



mainroads  
WESTERN AUSTRALIA

# Roe Highway Extension

## Flora and Vegetation Monitoring and Management Plan





Prepared for  
Main Roads Western Australia  
by Strategen

December 2015



## Table of contents

<b>1. Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Purpose and scope of document	2
1.2.1 Statement 1008	2
1.2.2 Previous documentation	3
1.2.3 Objectives	3
1.3 Relationship to management plans required by Ministerial Statement 1008	4
1.4 Consultation	4
<b>2. Project description</b>	<b>5</b>
2.1 Project activities	5
<b>3. Monitoring Program</b>	<b>7</b>
3.1 Baseline flora and vegetation survey	7
3.2 Ongoing monitoring program	7
3.2.1 Monitoring sites	7
3.2.2 Monitoring methodology	11
3.2.3 Timing	12
<b>4. Management</b>	<b>13</b>
4.1 Proposed triggers	13
4.2 Contingency actions	13
<b>5. Responsibilities</b>	<b>15</b>
<b>6. Review and reporting</b>	<b>16</b>
6.1 Review and revision	16
6.2 Reporting	16
<b>7. Auditing</b>	<b>17</b>
<b>8. References</b>	<b>18</b>

## List of tables

Table 1: Condition 10 requirements under Statement 1008	2
Table 2: Stakeholder consultation	4
Table 3: Numbers of monitoring sites per vegetation community	8
Table 4: Vegetation triggers and contingency actions	13
Table 5: Roles and responsibilities	15

## List of figures

Figure 1: Project development envelope	6
Figure 2: Proposed ongoing monitoring sites – Section 1	9
Figure 3: Proposed ongoing monitoring sites – Section 2	10

## List of appendices

Appendix 1 Monitoring sites
Appendix 2 Indicator species
Appendix 3 Vegetation Rehabilitation Plan
Appendix 4 Baseline Vegetation and Flora Condition Survey Scope





# 1. Introduction

Main Roads Western Australia (Main Roads) proposes to construct the Roe Highway Extension (the Project, Figure 1) which is part of the Perth Freight Link project (Figure 1). This document presents the flora and vegetation monitoring and management actions to manage the potential impacts of the Project on vegetation health condition.

The Project involves the construction of approximately 5 km of highway, extending Roe Highway from its current terminus at the Kwinana Freeway in Jandakot to Stock Road in Coolbellup. The proposed extension to Roe Highway is largely located within a primary regional road reserve which adjoins Beeliam Regional Park.

## 1.1 Background

The Project is located approximately 14 km south of Perth within the Swan Coastal Plain Bioregion. The Project is largely contained within the City of Cockburn, however, parts of the design extend northward in to the City of Melville along Murdoch Drive and Kwinana Freeway. Generally, the proposed Project is oriented east-west; largely within a road reserve that was set aside in the Metropolitan Region Scheme (MRS) in 1963. The alignment is between North and Bibra Lakes, which are part of the Eastern Chain of the Beeliam Wetlands.

The Project will consist of a dual carriageway with two lanes in each direction, separated by a concrete barrier in place of a median strip. The preferred design was selected following an extensive options analysis and consultative process. Once selected, the preferred design was optimised to avoid and minimise environmental impacts to the maximum extent possible.

In 2009 the Project was referred to the Environmental Protection Authority (EPA) under the Environmental Protection Act 1986 (EP Act), and to the then Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), now the Department of the Environment (DotE), under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The Project was set a level of assessment of Public Environmental Review (PER) and the bilateral agreement between the State and Commonwealth governments was enacted. The PER was released on 20 June 2011 for a 12 week public review period.

The Project was approved by the Minister for Environment in 2 July 2015, with the release of Ministerial Statement 1008 (Statement 1008) establishing conditions for the Project implementation.

Statement 1008 Condition 10 established a “zone of indirect impacts” which is to contain any potential environmental effects of the Project. Immediately outside the “zone of indirect impacts” there is not to be any detectable adverse effects on flora and vegetation communities. Condition 10 further requires ongoing monitoring in order to monitor potential impacts as well as the implementation of a progressive rehabilitation program for areas within the final Roe Highway road reserve that have been temporarily disturbed for construction. Details of the rehabilitation program have been incorporated into the Vegetation Rehabilitation Plan (VRP) included in Appendix 3.

## 1.2 Purpose and scope of document

### 1.2.1 Statement 1008

This FVMMP has been prepared on behalf of Main Roads to address the requirements under Condition 10 of Statement 1008 dated 2 July 2015, as outlined in Table 1.

