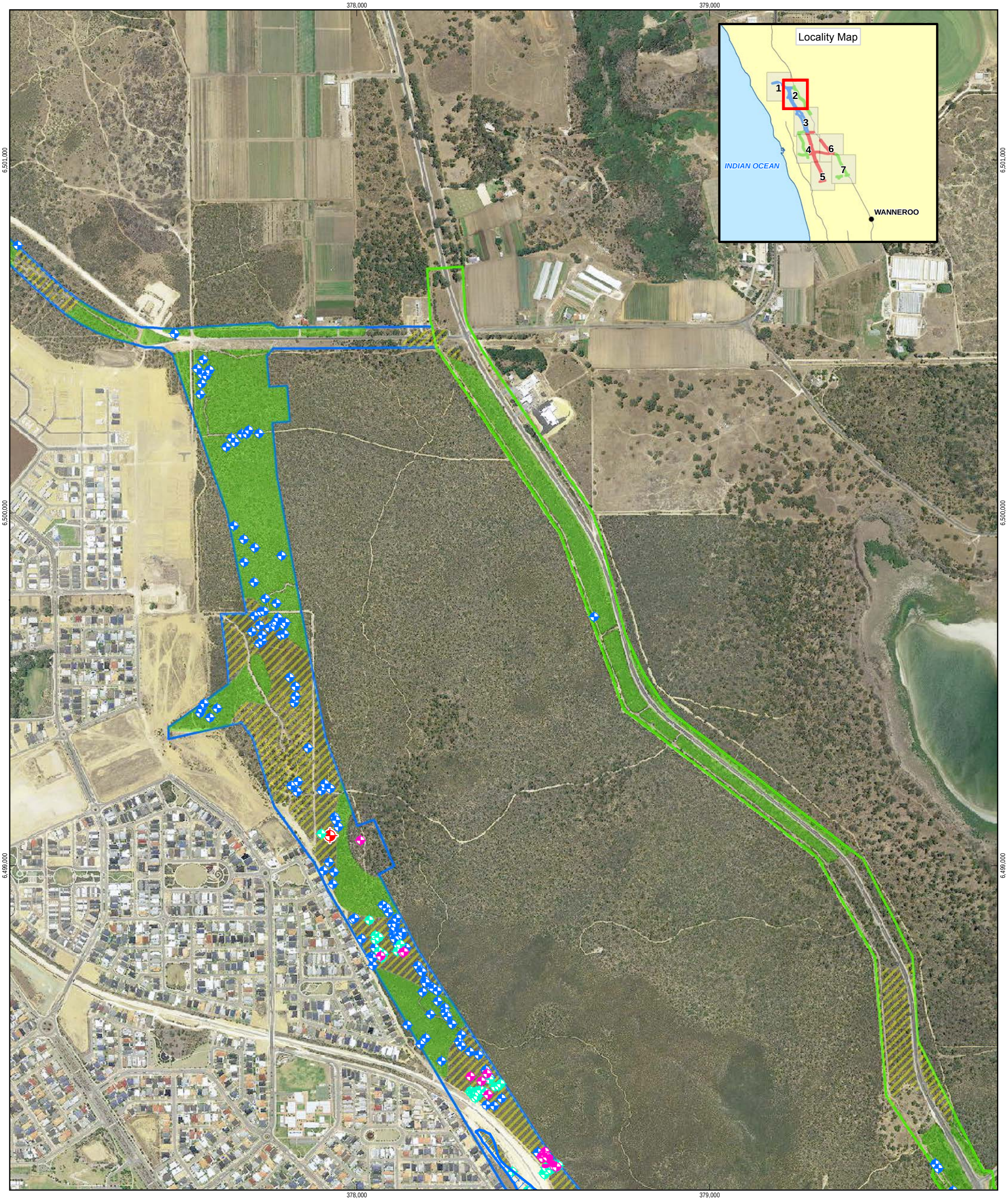

LEGEND

- *Melaleuca huegelii–M. acerosa* [now *M. systena*] shrublands on limestone ridges (DPaW Endangered TEC)

Priority Flora

- *Acacia ?benthamii* (DPaW Priority 2)
- *Jacksonia sericea* (DPaW Priority 4)
- *Pimelea calcicola* (DPaW Priority 3)
- *Stylidium maritimum* (DPaW Priority 3)

