



FLORA, VEGETATION AND FAUNA ASSESSMENT, KEANE ROAD



FLORA, VEGETATION AND FAUNA ASSESSMENT, KEANE ROAD

Prepared for

WATER CORPORATION

Prepared by

ENV Australia Pty Ltd
Level 1, 503 Murray Street
PERTH WA 6000
Phone: (08) 9214 6100
Fax: (08) 9226 4109
Email: env@env.net.au

Job Number: J113163

Report Number: 12/137

Document Version	Author/s and Editor/s	Reviewer/s	Endorsed for Release by:	Date
Draft	<i>Narelle Whittington, Chris Knuckey and Damian Buller</i>	<i>Denise True, Bridget Watkins</i>	<i>Denise True</i>	12/12/12
Final	<i>Narelle Whittington, Chris Knuckey and Damian Buller</i>	<i>Denise True, Bridget Watkins</i>	<i>Narelle Whittington</i>	19/03/13

TABLE OF CONTENTS

EXECUTIVE SUMMARY	III
1 INTRODUCTION.....	1
1.1 THE PROJECT	1
1.2 OBJECTIVES	1
1.2.1 Location	2
1.3 BACKGROUND TO THE PROTECTION OF FLORA, VEGETATION AND FAUNA.....	4
2 BIOPHYSICAL ENVIRONMENT	7
2.1 CLIMATE.....	7
2.2 GEOLOGY AND SOILS	7
2.3 BIOGEOGRAPHIC REGIONALISATION FOR AUSTRALIA	8
2.5 GEOMORPHIC WETLANDS.....	10
2.6 CONSERVATION ESTATE	10
2.6.1 Bush Forever and Ecological Linkages.....	10
2.7 PREVIOUS BIOLOGICAL STUDIES.....	11
3 METHODS	12
3.1.1 Database Review	12
3.1.2 Field Survey.....	13
3.1.3 Taxonomy and Nomenclature	14
3.1.4 Statistical Analysis.....	14
3.2 VEGETATION MAPPING.....	14
3.3 FAUNA ASSESSMENT	15
3.3.1 Database Review	15
3.3.2 Field Survey.....	16

3.3.3	Taxonomic Identification.....	16
4	RESULTS	17
4.1	SURVEY LIMITATIONS AND CONSTRAINTS	17
4.2	FLORA	18
4.2.1	Overview of Flora	18
4.2.2	Flora of Conservation Significance.....	18
4.2.3	Introduced Flora	23
4.3	VEGETATION.....	24
4.3.1	Vegetation Associations.....	24
4.3.2	Vegetation Condition.....	25
4.3.3	Floristic Community Types	26
4.3.4	Regional Representation.....	30
4.3.5	Vegetation of Conservation Significance.....	30
4.3.6	Wetlands.....	30
4.4	FAUNA	31
4.4.1	Habitat Assessment	31
4.4.2	Fauna Assemblage.....	32
4.4.3	Fauna of Conservation Significance	33
5	DISCUSSION	34
5.1	CONTEXT	34
5.2	FLORA OF CONSERVATION SIGNIFICANCE.....	34
5.3	VEGETATION OF CONSERVATION SIGNIFICANCE.....	35
5.4	VEGETATION CONDITION AND INTRODUCED FLORA.....	37
5.5	REGIONAL REPRESENTATION	37

5.6	BUSH FOREVER.....	37
5.7	WETLANDS.....	38
5.8	FAUNA HABITAT TYPES.....	38
5.9	FAUNAL ASSEMBLAGE.....	40
5.10	CONSERVATION SIGNIFICANT FAUNA.....	40
6	RECOMMENDATIONS.....	43
6.1	FLORA.....	43
6.2	FAUNA.....	43
7	ASSESSMENT OF FINDINGS AGAINST THE CLEARING PRINCIPLES.....	44
8	REFERENCES.....	48

TABLES

TABLE 1	BROAD VEGETATION TYPES WITHIN THE STUDY AREA AND THEIR REGIONAL REPRESENTATION
TABLE 2	LIMITATIONS AND CONSTRAINTS ASSOCIATED WITH THE KEANE ROAD SEWER MAIN FLORA, VEGETATION AND FAUNA SURVEY
TABLE 3	ASSESSMENT OF THE LIKELY OCCURRENCE OF DRF AND PRIORITY FLORA (AS PER DEC DATABASE SEARCHES) IN THE STUDY AREA
TABLE 4	INTRODUCED FLORA RECORDED IN THE STUDY AREA, INCLUDING THEIR RATING BY THE ENVIRONMENTAL WEED STRATEGY (CALM 1999) AND THE DEC INVASIVE PLANT PRIORITIZATION PROCESS (DEC 2012A)
TABLE 5	VEGETATION ASSOCIATIONS AND THEIR EXTENT IN THE STUDY AREA
TABLE 6	VEGETATION CONDITION RECORDED IN THE STUDY AREA
TABLE 7	FLORISTIC COMMUNITY TYPE ANALYSIS
TABLE 8	UNIQUE IDENTIFICATION NUMBER OF WETLANDS WITHIN THE STUDY AREA

PLATES

PLATE 1	<i>JACKSONIA GRACILLMA</i> (P3)
PLATE 2	<i>PETROPHILE RIGIDA</i>
PLATE 3	ARUM LILY (<i>*ZANTEDESCHIA AETHIOPICA</i>)
PLATE 4	ONE LEAF CAPE TULIP (<i>*MORAEA FLACCIDA</i>)

FIGURES

FIGURE 1	LOCATION OF STUDY AREA
FIGURE 2	AVERAGE LONG-TERM (1944-2012) AND 2012 MONTHLY RAINFALL AND AVERAGE MAXIMUM AND MINIMUM TEMPERATURES (1944-2012) FOR PERTH AERO (BOM 2012).
FIGURE 3	GEOLOGY OF THE STUDY AREA
FIGURE 4	SYSTEM 6 VEGETATION COMPLEXES OF THE STUDY AREA
FIGURE 5	GEOMORPHIC WETLANDS
FIGURE 6	FLORA QUADRAT LOCATIONS
FIGURE 7	FAUNA HABITAT ASSESSMENT LOCATIONS
FIGURE 8	LOCATIONS OF CONSERVATION SIGNIFICANT FLORA
FIGURE 9	LOCATIONS OF INTRODUCED FLORA
FIGURE 10	VEGETATION ASSOCIATIONS MAP
FIGURE 11	VEGETATION CONDITION MAP
FIGURE 12	FAUNA HABITAT MAP

APPENDICES

APPENDIX A	DEFINITION OF DECLARED RARE / PRIORITY / THREATENED FLORA SPECIES AND SIGNIFICANT FLORA SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA
APPENDIX B	DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE
APPENDIX C	DEFINITION OF THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES
APPENDIX D	ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES
APPENDIX E	BUSH FOREVER VEGETATION CONDITION SCALE
APPENDIX F	FAUNA SPECIES RECORDED WITHIN THE VICINITY OF THE STUDY AREA
APPENDIX G	FAUNA HABITAT ASSESSMENT DATA SHEETS

APPENDIX H	FLORA QUADRAT AND RELEVÉ DATA SHEETS
APPENDIX I	FLORA BY SITE MATRIX
APPENDIX J	FLORA INVENTORY
APPENDIX K	LOCATIONS OF PRIORITY FLORA
APPENDIX L	LOCATIONS OF INTRODUCED FLORA
APPENDIX M	POTENTIALLY OCCURRING CONSERVATION SIGNIFICANT FAUNA

PERMITS

This flora survey was conducted under the following licences issued by the Department of Environment and Conservation; Licence to take flora for scientific or other prescribed purposes: SL010155 issued to Narelle Whittington and SL009905 issued to Damian Buller.

STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ('the report') has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ('scope of services'). In some circumstances the scope of services may have been limited by factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied on data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ('the data'). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or in part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, unavailable, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied on the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, express or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and for no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including, without limitation, matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying on the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness

of any conclusions, and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

ENV will not be liable to update or revise the report to take into account any events or circumstances occurring or facts becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report, nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV.Australia Pty Ltd (ENV) was commissioned by the Water Corporation in August 2012, to undertake a Level 2 Flora and Vegetation Assessment and a Level 1 Fauna Assessment for the proposed Keane Road Sewer Main, Forrestdale (the study area). The Water Corporation has two possible options for the route of the sewer main which were surveyed concurrently. ENV understands that the impact of the two proposed sewer route options, which will have an approximately 10 m wide corridor, will either be 2.11 ha or 2.32 ha depending on the selected route.

The purpose of this study is to provide information on the significance of the flora, vegetation and fauna within the study area as part of supporting documentation for environmental approvals to construct the sewer infrastructure. This study may also provide supporting documentation for an application for a Native Vegetation Clearing Permit (NVCP) under the *Environmental Protection Act 1986* (EP Act).

The field survey was conducted on the 19th of October 2012 and recorded 94 taxa from 76 genera and 30 families.

No plant species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* or as Declared Rare Flora pursuant to the *Wildlife Conservation Act 1950* were recorded during the survey.

One Priority Flora, *Jacksonia gracillima* (Priority 3), was recorded in the study area. The presence of *Jacksonia gracillima* (Priority 3) does not form a statutory constraint to development of the study area. There is no written policy on responding to the presence of Priority Flora within proposed development sites. The presence of these species is dealt with by the Department of Environment and Conservation on a case by case basis.

Fifteen introduced species were identified during the survey. Two of these are listed as Declared Plants within the Swan Coastal Plain; Arum Lily (**Zantedeschia aethiopica*), and One Leaf Cape Tulip (**Moraea flaccida*).

The study area is mapped as the Southern River Complex: Vegetation consists of open woodland of *Corymbia calophylla*, *Eucalyptus marginata* and *Banksia* spp. with fringing woodland of *Eucalyptus rudis* – *Melaleuca raphiophylla* along creek beds. The pre-European vegetation in the Southern River Complex, which the study area is situated, is considered to be Vulnerable.

Four vegetation units were identified within the study area. These units are considered to represent four Floristic Community Types; SCP21c 'Low lying *Banksia attenuata* woodlands or shrublands' and SCP04 '*Melaleuca preissiana* damplands' SCP5 'Mixed Shrub damplands' and either SCP8 'Herb rich shrublands in claypans' or SCP10a 'Shrublands on dry clay flats'.

SCP21c is listed as a Priority Ecological Community by the Department of Environment and Conservation. Priority communities do not form a statutory constraint to development. There is no written policy on how to respond to the presence of Priority Ecological Communities within proposed development sites. The presence of these communities is dealt with by the Department of Environment and Conservation on a case by case basis.

SCP8 Herb rich shrublands in claypans and SCP10a Shrublands on dry clay flats both are listed as Threatened Ecological Communities by both the State and the Commonwealth. ENV advises that the presence of the Threatened Ecological Community needs to be confirmed by the Department of Environment and Conservation. If the Department of Environment and Conservation confirms the presence of the Threatened Ecological Community, they may seek a retention outcome in relation to the specific site characteristics.

The site is mapped by the Department of Environment and Conservation as supporting Conservation and Multiple Use Category wetlands. The wetlands cover the majority of the site according to the Geomorphic Wetland mapping. Conservation category wetlands are in the highest category of protection afforded by WA State legislation, and are listed as Environmentally Sensitive Areas under the *Environment Protection Act*.

The study area consists of three fauna habitat types; *Banksia* Woodland, *Melaleuca* Shrubland and Cleared Land. During the field survey a total of 26 vertebrate fauna species were recorded comprising one reptile, 23 avifauna and two mammal species.

A database search resulted in 27 conservation significant fauna species potentially occurring in the study area. Of these, one species, the Quenda which is a Priority 5 listed species by the Department of Environment and Conservation was recorded. Based on ecology, habitat present and fauna records, four species are classified as 'Likely' to occur (*Calyptorhynchus banksii naso*, *Calyptorhynchus baudinii*, *Calyptorhynchus latirostris* and *Merops ornatus*), six species are classified as 'Possible' to occur, ten species are classified as 'Unlikely' to occur and six are classified as 'Highly Unlikely' to occur.

1 INTRODUCTION

1.1 THE PROJECT

ENV.Australia Pty Ltd (ENV) was commissioned by the Water Corporation in August 2012, to undertake a Level 2 Flora and Vegetation Assessment and a Level 1 Fauna Assessment for the proposed Keane Road Sewer Main, Forrestdale (the study area). The Water Corporation has two possible options for the route of the sewer main which were surveyed concurrently. ENV understands that the impact of the two proposed sewer route options, which will have an approximately 10 m wide corridor, will either be 2.11 ha or 2.32 ha depending on the selected route (Figure 1).

The purpose of this study is to provide information on the significance of the flora, vegetation and fauna within the study area as part of supporting documentation for environmental approvals to construct the sewer infrastructure. This study will provide supporting documentation for an application for a Native Vegetation Clearing Permit (NVCP) under the *Environmental Protection Act 1986 (EP Act)*.

1.2 Objectives

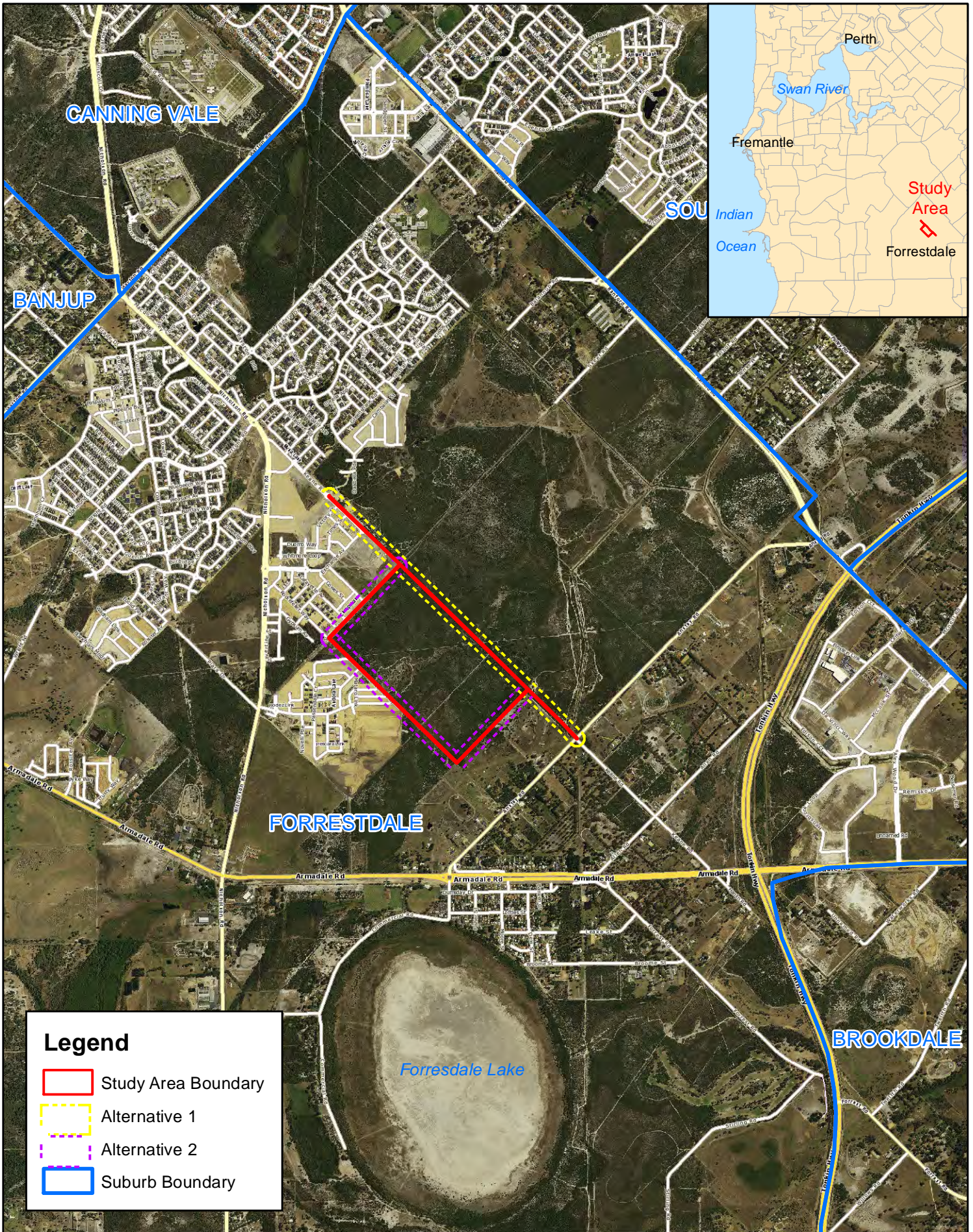
The objectives of the flora, vegetation and fauna assessment were to:

- conduct a comprehensive flora, vegetation and fauna database and literature review;
- compile an inventory of vascular plant species;
- provide an inventory of fauna species and habitats that occur or potentially occur in the study area;
- conduct targeted searches and flag the presence of field-identifiable plant species of conservation significance;
- record the occurrence of introduced plant species;
- document any potential signs of dieback disease;
- assess and map vegetation condition;
- document, describe and map the vegetation associations present;
- identify and map locations of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs);
- provide a list of suitable plant species for use in rehabilitation;

- provide recommendations to minimise the impact of construction on native flora and fauna; and
- assess the proposed development against the ten native Vegetation Clearing Principles as detailed in Schedule 5.0 of the EP Act 1986.

1.2.1 Location

The study area is approximately 4.43 ha in size and is located 1 km north of Forrestdale in the City of Armadale (Figure 1). The closest intersection is Keane Road and Anstey Road, Forrestdale. The study area consists of remnant vegetation with cleared areas for firebreaks and informal walking paths.



Legend

- Study Area Boundary
- Alternative 1
- Alternative 2
- Suburb Boundary



CLIENT Water Corporation	JOB NO. J113163
AUTHOR D. Buller	DRAWN M. Mikkonen
SCALE 1:30,000 @ A4	DATE 05-03-13
PROJECTION GDA 94 MGA 50	

Location of Study Area
Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale

FIGURE 1

1.3 BACKGROUND TO THE PROTECTION OF FLORA, VEGETATION AND FAUNA

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

Legislative Protection

- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*;
- *Wildlife Conservation Act 1950 (WC Act)*;
- *Environmental Protection Act 1986 (EP Act)*; and
- *Agriculture and Related Resources Protection Act 1976 (ARRP Act)*.

Non-Legislative Protection

- Western Australian Department of Environment and Conservation (DEC) Priority lists for flora and vegetation; and
- Recognition of locally significant populations by the DEC.

A short description of each is given below. Other definitions, including species conservation categories, are provided in Appendix A for flora and Appendix B for fauna. Conservation categories for ecological communities are provided in Appendix C.

Environment Protection and Biodiversity Conservation Act 1999

The *EPBC Act* aims to protect Matters of National Environmental Significance. Under the *EPBC Act*, the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (SEWPAC) lists threatened species and communities in categories determined by criteria set out in the Act (www.environment.gov.au/epbc/index.html) (Appendix A2 and Appendix B2 and Appendix C2).

Projects likely to impact on matters of national environmental significance should be referred to SEWPAC for assessment under the *EPBC Act*.

Wildlife Conservation Act 1950

The Western Australian DEC lists flora and fauna under the provisions of the *WC Act* as protected according to their need for protection (Appendix A for flora and Appendix B for fauna).

Flora is given Declared Rare status when populations are geographically restricted or are threatened by local processes. In addition, under the *WC Act*, by Notice in the

Western Australian Government Gazette of 9 October 1987, all native flora (spermatophytes, pteridophytes, bryophytes and thallophytes) is protected throughout the State.

Fauna are classified as Schedule 1 to Schedule 4 according to their need for protection (Appendix B).

Environmental Protection Act 1986

Declared Rare Flora (DRF) and TECs are given special consideration in environmental impact assessments, and have special status as Environmentally Sensitive Areas (ESAs) under the *EP Act* and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Exemptions for a clearing permit do not apply in an ESA. In addition, habitat necessary for the maintenance of indigenous fauna is a clearing principle and assessed during consideration of applications for a NVCP.

Agriculture and Related Resources Protection Act 1976

Plants may be 'Declared' by the Agriculture Protection Board (APB) under the *ARRP Act 1976 (WA)*. Declared Plants are gazetted under five categories (P1-P5), which define the action required. Details of the definitions of these categories are provided in Appendix D. A declaration may apply to the whole State, to districts, individual properties or even to single paddocks. If a plant is 'Declared', landholders are obliged to control that plant on their properties (Department of Agriculture and Food Western Australia [DAFWA] 2012).

The Environmental Weed Strategy for Western Australia (EWSWA) (Department of Conservation and Land Management [CALM] 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impacts, invasiveness and distribution (Appendix D). The Strategy defines environmental weeds as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.'