Table 1: Condition 10 requirements under Statement 1008

Condition	Requirement	Section
10-1	The proponent shall ensure that the ongoing implementation of the proposal does not cause any detectable adverse effects on flora and vegetation communities immediately outside of the 'zone of indirect impacts' as shown in Figure 2 and described in Schedule 1.	Section 3 & 4
10-2	The proponent shall undertake a Baseline Flora and Vegetation Condition Survey prior to commencement of construction to the requirements of the CEO on advice from the Department of Parks and Wildlife. The Baseline Flora and Vegetation Condition Survey shall: <ol style="list-style-type: none"> <li>1. use plot based surveys and cover of the area immediately outside the 'zone of indirect impacts', including immediately outside the 'zone of indirect impacts', and reference site locations;</li> <li>2. identify the indicators of flora and vegetation health including the condition and composition of flora and vegetation communities and correlative environmental parameters including soil moisture within the survey area; and</li> <li>3. include protocols to measure the indicators of flora and vegetation health including duration, timing and frequency.</li> </ol>	Section 3.1
10-3	Prior to commencement of construction, the proponent shall report the results of the Baseline Flora and Vegetation Survey required under condition 10-2 to the CEO.	Appendix 4
10-4	Prior to commencement of construction, the proponent shall prepare a Flora and Vegetation Monitoring and Management Plan to the requirements of the CEO, on advice from the Department of Parks and Wildlife. The Flora and Vegetation Monitoring and Management Plan shall: <ol style="list-style-type: none"> <li>1. when implemented, substantiate whether the requirements of conditions 10-1 are being met;</li> <li>2. include the location of impact and reference vegetation condition plots;</li> <li>3. include protocols for monitoring the indicators as identified in condition 10-2(2);</li> <li>4. determine the trigger levels for the indicators of flora and vegetation condition to apply to the area immediately outside the 'zone of indirect impacts';</li> <li>5. include protocols for monitoring flora and vegetation condition against the triggers levels identified in condition 10-4(4);</li> <li>6. identify management and contingency measures, including timeframes for their implementation, to be implemented in the event that trigger levels identified under condition 10-4(4) are not being met; and</li> <li>7. include a Vegetation Rehabilitation Plan consistent with the Rehabilitation Strategy – Roe Highway Extension (AECOM) dated 11 July 2012 for areas that have been temporarily cleared within the development envelope.; and</li> <li>8. determine the timing and frequency of reporting to the CEO.</li> </ol>	N/A
		Section 3 & 4
		Section 3.2.1 & Figure 2
		Section 3
		Section 4
		Section 3 & 4
		Section 4
		Appendix 3
		Section 5

Condition	Requirement	Section
10-9	In the event that the monitoring indicates that the trigger criteria specified in the Flora and Vegetation Monitoring and Management Plan have been exceeded the proponent shall: <ol style="list-style-type: none"> <li>1. immediately implement the management and/or contingency actions specified in the Flora and Vegetation Monitoring and Management Plan and continue implementation of those actions until the trigger criteria are being met, or until the CEO has confirmed by notice in writing that it has been demonstrated that the outcome in condition 10-1 is being and will continue to be met and implementation of the management and/or contingency actions is no longer required;</li> <li>2. investigate to determine the likely cause of the trigger criteria being exceeded and to identify any additional contingency actions required to prevent the trigger criteria being exceeded in the future; and</li> <li>3. provide a report to the CEO within seven days of an event, referred to in condition 10-9, occurring. The report shall include: <ol style="list-style-type: none"> <li>a. details of management and/or contingency actions implemented; and</li> <li>b. the findings of the investigation required by condition 10-9(2).</li> </ol> </li> </ol>	Table 4 & Section 6.2
10-10	The proponent shall submit the monitoring results required by condition 10-4, referenced against the environmental quality objective specified in condition 10-1 and the trigger levels specified in condition 10-4(4), to the CEO as part of the annual compliance reporting required by condition 4.	Section 6.2 and 7
10-11	The Flora and Vegetation Monitoring and Management Plan required by condition 10-4 shall be made publicly available in a manner approved by the CEO.	Section 1.2.3

### 1.2.2 Previous documentation

This FVMMP also includes commitments and management actions for flora and vegetation as outlined in the following documents:

- PER and relevant appendices (South Metro Connect 2011)
- Response to Submissions and relevant appendices (South Metro Connect 2013)
- EPA assessment report 1489 (EPA 2013)
- Flora, Vegetation and Fauna Management Plan (AECOM 2012a)
- Rehabilitation Strategy (AECOM 2012b).