Stage

- Stage 1
- Stage 2
- Stage 3

Priority Species Area

- *Jacksonia sericea* (DPaW Priority 4)
- *Stylidium maritimum* (DPaW Priority 3)
- Banksia dominated woodlands of the Swan Coastal Plain IBRA region (DPaW Priority 3 PEC)
- *Melaleuca huegelii–M. systena* shrubland on limestone
- Northern Spearwood Shrublands and Woodland (DPaW Priority 3 PEC)

1: 10,000 (at A3)

0 0.05 0.1 0.2 0.3 0.4 0.5

Kilometres

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Mitchell Freeway - Environmental Impact Assessment

Conservation significant vegetation & flora

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Figure 7

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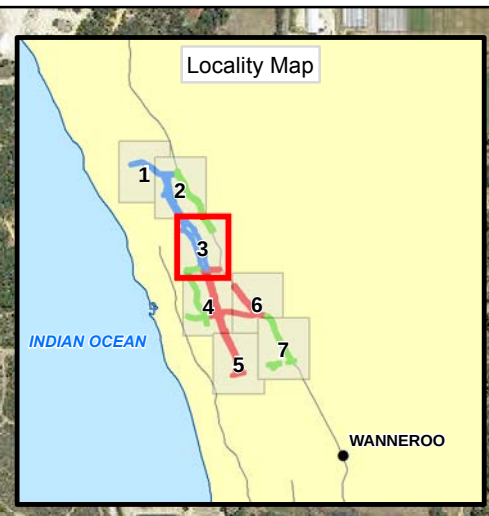

Melaleuca huegelii–M. systena **shrubland on limestone**

LEGEND

- *Melaleuca huegelii–M. acerosa* [now *M. systena*] shrublands on limestone ridges (DPaW Endangered TEC)

Priority Flora

- *Acacia ?benthamii* (DPaW Priority 2)
- *Jacksonia sericea* (DPaW Priority 4)
- *Pimelea calcicola* (DPaW Priority 3)
- *Stylidium maritimum* (DPaW Priority 3)

Stage

- Stage 1
- Stage 2
- Stage 3

Priority Species Area

- *Jacksonia sericea* (DPaW Priority 4)
- *Stylidium maritimum* (DPaW Priority 3)
- Banksia dominated woodlands of the Swan Coastal Plain IBRA region (DPaW Priority 3 PEC)
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Kilometres