The DEC Invasive Plant Prioritization (IPP) Process (DEC 2012) was developed to progress the EWSWA (CALM 1999). The prioritisation process focuses on a "species-led" and "site-led" approach to set priorities for weed management on DEC managed lands for each DEC region of WA. The IPP process is also developed to assist other landholders in their management of weeds.

The Australian Government along with the State and Territory governments has endorsed 20 species as Weeds of National Significance (WONS). Four major criteria were used in determining WONS:

- The invasiveness of a weed species;

- A weed's impacts;
- The potential for spread of a weed; and
- Socio-economic and environmental values.

Each WONS has a national strategy and a national coordinator, responsible for implementing the strategy. WONS are regarded as the worst weeds in Australia because of their invasiveness, potential for spread, and economic and environmental impacts (Commonwealth of Australia 2012).

Department of Environment and Conservation Priority Lists

The DEC lists 'Priority' flora and fauna that have not been assigned statutory protection under the *WC Act*, but which are under consideration for declaration as DRF or Scheduled fauna. Flora and fauna assessed as Priority 1-3 are considered to be in urgent need of further survey. Priority 4 taxa require monitoring every 5-10 years and Priority 5 taxa are subject to a specific conservation program (Appendix A).

The DEC maintains a list of PECs which identifies ecologically valuable communities that need further investigation before possible nomination for TEC status.

Once listed, a community is a PEC, and when endorsed by the Western Australian Minister of Environment becomes a TEC, and protected as an ESA under *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (Appendix B).

Informal Recognition of Flora

The International Union for Conservation of Nature (IUCN) publishes an international listing of species of conservation importance, known as the IUCN Red List (IUCN 2012). This list identifies those species most in need of conservation attention. The IUCN Red List is used for conservation planning, decision making and monitoring by government agencies, wildlife departments, conservation-related non-governmental organisations (NGOs), natural resource planners, educational organisations, and many others interested in preserving biodiversity.

Certain populations or communities of flora and fauna may be of local significance or interest because of their patterns of distribution and abundance. For example, a species may be locally significant because they are range extensions to the previously known distribution, or are newly discovered taxa (and have the potential to be of more than local significance). In addition, many species are in decline as a result of threatening processes (land clearing, grazing, changed fire regimes), and relict populations of such species assume local importance for the DEC. It is not uncommon for the DEC to make comment on these species of interest.

2 BIOPHYSICAL ENVIRONMENT

2.1 CLIMATE

The study area is located on the Swan Coastal Plain, this region experiences a Mediterranean climate characterised by hot, dry, summers and cool, wet, winters with an average maximum summer temperature of 30.8°C and an average minimum winter temperature of 11°C (Bureau of Meteorology [BoM] 2012) (Figure 2).

The average annual rainfall recorded at Perth Aero, the nearest BoM station, 20 km north of the study area, is 771.7 mm, with the majority of precipitation occurring in winter (BoM 2012) (Figure 2). Perth Aero recorded 694 mm of rain in the 12 months prior to survey (September 2011 – August 2012), 77.7 mm below the long term average rainfall of 771.7 mm for the same period (BoM, 2012). The three months prior to survey (June-August 2012), Perth Aero recorded 282.8 mm of rainfall, 35% below the 436.6 mm average rainfall for the same period (BoM 2012).

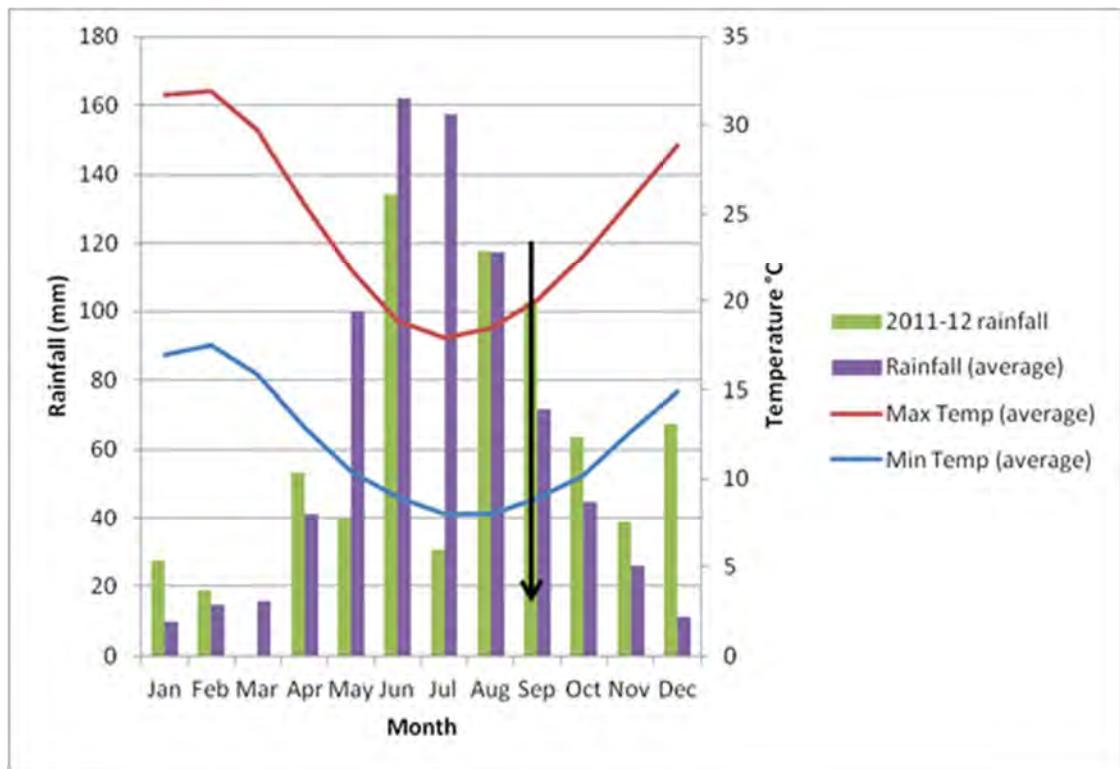


Figure 2: Average long-term (1944-2012) and 2012 Monthly Rainfall and Average Maximum and Minimum Temperatures (1944-2012) for Perth Aero (BoM, 2012). Arrow indicates survey time.

2.2 GEOLOGY AND SOILS

The study area occurs on the Swan Coastal Plain portion of the Darling System (Churchward & McArthur 1980). Soils of the Swan Coastal Plain have been described by

Churchward and McArthur (1980) as consisting of aeolian and fluvial deposits. The study area occurs on:

- Southern River: Sandplain with low dunes and many intervening swamps; iron and humus podzols, peats and clays (Churchward & McArthur 1978)

Geological mapping of the Perth Metropolitan Region as part of the 1:50000 Geological Series, has identified the soils of study area as belonging to the following units (GSWA 1986) (Figure 3):

- (Sp₁) Peaty Sand - grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty of lacustrine origin.
- (Sp₈) Sand - white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals.
- (Sp₁₀) Sand: as S₈ over sandy clay to clayey sand of the Guildford formation, of eolian origin.

2.3 BIOGEOGRAPHIC REGIONALISATION FOR AUSTRALIA

The Biogeographic Regionalisation for Australia (IBRA) divides Australia into 89 bioregions based on major biological and geographical/ geological attributes (SEWPAC 2012c). These bioregions are subdivided into 419 subregions, as part of a refinement of the IBRA framework (SEWPAC 2012c).

The study area is located in the Perth subregion (SWA02) of the Swan Coastal Plain bioregion (Thackway & Cresswell 1995). The Perth subregion is composed of colluvial and aeolian sands, alluvial river flats and coastal limestone (Mitchell et al. 2002). Vegetation can be characterised by heath and/or Tuart woodlands on limestone, Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of various ages and Marri on colluvial and alluvials (Mitchell et al. 2002).

2.4 BROAD VEGETATION TYPES

Mapping of the Swan region vegetation of Western Australia was completed on a broad scale (1:250,000) by Heddle et al. (1978). The study area is situated in South West Botanical Province and the Darling Botanical District (Beard 1990). This region typically consists of forest country with related woodlands and is divided into four subregions or botanic subdistricts. The study area is located within the Swan Coastal Plain Subregion in the Drummond Botanical Subdistrict, which consists mainly of the following vegetation communities:

- *Banksia* Low Woodland on leached sands and *Melaleuca* Swamps in poorly drained areas;
- Woodland of Tuart (*Eucalyptus gomphocephala*); and
- Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) on less leached soils (Beard 1990).

Vegetation complexes of the Darling System, in which the Swan Coastal Plain occurs, have been mapped by Heddle et al. (1978). The study area contains one Swan Coastal Plain vegetation complex which is related to the underlying soil profile (Figure 4):

- Southern River Complex – Open woodland of *Eucalyptus calophylla* – *E. marginata* – *Banksia* spp. with fringing woodlands of *E. rudis* – *Melaleuca raphiophylla* along creek beds (Heddle et al. 1978).

This vegetation complex belongs to a combination of several major geomorphic units: Bassendean Dunes/Pinjarra Plain/Spearwood Dunes (Government of Western Australia 2000b).

The Southern River Complex was estimated to have 19.8% native vegetation remaining based on the pre-European extent with 1.5% in secure tenure (EPA 2006). More recently the Perth Biodiversity Project (PBP 2010) has mapped native vegetation extent by vegetation complex on the Swan Coastal Plain. It is estimated that 19.7% of Southern River Complex remains compared to its pre-European extent (PBP 2010) (Table 1).

The EPA recognises vegetation complexes that are not well represented in reserves as being significant. Vegetation complexes which have 10-30% remaining may be considered regionally significant. Proposals that would affect a vegetation complex with 10% or less remaining are likely to be formally assessed by the EPA (EPA 2006).

Table 1: Broad Vegetation Types within the Study Area and their Regional Representation

	Pre-European area (ha) ¹	Current extent (ha) ₁	Remaining (%) ¹	Pre-European % in IUCN Class I-IV Reserves ¹	Conservation Status ²
IBRA Bioregion Swan Coastal Plain	1,501,209.2	587,832.9	39.16	10.13	Vulnerable
Vegetation Types (Beard 1979/ Shepherd et al. 2001) Swan Coastal Plain Bioregion					
1001	57410.23	14151.90	7.19	1.14	Critically Endangered
968	136188.20	9798.61	24.65	1.12	Endangered

¹ Government of Western Australia (2011)

² EPA (2000)

2.5 GEOMORPHIC WETLANDS

In an effort to protect wetlands on the Swan Coastal Plain, the DEC developed a dataset, mapping the location and management category of wetlands on the Swan Coastal Plain (DEC 2012g). A management category is assigned to each wetland, which provides guidance on the nature of the management and protection of the wetland.

The DEC Geomorphic Wetlands Dataset identified several wetlands of both Conservation and Multiple Use management categories as occurring within the study area (DEC 2012g) (Figure 5).

2.6 CONSERVATION ESTATE

2.6.1 Bush Forever and Ecological Linkages

Bush Forever is a State Government Policy and program that identifies 51,200 ha of regionally significant vegetation for protection, covering 26 vegetation complexes (Government of Western Australia 2000a; 2000b). This amounts to approximately 18% of the original vegetation on the SCP portion of the Perth metropolitan area (Government of Western Australia 2000a; 2000b).

Regionally significant vegetation has been identified based on criteria relating to its conservation value. Important criteria in the identification process include the achievement, where possible, of a comprehensive representation of all the ecological communities originally occurring in the region, principally through protecting a target of at least 10% of each vegetation complex in the Bush Forever project boundary (Government of Western Australia 2000a; 2000b).

The study area is mapped as Bush Forever Site No. 342, also known as the Anstey/Keane Dampland and Adjacent Bushland, Forrestdale (Government of Western Australia 2000a). The next nearest Bush Forever sites to the study area are: Balannup Lake and Adjacent Bushland, Southern River/Forrestdale (Bush Forever site 413), abutting the northern edge of Site 342 and the Piarra Nature Reserve, Forrestdale (Bush Forever Site 262), approximately 0.6 km south-west of the study area (Government of Western Australia 2000a). Forrestdale Lake is a seasonal brackish lake situated 1.2 km south of the study area (AHC 2000). The wetland is listed as an 'Indicative Place' on the Australian Heritage Commission Register of the National Estate, Bush Forever Site no. 345 (Government of Western Australia 2000a) and as a RAMSAR wetland in the Directory of Important Wetlands in Australia (SEWPAC 2012a).

2.7 PREVIOUS BIOLOGICAL STUDIES

Previous biological surveys most relevant to the current survey include:

- Heron Park Phase Two Flora and Vegetation Assessment (ENV 2010).

The key findings of the report are provided below. It should be noted that differences in survey timing, extent and the size and locations of each study area will influence the results of each survey. For further details of specific survey methods and timing please refer to the original report.

- No plant species listed as Threatened under the EPBC Act or as DRF pursuant to the WC Act were recorded during the survey.
- One Priority Flora, *Jacksonia gracillima* (Priority 3), was recorded in the study area.
- SCP21c 'Low lying *Banksia attenuata* woodlands or shrublands' and SCP04 '*Melaleuca preissiana* damplands' were identified as occurring on site. These Floristic Community Types are not protected under Federal or State Legislation. SCP21c is listed as a Priority Ecological Community by the DEC.
- The DEC's Geomorphic Wetlands Dataset identifies five Multiple Use wetlands as occurring within the study area.

3 METHODS

3.1 FLORA ASSESSMENT

The survey was consistent with a single season Level 2 survey as per the EPA requirements for environmental surveying and reporting for flora and vegetation in Western Australia, as set out in the following documents:

- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No.2* (EPA 2000);
- *Environment Protection of Wetlands. Position Statement No. 4* (EPA 2001);
- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002);
- *EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51* (EPA 2004b); and
- *EPA Guidance for the Level of Assessment for Proposals affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 region. Guidance Statement No. 10* (EPA 2006).

3.1.1 Database Review

The desktop study provided background information on the flora and vegetation of the project area. This involved a search of the following sources:

- DEC combined biological database *NatureMap* (DEC 2012b);
- DEC Threatened and Priority Flora database (DEC 2012f);
- DEC Threatened and Priority Ecological Communities information (DEC 2012d);
- IUCN Red List (IUCN 2012);
- SEWPAC Protected Matters Search Tool (SEWPAC 2012b); and
- previous flora surveys (refer to Section 2.7).

A request for a database search was submitted to the DEC September 5th 2012 within 5 kilometres of coordinates 32°08'04.23"S and 115°56'19.42"E to obtain a list of DRF/T or Priority flora, and TECs and PECs near the project area. These sources were used to

compile a list of expected DRF or Priority species and TECs and PECs that may occur on the landforms in the project area.

3.1.2 Field Survey

The field survey was conducted on 19th October 2012, with 2 person-days invested in the field survey.

Flora and Vegetation Assessment

The survey included the assessment of one site, consisting of six quadrats and four relevés (Figure 6). Quadrats are vegetation survey plots which are accurately measured out as 5 x 20 m and marked at the NW corner using a handheld Garmin GPS unit. Relevés are 'unmarked quadrats', where a centre point is marked and an area equivalent to that of a quadrat is visually approximated around this point for the purpose of estimating species composition and cover.

The information recorded at each quadrat included landscape features, surface soil colour and texture, bare ground, litter cover, disturbance, fire age, aspect and vegetation condition (Government of Western Australia 2000b). Each species of plant at each quadrat was recorded, including information on height and percentage cover.

Targeted or Systematic Searches

Habitats and locations likely to support conservation significant flora were targeted for searches. Further opportunistic collections focused on the location of taxa not recorded in the quadrats and on locations of introduced species. For each population of significant flora identified the following was recorded:

- Co-ordinate locations (using handheld GPS units);
- Description of vegetation association present;
- Estimation of population size; and
- Photograph of plant *in situ*, where possible.

If a specimen was collected, a voucher will be lodged at the Western Australian Herbarium.

Targeted or Systematic Searches for Introduced Species

A targeted survey of the study area was undertaken, focussing on:

- Declared plants listed under the ARR Act; and

- Other environmental weed species as listed by DEC on FloraBase (WAH 2012), and based on results of previous surveys in and adjacent to the study area.

3.1.3 Taxonomy and Nomenclature

Where field identification of plant taxa was not possible, specimens were collected systematically for later identification by taxonomists utilising identification keys including, Flora of Australia (1981-2011), AusGrass (Sharp & Simon 2002), EUCLID (EUCLID 2006), WATTLE (Maslin 2001), relevant taxonomic papers published in journals including Australian Systematic Botany (1988-2011) and Nuytsia (1975-2011). If required, resources of the Western Australian Herbarium (WAH) were also utilised.

The species list was checked against FloraBase (WAH 2012) to determine the species' conservation status. Threatened and Priority Flora were verified against the *EPBC Act* listing of threatened species to determine federal listing.

Introduced species were checked against the Environmental Weed Strategy for Western Australia (CALM 1999) and the DEC Invasive Plant Prioritisation Process – Swan Weed Assessment List (DEC 2012a), to determine their ranking in terms of environmental impact, and the ARR Act was consulted to determine if any are Declared Plants.

3.1.4 Statistical Analysis

To determine the likely occurrence of TECs or PECs, a multivariate analysis was undertaken. This analysis involved transformation (presence-absence) and normalisation of the data, and computation of a similarity matrix based on Bray-Curtis similarity. The matrix allows comparison of the study area's species data similarity against Gibson et al. (1994) FCTs data and allows determination of the probability that the vegetation communities represent TECs or PECs. A dendrogram was computed, using hierarchical agglomerative cluster analysis using Primer-E version 6.1.5 (Clarke & Gorley 2006).

3.2 VEGETATION MAPPING

The vegetation associations were described based on their structure and species composition, as defined by quadrat data, results of the multivariate analysis and field observations. Vegetation was mapped in the field using handheld GPS (Garmin) units and high-resolution aerial photographs, which in the office were digitised using GIS software (OziExplorer and ArcGIS 9.3.1).

The vegetation descriptions were referenced against Gibson et al. (1994) to determine the Floristic Community Types ('FCTs') present and the potential for the study area to support TECs or PECs. FCTs were defined on the basis of Multivariate Analysis of quadrat data, species composition, soils and topography.

Vegetation condition was mapped in the field using handheld GPS (Garmin) units and high-resolution aerial photographs, which in the office were digitised using GIS software (OziExplorer and ArcGIS 10). Vegetation condition was assessed based on Bush Forever (Government of Western Australia 2000b) /Trudgen (1991) (Appendix E).

3.3 FAUNA ASSESSMENT

The survey was carried out in a manner designed to be consistent with the Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of fauna surveys in Western Australia, as set out in the following documents:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002);
- *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56* (EPA 2004a); and
- *Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA-DEC 2010).

3.3.1 Database Review

The purpose of the desktop review was to gather background information on the study area and the vertebrate fauna that it may support. This involved a search for records (using a 20 km buffer around the location of: 32°08'08"S, 115°56'09" from the following databases:

- Western Australian Museum (WAM) and DEC combined biological database *NatureMap* (DEC 2012b);
- DEC Threatened and Priority Fauna database (DEC 2012e);
- SEWPAC Protected Matters Search Tool (also known as an EPBC search) (SEWPAC 2012b); and
- Birddata, Birds listed by Birdlife Australia (Birdlife Australia 2012a).

Collectively, these sources were used to compile a list of species that have been recorded or that may potentially occur in the region (Appendix F). This list will invariably include some species that do not occur in the study area, as some fauna have a limited or patchy distribution, exhibit a high level of habitat specificity, are locally extirpated or were erroneously identified in previous surveys. Extinct species, clearly erroneous records and species with a high level of habitat specificity for habitats not present in the study area were excluded from this list and species which are predominantly marine in nature and do not occupy terrestrial habitats represented in the study area (i.e. Terns, Gulls, Albatross, Sandpipers).

3.3.2 Field Survey

The purpose of the field survey was to verify the accuracy of the review and to further delineate and characterise the habitat and faunal assemblages in the study area. The fauna field survey consisted of a fauna habitat assessment and opportunistic observations.

Habitat Assessment

Five habitat assessments were completed during the field survey (Appendix G; Figure 7). Each habitat was scored numerically on the basis of the presence and complexity of fauna microhabitats including vegetation cover, presence of water, tree hollows, loose bark, leaf litter etc. In addition the habitat assessment included the identification of landscape features such as soil type, rock type, vegetation type and disturbance levels. The numerical scoring system individually ranked 24 microhabitat variables as a value between 0-3 based on whether it was common (3), moderately common (2), rare (1) or not present (0). The composition and presence of ground and vegetation cover was also assessed and scores were given based on their percentage cover of the 100 x 100 m quadrat. Three was the highest possible score for each feature and corresponded to a high habitat value, while zero was the lowest value reflecting a feature that was absent and/or provided little to no fauna habitat value. For each assessment the scores were tallied to give a total numerical value out of a possible 70.