### 1.2.3 Objectives

The EPA's environmental objective for flora and vegetation is to maintain representation, diversity, viability and ecological function at the species and community level.

The environmental objectives of this FVMMP are to:

- ensure compliance with Statement 1008 condition 10 outlined above
- reduce and minimise the impacts of construction activities on vegetation
- ensure no ongoing detectable impacts from the Project during operation on vegetation communities outside the 'zone of indirect impacts' area
- rehabilitate all temporary disturbed areas not required for permanent infrastructure within the development envelope .

To meet these objectives a VRP has also been prepared and included in Appendix 3.

This plan will be made publically available in a manner approved by the Chief Executive Officer (CEO) of the OEPA.

### 1.3 Relationship to management plans required by Ministerial Statement 1008

In addition to the preparation of the FVMMP, Statement 1008 also requires the preparation of:

- a Baseline Flora and Vegetation Condition Survey (FVCS, Condition 10-2), including monitoring of the pre-development flora and vegetation conditions directly outside of the 'zone of indirect and within reference sites
- a Baseline Wetland Condition Survey and Baseline Basin Monitoring (BWCS, Condition 9-2 and 8-3), including monitoring of the pre-development surface and groundwater conditions within and adjacent to North Lake, Bibra Lake and Roe Swamp and baseline monitoring adjacent to drainage basins
- a Wetlands Monitoring and Management Plan (WMMP, Condition 9-4) to undertake ongoing monitoring of surface and groundwater conditions within and adjacent to the Wetlands
- a Drainage Monitoring and Management Plan (DMMP, Condition 8-2) to manage drainage around the development envelope.

The FVMMP is designed to work with the FVCS, BWCS, WMMP and the DMMP to provide an integrated vegetation health monitoring and management program.

In addition, a number of plans were produced during the EPA assessment process, which is also relevant to this plan. These include:

- Flora, Vegetation and Fauna Management Plan which details actions for the project in order to minimise and manage impacts on flora, vegetation and fauna during construction
- Rehabilitation Strategy which provides an overarching framework to guide the VRP.

### 1.4 Consultation

As part of the preparation of the FVMMP, consultation with various stakeholders has been undertaken as detailed Table 2.

Table 2: Stakeholder consultation

Stakeholder	Date	Outcome
Department of Parks and Wildlife	27 July 2015	The Scope of Works for the Baseline Flora and Vegetation Survey was provided to DPaW for comment and comments were received from DPaW on the 27 July 2015. The VPMMP has been updated to address relevant comments.
	25 August 2015	The FVMMP was provided to DPaW for comment and comments were received from DPaW on the 25 August 2015. The FVMMP has been updated to address relevant comments.
Office of the Environmental Protection Authority	2 September 2015	The Scope of Works for the Baseline Flora and Vegetation Survey was provided to OEPA for comment and comments were received from OEPA on the 2 September 2015. The FVMMP has been updated to address relevant comments.



## 2. Project description

### 2.1 Project activities

Construction of the Project is described in the PER (South Metro Connect 2011) as requiring the following key activities:

- construction of road formation and associated infrastructure including, road drainage basins, principal Shared Paths (pedestrian and cycle paths), retaining walls, fauna underpasses and culverts, bridges and overpasses and noise attenuation walls
- installation of street and PSP lighting
- realignment of a short section of Murdoch Drain
- rehabilitation of areas disturbed for construction.

Operation of the proposed Project will result in the following key activities:

- freight transport
- private and commercial vehicle movements
- operation of street lighting
- maintenance.



**Figure 1: Project development envelope**

Scale 1:30,000 at A4  
 0 200 400 600 800 1,000 Meters  
 Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 3/12/2015  
 Author: DWhite  
 Source: Aerial image: ESRI, approx. 2010; Client 2015; Wetlands: DPaw 2015.



**Legend**

- Project development envelope
- Proposed construction footprint
- Wetlands





### 3. Monitoring Program

The FVMMP has been developed in order to monitor and manage the potential indirect impacts of the Project on vegetation health outside the zone of indirect impact. The potential direct and indirect impacts of the Project on flora and vegetation have been assessed by the EPA (EPA 2013), and the potential impacts on vegetation health that are to be managed as part of this plan are summarised below:

- localised indirect hydrological changes due to compaction outside the 10 m zone of indirect impact
- edge effects such as shading, dust and weeds outside the 10 m zone of indirect impact.

Monitoring and management actions to avoid, minimise, reduce and rectify these impacts are addressed in section 3 and 4.

This plan provides an ongoing monitoring program, identifies trigger levels whereby contingency actions are to be considered, and defines contingencies in case an impact occurs.