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Figure 7

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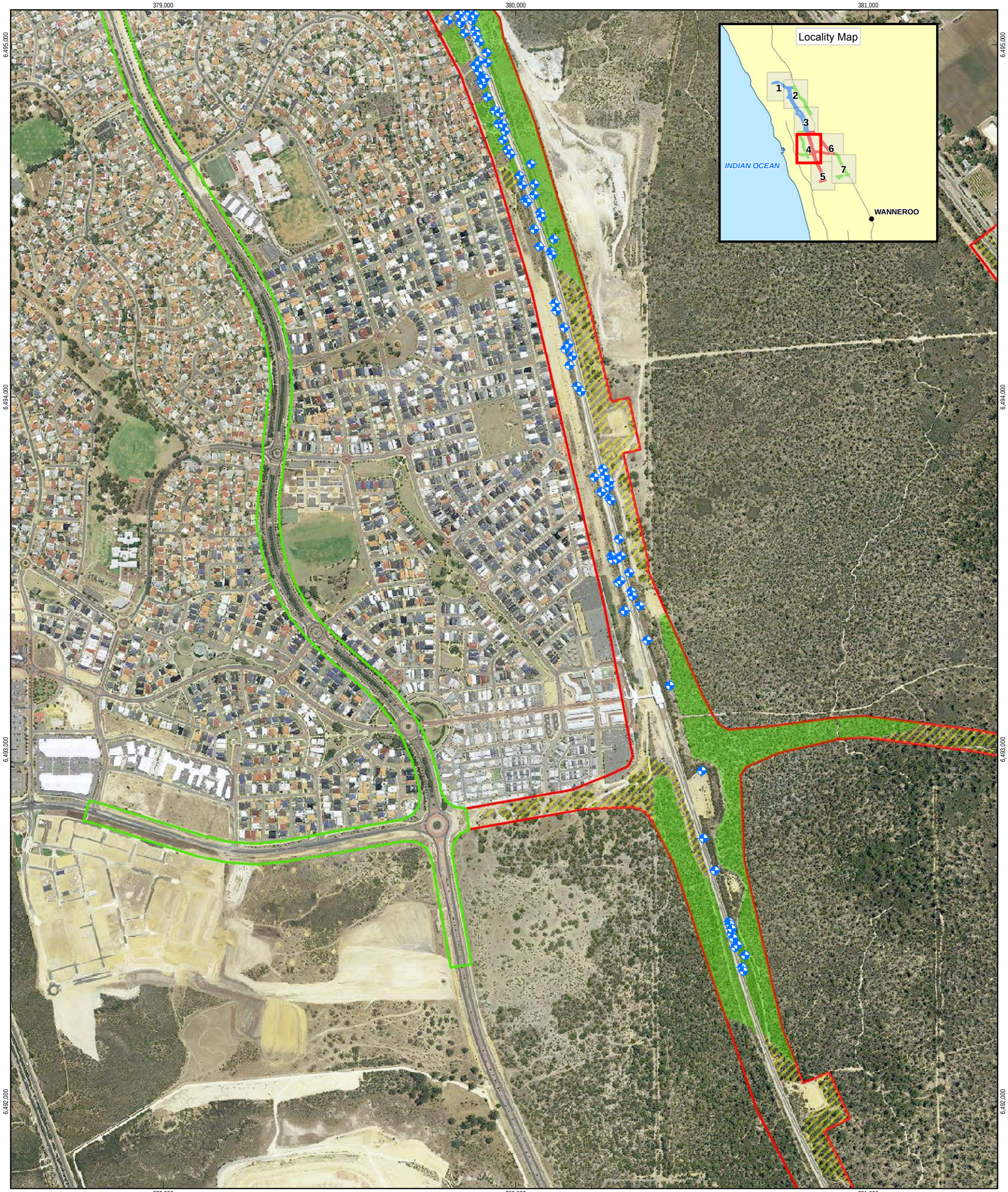

LEGEND

- *Melaleuca huegelii–M. acerosa* [now *M. systena*] shrublands on limestone ridges (DPaW Endangered TEC)

Priority Flora

- *Acacia ?benthamii* (DPaW Priority 2)
- *Jacksonia sericea* (DPaW Priority 4)
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- *Stylidium maritimum* (DPaW Priority 3)

Stage

- Stage 1
- Stage 2
- Stage 3

Priority Species Area

- *Jacksonia sericea* (DPaW Priority 4)
- *Stylidium maritimum* (DPaW Priority 3)
- Banksia dominated woodlands of the Swan Coastal Plain IBRA region (DPaW Priority 3 PEC)
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1: 10,000 (at A3)

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Kilometres

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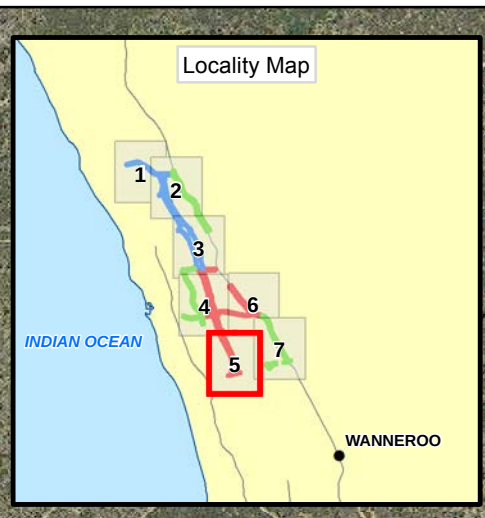

LEGEND

- *Melaleuca huegelii–M. acerosa* [now *M. systena*] shrublands on limestone ridges (DPaW Endangered TEC)

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Stage

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- Stage 3

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Kilometres

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Appendix B – Background, Legal Framework and Conservation Codes

Background and legal framework

Hydrology & water resources

The water resource aspects proclaimed under State legislation and mapped by the Department of Water (DoW) Geographic Data Atlas have been summarised in Table B.0.