Opportunistic and Targeted Observations

Fauna were opportunistically observed and recorded during the foot traverse of site. Field staff investigated scats, tracks, burrows and other traces of animals throughout the entire study area. Where conservation significant species were located, the coordinates were recorded by GPS.

3.3.3 Taxonomic Identification

The taxonomy and naming of wildlife species is dynamic because of the ongoing description of new species, and increased understanding of the relationships of taxa through genetic, morphological and vocal studies. The taxonomy and nomenclature (common and scientific names) in this report follows authorities supplemented by the latest scientific articles which update the established names for frogs (Tyler & Doughty 2009); reptiles (Wilson & Swan 2010); mammals (van Dyck & Strahan 2008), and birds (Gill & Donsker 2012). This latter authority has replaced the taxonomic treatment of Christidis and Boles (2008) for birds.

Fauna species were identified in the field, where needed using standard field guides or scientific publications for frogs (Tyler & Doughty 2009; Tyler & Knight 2009); reptiles (Storr et al. 1999; 2002; Wilson & Swan 2010), birds (Pizzey & Knight 2007; Simpson & Day 2010) and mammals (van Dyck & Strahan 2008; Menkhorst & Knight 2011).

4 RESULTS

4.1 SURVEY LIMITATIONS AND CONSTRAINTS

It is important to note the specific constraints imposed on surveys. Constraints are often difficult to predict as is the extent to which they influence survey effort. Survey constraints of the Keane Road Sewer main flora and vegetation survey are detailed in Table 2.

Table 2: Limitations and Constraints Associated with the Keane Road Sewer Main Flora, Vegetation and Fauna Survey

Variable	Impact on Survey Outcomes
Access	No access problems were encountered.
Experience	<p>The botanists and zoologists who executed these surveys were practitioners suitably qualified in their respective fields.</p> <ul style="list-style-type: none"> • Coordinating Botanist: Narelle Whittington (Principal Botanist); • Coordinating Zoologist: Dr Ronald Firth (Principal Zoologist) • Field Staff: Damian Buller (Environmental Biologist), Narelle Whittington and Ronald Firth. • Taxonomy: Peter Jobson (Senior Botanist / Taxonomist); • Botanical Data Interpretation and Reporting: Narelle Whittington and Damien Buller. • Zoological Data Interpretation and Reporting: Ron Firth and Chris Knuckey (Environmental Biologist).
Timing, weather, season.	<p>The survey was conducted during Spring. Therefore, the seasonal conditions for the survey were considered optimal.</p> <p>Flora composition changes with time particularly over the seasons and with seasonal conditions. A large proportion of arid flora is herbaceous annuals and ephemerals with specific growing periods and rainfall requirements. Fire history also affects the composition of flora. Therefore, botanical surveys completed at different times will have varying results.</p> <p>The timing, weather and season of the survey did not limit the survey outcomes and would not have impacted the occurrence of conservation significant fauna.</p>
Scope: Life forms sampled	The scope of this project included the sampling of flora and the description of vegetation associations and floristic Community types. This survey scope also included searching and sampling for significant

Variable	Impact on Survey Outcomes
	flora and describing vegetation condition. A Level 1 fauna survey was carried out which included habitat assessments and opportunistic fauna records which was deemed adequate for this site.
Sources of information	The Swan Coastal Plain bioregion has been extensively surveyed; as a result, numerous published and unpublished flora surveys have been undertaken in the area. Those most relevant to the current study are listed in Section 2.7.
Completeness	The study area was accessible and the survey season was considered to be optimal and the time spent conducting the survey was considered to be adequate. It was considered that all vegetation types and fauna habitats within the study area were adequately surveyed; with quadrats, relevés and vegetation mapping notes recorded for all vegetation and fauna habitat types.

4.2 FLORA

4.2.1 Overview of Flora

A total of 94 taxa (including species, subspecies, varieties and forms) from 76 genera and 30 families were recorded from the study area. The most frequently recorded families were: Myrtaceae (14 taxa), Fabaceae (12 taxa), and Proteaceae (9 taxa). The most frequently recorded genera were *Melaleuca* (5 taxa), *Drosera* (5 taxa), *Jacksonia* (3 taxa) and *Banksia* (3 taxa). An average of 18.1 species were recorded in each quadrat, with a standard deviation of ± 5.6 .

Quadrat data, including photographs, is presented in Appendix H, the flora by site matrix in Appendix I and the flora inventory in Appendix J.

4.2.2 Flora of Conservation Significance

No Threatened species pursuant to the EPBC Act and/or gazetted as DRF (Threatened) pursuant to the WC Act were recorded during the survey.

One Priority flora as recognised by the DEC, was recorded during the survey:

- *Jacksonia gracillima* (P3);

Jacksonia gracillima (Plate 1) was recorded during the current survey from eight locations, representing approximately 13 individuals in the study area. Details of locations are in Appendix K and presented in Figure 8.



Plate 1: *Jacksonia gracillma* (P3). Source: ENV

One further species of conservation significance was noted during the survey (*Petrophile rigida*). This species is of taxonomic interest as this record represents a significant extension from its known range.

Petrophile rigida (Plate 2) was recorded during the current survey from one location, representing four individuals in the study area.



Plate 2: *Petrophile rigida*. Source: ENV

The review of previous surveys and DEC database searches identified 26 DRF/T and Priority flora previously recorded within 5 km of the study area; six DRF /T taxa, four P1 taxa, one P2 taxa, five P3 taxa and ten P4 taxa.

The likelihood of these 26 conservation significant taxa occurring in the study area is shown in Table 3.

Table 3: Assessment of the likely occurrence of DRF and Priority Flora (as per DEC Database Searches) in the Study Area

Conservation Status	Species	Life Form	Habitat Information (WAH 2011, DEC 2012b)	Suitable Habitat Present	Number of Records ¹	Closest Record ²	Likelihood of occurrence in the study area
T	<i>Caladenia huegelii</i>	Perennial	Grey or brown sand or clay loam, Coastal plain, near river or swamps.	Yes	10	>1 km	Likely
T	<i>Diuris purdiei</i>	Perennial	Grey-black sand, moist. Winter wet swamps.	Yes	4	>1 km	Likely
T	<i>Drakaea elastica</i>	Perennial	Brown dry rocky soils on flood plain and on rangeland.	No	1	>5 km	Likely
T	<i>Drakaea micrantha</i>	Perennial	White-grey sand	Yes	2	>5 km	Likely
T	<i>Lepidosperma rostratum</i>	Perennial	Brown. Peaty sand, clay.	Yes	5	>5 km	Likely
T	<i>Verticordia plumosa</i> var. <i>pleiobotrya</i>	Perennial	Clay, sandy loam. Seasonally inundated swamps, road verges.	Yes	1	>5 km	Likely
P1	<i>Acacia lasiocarpa</i> var. bracteolate long peduncle variant (G.J Keighery 5026)	Perennial	Grey or black sand over clay in swampy areas or winter wet lowlands.	Yes	1	>10 km	Likely
P1	<i>Austrostipa jacobiana</i>	Perennial	Wets over limestone, sandy clay pans, seasonally damp salinized soils.	No	1	>5 km	Likely
P1	<i>Eremaea asterocarpa</i> subsp. <i>brachyclada</i>	Perennial	Deep grey sand.	Yes	1	>5 km	Likely

Conservation Status	Species	Life Form	Habitat Information (WAH 2011, DEC 2012b)	Suitable Habitat Present	Number of Records ¹	Closest Record ²	Likelihood of occurrence in the study area
P1	<i>Schoenus pennisetis</i>	Annual	Grey or peaty sand, sandy clay. Swamps, winter-wet depressions.	Yes	2	>1 km	Likely
P2	<i>Acacia benthamii</i>	Perennial	In sand, typically on limestone breakaways.	No	1	>5 km	Likely
P3	<i>Byblis gigantea</i>	Perennial	Sandy-peat swamps. Seasonally wet areas.	Yes	3	>1 km	Likely
P3	<i>Eryngium pinnatifidum</i> subsp. <i>palustre</i>	Perennial	Clay or sandy clay of claypans and seasonally wet flats.	Yes	1	Not Known	Not Known
P3	<i>Jacksonia gracillima</i>	Perennial	Grey or brown sand or sandy loam on plains and wetlands.	Yes	7	Within study area	Within study area
P3	<i>Schoenus capillifolius</i>	Annual	Brown mud of claypans.	No	2	>5 km	Likely
P3	<i>Stylidium longitubum</i>	Annual	Sandy clay or clay of seasonal wetlands.	Yes	3	>1 km	Likely
P4	<i>Aponogeton hexatepalus</i>	Perennial	In mud of freshwater ponds, rivers or claypans.	Yes	3	>5 km	Likely
P4	<i>Dodonea hackettiana</i>	Perennial	Sand of outcropping limestone.	No	1	>10 km	Possible
P4	<i>Drosera occidentalis</i> subsp. <i>occidentalis</i>	Perennial	Sandy and clayey soils. Swamps and wet depressions.	Yes	2	>1 km	Likely
P4	<i>Grevillea thelemanniana</i> subsp. <i>thelemanniana</i>	Perennial	Winter-wet heathland swamp.	Yes	1	>15 km	Unlikely

Conservation Status	Species	Life Form	Habitat Information (WAH 2011, DEC 2012b)	Suitable Habitat Present	Number of Records ¹	Closest Record ²	Likelihood of occurrence in the study area
P4	<i>Jacksonia sericea</i>	Perennial	Calcareous and sandy soils.	Yes	2	>1 km	Likely
P4	<i>Microtis quadrata</i>	Annual	Coastal swamps	No	1	>10 km	Possible
P4	<i>Ornduffia submersa</i>	Annual	Clay pan soils, wetlands/seasonally inundated depressions.	Yes	6	>1 km	Likely
P4	<i>Thysanotus glaucus</i>	Perennial	White, grey or yellow sand, sandy gravel.	Yes	3	>5 km	Likely
P4	<i>Tripterococcus paniculatus</i>	Perennial	Grey, black or peaty sand. Winter-wet flats	Yes	6	>1 km	Likely
P4	<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	Perennial	Sand, Sandy clay. Winter-wet depressions	Yes	10	>1 km	Likely

¹ Number of DEC records from database search area (DEC, 2012f)

² Closest DEC record to study area (DEC, 2012f)

'Likely' = suitable habitat present and records less than 5 km from the study area.

'Possible' = suitable habitat present, but records within 5 to 10 km from the study area

'Unlikely' = a lack of suitable habitat, and/or there are no records closer than 10 km from the study area

4.2.3 Introduced Flora

Fifteen introduced species were recorded; their locations are presented in Figure 9 and detailed in Appendix L.

None of these species are registered as WONS. Two of these species are listed as Declared Plants under the ARR Act. All 15 species are listed as environmental weeds, as defined by the *Environmental Weed Strategy for Western Australia* (CALM 1999). The rating and criteria for these species' inclusion under this strategy, as well as their rating against the invasiveness criteria of the DEC Invasive Plant Prioritization Process (DEC 2012a), is presented in Table 4.

Table 4: Introduced Flora Recorded in the Study Area, Including Their Rating by the Environmental Weed Strategy (CALM 1999) and the DEC Invasive Plant Prioritization Process (DEC 2012a)

Taxon (Common Name)	Rating (CALM 1999)	Criteria (DEC 2012a)		
		Ecological Impact	Invasiveness	Feasibility of Control
* <i>Arctotheca calendula</i> (capeweed)	Moderate	Moderate	Moderate	Low
* <i>Briza maxima</i> (blowfly grass)	Moderate	Unknown	Rapid	Low
* <i>Carpobrotus edulis</i> (hottentot fig)	Moderate	Unknown	Rapid	High
* <i>Cortaderia selloana</i> (pampas grass)	High	High	Rapid	Moderate
* <i>Crassula natans</i> var. <i>minus</i> (pond stone crop)	Moderate	Low	Rapid	Unknown
* <i>Cynodon dactylon</i> (couch)	Moderate	High	Rapid	Moderate
* <i>Ehrharta longiflora</i> (annual veldt grass)	Moderate	Unknown	Rapid	Moderate
* <i>Eragrostis curvula</i> (african lovegrass)	High	Unknown	Rapid	Low
* <i>Hypochaeris glabra</i> (flat weed)	Moderate	Moderate	Rapid	Low
* <i>Lotus subbiflorus</i> (hairy birdsfeet)	unknown	Unknown	Rapid	Low
* <i>Moraea flaccida</i> (one leaf cape tulip)	High	High	Moderate	Moderate
* <i>Poa annua</i> (winter grass)	Mild	Unknown	Unknown	Unknown

Taxon (Common Name)	Rating (CALM 1999)	Criteria (DEC 2012a)		
		Ecological Impact	Invasiveness	Feasibility of Control
* <i>Ursinia anthemoides</i>	Moderate	Unknown	Rapid	Unknown
* <i>Vulpia myuros</i> (rats tail fescue)	Moderate	Unknown	Rapid	Unknown
* <i>Zantedeschia aethiopica</i> (Arum lily)	High	High	Moderate	Low

The two species listed as Declared Plants on the Swan Coastal Plain identified during the survey (Figure 9) were:

- Arum Lily (**Zantedeschia aethiopica*) (Plate 3) listed as P1 for the Whole State; and
- One Leaf Cape Tulip (**Moraea flaccida*) (Plate 4) listed as P1 for the Whole State.



Plate 3: : Arum Lily (**Zantedeschia aethiopica*)
Source: ENV



Plate 4: One Leaf Cape Tulip (**Moraea flaccida*) Source: WAH (2012)

4.3 VEGETATION

4.3.1 Vegetation Associations

Four vegetation associations were identified across the study area (Figure 10). The extent of each association is presented in Table 5.

Table 5: Vegetation Associations and their Extent in the Study Area

Map Reference Vegetation Code	Vegetation Association	Extent in Study Area (%)	Extent in Study Area (ha)
KRZ1 & KRZ3 MpMr	Low Open Woodland of <i>Melaleuca preissiana</i> , <i>Melaleuca raphiophylla</i> , over <i>Regelia ciliata</i> , <i>Kunzea glabrescens</i> , <i>Acacia pulchella</i> and <i>Hypolaena exsulca</i> .	9	0.41
KRZ2 & KRZ6 Kg	Tall Open Scrub of <i>Kunzea glabrescens</i> with <i>Regelia ciliata</i> , <i>Melaleuca viminea</i> , <i>Hypolaena exsulca</i> , <i>Baumea juncea</i> and <i>Acacia pulchella</i> with scattered <i>Melaleuca preissiana</i> .	14	0.59
KRZ4 Ba	Woodland of <i>Banksia attenuata</i> and <i>Banksia ilicifolia</i> over <i>Kunzea glabrescens</i> , <i>Hibbertia subvaginata</i> , <i>Melaleuca thymoides</i> , <i>Dasyogon bromeliifolius</i> , <i>Lyginia imberbis</i> and <i>Phlebocarya ciliata</i> .	10	0.45
KRZ5 Mv	Shrubland of <i>Melaleuca viminea</i> over <i>Centrolepis polygyna</i> , <i>Isolepis cernua</i> var. <i>setiformis</i> , * <i>Crassula natans</i> var. <i>minus</i> and * <i>Lotus subbiflorus</i> .	1	0.03

4.3.2 Vegetation Condition

Vegetation condition ranged from Completely Degraded to Excellent (Figure 11). Vegetation clearing for access tracks and fire breaks, recreational vehicle access, urban development and weeds within and adjacent to the study area were the most frequently observed impacts on native vegetation.

The entire study area was dissected by an access track; this has been mapped as Completely Degraded and covered 66% of the study area (Table 6). In some areas the track did not influence the condition of the vegetation adjacent and therefore the vegetation was regarded to be in excellent condition. In other areas the track has been used by recreational vehicles and this has contributed to the disturbance and introduction of weeds into the adjacent vegetation, therefore reducing the condition.

Approximately 15.48% of the study area was in Excellent condition (Table 6). Areas mapped as Excellent show relatively low levels of disturbance, with exception of the track, with low densities of aggressive weeds.

Table 6: Vegetation Condition Recorded in the Study Area

Vegetation Condition	Area (ha)	Proportion of Study Area (%)
Excellent	0.68	15.4
Very Good	0.01	0.3
Good	0.51	11.5
Degraded	0.29	6.6
Completely Degraded (cleared)	2.94	66.2
Total	4.43	100

Fire age was variable across the site and ranged between Young (one to four years since last fire) to Old (eight to 12 years since the last fire).

4.3.3 Floristic Community Types

The FCTs represented by the vegetation within the study area were inferred by statistical analysis (Primer) and further data interpretation, as shown in Table 7 below. Due to the inconclusive results of the statistical analysis there was a need to further analyse the data to clarify what FCTs best correlate with the vegetation associations in the study area. This involves reviewing site data for other factors that are diagnostic for FCTs, including the presence of indicator species, soil types and landform position.

Table 7: Floristic Community Type Analysis

ENV Vegetation Association	Floristic Community Types ¹	Similarity %	Comments	ENV Inferred Floristic Community Type
MpMr (KRZ1 & KRZ3) Low Open Woodland of <i>Melaleuca preissiana</i> ...	SCP14-Deeper Wetlands on sandy soils	25.8	SCP14 is only known to occur north of Perth and so the analysis results are considered incorrect. SCP4 is more likely to occur on site and there are similarities between SCP4 and the flora on site.	SCP4- <i>Melaleuca preissiana</i> damplands
	SCP12 – <i>Melaleuca teretifolia</i> and/or <i>Astartea</i> aff. <i>fascicularis</i> shrublands	20.7	The vegetation is not representative of SCP12 as the vegetation was a <i>Melaleuca</i> woodland and many of the typical species of SCP12 was absent.	
	SCP6 – Weed dominated wetlands on heavy soils	19.5	SCP6 is not known to occur on the landform type that is present at the site.	
Kg (KRZ2 & KRZ6) Tall Open Scrub of <i>Kunzea glabrescens</i>	SCP14-Deeper Wetlands on sandy soils	25.8	SCP14 is only known to occur north of Perth and so the analysis results are considered incorrect. SCP4 is more likely to occur on site and there are similarities between SCP4 and the flora on site.	SCP5-Mixed Shrub damplands
	SCP12- <i>Melaleuca teretifolia</i> and/or <i>Astartea</i> aff. <i>fascicularis</i> shrublands	22.64	The vegetation is not represented by SCP12 as the majority of the species typical of SCP12 were not present.	
	SCP11-Wet forests and woodlands	21.69	The vegetation is not represented by SCP11 as the majority of the species typical of SCP11 were not present.	

ENV Vegetation Association	Floristic Community Types ¹	Similarity %	Comments	ENV Inferred Floristic Community Type
Ba (KRZ4) Woodland of <i>Banksia attenuata</i> and <i>Banksia ilicifolia</i>	SCP22- <i>Banksia ilicifolia</i> woodlands	26.5	Even though <i>Banksia ilicifolia</i> was present on site it was not dominant and the majority of the other typical species for this vegetation type were absent.	SCP21c-Low lying <i>Banksia attenuata</i> woodlands or shrublands (Priority 3)
	SCP21c-Low lying <i>Banksia attenuata</i> woodlands or shrublands	19.91	Even though <i>Banksia menziesii</i> , which is a common species found within SCP21c, was not recorded from the site, the vegetation does have the most similarity with SCP21c in terms of landscape characteristics and understory species.	
	SCP23a-Central <i>Banksia attenuata</i> – <i>Banksia menziesii</i> woodlands	17.82	Due to the low lying situation of the vegetation community it is unlikely that the vegetation is represented by 23a	
Mv (KRZ5) Shrubland of <i>Melaleuca viminea</i>	SCP12- <i>Melaleuca teretifolia</i> and/or <i>Astartea</i> aff. <i>fascicularis</i> shrublands	14.63	The vegetation is not represented by SCP12 as the majority of the species typical of SCP12 was not present.	Due to the lack of species present within the community it is not possible to determine the FCT for the site through data

ENV Vegetation Association	Floristic Community Types ¹	Similarity %	Comments	ENV Inferred Floristic Community Type
	SCP16-Highly saline seasonal wetlands	11.76	SCP16 is not known to occur in the area therefore it is unlikely the vegetation type is present on site.	analysis, however based on the soil, location, and community structure the site is likely to be either SCP8 Herb rich shrublands in claypans (listed as 'Vulnerable' by the state and 'Critically Endangered' under the EPBC Act 1999) or SCP10aShrublands on dry clay flats (listed as 'Endangered' by the state and 'Critically Endangered' under the EPBC Act 1999)
	SCP18-Shrublands on calcareous silts	11.11	SCP18 is known to occur on lake deposits therefore would not be present on site.	