To achieve this, this plan details:

1. The methodology for a baseline flora and vegetation survey (Section 3.1).
2. The methodology for an ongoing flora and vegetation monitoring program (Section 3.2).
3. Proposed trigger levels (Section 4.1).
4. Contingency actions to be undertaken if an impact occurred as a result of the Project (Section 4.2).

#### 3.1 Baseline flora and vegetation survey

A baseline flora and vegetation survey is required under condition 10-2 of Statement 1008 dated 2 July 2015. Consistent with Statement 1008 the baseline flora and vegetation survey has been completed. The baseline survey provides information on flora and vegetation health prior to the commencement of construction which will feed into the ongoing monitoring program. The methodology of the ongoing monitoring program described below has been updated to be consistent with the baseline survey. The results of the baseline surveys will also be provided to the OEPA.

#### 3.2 Ongoing monitoring program

The ongoing monitoring program covers monitoring of flora and vegetation health in order to:

- determine if changes are occurring to these factors through routine monitoring
- assess whether any changes are due to the Project or external/natural factors.

The methodology and parameters for ongoing monitoring is proposed to be consistent with the baseline survey to enable accurate comparisons.

##### 3.2.1 Monitoring sites

Ongoing monitoring will be undertaken within the 'buffer area' and within the 'reference area' as depicted in Figure 2. The 'buffer area' comprises a 15 m wide 'band' occurring immediately outside the 'zone of indirect impacts' while the 'reference sites will be located outside the 'buffer area' and further from the 'zone of indirect impacts'. Degraded and non-native vegetation communities were excluded from the ongoing monitoring program.

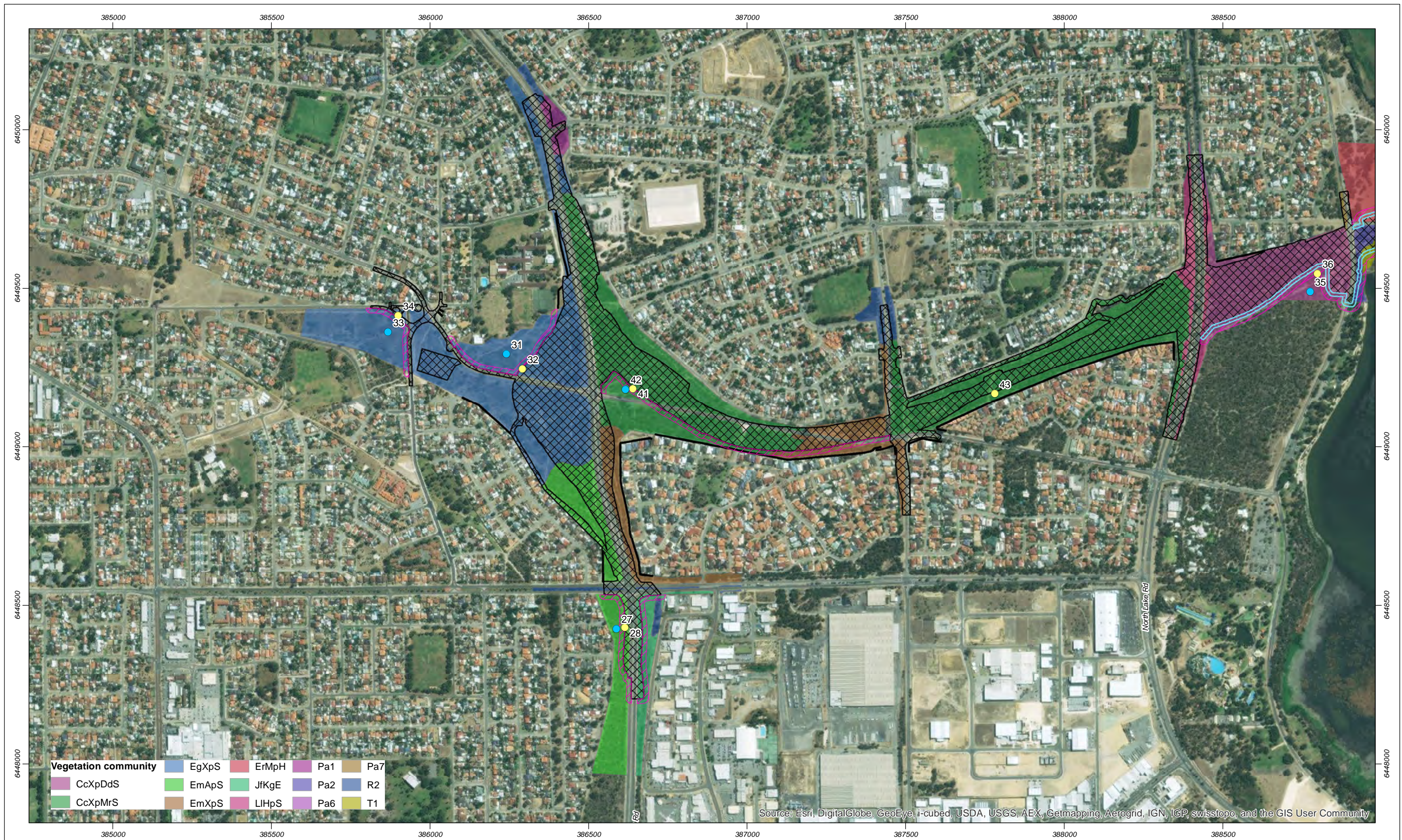
Due to the different sizes of each vegetation communities to be monitored, varying numbers of monitoring sites will be established within each community type as outlined in Table 3. The location of each vegetation monitoring site within these vegetation communities, is indicated on Figure 2 and the details of these monitoring location are provided in Appendix 1. These locations have been refined based on the results of the baseline survey. Each monitoring site will contain:

- one vegetation monitoring plot
- a soil moisture sampling point.

Table 3: Numbers of monitoring sites per vegetation community

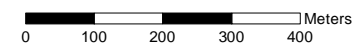
Vegetation community	Number of buffer sites	Number of reference sites	Upland or wetland vegetation
BaNfW	1	0	Upland
BaTs	2	2	Upland
BiSiH	1	1	Wetland
BXpW	2	2	Upland
CcBKgS	2	2	Upland
CcXpDdS	1	1	Upland
CcXpMrS	2	1	Upland
EgXpS	2	2	Upland
EmApS	1	1	Upland
EmKgS	0	1	Wetland
ErCtS	1	2	Wetland
ErMpAfS	2	2	Upland
ErMpGeS	1	0	Upland
ErMpH	1	1	Upland
EtKgS	1	1	Wetland
MpBaS	1	2	Wetland
MpKgS	1	1	Upland
<b>Total</b>	<b>22</b>	<b>22</b>	





**Figure 2: Proposed baseline monitoring sites - Section 1**

Scale 1:11,000 at A3



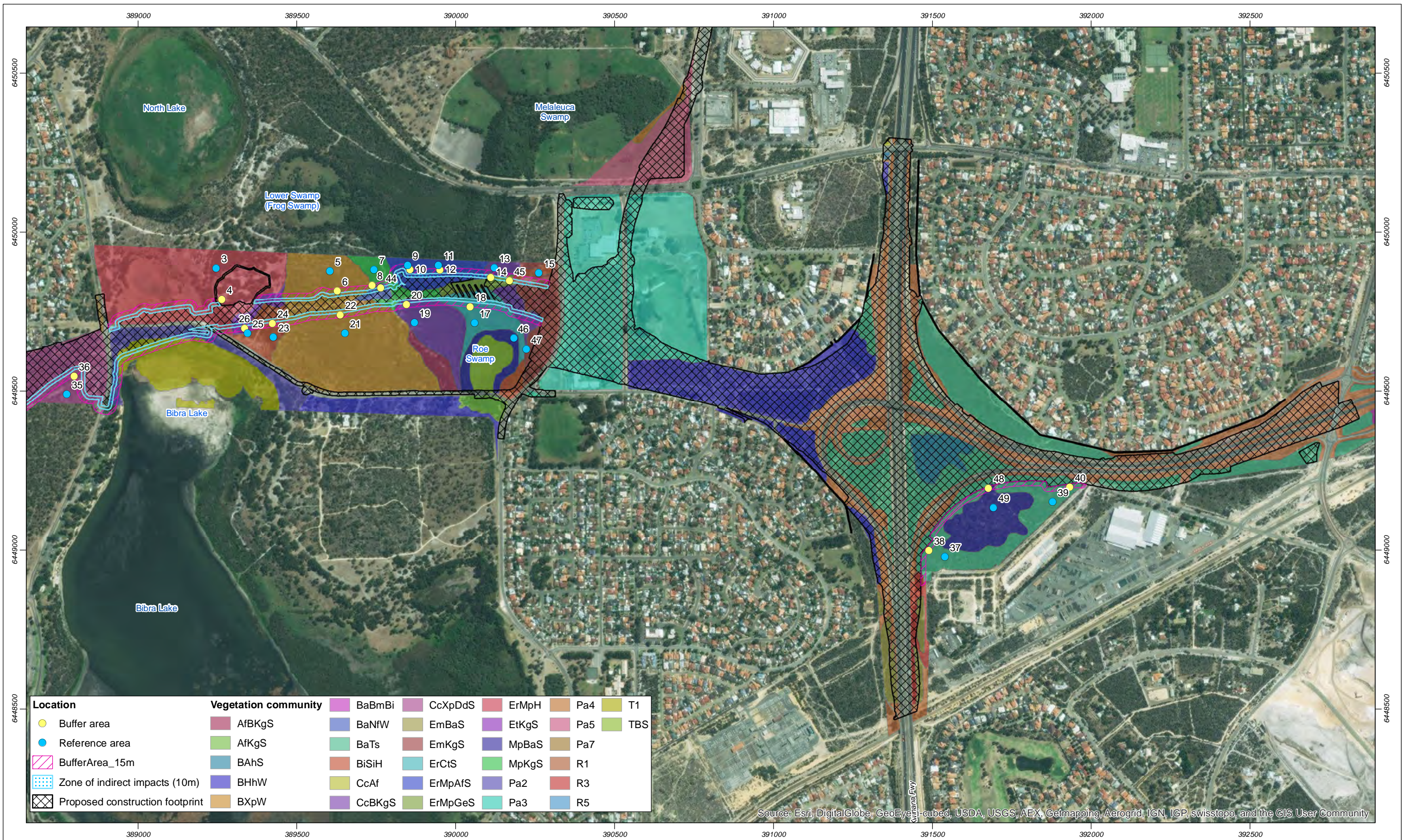
Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 8/12/2015  
 Author: DWhite