Table B.0 Department of Water Geographic Data Atlas information

Aspect	Details
RIWI Groundwater Areas	Groundwater areas proclaimed under the *Rights in Water and Irrigation Act 1914* (RIWI Act).
RIWI Surface Water Areas	Surface water areas proclaimed under the RIWI Act.
RIWI Irrigation District	Irrigation Districts proclaimed under the RIWI Act.
RIWI Rivers	Rivers proclaimed under the RIWI Act.
Public Drinking Water Source Areas (PDWSA)	PDWSA 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* (MWSSD Act) or the *Country Area Water Supply Act 1947* (CAWS Act).
Waterway Management Areas	Areas proclaimed under the *Waterway Conservation Act 1976*.

Wetlands

Wetlands include not only lakes with open water, but areas of seasonally, intermittently or permanently waterlogged soil. Approximately 25 percent of the Swan Coastal Plain between Moore River and Mandurah is classified as wetland (Hill et al. 1996).

Though extensive in area, not all wetlands retain significant ecological values due to the concentration of urban and agricultural development in the region. Most wetlands have been cleared, filled or developed over, leaving only 20 percent of all the wetlands that were present on the Swan Coastal Plain prior to European settlement. Of these, an estimated 15 percent of the wetland area has retained high ecological values (Hill et al. 1996).

Ramsar wetlands

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international co-operation for the conservation and wise use of wetlands and their resources.

The EPBC Act enhances the management and protection of Australia's Ramsar wetlands. A 'declared Ramsar wetland' is an area that has been designated under Article 2 of the Ramsar convention or declared by the Minister to be a declared Ramsar wetland under the EPBC Act. Ramsar wetlands are recognised as a matter of national environmental significance under the EPBC Act. Consequently, an action that has, will have, or is likely to have, a significant impact on the ecological character of a Ramsar wetland must be referred to the Minister and undergo an environmental assessment and approval process (DotE 2013b).

Lakes covered under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*

The *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes) protects the environmental values of selected wetlands on the Swan Coastal Plain.

Geomorphic wetlands

Categorisation of wetlands has been conducted by Hill et al. (1996), delineating the Swan Coastal Plain into levels of protection and management categories. Conservation Category Wetlands are wetlands that support high levels of attributes and functions. Resource Enhancement Wetlands are those that have been partly modified but still support substantial functions and attributes. Multiple Use Wetlands are classified as those wetlands with few attributes that still provide important wetland functions. Multiple Use wetlands have few important ecological attributes and functions remaining.

The Geomorphic Wetlands Swan Coastal Plain dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the Swan Coastal Plain.

Acid sulphate soils

The DEC (now Department of Environment Regulation; DER) describes Acid Sulphate Soils (ASS) as "naturally occurring soils, sediments and peats containing iron sulphides (often present as pyrite materials)" and can be "found in low-lying land bordering the coast or estuarine and saline wetlands and freshwater groundwater-dependent wetlands" (DEC 2013a). When buried, these materials do not pose a significant risk to human health or the environment. However, exposing ASS to oxygen (by disturbing the soil), has the potential to cause significant environmental and economic impacts including:

- Fish kills and loss of biodiversity in wetlands and waterways.
- Effects on estuarine fisheries and aquaculture projects.
- Contamination of groundwater resources by acid, arsenic, heavy metals and other contaminants.
- Reduction in agricultural productivity through metal contamination of soils (predominantly by aluminium).
- Damage to infrastructure through the corrosion of concrete and steel pipes, bridges and other subsurface assets.

Projects which disturb potential ASS must be assessed to determine associated risks and management measures put in place to avoid or mitigate environmental harm.

Bush Forever

Bush Forever, which was released in December 2000 and proclaimed in 2010, is a government initiative to retain and protect regionally significant bushland on the Swan Coastal Plain within the Perth Metropolitan Region. Bush Forever aims to protect more than 51,000 hectares of regionally significant bushland within 287 sites across the metropolitan portion of the Swan Coastal Plain (Government of Western Australia 2000).

Environmentally sensitive areas

Environmentally Sensitive Areas (ESAs) are declared by a notice under Section 51B of the EP Act. The aspects of areas declared as an ESA (under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* – Regulation 6) are as follows:

- A declared World Heritage property as defined in Section 13 of the EPBC Act.
- An area that is registered on the Register of the National Estate (RNE), because of its natural values, under the *Australian Heritage Commission Act 1975* of the Commonwealth (the RNE was closed in 2007 and is no longer a statutory list).