1. Gibson et al. 1994

4.3.4 Regional Representation

Vegetation associations described in the study area were not able to be correlated with the Beard (1979)/ Shepherd et al. (2001) broad vegetation types. This is due to the Beard mapping being undertaken at a scale of 1:250 000 and the site being surveyed at a much finer scale.

4.3.5 Vegetation of Conservation Significance

Of the four vegetation associations mapped on site two are considered to be of conservation significance. Ba (KRZ4) has been identified as FCT SCP21c-Low lying *Banksia attenuata* woodlands or shrublands, which is listed as a Priority 3 by the Species and Communities Branch, DEC.

The other vegetation association considered to be of conservation significance is Mv (KRZ5) which, although it is unable to be definitively identified to a single FCT, is conclusively either SCP8 Herb rich shrublands in claypans (which is listed as Vulnerable by the state and Critically Endangered under the EPBC Act) or SCP10a Shrublands on dry clay flats (which is listed as Endangered by the state and Critically Endangered under the EPBC Act).

4.3.6 Wetlands

The DEC Geomorphic Wetlands Dataset identified wetlands of both Conservation and Multiple Use management categories as occurring within the study area (Figure 5). The unique identification numbers (UFI) of the 13 wetlands within the study area are provided within Table 8.

Table 8: Unique Identification Number of Wetlands within the Study Area

Wetland UFI	Management Category
13347	Multiple Use
7219	
14844	
14876	
7384	Conservation Category
14167	
14891	
7482	
14893	
14165	
15183	
15427	
14170	
14875	

4.4 FAUNA

4.4.1 Habitat Assessment

The study area contains three habitat types; *Banksia* Woodland, *Melaleuca* Shrubland and Cleared Land which encompasses all land where native vegetation has been cleared e.g. tracks, roads etc (Figure 12).

Banksia Woodland

The *Banksia* Woodland covers approximately 0.16 ha of the study area (3.56%). The woodland is dominated by *Banksia attenuata* and *Banksia ilicifolia* over *Kunzea glabrescens*, *Hibbertia subvaginata*, *Melaleuca thymoides*, *Dasyopogon bromeliifolius*, *Lyginia imberbis* and *Phlebocarya ciliata*. The *Banksia* Woodland is the highest ranked habitat within the study area with an average habitat value of 23. High habitat values are driven by the soft sands which provide burrowing suitability for borrowing and digging amphibians, reptiles and mammals. The *Banksia* Woodland also has a relatively high cover for all three vegetation layers (overstorey, midstorey and understorey) which provide habitat for a range of different avifauna species. Due to the low topography much of the surrounding area becomes seasonally inundated following large periods of rainfall, as such most of this habitat received high values for its close proximity to water which provides a drinking resource for mammals and breeding habitat for amphibians. The ground contained relatively high amounts of leaf litter and woody debris which provides habitat for ground dwelling fauna.

Melaleuca Shrubland

The *Melaleuca* shrubland is the most widespread and dominant habitat within the study area, it covers approximately 1.34 ha of the study area (30.07%). The habitat is dominated by *Melaleuca preissiana*, *Melaleuca raphiophylla*, *Melaleuca viminea* and *Kunzea glabrescens* over *Regelia ciliata*, *Centrolepis polygyna* and *Isolepis cernua* var. *setiformis*. The average habitat value for *Melaleuca* shrublands is 18.75 with a habitat score ranging from 18-20. High habitat values are driven by the soft sand which provides burrowing suitability for borrowing and digging amphibians, reptiles and mammals. The surrounding area was inundated with water and the habitat received high scores for its close proximity to water and the value it provides for species who prefer or are dependent on a water resource. The *Melaleuca* Shrublands have a high proportion of leaf litter cover and understorey vegetation of herbs, grasses and sedges which provides suitable habitat for ground dwelling species. The lack of overstorey vegetation is suited to larger birds such as raptors that may utilise the area when foraging.

Cleared Land

The cleared land covers approximately 2.95 ha of the study area (66.37%). The cleared land is completely degraded, it composes of sand tracks and fire breaks which run the length of the study area. These areas are sparsely vegetated and provide very little

microhabitat complexity, lacking cover and food resources for vertebrate fauna. While the soft sands are well suited for digging and burrowing vertebrate species, the lack of vegetation will discourage species from utilising these areas. No habitat assessments were undertaken in these areas due to the lack of habitat it provides for vertebrate fauna.

4.4.2 Fauna Assemblage

All fauna previously recorded in the vicinity of the site are listed in Appendix F. As a Level 1 survey was conducted, a limited number of fauna were recorded during the survey, particularly ground dwelling reptiles and mammals. A total of 26 species were recorded from within the study area, 253 species have been previously recorded within the vicinity of the study area.

Amphibians

A total of twelve species of amphibians have been previously recorded in vicinity of the study area (Appendix F). The amphibians most likely to occur are the Western Banjo Frog (*Limnodynastes dorsalis*) and the Turtle Frog (*Myobatrachus gouldii*).

No amphibians were recorded during the fauna assessment.

Reptiles

Sixty-three species of reptile have been previously recorded in the vicinity of the study area (Appendix F). Reptiles likely to occur at the site include the Variegated tree Dtella (*Gehyra variegata*), the Bobtail (*Tiliqua rugosa rugosa*) and the Western Bearded Dragon (*Pogona minor minor*).

One species of reptile was recorded during the fauna assessment, a Dugite (*Pseudonaja affinis*).

Avifauna

Two hundred and twenty-four species of birds have been previously recorded in the vicinity of the study area (Appendix F). Many of these are unlikely to occur at the site, since these records are from a larger area encompassing a wide range of habitats and include rare birds that only occur on a transitory basis.

Twenty-four species of bird from seventeen families were recorded during this survey including three species belonging to the family Meliphagidae (Honeyeaters) and three species belonging to the family Columbidae (Pigeons, Doves). Other common birds of the study area included the Galah (*Eolophus roseicapilla*), Pacific Black Duck (*Anas superciliosa*) and Splendid Fairywren (*Malurus splendens*).

Mammals

Twenty-five species of mammal have previously been recorded in the vicinity of the study area (Appendix F). Many of these are unlikely to occur at the site, since these records are from larger areas encompassing a wide range of habitats, and small mammals tend to be habitat-specific.

During the fauna assessment evidence of two mammal species were recorded. This included evidence of one native mammal, the Quenda (Southern Brown Bandicoot; *Isoodon obesulus*) and one introduced mammal species, the Rabbit (*Oryctolagus cuniculus*).

4.4.3 Fauna of Conservation Significance

There are 27 conservation significant fauna species which have been previously recorded within the vicinity of the study area (Appendix M). Some of these are unlikely to occur on the site as they have a limited or patchy distribution, high level of habitat specificity, are locally extinct or were erroneously recorded in previous surveys.

Evidence of one species was recorded during the survey, the Quenda which is a Priority 5 listed species by the DEC. Four species of conservation significant species are considered 'Likely' to occur within the study area: Forest Red-tailed Cockatoo (*Calyptorhynchus banksii naso*), Baudin's Cockatoo (*Calyptorhynchus baudinii*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*) and the Rainbow Bee-eater (*Merops ornatus*) (Appendix O). A further six species are considered 'Possible' to occur, ten species are considered 'Unlikely' to occur and six are classified as 'Highly Unlikely' to occur; based on their ecology, habitat present and fauna records (Appendix M).

5 DISCUSSION

5.1 CONTEXT

A total of 94 taxa (including species, subspecies, varieties and forms) from 76 genera and 30 families were recorded from the study area. An average of 18.1 species was recorded in each quadrat, with a standard deviation of ± 5.6 .

The flora species richness recorded during the survey is considered to be low for the area and for the condition of the vegetation. The average flora richness per quadrat recorded during this survey, 18.1 species per quadrat, is lower than the species richness recorded by Gibson et al. (1994) within the FCTs represented on site. For example Gibson et al. (1994) recorded a mean species richness of 36.9 species within SCP04 'Melaleuca preissiana damplands' and 40.5 species within SCP21c 'Low lying *Banksia attenuata* woodlands or shrublands'.

Part of the difference in species richness can be attributed to survey differences, variation and environmental factors. The survey differences include that Gibson et al. (1994) conducted a larger number of quadrats (16 within both SCP04 and SCP21c) and that these quadrats were conducted within vegetation of best condition for each FCT. In contrast, the current survey is based on six quadrats and is adjacent to disturbed areas.

Environmental factors including the low rainfall experienced in the year prior to the survey being undertaken have also affected the species richness. However, it is not possible to quantify the extent that low rainfall would have impacted on the current species diversity within the study area. For example, the low rainfall may have suppressed the rejuvenation of species that usually germinate seasonally.

5.2 FLORA OF CONSERVATION SIGNIFICANCE

No threatened species pursuant to the *EPBC Act* and no plant taxa gazetted as DRF/Threatened pursuant to the *WC Act* were recorded in the study area. This is despite five species listed as Endangered and one listed as Vulnerable by the *EPBC Act* being identified as potentially occurring in the study area. These include four orchid species, one sedge species and one shrub species.

The four Endangered / Vulnerable orchids (*Caladenia huegelii*, *Diuris purdiei*, *Drakaea elastica* and *Drakaea micrantha*) are all perennial species persisting as tubers in the soil and only identifiable when in flower. Orchids are known to be sensitive to rainfall and in low rainfall seasons may flower late in the season or not at all. Suitable habitat for all of these species is present within the study area. These species were not recorded during the survey but potentially could be present.

The remaining Endangered species, one sedge species (*Lepidosperma rostratum*) and the one shrub species (*Verticordia plumosa* var. *pleiobotrya*), were searched for and neither were located. ENV considers that these species would have been present at the time of the survey and as they were not recorded, these species are not expected to occur within the study area.

One Priority 3 Flora was located within the study area, *Jacksonia gracillima* (P3). *Jacksonia gracillima* is known from two locations in Western Australia, Forrestdale and Busselton-Capel. Eleven records exist in the vicinity of Forrestdale, approximately 6 km south east of the study area, and ten records exist in the vicinity of Busselton-Capel, approximately 213 km south of the study area (DEC 2012f). The number of individuals present at each of these locations has not been recorded. Thus, it is not possible to determine the significance of the population recorded within the study area. However, there are two distinct populations and the individuals of *Jacksonia gracillima* recorded within the study area increases the known Forrestdale populations. The field survey included a targeted search for this species and it is considered unlikely that additional individuals occur within the study area. The presence of *Jacksonia gracillima* (Priority 3) does not form a statutory constraint to development of the study area. There is no written policy on how to respond to the presence of Priority Flora species within proposed work sites. The presence of these species is dealt with by the DEC on a case by case basis.

Of the remaining Priority Flora identified as potentially occurring within the study area, 15 are perennial species and five are annual species. Individuals of the 15 perennial species should have been identifiable and present at the time of the survey. Therefore, it is considered unlikely that these species occur within the study area. The annual species, *Schoenus capillifolius* (P3) and *Microtis quadrata* (P4), occur within habitat that is not present on site. The remaining annual priorities, *Schoenus pennisetis* (P1), *Stylidium longitubum* (P3) and *Ornduffia submerse* (P4) are known to favour seasonally wet flats (WAH 2012). The low winter rainfall experienced during 2010 may have affected the emergence of these species, and they may occur on site.

The survey was undertaken at the appropriate time of year (spring); however the low winter rainfall in the region may have affected the emergence of some orchid and/or annual species within the study area.

5.3 VEGETATION OF CONSERVATION SIGNIFICANCE

The vegetation association Ba is considered to be representative of SCP21c, despite SCP22 generating the highest percentage similarity with the vegetation (26.5% similarity). Both of these FCTs are listed as PECs by the DEC and based on factors, including the landform on which they occur and their position on the Swan Coastal Plain, the vegetation could represent either FCT. However, the vegetation association, Ba, is considered to represent SCP21c. This comparison is supported by the dominant

and typical species identified by Gibson et al. (1994) as being characteristic of SCP21c. Importantly, the dominant overstorey species are common between the vegetation unit and SCP21c; these being *Banksia attenuata* and *Banksia menziesii*. In contrast the overstorey species of SCP22, *Banksia illicifolia* was sparse within the vegetation on site. SCP21c is known to occur within the Harrisdale area and has been inferred as occurring within the surrounding Bush Forever sites including sites 262, 342 and 413 (Government of Western Australia 2000b).

SCP21c is listed as a Priority 3 PEC by the DEC. Priority communities listed by the DEC have no formal protection. There is no written policy on how to respond to the presence of PECs within proposed development sites. The presence of these communities is dealt with by the DEC on a case by case basis.

The analysis identified SCP12, SCP16 and SCP18 as possible FCTs for vegetation association Mv; however these were not considered to be probable based on the lack of typical species present at the site and also the location. The site is neither a saline seasonal wetland or within a lake deposit.

Given the very low diversity of vegetation association Mv, a single FCT could not be determined. Based on the soil, location, and community structure it can however be concluded that the site is likely to be either SCP8 Herb rich shrublands in claypans or SCP10a Shrublands on dry clay flats. Both these FCTs have been previously recorded within close proximity (one record is as close as 250 m away). Both of these FCTs are listed as TECs by both the State and the Commonwealth.

ENV advises that the presence of the TEC needs to be confirmed by the DEC. The DEC advises that it is not able to make decisions regarding the presence of a TEC without receiving a flora and vegetation report in conjunction with a planning application as part of the statutory approvals process.

If the DEC identifies that the vegetation within the site is not representative of the TEC then no further action will need to be taken regarding this matter. ENV considers that under this circumstance the vegetation association Mv will not pose a constraint to development.

If the DEC confirms the presence of the TEC, they may seek a retention outcome in relation to the specific site characteristics. The DEC makes decisions regarding TECs on a case by case basis. It is ENVs understanding that many factors influence the constraints and requirements imposed by the DEC in regards to the presence of a TEC. These include but are not limited to: the size and condition of the remnant within the study area; the representation and condition of the TEC in other remnants in the local area; and the representation of the TEC within protected areas. The DEC typically seeks at a minimum, the retention of vegetation in good or better condition plus a management buffer.

5.4 VEGETATION CONDITION AND INTRODUCED FLORA

Fifteen introduced species were recorded within the study area. The majority of these are considered to be common agricultural and bushland weeds in the region (Hussey et al. 2007). None of these species are registered as WONS, however, all 15 species are listed as environmental weeds, as defined by the Environmental Weed Strategy for Western Australia (CALM 1999).

Two Declared Plants were recorded within the study area: Arum Lily (*Zantedeschia aethiopica*) and One Leaf Cape Tulip (*Moraea flaccida*). These species are listed as P1 for the Whole State.

5.5 REGIONAL REPRESENTATION

The study area is mapped as Southern River Complex (Heddle et al. 1978). The Southern River Complex was estimated to have 19.8% native vegetation remaining based on the pre-European extent with 1.5% in secure tenure (EPA 2006).

More recently the Perth Biodiversity Project (PBP 2010) has mapped native vegetation extent by vegetation complex on the Swan Coastal Plain. It is estimated that 19.7% of Southern River Complex remains compared to its pre-European extent (PBP 2010).

The EPA's policy on the protection of native vegetation in Western Australia, in the context of pre-European vegetation extent remaining, is based on the following criteria:

From purely a biodiversity perspective and taking no account of any other land degradation issues, there are several key criteria now being applied where clearing is still occurring (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% of the pre-clearing extent of the vegetation type; and
- A level of 10% of the original extent is regarded as being a level representing "endangered".

The pre-European vegetation in the Southern River Complex, which the study area is situated, is under the threshold level set by the EPA (EPA 2000). Due to the study area being below the 30% threshold level, the EPA would expect alternative mechanisms to be put forward to address the protection of biodiversity (EPA 2000).

5.6 BUSH FOREVER

The Government of Western Australia has endorsed Bush Forever as the means of seeking the appropriate protection and management of areas of regionally significant

bushland on the Swan Coastal Plain Portion of the Perth Metropolitan Region and a balance between environmental, social and economic objectives.

The majority of the survey area is within a Bush Forever site that has been identified as containing regionally significant bushland with some existing protection. The vegetation varies between Good and Excellent condition in these areas.

The site meets criteria for regionally significant vegetation based on its representation of ecological communities, diversity, rarity (species and communities, Scientific or evolutionary importance, and General Criteria for the protection of wetlands.

5.7 WETLANDS

The site is mapped by the DEC as supporting Conservation and Multiple Use Category wetlands. The wetlands cover the majority of the site according to the Geomorphic Wetland mapping (DEC 2012g). Each of the vegetation associations mapped on site correlate with this information as they are either wetland communities or are likely to occur on low lying landscapes with higher soil moisture. Due to the broad scale of the DEC wetland mapping however, tracks have also been mapped as wetlands. Therefore more than half of the site (66.2%) does not actually contain wetland vegetation (Figure 5).

Conservation category wetlands are in the highest category of protection, and they are ESAs under the EP Act. Conservation Category wetlands are also identified for protection and enhancement in the Western Australian Planning Commission State Planning Policy 2.9 – Water Resources.

5.8 FAUNA HABITAT TYPES

The study area consists of three habitat types; *Banksia* Woodland dominated by *Banksia attenuata* and *Banksia ilicifolia*, *Melaleuca* Woodland dominated by *Melaleuca preissiana*, *Melaleuca raphiophylla*, *Melaleuca viminea* and *Kunzea glabrescens* and Cleared Land. Both the *Banksia* Woodland and *Melaleuca* Woodland habitats included in the study area border severely degraded areas which contain low fauna habitat value. Furthermore the habitat included in the study area is a very small proportion in comparison to the bushland surrounding the area. Species that occur within these habitats are likely to utilise these areas on a short term basis only (i.e. when commuting between neighbouring habitats).

Banksia Woodland

High habitat values of the *Banksia* Woodland are driven by the soft sands and high densities overstorey, midstorey and understorey vegetation layers. The soft sands provide ideal habitat for borrowing and digging amphibians such as the Banjo Frog (*Limnodynastes dorsalis*), reptiles such as Burton's Legless Lizard (*Lialis burtonis*) and

mammals such as the Quenda/Southern Brown Bandicoot (*Isodon obesulus*). The ground contains relatively high amounts of leaf litter and woody debris providing ground dwelling fauna, particularly reptiles, places to bask and forage while keeping hidden from predators. The high cover values of overstorey, midstorey and understorey vegetation are ideal for small passerine species such as the Hooded Robin (*Melanodryas cucullata*) and Splendid Fairy Wren (*Malurus splendens*) which forage low to the ground for small insects. *Banksia* species are an important food resource for many species both common species such as honeyeaters but also for threatened species such as the three Black Cockatoo species known to occur across the region. Black Cockatoo feed on the flowers and seeds of *Banksia* species (Groom 2011) which is historically a large component of the species diet and has extensively cleared due to urban expansion (Johnstone & Kirkby 2011). The *Banksia* Woodland in the study area is however highly degraded and covers a small area (< 1 ha) and clearing of the study area will have minimal impact to any species that occur in this habitat.

Melaleuca Shrubland

High habitat values of the *Melaleuca* Woodlands are due to the soft sand for burrowing species and the high proportion of leaf litter which provides suitable cover for ground dwelling species. Reptile species, in particular, forage and bask amongst the leaf litter as it provides cover from predators above e.g. small skinks such as *Hemiergis quadrilineata*, legless lizards such as *Pygopus lepidopodus* and snakes such as the Bardick (*Echiopsis curta*). The dense *Melaleuca* shrubs provide foraging habitat for small common passerines which feed on insects and small reptiles such as the Rufous Whistler (*Pachycephala rufiventris*), Western Gerygone (*Gerygone fusca*) and Grey Shrike-thrush (*Colluricincla harmonica*). The *Melaleuca* and *Kunzea*, when in flower, provide a foraging resource for a suite of common nectivorous species such as the Red Wattlebird (*Anthochaera carunculata*) and the Tawny-crowned Honeyeater (*Gliciphila melanops*). This habitat coverage within the study area is minimal in comparison to the surrounding bushland, clearing of this land will have minimal effect on any species which occur in the area.

Cleared Land

The Cleared Land within the study area provides very little fauna habitat. Species most likely to occur in this area are generalist species that are common and widespread throughout the region. Birds include the Australian Magpie (*Gymnorhina tibicen*), Australian Raven (*Corvus coronoides*) and the Australian Ringneck (*Barnardius zonarius*). Ground dwelling fauna are only likely to occur when commuting to and from neighbouring habitats, as such any species which occurs within this habitat is not dependent on it and will not be affected by the planned development.