Source: Aerial image: ESRI, approx. 2010; Construction footprint: Client 2015.  
 Path: Q:\Consult\2015\MRO\MRO15099\ArcMap\_documents\MRO15099\_07\R0011\Rev 1\MRO15099\_06 R001 Rev1 F002\_A3.mxd

**Legend**

- Buffer area
- Reference area
- Zone of indirect impacts (10m)
- Buffer areas (15m)
- Proposed construction footprint





**Figure 3: Proposed baseline monitoring sites - Section 2**

Scale 1:11,000 at A3  
 0 100 200 300 400 Meters



Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 8/12/2015  
 Author: DWhite  
 Source: Aerial image: ESRI, approx. 2010; Construction footprint: Client 2015.  
 Path: Q:\Consult\2015\MRO\MRO15099\ArcMap\_documents\MRO15099\_07\R0011\Rev 1\MRO15099\_06 R001 Rev2 F003\_A3.mxd



### 3.2.2 Monitoring methodology

#### *Vegetation*

Vegetation monitoring sites will be permanently established and marked by recording locations with a GPS unit. Each vegetation monitoring site will contain one 10 x 10 m quadrat. Data collected from within the quadrat will include:

- GPS location
- vegetation composition
- plant density (plants/m<sup>2</sup>)
- plant/weed foliage cover (%)
- vegetation condition
- visual observation of plant health of indicator species
- a photograph taken at a designated point that can be compared to subsequent and/or previous photographs, to assess visible progress in maturing vegetation growth and visual aesthetics.

The indicative locations of each vegetation monitoring site within the vegetation communities are indicated on Figure 2 and defined in Appendix 1. These locations have been refined based on the baseline survey.

All flora species occurring within monitoring quadrats will be identified. Flora species that are unidentifiable in the field will be systematically collected, pressed, dried and fumigated in accordance with the requirements of the West Australian Herbarium. These plant species will be identified via comparison with pressed specimens housed at the herbarium, and using taxonomic keys and other references.

Vegetation condition will be determined using the measurements taken in each quadrat (i.e. percentage increase in weed cover and potential decrease in native vegetation cover). This will also consider disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure, site ecology and other relating factors.

Vegetation health will be determined by data collected from the monitoring plots. This will include observation of the wetland and/or groundwater dependant taxa that are considered to be indicator species. Indicator species are presented in Appendix 2 and these are based on species observed as key species during the baseline survey. Vegetation composition, plant density and foliage cover will indicate if native plants are declining in occupied area which could potentially indicate vegetation stress and decline. Soil moisture sampling as described below will identify if any potential decline in vegetation health can be attributed to changes in groundwater.

#### *Soil moisture*

Vegetation may obtain water from groundwater, unsaturated soil above the groundwater table or a mixture of both. Therefore any potential reduction in available water within the soil has the potential to impact the health of vegetation.