- A defined wetland and the area within 50 m of the wetland.
- The area covered by vegetation within 50 m of rare flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located.
- The area covered by a Threatened Ecological Community (TEC).
- A Bush Forever site.
- The areas covered by the following policies:
  - The *Environmental Protection (Gnangara Mound Crown Land) Policy 1992.*
  - The *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002.*
- The areas covered by the lakes to which the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (SCPL) (EPP Lakes) applies.
- Protected wetlands as defined in the *Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998*.
- Areas of fringing native vegetation in the policy area as defined in the *Environmental Protection (Swan and Canning Rivers) Policy 1997*.

Vegetation, flora & fauna

Vegetation extent & status

The National Objectives and Targets for Biodiversity Conservation 2001-2005 (Commonwealth of Australia 2001) recognise that the retention of 30 percent or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected. This is the threshold level below which species loss appears to accelerate exponentially and loss below this level should not be permitted. This level of recognition is in keeping with the targets recommended in the review of the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC 2000) and in EPA Position Statement No. 2 on environmental protection of native vegetation in Western Australia (EPA 2000).

From a purely biodiversity perspective and taking no account of any other land degradation issues, there are a number of key criteria now being applied to the clearing of native vegetation in Western Australia (EPA 2000).

- The "threshold level" below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at a level of 30 percent of the pre-European extent of the vegetation type.
- A level of 10 percent of the original extent is regarded as being a level representing Endangered.
- Clearing which would put the threat level into the class below should be avoided.
- From a biodiversity perspective, stream reserves should generally be in the order of at least 200 m wide.

Within the Swan Coastal Plain, EPA Position Statement No. 9 identifies vegetation complexes with 30 percent or less or their pre-clearing extent remaining in a bioregion, or 10 percent or less of their pre-clearing extent remaining in constrained areas (i.e. areas of urban development in cities and major towns) on the Swan Coastal Plain, to be critical assets (EPA 2006b).

The extent of remnant native vegetation has been assessed by Shepherd et al. (2002) and the Government of Western Australia (2013), based on broadscale vegetation association mapping by Beard (1979).

The EPA Guidance Statement No. 10 (EPA 2006a) assesses the extent of Heddle et al. (1980) vegetation complexes currently present against presumed pre-European extents.

Conservation codes

Significant flora, fauna and ecological communities are protected under both Federal and State Acts. The Federal EPBC Act provides a legal framework to protect and manage nationally important flora and communities. The State WC Act is the primary wildlife conservation legislation in Western Australia. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the WC Act can warrant referral to the DotE and/or the EPA. Information on the conservation codes is provided below.

Threatened & Priority Ecological Communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (English and Blythe 1997). Federally listed TECs are protected under the EPBC Act administered by the DotE. The DPaW also maintains a list of TECs which have been endorsed by the Minister for the Environment (August 2010), however, they are not formally protected under the State WC Act; some of which are also protected under the EPBC Act. 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.

DEC listed ecological communities are given special consideration in environmental impact assessments and have special status under the land clearing regulations of the *Environmental Protection Act 1986* (EP Act). The EPA's position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment.

Possible TECs that do not meet survey criteria are added to the DPaW Priority Ecological Community (PEC) Lists under Priorities 1, 2 and 3. These 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 description of the conservation categories for TECs and PECs is provided in Table B.1.

Table B.1 Conservation codes for Threatened Ecological Communities (TEC) endorsed by the Western Australian Minister for the Environment and listed under the EPBC Act.

Western Australia Conservation Categories		Federal Government Conservation Categories (EPBC Act)	
Presumed Totally Destroyed (PD)	The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.	Critically Endangered (CR)	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already	Endangered (EN)	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future

	severely degraded throughout its range but capable of being substantially restored or rehabilitated		
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.	Vulnerable (VU)	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.		

Table B. 2 Conservation categories and definitions for Priority Ecological Communities (PECs) as listed by the DEC

Category	Description
Priority 1	Poorly known ecological communities. Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority 2	Poorly known ecological communities. Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority 3	Poorly known ecological communities. (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which

	are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
Priority 4	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority 5	Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Other significant vegetation

Vegetation may be significant for a range of reasons, other than a statutory listing as a TEC or because the extent is below a threshold level. The EPA (2004a) states that significant vegetation may include vegetation that includes the following:

- Scarcity
- Unusual species
- Novel combinations of species
- A role as a refuge
- A role as a key habitat for Threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of the range of a unit (particularly, a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- A restricted distribution

This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

Conservation significant flora

The EPBC Act provides a legal framework to protect and manage nationally important flora.