5.9 FAUNAL ASSEMBLAGE

A total of 26 species were recorded from within the study area, comprising one reptile, 23 birds and two mammals. A total of 253 species have been previously recorded within the vicinity of the study area. As this was a Level One survey to assess fauna habitat types, many of the potentially occurring species were not recorded. For example, many of the ground dwelling reptiles and mammals are mainly recorded or captured from trapping techniques employed during a Level Two survey. In addition, some potentially occurring species are nocturnal and the surveys were conducted during the day.

The expected fauna assemblage of the study area consists of species that are generally common and widespread throughout the region and are not dependent upon the habitat found within the study area.

5.10 CONSERVATION SIGNIFICANT FAUNA

No conservation significant species were recorded during the survey. Four species of conservation significant fauna are considered as 'Likely' to occur in the study area; Forest Red-tailed Cockatoo, Baudin's Black Cockatoo, Carnaby's Black Cockatoo and the Rainbow Bee-eater.

Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo (FRBC) is distributed throughout the humid and subhumid southwest of Western Australia from Gingin through the Darling Ranges to the southwest, from approximately Bunbury to Albany (Johnstone & Storr 1998). The FRBC occurs in pairs or small flocks, or occasionally in large flocks of up to 200 birds (Johnstone & Storr 1998). The FRBC usually inhabits dense Jarrah (*Eucalyptus marginata*), Karri (*Eucalyptus diversicolor*) and Marri forests that receive more than 600 mm average annual rainfall (Chapman 2007). This species breeds in the southwest between October and November. The FRBC feeds primarily on Marri and Jarrah fruit (SEWPAC 2011). They have also been known to feed on Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri, Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*) (Johnstone & Kirkby 1999). The FRBC population is estimated at approximately 15,000 birds (Johnstone & Kirkby 1999). The primary threat to the FRBC is the loss of habitat loss due to clearing and forestry (Garnett et al. 2011). The FRBC has been frequently recorded within the vicinity of the study area. While historically the species was more common in the south-west of its distribution, degradation and clearing of foraging resources in the southwest have meant a dynamic expansion of the species onto the Swan Coastal Plain, particularly within the Perth region (Johnstone & Kirkby 2011). Habitat suitable for the species within the study area is limited and degraded. the vegetation of the study area provides no known foraging, roosting or breeding species for the FRBC and there will be minimal impact to the species by the proposed development.

Baudin's Cockatoo

The Baudin's Cockatoo is distributed throughout the south western humid and sub humid zones, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and across to Albany (Johnstone & Storr 1998). This species forages primarily in eucalypt forest, where it feeds on Marri seeds, flowers, nectar and buds (Johnstone & Kirkby 2008). They also feed on a wide range of seeds of *Eucalyptus*, *Banksia*, *Hakea* and exotic *Pinus* (Pine) species, as well as fruiting apples and pears and beetle larvae from under the bark of trees (Johnstone & Kirkby 2008; Johnstone & Storr 1998). Baudin's Cockatoo is mostly a postnuptial nomad, although some populations are resident (Johnstone & Kirkby 2008). Most Baudin's Cockatoos breed in the deep south-west in spring-summer, from around October to March. Following breeding birds leave nesting areas and amalgamate to form large foraging flocks. These flocks generally migrate north to the main non-breeding wintering area in the northern Darling Range between Collie and Mundaring (Johnstone & Kirkby 2008). The total population of Baudin's Cockatoo is estimated to be about 15 000 birds, and has declined greatly in the last 50 years primarily from habitat destruction (Johnstone & Kirkby 2008). The Baudin's Black Cockatoo has been frequently recorded within the vicinity of the study area. The *Banksia attenuata* within the *Banksia* Woodland habitat is a potential food resource for the species (Chapman 2007; Johnstone & Kirkby 2008; SEWPAC 2011). This habitat within the study area is limited (0.16 ha) and widely distributed in the bushland surrounding the study area. Due to the limited habitat suitable of the species and its degraded condition, there will be minimal impact to the Baudin's Black Cockatoo.

Carnaby's Cockatoo

The Carnaby's Cockatoo is listed as Endangered under the *EPBC Act* and Schedule 1 under the *WC Act*. Carnaby's Cockatoo is endemic to southwest Western Australia, and is distributed from the Murchison River to Esperance and inland to Coorow, Kellerberrin and Lake Cronin (Cale 2003). The species was once common, but the population has declined significantly in the last 45 years, and is now locally extinct in some areas (Johnstone & Storr 1998; Shah 2006). In the last 45 years the species has suffered a 50% reduction in its abundance due to the extensive clearing of core breeding habitat in the wheatbelt, and the clearing of food resources upon the Swan Coastal Plain (Cale 2003). The total population of Carnaby's Cockatoo is currently estimated at 40,000 (Garnett et al. 2011). Breeding usually occurs from early July to mid-December, in the semi-arid and subhumid interior of WA's wheatbelt (Johnstone & Storr 1998). The Carnaby's Black Cockatoo (DEC 2012e) has been previously recorded throughout the vicinity of the study area. The *Banksia attenuata* and *Banksia ilicifolia* of the *Banksia* Woodland habitat within the study area provides potential foraging habitat for the species (Groom 2011; Valentine & Stock 2008; SEWPAC 2011). This habitat encompasses a small area and is highly disturbed. As such, there is likely to be minimal impact to the Carnaby's Black Cockatoo.

Rainbow Bee-eater

The Rainbow Bee-eater is listed as Migratory under the EPBC Act. This species is one of the most common and widespread birds in Australia with a distribution that covers the majority of Australia (Barrett et al. 2003). In Western Australia this bird can occur as a 'resident, breeding visitor, postnuptial nomad, passage migrant and winter visitor' (Johnstone & Storr 1998). Although the species was not recorded during this survey it has been previously recorded in the vicinity of the study area (DEC 2012e). The study area provides suitable foraging habitat and suitable nest sites in the sandy soil and can be expected in all of the habitats present. The species is not however, dependent on the habitats represented in the study area, and the common and widespread distribution of this species ensures that the proposed development will not impact upon its conservation status.

6 RECOMMENDATIONS

ENV.Australia makes the following recommendations:

6.1 FLORA

- Clearing of any TEC or PEC vegetation should be avoided;
- As a matter of principle, any clearing of native vegetation should be kept to a minimum;
- Existing tracks should be used where possible and vehicles should avoid parking, turning or reversing into vegetation;
- Clearing of known locations of all Priority flora should be avoided wherever possible; and
- Hygiene practices should be put into place to avoid the spreading of weeds.

6.2 FAUNA

The following recommendations are provided to manage and minimise impacts on fauna:

- Clear the vegetation in stages to enable the resident fauna to seek refuge outside of the study area;
- Any conservation significant ground dwelling species found during the clearing process need to be trapped and translocated by appropriately trained zoologists;
- No dead, standing or fallen timber should be removed unnecessarily;
- Where possible, current tracks and cleared sections should be used for site access to minimise the impact on the area's fauna and habitat;
- Boundaries of areas to be disturbed should be clearly demarcated to prevent any erroneous damage to habitat; and
- Clear during the non-breeding season for Black Cockatoos to avoid disturbance of breeding.

7 ASSESSMENT OF FINDINGS AGAINST THE CLEARING PRINCIPLES

Any clearing of native vegetation requires a permit under Part V Division 2 of the *EP Act*, except where an exemption applies under Schedule 6 of the *EP Act*, or where the clearing is prescribed by regulations in the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions do not apply in an ESA.

Each of the ten clearing principles, as outlined in the *EP Act* 1986, are individually assessed below, within the scope and knowledge of this flora, vegetation and fauna assessment. This project may be at variance with four of the ten clearing principles, depending upon the areas proposed for future impacts.

PRINCIPLE A - NATIVE VEGETATION SHOULD NOT BE CLEARED IF IT COMPRISES A HIGH LEVEL OF BIOLOGICAL DIVERSITY

The flora species richness recorded during the survey is considered to be low for the area and for the condition of the vegetation. The average flora richness per quadrat recorded during this survey, 18.1 species per quadrat, is lower than the species richness recorded by Gibson et al. (1994) within the FCTs represented on site. For example Gibson et al. (1994) recorded a mean species richness of 36.9 species within SCP04 'Melaleuca preissiana damplands' and 40.5 species within SCP21c 'Low lying Banksia attenuata woodlands or shrublands'.

A total of 26 vertebrate fauna (one reptile, 23 birds and two mammals) were recorded in the study area. The study area contains three habitat types namely *Banksia* Woodland, *Melaleuca* Shrubland and Cleared Land.

A total of 253 fauna have been previously recorded in the vicinity of the study area from the database search. These consist of 12 amphibians, 63 reptiles, 153 birds and 25 mammals. The proposed development is unlikely to disrupt the fauna assemblage of the study area as the fauna are generally common and widespread throughout the region and are not dependent upon the study area.

Therefore, clearing in the study area is unlikely to be at variance with this principle.

PRINCIPLE B - NATIVE VEGETATION SHOULD NOT BE CLEARED IF IT COMPRISES THE WHOLE OR A PART OF, OR IS NECESSARY FOR THE MAINTENANCE OF, A SIGNIFICANT HABITAT FOR FAUNA INDIGENOUS TO WESTERN AUSTRALIA

No fauna taxa of conservation significance were recorded during the current survey of the study area. Four fauna species of conservation significance are considered as 'Likely' to occur within the project area as it provides suitable habitat; the Forest Red-tailed Black Cockatoo, Baudin's Black Cockatoo, Carnaby's Black Cockatoo and the Rainbow

Bee-eater. All four species of conservation significance likely to occur within the study area are wide-ranging, mobile and not dependent on the study area.

The *Banksia* Woodland of the study area provides a potential foraging resource for the Carnaby's Cockatoo and Baudin's Cockatoo. The *Banksia* Woodland covers a small proportion of the study area and is highly disturbed. Furthermore *Banksia* Woodlands are widespread in the surrounding bushland, as such the Black Cockatoo Species will not be impacted by the clearing of this habitat within the study area.

The Rainbow Bee-eater is a common and wide-ranging species. The study area provides potential foraging and nesting habitat for the species. The species is however, not dependent on the habitats represented within the study area as such the species local or regional status will not be impacted by clearing of the habitats within the study area.

Therefore, clearing in the study area is unlikely to be at variance with this principle.

PRINCIPLE C - NATIVE VEGETATION SHOULD NOT BE CLEARED IF IT INCLUDES, OR IS NECESSARY FOR THE CONTINUED EXISTENCE OF, RARE FLORA

No Threatened species pursuant to the EPBC Act and/or gazetted as Declared Rare Flora (Threatened) pursuant to the WC Act were recorded during the survey.

Therefore, clearing in the study area is unlikely to be at variance with this principle.

PRINCIPLE D: NATIVE VEGETATION SHOULD NOT BE CLEARED IF IT COMPRISES THE WHOLE OR PART OF, OR IS NECESSARY FOR THE MAINTENANCE OF, A THREATENED ECOLOGICAL COMMUNITY

Vegetation association Mv (KRZ5) which, although it is unable to be definitively identified to a single FCT, is conclusively either SCP8 Herb rich shrublands in claypans (listed as Vulnerable by the state and Critically Endangered under the *EPBC Act*) or SCP10a Shrublands on dry clay flats (listed as Endangered by the state and Critically Endangered under the *EPBC Act*).

The disturbances associated with the project are therefore likely to be at variance with this principle.

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

Vegetation associations described in the study area were not able to be correlated with the Beard (1979)/ Shepherd et al. (2001) broad vegetation types. This is due to the Beard mapping being undertaken at a scale of 1:250 000 and the site being surveyed at a much finer scale.

More recently the Perth Biodiversity Project (PBP 2010) has mapped native vegetation extent by vegetation complex on the Swan Coastal Plain. It is estimated that 19.7% of Southern River Complex remains compared to its pre-European extent (PBP 2010).

The pre-European vegetation in the Southern River Complex, which the study area is situated, is considered to be Vulnerable (EPA 2000)

Disturbances associated with the project may be at variance with this principle.

PRINCIPLE F: NATIVE VEGETATION SHOULD NOT BE CLEARED IF IT IS GROWING IN, OR IN ASSOCIATION WITH, AN ENVIRONMENT ASSOCIATED WITH A WATERCOURSE OR WETLAND

The site is mapped by the DEC as supporting Conservation and Multiple Use Category wetlands. The wetlands cover the majority of the site according to the Geomorphic Wetland mapping (DEC 2010).

Conservation category wetlands are in the highest category of protection, and they are recognised as ESAs under the EP Act. Conservation Category wetlands are also identified for protection and enhancement in the Western Australian Planning Commission State Planning Policy 2.9 – Water Resources.

This project is at variance with this principle.

PRINCIPLE G: NATIVE VEGETATION SHOULD NOT BE CLEARED IF THE CLEARING OF THE VEGETATION IS LIKELY TO CAUSE APPRECIABLE LAND DEGRADATION

The gradient across the site is less than five metres (Landgate 2012). The uniformity of the landscape means it is unlikely to be effected by erosion. Due to the scale of proposed clearing it is unlikely to have effect on salinity, nutrient export, acidification or flooding.

Therefore, disturbances associated with the project are unlikely to be at variance with this principle.

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 AREAS

The study area is mapped as Bush Forever Site No. 342, also known as the Anstey/Keane Dampland and Adjacent Bushland, Forrestdale (Government of Western Australia 2000a). The next nearest Bush Forever sites to the study area are; Balannup Lake and Adjacent Bushland, Southern River/Forrestdale (Bush Forever site 413), abutting the northern edge of Site 342 and the Piarra Nature Reserve, Forrestdale (Bush Forever Site 262), approximately 0.6 km south-west of the study area (Government of Western Australia 2000a).

Therefore, disturbances associated with the project may be at variance with this principle.

PRINCIPLE I: NATIVE VEGETATION SHOULD NOT BE CLEARED IF THE CLEARING OF THE VEGETATION IS LIKELY TO CAUSE DETERIORATION IN THE QUALITY OF SURFACE OR UNDERGROUND WATER

As the proposed disturbance area is along existing tracks and involves minimal vegetation clearing, it is unlikely to affect surface or groundwater deterioration.

Therefore, disturbances associated with the project are unlikely to be at variance with this principle.

PRINCIPLE J: NATIVE VEGETATION SHOULD NOT BE CLEARED IF THE CLEARING OF THE VEGETATION IS LIKELY TO CAUSE, OR EXACERBATE, THE INCIDENCE OR INTENSITY OF FLOODING

As the proposed disturbance area is along existing tracks and involves minimal vegetation clearing it is unlikely to cause or exacerbate the instance of flooding in the area.

Therefore, disturbances associated with the project are not likely to be at variance with this principle.

8 REFERENCES

- Abbott, I. (2008). Historical perspectives of the ecology of some conspicuous vertebrate species in south-west Western Australia. *Conservation Science Western Australia*, 6(3), 1-214.
- Australian Heritage Commission [AHC]. 2000. *Register of the National Estate Database* Canberra: Author.
- Barrett, G., Silcocks, A., Barry, S., Cunningham, R., & Poulter, R. (2003). *The New Atlas of Australian Birds*. Victoria: Royal Australasian Ornithologists Union.
- Beard, J. S. (1990). *Plant Life of Western Australia*. New South Wales: Kangaroo Press Pty Ltd.
- Beard, J.S. (1979). Vegetation Survey of Western Australia: *The Vegetation of the Perth Area, Western Australia*. Perth: Vegmap Publications.
- Birdlife Australia. (2012a). *Birdata: Distribution Maps*. Retrieved [date], from www.birdata.com.au/maps.vm
- Birdlife Australia. (2012b). Species factsheets: Peregrine Falcon. Retrieved September 2012, from <http://www.birdlife.org.au/images/uploads/branches/documents/ARA-Peregrine-Factsht.pdf>
- Bureau of Meteorology [BOM]. (2012). *Daily Weather Observations*, Commonwealth of Australia. Retrieved March 8, 2012, from <http://www.bom.gov.au/climate>
- Bush, B., Maryan, B., Browne-Cooper, R., & Robinson, D. (2007). *Reptiles and Frogs in the Bush: Southwestern Australia*. Nedlands: University of Western Australia Press.
- Cale, B. (2003). *Carnaby's Black-Cockatoo (Calyptorhynchus latirostris) Recovery Plan*. Perth: Department of Conservation and Land Management.
- Chapman, T. (2007). *Forest Black Cockatoo (Baudin's Cockatoo Calyptorhynchus baudinii and Forest Red-tailed Black Cockatoo Calyptorhynchus banksii naso) Recovery Plan 2007-2016* (Wildlife Management Program No. 42). Perth: Department of Environment & Conservation.
- Churchward, H. M., and McArthur, W. M. (1978) *Darling System, Landforms and Soils* [Map]. Division of Land Resources Management, C.S.I.R.O, Perth, Western Australia.
- Churchward, H. M., and McArthur, W. M. (1980). Landforms and Soils of the Darling System Western Australia. In: *Department of Conservation and Environment. (1980)*.
- Christidis, L., & Boles, W. (2008). *Systematics and Taxonomy of Australian Birds*. Victoria: CSIRO Publishing.

Clarke, K.R. and Gorley, R.N. (2006). PRIMER (version 6.1.5) [Computer software]. Plymouth, UK: Primer-E Ltd.

Cogger, H. G. (2000). *The Reptiles and Amphibians of Australia*. Sydney: Reed New Holland Publishers.

Commonwealth of Australia. (2012). *Weeds of National Significance*. Retrieved March 8, 2012, from <http://www.weeds.gov.au/weeds/lists/wons.html>

Department of Agriculture and Food Western Australia [DAFWA]. (2012). *Declared Plants in Western Australia*. Available from http://www.agric.wa.gov.au/PC_93088.html

Department of Conservation and Land Management [CALM]. (1999). *Environmental Weed Strategy for Western Australia*. Retrieved March 12 2012, from http://www.dec.wa.gov.au/pdf/plants_animals/environmental_weed_strategy_wa.pdf

Department of Environment and Conservation [DEC]. (2006). *Brush-tailed Phascogale. Online factsheet*. Retrieved October 2012, from <http://dec.wa.gov.au>

Department of Environment and Conservation [DEC] (2012a). *Invasive Plant Prioritization Process, Swan Weed Assessment. Department of Environment and Conservation*. Retrieved from <http://www.dec.wa.gov.au/content/view/6295/2275/1/1/>

Department of Environment and Conservation [DEC]. (2012b). *NatureMap: Mapping Western Australia's Biodiversity*. Department of Environment and Conservation and Western Australian Museum. Retrieved October 2012, from <http://naturemap.dec.wa.gov.au/> Department of Environment and Conservation [DEC]. (2012c). *Priority Ecological Communities for Western Australia Version 17 (13 April 2012)*. Available from <http://www.dec.wa.gov.au/content/view/852/2010/>

Department of Environment and Conservation [DEC]. (2012d). *Threatened and Priority Ecological Communities Information (custom search)*. Requested September, 2012.

Department of Environment and Conservation [DEC]. (2012e). *Threatened and Priority Fauna Database (custom search)*. Retrieved October 2012.

Department of Environment and Conservation [DEC]. (2012f). *Threatened and Priority Flora database (custom search)*. Requested September, 2012.

Department of Environment and Conservation [DEC]. (2012g). *Geomorphic Wetlands Swan Coastal Plain (DEC-004)(18-10-2012) [Data set]*. Perth: Author

Department of Sustainability, Environment, Water, Population and Communities [SEWPAC]. (2011). *Environmental Protection and Biodiversity Conservation Act 1999 draft referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo, Baudin's cockatoo, Forest red-tailed black cockatoo*. Canberra: Author.

Department of Sustainability, Environment, Water, Populations and Communities [SEWPAC]. (2012b). *EPBC Protected Matters Search Tool*. Available from <http://www.environment.gov.au/erin/ert/epbc/index.html>

Department of the Sustainability, Environment, Water, Population and Communities [SEWPAC]. (2012c). *Maps: Australia's Bioregions (IBRA)*. Available from: <http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html>

Environmental Protection Authority & Department of Environment and Conservation [EPA-DEC]. (2010). *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*. Perth: Author.

Environmental Protection Authority [EPA]. (2000). *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas* (Position Statement No. 2). Perth: Author.

Environmental Protection Authority. [EPA]. (2001). *Environmental Protection of Wetlands. Position Statement No. 4*. EPA. Perth: Author

Environmental Protection Authority [EPA]. (2002). *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (Position Statement No. 3). Perth: Author.

Environmental Protection Authority [EPA]. (2004a). *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia: Guidance Statement No. 56*. Perth: Author.

Environmental Protection Authority [EPA]. (2004b). *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (Guidance Statement No. 51). Perth: Author.