Soil moisture has the potential to be highly variable from one event to another, however when monitored over time the data may provide an indication of trends that allow comparison between the development envelope and reference sites.

Soil moisture content in the unsaturated zone can be affected by a number of factors including:

- soil type (coarse grained sandy soils are less effective at holding moisture than clayey soils)
- depth to groundwater (soil below the groundwater table is saturated, while soils above this display varying soil moisture contents)
- water inputs to soil, through precipitation or irrigation
- plant water uptake.

Soil moisture samples shall be taken from an approximate depth of 1 m within each vegetation monitoring plot. The sampling process will consist of:

- obtaining a soil sample from an approximate depth of 1 m using an appropriate soil core sampler
- placing the sample in a sealed bag (with as much air as possible removed)
- placing the sealed bag inside another similarly sealed bag
- analysis for soil moisture at a NATA accredited laboratory.

Soil corers shall be of a small diameter (maximum diameter 50 mm) to limit impacts to plant roots. Soil moisture samples shall be kept cool during transport to prevent evaporation.

Duplicate samples shall be taken at a rate of one duplicate sample per ten holes.

### **3.2.3 Timing**

Prior to commencement of construction, the proponent shall implement the approved FVMMP, and continue implementation until otherwise agreed by the CEO.

The timing of vegetation monitoring will include:

- vegetation and flora baseline survey in spring prior to commencement of construction
- ongoing vegetation monitoring in spring during construction
- ongoing vegetation monitoring in spring for five years post construction.

Soil moisture sampling will be undertaken at the same time as vegetation data is collected.

## 4. Management

Management actions may be necessary in the event that monitoring indicates a change in vegetation health outside of the “zone of indirect impacts”, potentially caused by the Project. Indirect impacts may include edge effects, increased dispersal of weeds, dust and changes to hydrological processes.

### 4.1 Proposed triggers

Triggers for the implementation of management actions will be based on the comparison of baseline flora and vegetation data to the ongoing monitoring of buffer sites and reference sites. Following each monitoring round, the data will be reviewed to determine whether the following trigger event has occurred:

- a differential change of 10% in foliage cover, plant condition and/or plant density compared with baseline and reference sites
- a increase of 10% in weed cover and/or density compared with baseline and reference sites.

### 4.2 Contingency actions

Should the trigger be exceeded, a decision-making process would be followed to determine if the trigger event is considered a result of the Project and whether a contingency action is required to be implemented (Table 4). Contingency actions will be undertaken in accordance with condition 10-9, and as outlined in Table 4. All contingency actions undertaken shall be documented in the annual compliance report.

Table 4: Vegetation triggers and contingency actions

Trigger	Potential contingency action
Evidence of a differential change of 10% in foliage cover, plant condition and/or plant density in the buffer area relative to baseline and reference sites.	<ol style="list-style-type: none"> <li>1. Identify potential cause, which could include:               <ol style="list-style-type: none"> <li>a. Change to hydrological processes – review soil moisture and review available groundwater data (as per the DMMP and WMMP) to determine whether the overall groundwater levels have changed</li> <li>b. Edge effects such as shading and dust emissions.</li> </ol> </li> <li>2. Implement remedial action as related to identified potential causes:               <ol style="list-style-type: none"> <li>a. Hydrological processes - review of the water management system including drainage and bore abstraction</li> <li>b. Edge effects - review current construction practices against CEMP and implement contingencies accordingly</li> <li>c. Commence revegetation of impacted areas.</li> </ol> </li> <li>3. As per condition 10-9 provide a report to the CEO within seven days of an event which will include:               <ol style="list-style-type: none"> <li>a. Details of management and/or contingency actions implemented</li> <li>b. The findings of investigations to determine likely cause.</li> </ol> </li> <li>4. Continue monitoring vegetation responses and the effectiveness of remedial actions.</li> </ol>