The WC Act is the primary wildlife conservation legislation in the State and the Minster for the Environment can declare taxa (species, subspecies or variety) as “Rare Flora” if they are considered to be in danger of extinction, rare or otherwise in need of special protection”. According to the DPaW (WA Herbarium, 1998–): “Threatened flora are plants which have been assessed as being at risk of extinction. In Western Australia the term Declared Rare Flora (DRF) is applied to Threatened flora due to the laws regarding threatened flora conservation. For the purposes of this report, flora listed by the WC Act as DRF are described as Threatened.

The DPaW also produces a supplementary list of Priority Flora, for species that are not considered Threatened under the WC Act but for which the DPaW feels there is cause for concern. Conservation codes for Priority species are assigned by the DPaW to define the level of conservation significance. 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. These taxa need further survey and evaluation of conservation status before consideration can be given to declaration as Threatened flora.

For the purposes of this assessment, all species listed under the EPBC Act, WC Act and DPaW Priority list are considered conservation significant.

Conservation significant fauna

The Federal conservation level of fauna species and their significance status is currently assessed under the EPBC Act. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994).

The EPBC Act also protects migratory species that are listed under the following 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).

The State conservation level of fauna species and their significance status is currently assessed under the WC Act (*Wildlife Conservation (Specially Protected Fauna) Notice 2010(2)*). The WC Act uses a set of Schedules but also classifies species using some of the IUCN categories. Schedule 3 fauna species are those which are subject to agreements between the government of Australia and the governments of Japan, China and the Republic of Korea relating to the protection of migratory birds and are declared to be fauna that is in need of special protection.

A supplementary list of Priority Fauna is also produced by DPaW, these being species that are not considered Threatened under the WC Act but for which the Department feels there is a cause for concern. Such taxa need further survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. 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.

For the purposes of this assessment, all species listed under the EPBC Act, WC Act and DPaW Priority list are considered conservation significant. A description of relevant conservation categories is provided below (Table B. 3 and Table B. 4).

Table B. 3 Conservation categories and definitions for *Environment Protection and Biodiversity Conservation Act 1999* (EPBC 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

Migratory Species listed under the EPBC Act

The EPBC Act protects lands and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II);
- Migatory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA); and
- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Table B.4 Conservation codes and descriptions for Western Australian Flora and Fauna

Code	Conservation category	Description
Wildlife Conservation Act 1950		
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.
DEC Priority Listed		
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 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.
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.

Other significant flora and fauna

In addition to conservation significant species, flora and fauna can be considered important if they are significant either on the Swan Coastal Plain or in the Perth metropolitan region. This includes species discussed in *Bush Forever – Keeping the Bush in the City* (Government of Western Australia 2000).

Introduced plants (weeds)

Weeds of National Significance

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

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

Declared Pest

Under the *Biosecurity and Agriculture Management Act 2007* (BAM Act), a Declared Pest is a prohibited organism or an organism for which a declaration under Section 22(2) is in force. The DAFWA maintains a list of Declared Pests for Western Australia. If a plant is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to comply with the specific category of control.

Declared plants are gazetted under categories, which define the action required. The category may apply to the whole of the State, districts, individual properties or even paddocks. Categories of control are defined in Table B.5. Among the factors considered in categorising Declared Pests are:

- The impact of the plant on individuals, agricultural production and the community in general

- Whether it is already established in the area
- The feasibility and cost of possible control measures

Table B. 5 Department of Agriculture and Food Western Australia Control Classes for Declared Plants listed under the *Agriculture and Related Resources Protection Act 1976*.

Control Class Code	Description
P1	Introduction of the plant into, or movement of the plant within, an area is prohibited.
P2	Plant to be eradicated in the area.
P3	Plant to be controlled by reduction in number or distribution of the plant or both.
P4	Spread of plant beyond where it currently occurs to be prevented.
P5	Particular action to be taken on public land or land under the control of a local government.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	D. Mullan M Dilly L Zimmermann	D. Farrar		T. Moulds		9/04/2014
0	M Dilly L Zimmermann	D. Farrar		D. Farrar		28/05/2014

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