Environmental Protection Authority [EPA]. 2006. *Level of Assessment for Proposals affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 region in Western Australia* (Guidance Statement No. 10). Perth: Author.

EUCLID. (2006). *EUCLID: Eucalypts of Australia* [Computer software]. Canberra: Australian Biological Resources Study and CSIRO.

Garnett, S. T., Szabo, J. K., & Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. Victoria: CSIRO Publishing.

Garnett, S., & Crowley, G. M. (2000). *The action plan for Australian birds 2000*. Canberra: Environment Australia. Retrieved from: <http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html>

Geological Survey of Western Australia [GSWA]. (1986). *Geology of the 1:50 000 mapsheet PERTH (20342), first edition* [Data set]. East Perth: Author

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

Gill, F., & Donsker, D. (Eds). (2012). *IOC World Bird Names (Version 2.11)*. Retrieved October 2012, from <http://www.worldbirdnames.org/>.

Government of Western Australia. (2000a). *Bush Forever: Volume 1: Policies, Principles and Processes*. Perth: Department of Environmental Protection

Government of Western Australia. (2000b). *Bush Forever: Volume 2: Directory of Bush Forever Sites*. Perth: Department of Environmental Protection

Government of Western Australia. (2011). *2011 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report)*. Perth: Western Australian Department of Environment and Conservation.

Groom, C. (2011). *Plant's used by the Carnaby's Black Cockatoo*. Perth: Department of Environment and Conservation.

Heddle, E. M., Loneragan, O. W., and Havel, J. J. (1978) *Vegetation complexes of the Darling System (WA)* [Map]. Perth: Department of Conservation and Land Management.

Higgins, P. J. (Ed.) (1999). *Handbook of Australian, New Zealand and Antarctic Birds. Volume Four - Parrots to Dollarbird*. Melbourne: Oxford University Press.

Hussey, B. J. M., Keighery, G. J., Dodd, J., Lloyd, S. G., & Cousens, R. D. (2007). *Western Weeds: A Guide to the Weeds of Western Australia* (2nd ed.). Perth: The Weeds Society of Western Australia.

International Union for Conservation of Nature and Natural Resources [IUCN]. (2012) IUCN Red List. Retrieved July 2012 from <http://www.iucnredlist.org/>

Landgate. (2012) Retrieved March 2013 from <https://www2.landgate.wa.gov.au/ows/wmspublic?>

Johnstone, R. E., & Storr, G. M. (1998). *Handbook of Western Australian Birds: Volume 1 – Non-passerines (Emu to Dollarbird)*. Perth: Western Australian Museum.

Johnstone, R., & Kirkby, T. (1999). Food of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* in south-west Western Australia. *The Western Australian Naturalist*, 22(3), 167-177.

Johnstone, R., & Kirkby, T. (2008). Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (*Calyptorhynchus baudinii*) in South-west Western Australia. *Records of the Western Australian Museum*, 25, 107-118.

Johnstone, R., & Kirkby, T. (2011). Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) on the Swan Coastal Plain (Lancelin–Dunsborough), Western Australia. Studies on distribution, status, breeding, food, movements and historical changes. Perth: Department of Planning, Western Australia.

Long, K. (2009). Burrowing bandicoots – an adaptation to life in a fire-prone environment? *Australian Mammalogy*, 31, 57-59.

Maslin, B. (2001). *WATTLE: Acacias of Australia* [Computer software]. Canberra: Australian Biological Resources Study and CSIRO.

Menkhorst, P., & Knight, F. (2011). *A Field Guide to the Mammals of Australia (3rd Ed.)*. Melbourne: Oxford University Press.

Mitchell, D., Williams, K., & Desmond, A. (2002). Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion). In: J. E. May, & N. L. McKenzie (Eds.), *A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002* (pp. 606-623). Perth: Department of Conservation and Land Management.

Olsen, J., Debus, S., Rose, A. B., Hayes, G. (2004). Breeding success, cliff characteristics and diet of Peregrine Falcons at high altitude in the Australian Capital Territory. *Corella*, 28(2), 33-37.

Parsons, B. C., Short, J. C., & Roberts, J. D. (2008). Contraction in the range of Malleefowl (*Leipoa ocellata*) in Western Australia: a comparative assessment using presence-only and presence-absence datasets. *Emu*, 108, 221-231.

Pearson, D. J. (1993). Distribution, status and conservation of pythons in Western Australia. In: D. Lunney & D. Ayers (Eds.), *Herpetology in Australia: a Diverse Discipline* (pp. 383-395). Sydney: Royal Zoological Society of NSW.

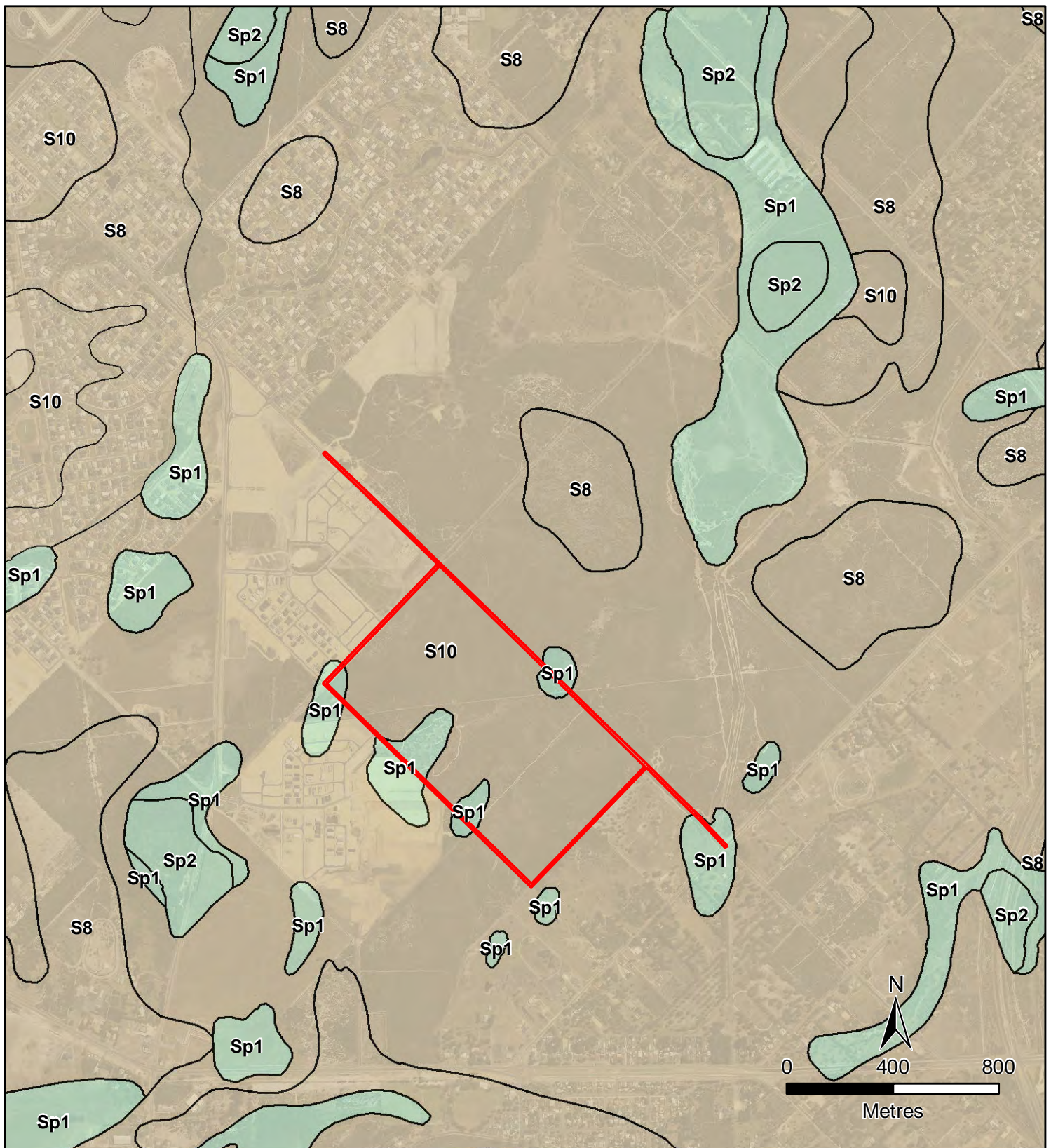
Pizzey, G., & Knight, F. (2007). *The Field Guide to the Birds of Australia (8th Ed.)*. Sydney: Harper Collins.

Rowley, I., & Chapman, G. (1991). The breeding biology, food, social-organization, demography and conservation of the Major Mitchell or Pink Cockatoo, *Cacatua leadbeateri*, on the margin of the Western Australian Wheatbelt. *Australian Journal of Zoology*, 39(2), 211-261.

Shah, B. (2006). *Conservation of Carnaby's Black-Cockatoo on the Swan Coastal Plain, Western Australia*. Perth: Birds Australia.

- Sharp, D., & Simon, B. K. (2002). *AusGrass: Grasses of Australia*. [Computer software]. Canberra: Australian Biological Resources Study and CSIRO.
- Shepherd, D. P., Beeston, G. R., and Hopkins, A. J. M. (2001). *Native Vegetation in Western Australia* (Technical Report 249). Perth: Department of Agriculture.
- Simpson, K., & Day, N. (2010). *A Field Guide to the Birds of Australia* (8th Ed.). Melbourne, Victoria: Penguin Books Australia Ltd.
- Storr, G. M., Smith, L. A., & Johnstone, R. E. (1999). *Lizards of Western Australia. I. Skinks*. Perth: Western Australian Museum.
- Storr, G. M., Smith, L. A., & Johnstone, R. E. (2002). *Snakes of Western Australia*. Perth: Western Australian Museum.
- Thackway, R., & Cresswell, I. D. (1995). *An Interim Biogeographic Regionalisation for Australia: A framework for setting priorities in the National Reserves System Cooperative Program (Version 4.0)*. Canberra: Australian Nature Conservation Agency.
- Trudgen, M.E. (1991). Vegetation Condition Scale. In *Urban Bushland Policy*. Perth: National trust of Australia (WA).
- Tyler, M. J., & Doughty, P. (2009). *Field Guide to Frogs of Western Australia* (4th Ed.). Perth: Western Australian Museum.
- Tyler, M. J., & Knight, F. (2009). *Field Guide to the Frogs of Australia*. Collingwood: CSIRO Publishing.
- Van Dyck, S., & Strahan, R. (2008). *The Mammals of Australia* (3rd Ed.). Sydney: New Holland Publishers.
- Western Australian Herbarium [WAH]. (2012). *Florabase - Information on the Western Australian Flora*. Accessed from <http://florabase.calm.wa.gov.au/>
- Wilson, S., & Swan, G. (2010). *A Complete Guide to Reptiles of Australia* (3rd Ed.). Chatswood: New Holland Publishers.
- Yeatman, G. J., & Groom, C. J. (2012). *National Recovery Plan for the Woylie Bettongia penicillata (Wildlife Management Program No. 51)*. Perth: Department of Environment and Conservation.
- Ziembicki, M. (2010). *Australian Bustard*. Collingwood: CSIRO Publishing.

FIGURES



Legend

- Sp1** PEATY SAND - grey to black, fine to medium-grained, moderately sorted quartz sand, slightly peaty, of lacustrine origin
- S8** SAND - white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals,
- S10** SAND - as S8 over sandy clay to clayey sand of the Guildford Formation, of eolian origin

Geological Survey of WA, 1:50K Surface Geology



CLIENT Water Corporation	JOB NO. J113163
AUTHOR D. Buller	DRAWN T. Ellis
SCALE 1:20,000 @ A4	DATE 02-10-12
PROJECTION GDA 94 MGA 50	

Geology of the Study Area

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



Bassendean Complex-Central And South

Southern River Complex

Guildford Complex

Beermullah Complex



CLIENT
Water Corporation

AUTHOR
D. Buller

SCALE
1:50,000 @ A4

DRAWN
T. Ellis

PROJECTION
GDA 94 MGA 50

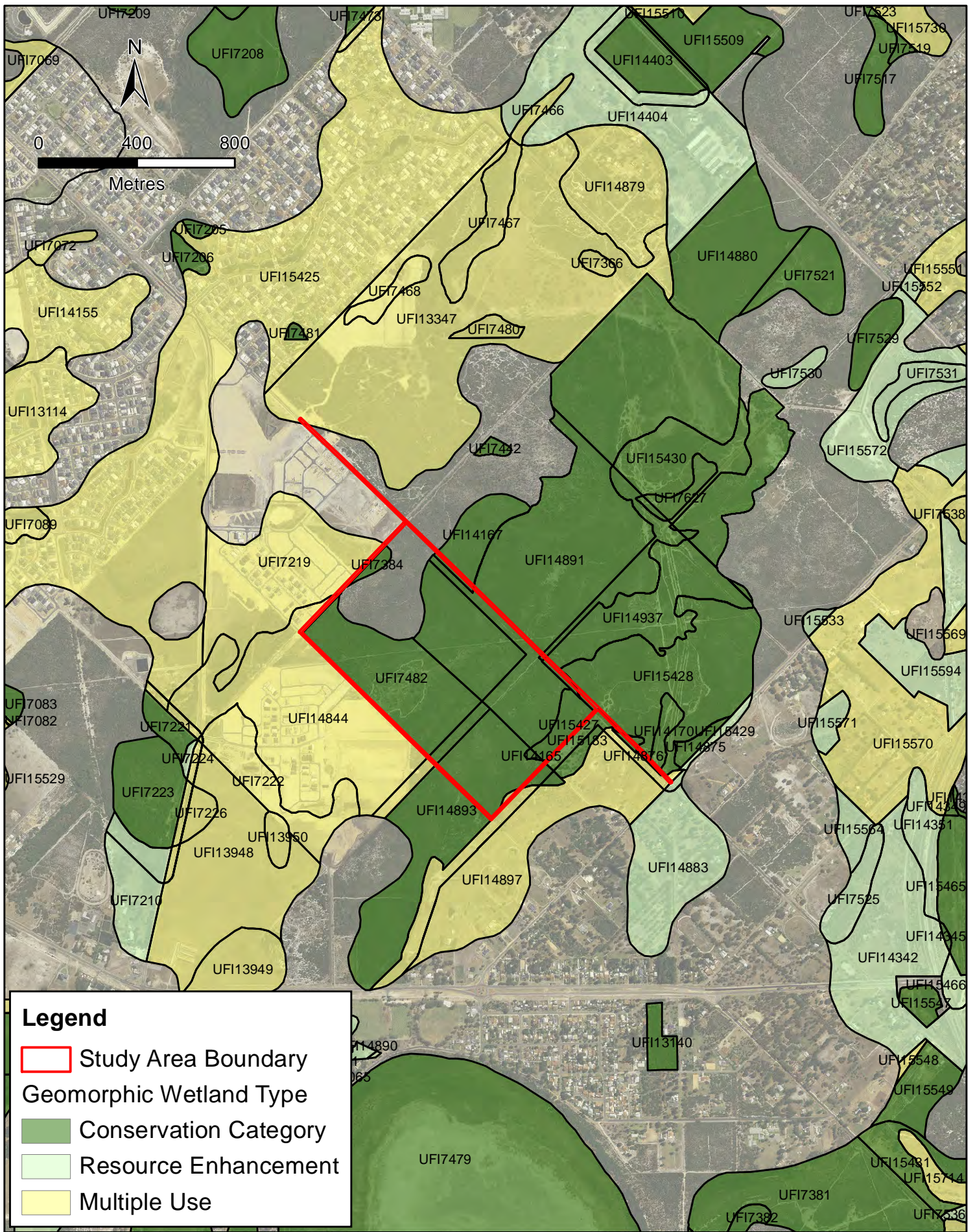
JOB NO.
J113163

DATE
02-10-12

System 6 Vegetation Complexes of the Study Area


Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale

FIGURE **4**



Legend

- Study Area Boundary
- Geomorphic Wetland Type
- Conservation Category
- Resource Enhancement
- Multiple Use

	CLIENT	JOB NO.	
	Water Corporation	J113163	
	AUTHOR	DRAWN	DATE
	D. Buller	T. Ellis	16-10-12
SCALE	PROJECTION		
1:20,000 @ A4	GDA 94 MGA 50		

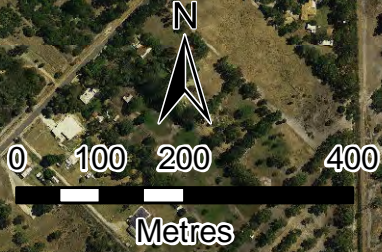
Geomorphic Wetlands
 Flora, Vegetation & Fauna Assessment
 Keane Road, Forrestdale




Legend

Study Area Boundary

■ Quadrat



	CLIENT	JOB NO.	
	Water Corporation	J113163	
	AUTHOR	DRAWN	DATE
	D. Buller	M. Mikkonen	17-10-12
	SCALE	PROJECTION	
1:9,000 @ A4	GDA 94 MGA 50		

Flora Quadrat Locations
 Flora, Vegetation & Fauna Assessment
 Keane Road, Forrestdale



Legend

- Study Area Boundary
- Habitat Assessment Location



CLIENT Water Corporation	JOB NO. J113163
AUTHOR C. Knuckey	DRAWN M. Mikkonen
SCALE 1:9,000 @ A4	DATE 15-10-12
PROJECTION GDA 94 MGA 50	

Fauna Habitat Assessment Locations

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



CLIENT
Water Corporation

AUTHOR
D. Buller

SCALE
1:9,000 @ A4

DRAWN
M. Mikkonen

PROJECTION
GDA 94 MGA 50

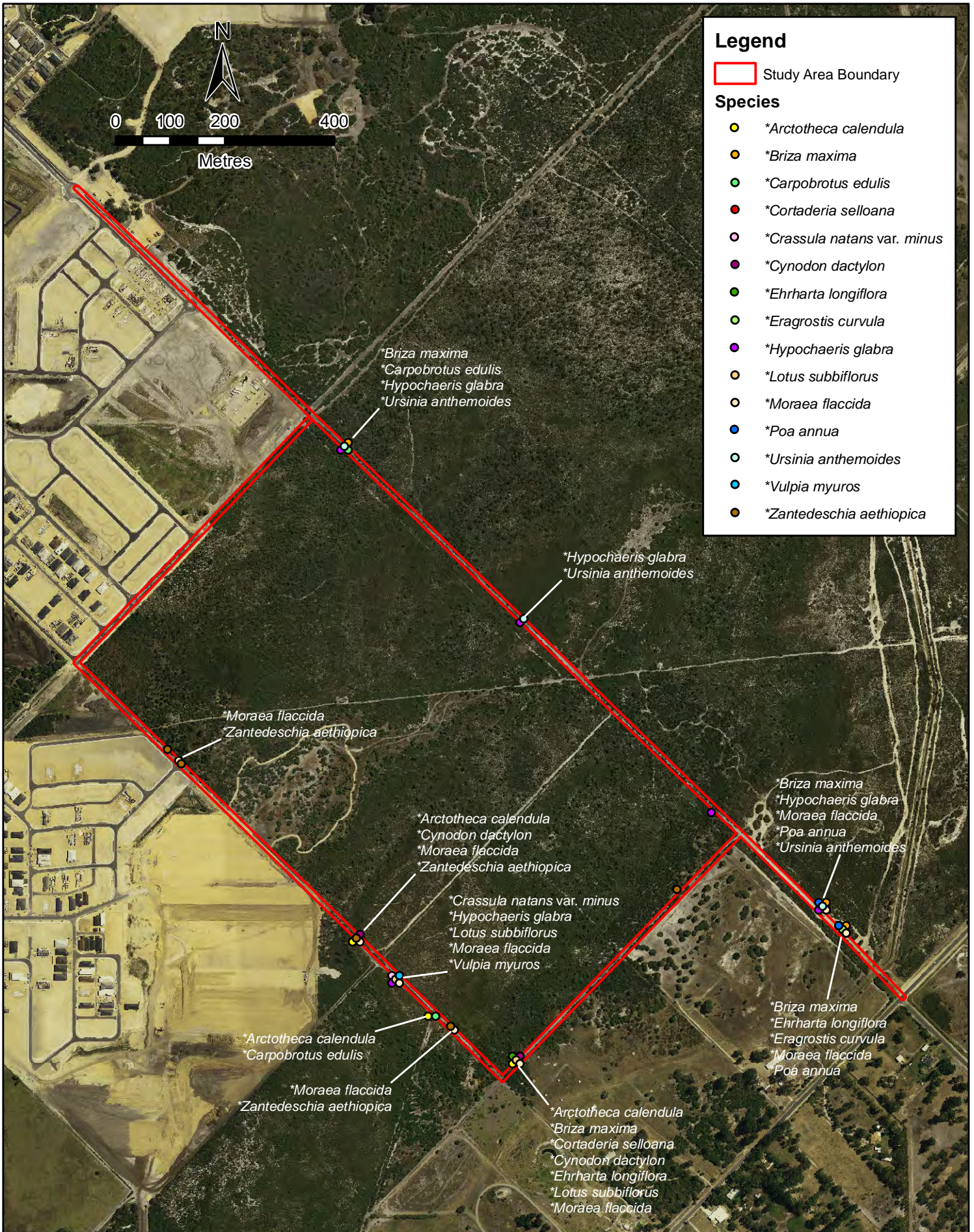
JOB NO.
J113163

DATE
17-10-12

Location of Conservation Significant Flora

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale

FIGURE 8



CLIENT
Water Corporation

AUTHOR
D. Buller

SCALE
1:9,000 @ A4

DRAWN
M. Mikkonen

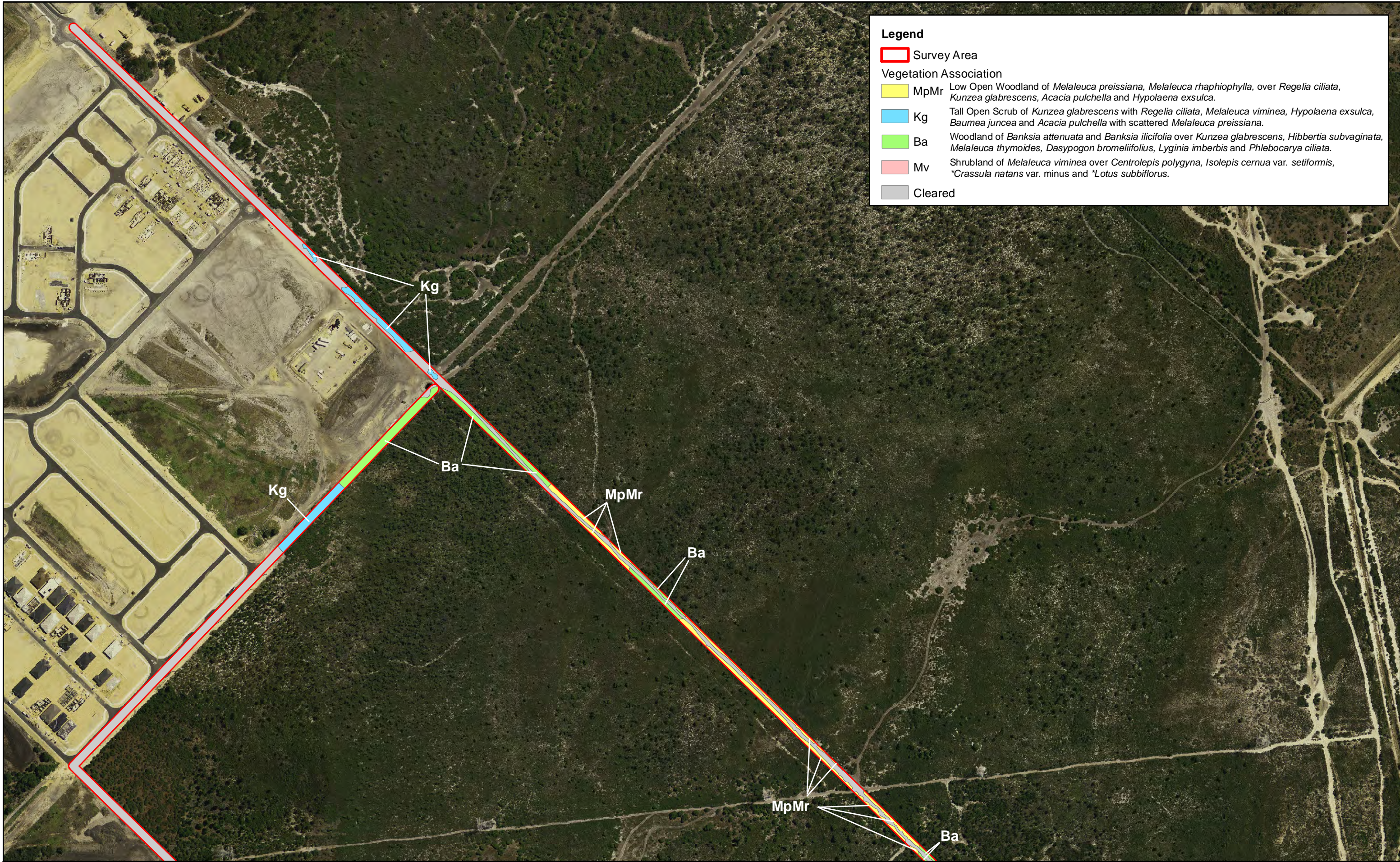
PROJECTION
GDA 94 MGA 50

JOB NO.
J113163

DATE
17-10-12

Location of Introduced Flora

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



Legend

Survey Area

Vegetation Association

MpMr Low Open Woodland of *Melaleuca preissiana*, *Melaleuca raphiophylla*, over *Regelia ciliata*, *Kunzea glabrescens*, *Acacia pulchella* and *Hypolaena exsulca*.

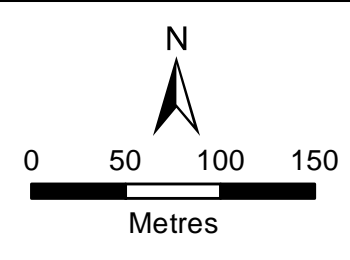
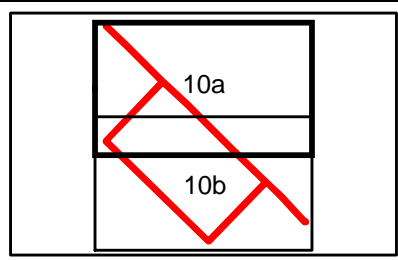
Kg Tall Open Scrub of *Kunzea glabrescens* with *Regelia ciliata*, *Melaleuca viminea*, *Hypolaena exsulca*, *Baumea juncea* and *Acacia pulchella* with scattered *Melaleuca preissiana*.

Ba Woodland of *Banksia attenuata* and *Banksia ilicifolia* over *Kunzea glabrescens*, *Hibbertia subvaginata*, *Melaleuca thymoides*, *Dasypogon bromeliifolius*, *Lyginia imberbis* and *Phlebocarya ciliata*.

Mv Shrubland of *Melaleuca viminea* over *Centrolepis polygyna*, *Isolepis cernua* var. *setiformis*, **Crassula natans* var. *minus* and **Lotus subbiflorus*.

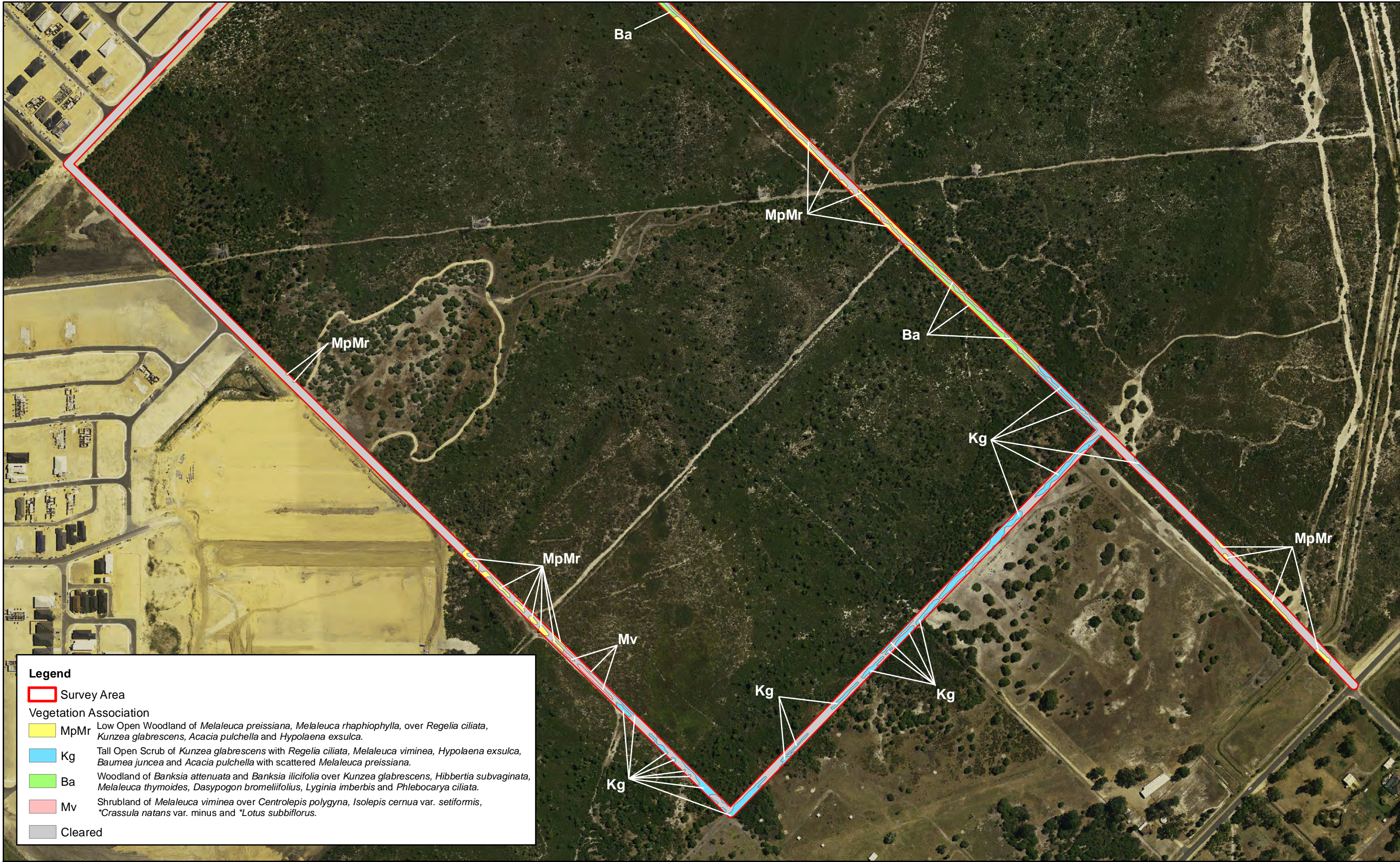
Cleared

	CLIENT	Water Corporation	JOB NO.	J113163
	AUTHOR	N. Whittington	DRAWN	T. Ellis
	SCALE	1:4,000 @ A3	PROJECTION	GDA 94 MGA 50
	DATE	28-11-12		



Vegetation Association Map

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



Legend

Survey Area

Vegetation Association

MpMr Low Open Woodland of *Melaleuca preissiana*, *Melaleuca raphiophylla*, over *Regelia ciliata*, *Kunzea glabrescens*, *Acacia pulchella* and *Hypolaena exsulca*.

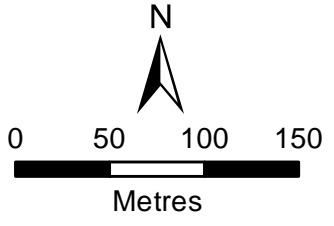
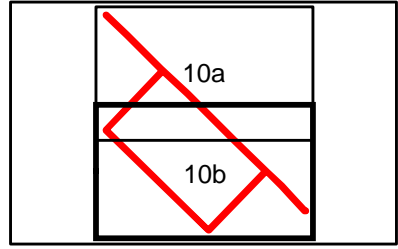
Kg Tall Open Scrub of *Kunzea glabrescens* with *Regelia ciliata*, *Melaleuca viminea*, *Hypolaena exsulca*, *Baumea juncea* and *Acacia pulchella* with scattered *Melaleuca preissiana*.

Ba Woodland of *Banksia attenuata* and *Banksia ilicifolia* over *Kunzea glabrescens*, *Hibbertia subvaginata*, *Melaleuca thymoides*, *Dasyopogon bromeliifolius*, *Lyginia imberbis* and *Phlebocarya ciliata*.

Mv Shrubland of *Melaleuca viminea* over *Centrolepis polygyna*, *Isolepis cernua* var. *setiformis*, **Crassula natans* var. *minus* and **Lotus subbiflorus*.

Cleared

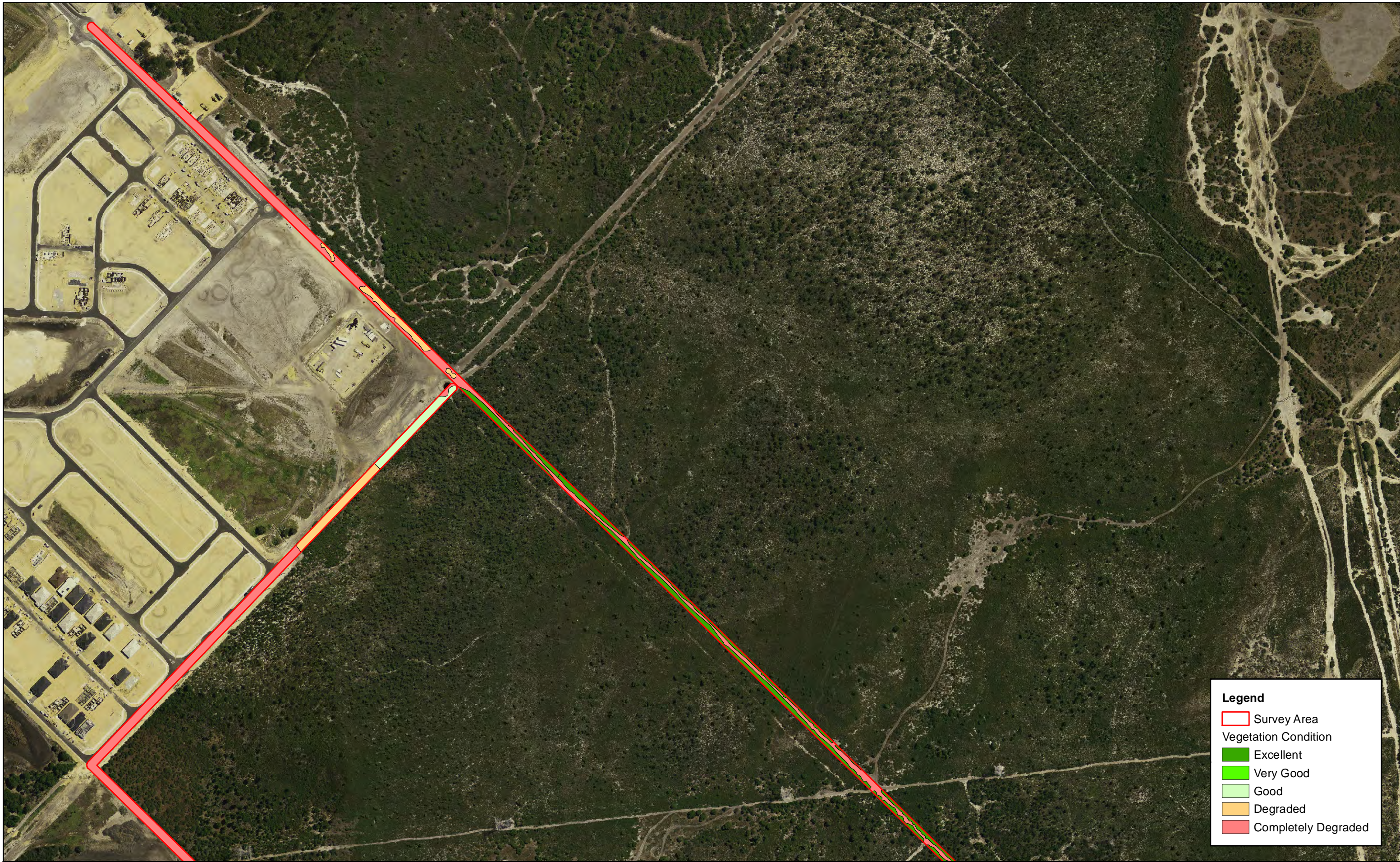
	CLIENT	Water Corporation	JOB NO.	J113163
	AUTHOR	N. Whittington	DRAWN	T. Ellis
	SCALE	1:4,000 @ A3	PROJECTION	GDA 94 MGA 50
	DATE	28-11-12		



Vegetation Association Map

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale

FIGURE **10b**

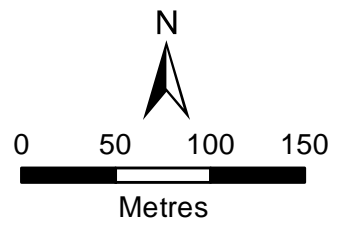
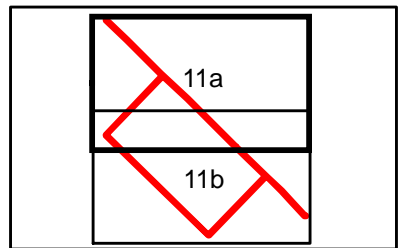


Legend

- Survey Area
- Vegetation Condition
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

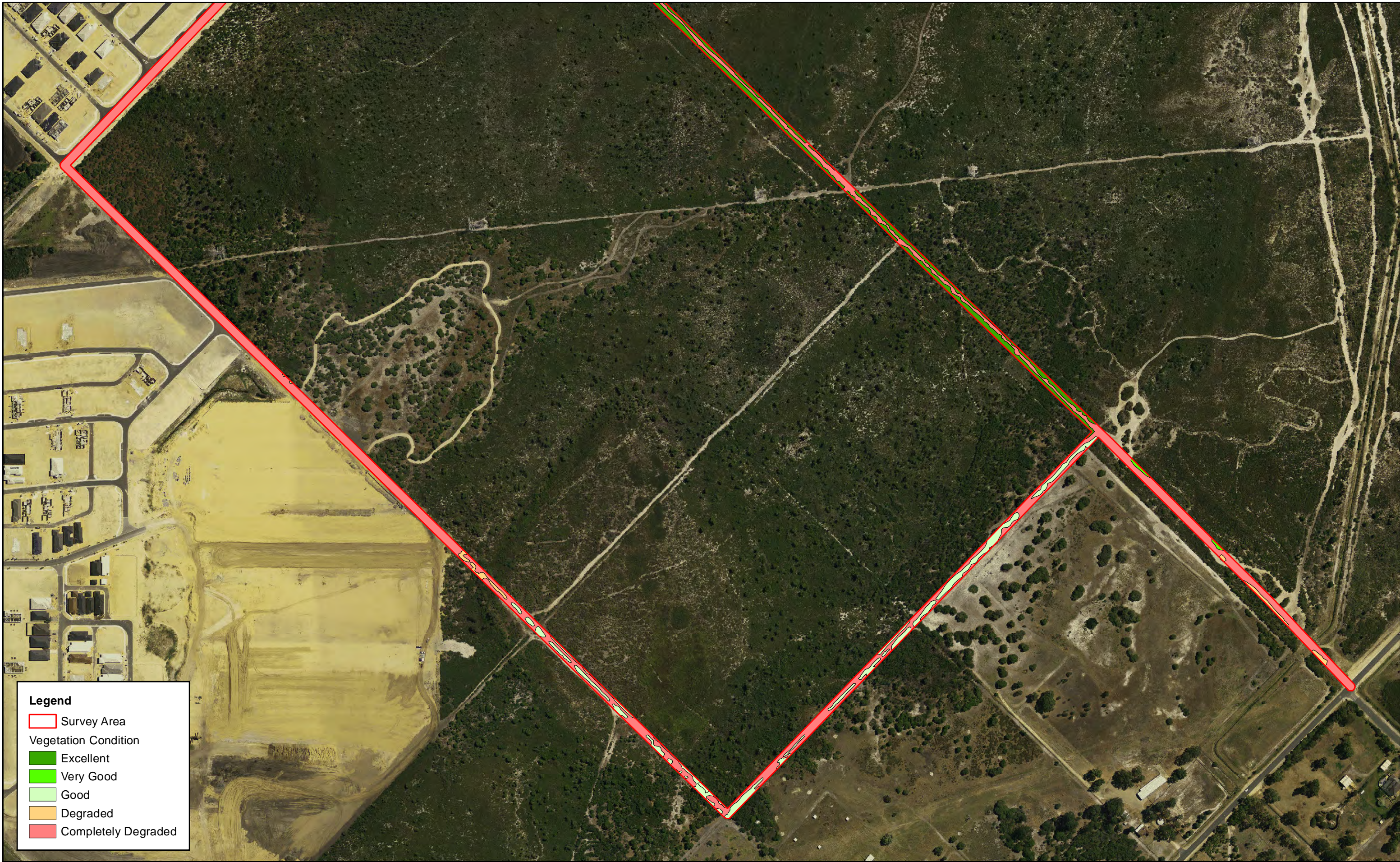


CLIENT Water Corporation	JOB NO. J113163
AUTHOR N. Whittington	DATE 01-11-12
SCALE 1:4,000 @ A3	PROJECTION GDA 94 MGA 50
DRAWN T. Ellis	



Vegetation Condition Map

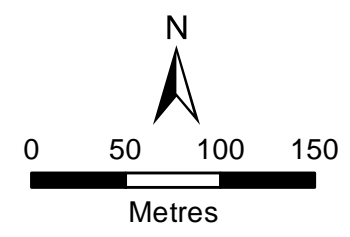
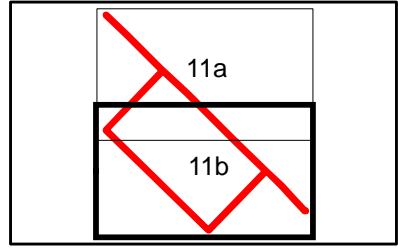
Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



Legend

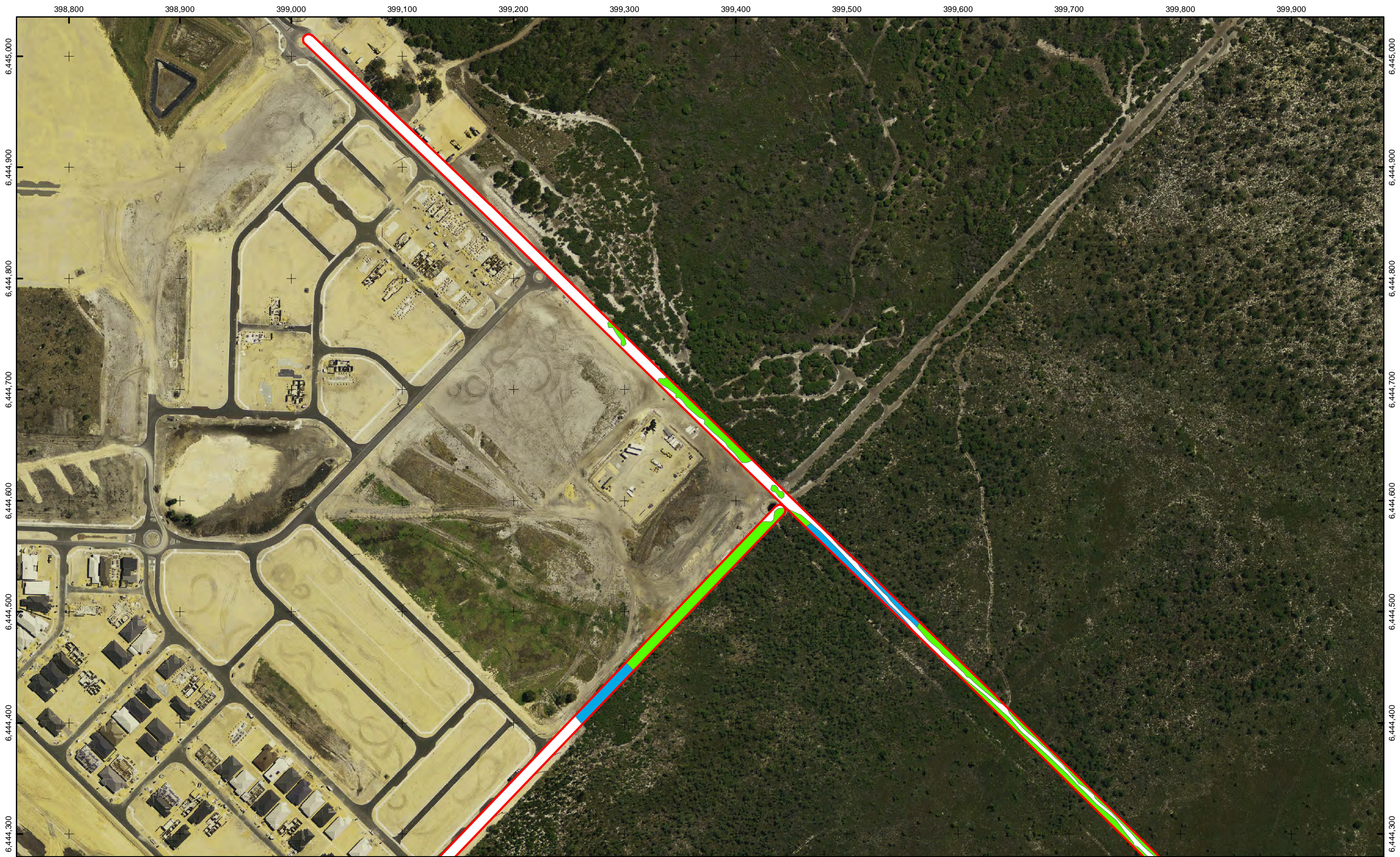
- Survey Area
- Vegetation Condition
- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

	CLIENT	Water Corporation	JOB NO.	J113163
	AUTHOR	N. Whittington	DRAWN	T. Ellis
	SCALE	1:4,000 @ A3	PROJECTION	GDA 94 MGA 50
	DATE	01-11-12		

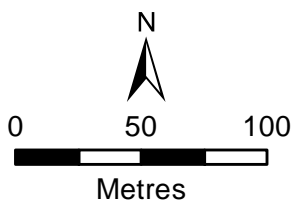
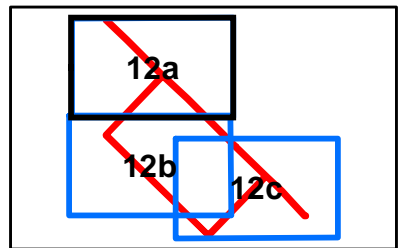


Vegetation Condition Map

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



CLIENT Water Corporation	JOB NO. J113163
AUTHOR R. Firth	DATE 12-10-12
DRAWN M. Mikkonen	PROJECTION GDA 94 MGA 50
SCALE 1:3,000 @ A3	

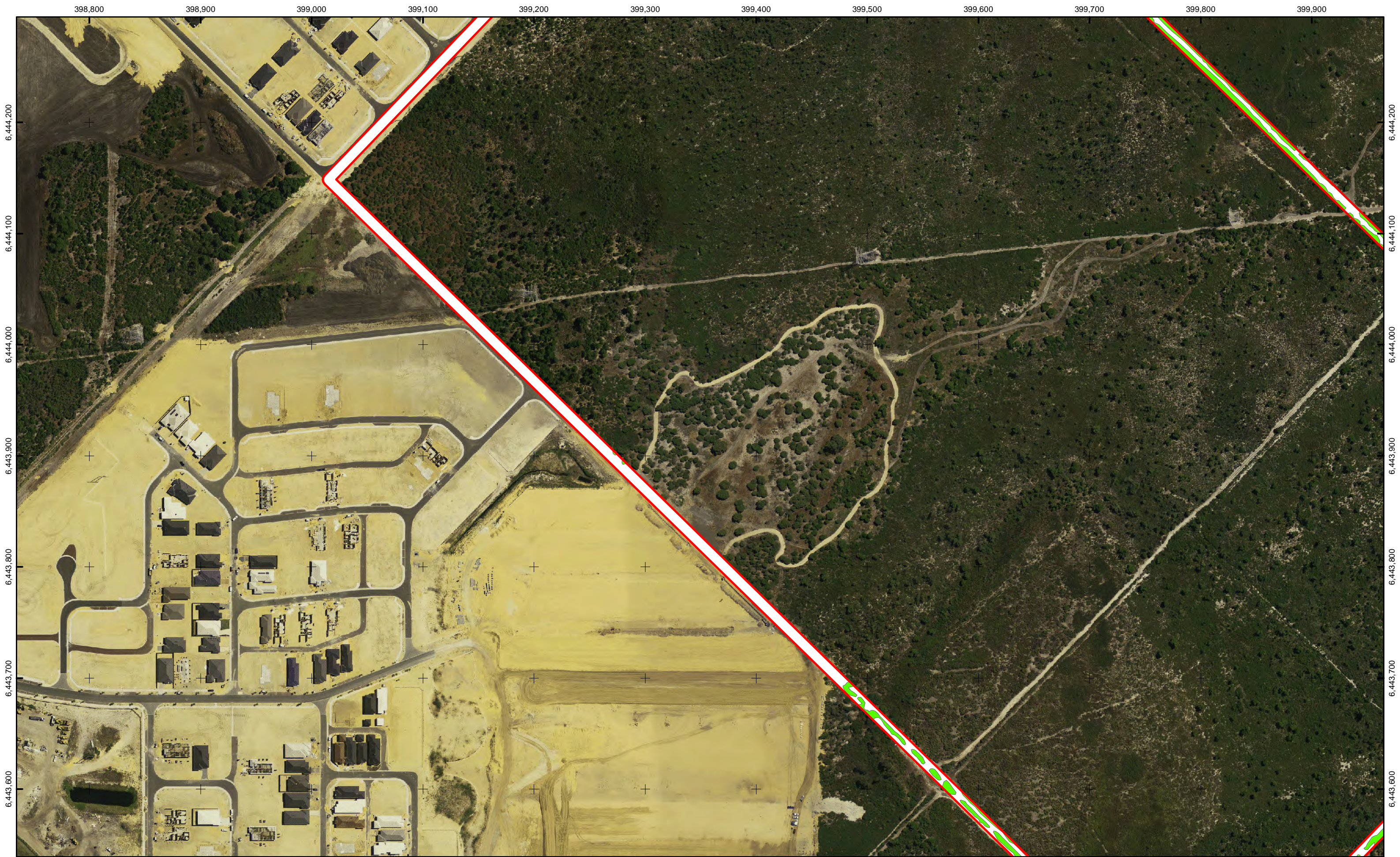


- Legend**
- Survey Area
 - Habitat
 - Banksia Woodland
 - Melaleuca Shrubland
 - Cleared

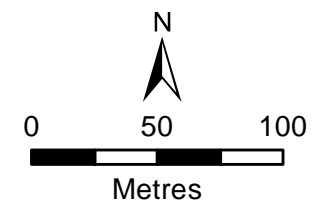
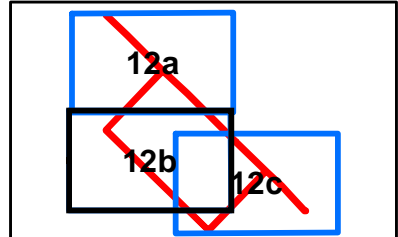
Fauna Habitat Map

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale

FIGURE **12a**



CLIENT Water Corporation	JOB NO. J113163
AUTHOR R. Firth	DRAWN M. Mikkonen
SCALE 1:3,000 @ A3	DATE 12-10-12
PROJECTION GDA 94 MGA 50	



Legend

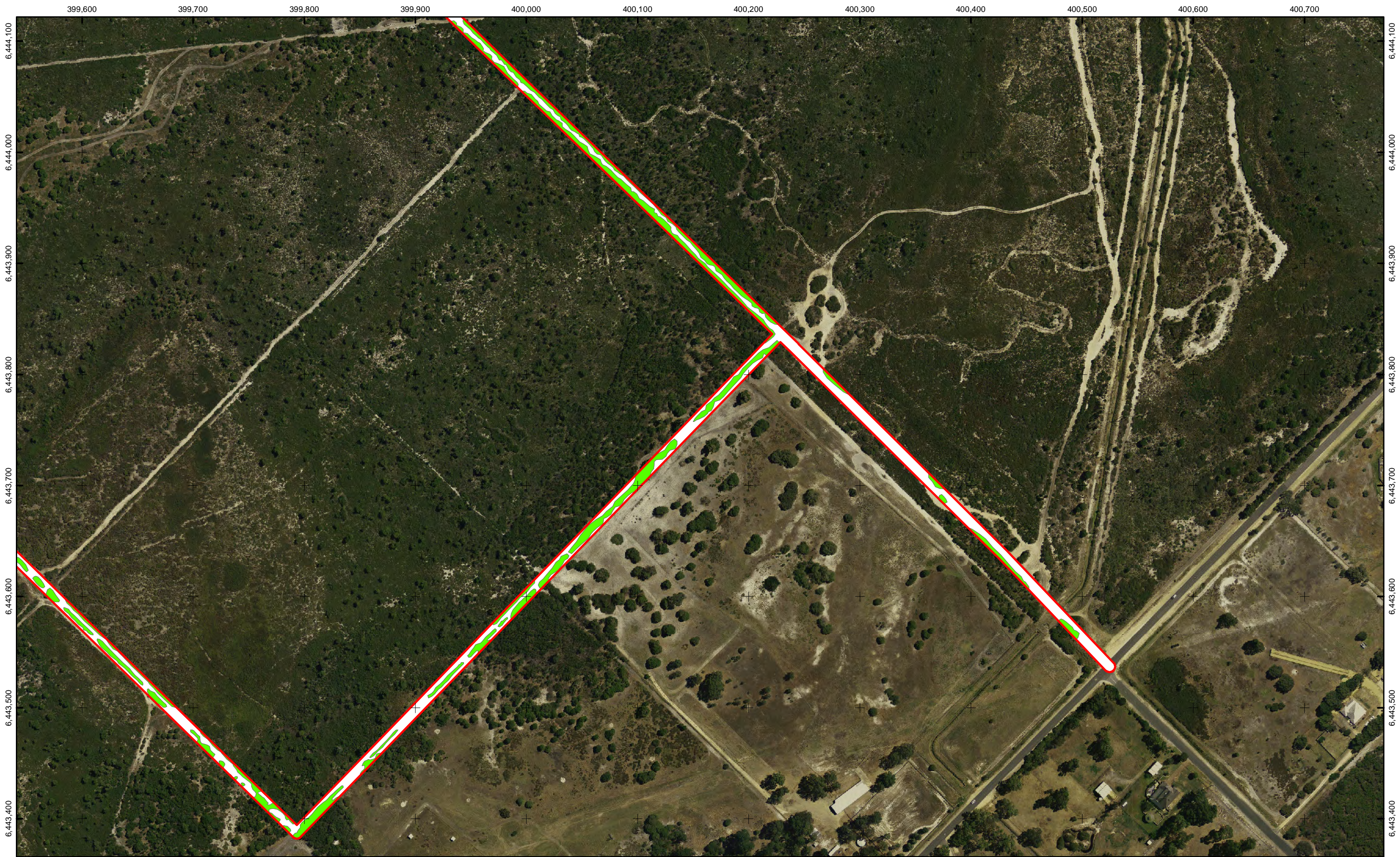
Survey Area

Habitat

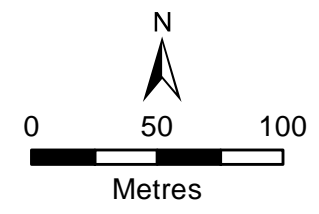
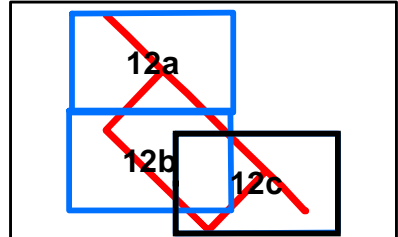
- █ Banksia Woodland
- █ Melaleuca Shrubland
- Cleared

Fauna Habitat Map

Flora, Vegetation & Fauna Assessment
Keane Road, Forrestdale



CLIENT	Water Corporation	JOB NO.	J113163
AUTHOR	R. Firth	DRAWN	M. Mikkonen
SCALE	1:3,000 @ A3	PROJECTION	GDA 94 MGA 50
		DATE	12-10-12



- Legend**
- Survey Area
 - Habitat**
 - Banksia Woodland
 - Melaleuca Shrubland
 - Cleared

Fauna Habitat Map
 Flora, Vegetation & Fauna Assessment
 Keane Road, Forrestdale

APPENDIX A
DEFINITION OF DECLARED RARE /
PRIORITY / THREATENED FLORA
SPECIES AND SIGNIFICANT FLORA
SPECIES POTENTIALLY OCCURRING IN
THE STUDY AREA

APPENDIX A

DEFINITIONS OF DECLARED RARE / PRIORITY / THREATENED FLORA

A1: Categories of Declared Rare and Priority Flora

Conservation Code	Category
X	<p>Presumed Extinct Flora (Declared Rare Flora – Extinct)</p> <p>“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 (Schedule 2 under the <i>Wildlife Conservation Act 1950</i>).”</p>
T	<p>Threatened Flora (Declared Rare Flora – Extant)</p> <p>“Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the <i>Wildlife Conservation Act 1950</i>).”</p> <p>“Threatened Flora (Schedule 1) are further ranked by the Department according to their level of threat using IUCN Red List criteria:</p> <ul style="list-style-type: none"> • 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.”
P1	<p>Priority One: Poorly-known taxa</p> <p>“Taxa which 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.”</p>
P2	<p>Priority Two: Poorly-known taxa</p> <p>“Taxa which 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.”</p>
P3	<p>Priority Three: Poorly-known taxa</p> <p>“Taxa which are known from collections or sight records from several localities not under imminent threat, or 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.”</p>

Conservation Code	Category
P4	<p>Priority Four: Rare, Near Threatened and other taxa in need of monitoring</p> <p>a. Rare. "Taxa which 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."</p> <p>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."</p> <p>c. "Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy."</p>
P5	<p>Priority Five: Conservation Dependent taxa</p> <p>"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."</p>

Source: Department of Environment and Conservation (2012). *Western Australian Flora Conservation Codes*. Department of Environment and Conservation, Perth, Western Australia. Online: <http://florabase.calm.wa.gov.au>.

A2: Categories of Threatened Flora Species

Category Code	Category
Ex	<p>Extinct</p> <p>Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died.</p>
ExW	<p>Extinct in the Wild</p> <p>Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.</p>
CE	<p>Critically Endangered</p> <p>Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.</p>
E	<p>Endangered</p> <p>Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.</p>
V	<p>Vulnerable</p> <p>Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.</p>
CD	<p>Conservation Dependent</p> <p>Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.</p>

Source: *Environment Protection and Biodiversity Conservation Act 1999*

APPENDIX B
DEFINITIONS OF CONSERVATION
CODES FOR FAUNA OF CONSERVATION
SIGNIFICANCE

APPENDIX B

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

B1: *Environment Protection and Biodiversity Conservation Act 1999 (Cth)*: Threatened Species and Threatened Ecological Communities Codes

The *EPBC Act* prescribes seven matters of national environmental significance:-

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance;
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Species in the categories ExW, CE, E, V and M (see below), and Threatened Ecological Communities in the CE and E categories are protected as matters of national environmental significance under the *EPBC Act*.

Category	Code	Category
Extinct	Ex	Taxa for which there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	ExW	Taxa known to survive only in cultivation, in captivity or as a naturalised population well outside its past range; or not recorded in its known and/or expected habitat at appropriate seasons anywhere in its past range despite exhaustive surveys over a timeframe appropriate to its life cycle and form.
Critically Endangered	CE	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	E	Taxa not critically endangered and facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Vulnerable	V	Taxa not critically endangered or endangered and facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	CD	Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within five years.

Category	Code	Category
Migratory	Mi	<p>Taxa that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations, that are included in an international agreement approved by the Minister for the Environment, Heritage and the Arts and that have been placed on the national List of Migratory Species under the provisions of the EPBC Act. At present there are four such agreements:</p> <ul style="list-style-type: none"> • the Bonn Convention • the China-Australia Migratory Bird Agreement (CAMBA) • the Japan-Australia Migratory Bird Agreement (JAMBA) • the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Marine	Ma	<p>Taxa protected in a Commonwealth Marine Protected Area by virtue of section 248 of the <i>EPBC Act</i>. These taxa include certain seals, crocodiles, turtles and birds, as well as various marine fish.</p> <p>Commonwealth marine areas are matters of national environmental significance under the <i>EPBC Act</i>.</p> <p>An action will require approval if the:</p> <ul style="list-style-type: none"> • action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or • action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area¹ <p>The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters.</p> <p>The Commonwealth marine area stretches from 3 to 200 nautical miles (approximately 5-370 km) from the coast. Marine protected areas are marine areas which are recognised to have high conservation value.</p>

B2: Western Australian Threatened Fauna Categories

Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

B3: Department of Environment and Conservation Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

B4: IUCN Redlist Conservation Fauna Codes

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last individual has died.
Extinct in the Wild	EW	Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically Endangered	CR	Taxa facing an extremely high risk of extinction in the wild.
Endangered	EN	Taxa facing a very high risk of extinction in the wild.
Vulnerable	VU	Taxa facing high risk of extinction in the wild
Near Threatened	NT	Taxa which has been evaluated but does not qualify for CR, EN, or VU now but is close to qualifying or likely to qualify in the near future.
Least Concern	LC	Taxa which has been evaluated but does not qualify for CR, EN, VU, or NT but is likely to qualify for NT in the near future.
Data Deficient	DD	Taxa for which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.