Trigger	Potential contingency action
Evidence of a differential change of 10% in indicator species plant health relative to baseline and reference sites.	<ol style="list-style-type: none"> <li>1. Identify potential cause, which could include:               <ol style="list-style-type: none"> <li>a. Change to hydrological processes – review soil moisture and review available groundwater data (as per the DMMP and WMMP) to determine whether the overall groundwater levels have changed</li> <li>b. Edge effects such as shading and dust emissions.</li> </ol> </li> <li>2. Implement remedial action as related to identified potential causes:               <ol style="list-style-type: none"> <li>a. Hydrological processes - review of the water management system including drainage and bore abstraction</li> <li>b. Edge effects - review current construction practices against CEMP and implement contingencies accordingly</li> <li>c. Commence revegetation of impacted areas.</li> </ol> </li> <li>3. As per condition 10-9 provide a report to the CEO within seven days of an event which will include:               <ol style="list-style-type: none"> <li>a. Details of management and/or contingency actions implemented</li> <li>b. The findings of investigations to determine likely cause.</li> </ol> </li> <li>4. Continue monitoring vegetation responses and the effectiveness of remedial actions.</li> </ol>
Evidence of an increase of 10% in weed cover and/or density compared with baseline and reference sites.	<ol style="list-style-type: none"> <li>1. Identify cause.</li> <li>2. Implement remedial action which could include weed control, revegetation, contractor re-education.</li> <li>3. As per condition 10-9 provide a report to the CEO within seven days of an event which will include:               <ol style="list-style-type: none"> <li>a. Details of management and/or contingency actions implemented</li> <li>b. The findings of investigations to determine likely cause.</li> </ol> </li> <li>4. Continue monitoring vegetation responses and the effectiveness of remedial actions.</li> </ol>



## 5. Responsibilities

This section provides a summary of the key personnel involved in implementation of the FVMMP and their roles and responsibilities.

Table 5: Roles and responsibilities

Role	Responsibility
Main Roads	<ul style="list-style-type: none"> <li>• Main Roads has the overall responsibility for the implementation of this FVMMP</li> <li>• the roles below may be delegated to a contractor by Main Roads</li> <li>• if the roles are delegated, Main Roads has the responsibility to audit compliance and ensure any contingency actions are implemented.</li> </ul>
Environmental manager	<ul style="list-style-type: none"> <li>• overall accountability for auditing and compliance assessment with this FVMMP to ensure it is maintained and meets objectives and targets</li> <li>• provide technical support to all Project personnel to ensure this FVMMP is implemented correctly and complied with</li> <li>• implement and maintain this FVMMP, review its effectiveness and review the implementation as required</li> <li>• undertaking ongoing monitoring and documenting monitoring results</li> <li>• assess the performance against triggers</li> <li>• liaise with stakeholders and technical advisors for advice and resolution of management aspects/objectives as required</li> <li>• review and close out any contingency actions</li> <li>• report as required to regulating authorities</li> <li>• may delegate all or part responsibility to an appropriately qualified person</li> <li>• providing data to Main Roads for inclusion in the annual compliance report.</li> </ul>
Contractors	<ul style="list-style-type: none"> <li>• support the proponent's flora and vegetation management initiative and culture</li> <li>• comply with all legal requirements and the requirements of this FVMMP</li> <li>• ensure staff employed are adequately trained in flora and vegetation management</li> <li>• ensure all personnel involved in the project will adhere to FVMMP requirements</li> <li>• seek advice from proponent when in doubt about requirements.</li> </ul>
All personnel	<ul style="list-style-type: none"> <li>• must receive induction prior to commencement of work on site</li> <li>• comply with all legal requirements and the requirements of this FVMMP</li> <li>• report flora and vegetation incidents to their Supervisor or Site Environmental Coordinator</li> <li>• attend environmental inductions and any other training required on flora and vegetation management</li> <li>• participate in toolbox meetings and suggest improvements to flora and vegetation management.</li> </ul>

## **6. Review and reporting**

### **6.1 Review and revision**

The FVMMP will be reviewed on an annual basis to ensure that the plan takes into consideration amendments to operations, monitoring results, audits, continuous improvement and changes in regulatory and corporate requirements. Any proposed amendments to the plan will be undertaken in accordance with condition 10-6, 10-7 and 10-8 and provided to the CEO of the OEPA for approval prior to implementation.

### **6.2 Reporting**

A monitoring report will be prepared after each monitoring event, summarising the results produced prior to the preparation of the Annual Compliance Report.

## 7. Auditing

Auditing of the FVMMP shall be conducted in accordance with Main Roads Corporate Procedure 6707/044 Environmental Auditing.

Internal audits will be undertaken once a year during construction, and compliance audits will be undertaken annually during construction and annually for the first five years of operation.

An annual compliance report, detailing the results of the compliance audit, shall be provided to the CEO of the OEPA and the DPaW.

The Annual Compliance Report will include:

- climate and rainfall information
- demonstration of compliance with maintenance requirements
- documentation of monitoring undertaken
- comparison of monitoring results to trigger values
- documentation of any contingency actions undertaken.

## 8. References

- AECOM 2009, *Flora and Vegetation Spring Survey 2009*, prepared by AECOM for the Department of Main Roads.
- AECOM 2010, *Kwinana Freeway Third Lane: Flora and Fauna Survey*. Report prepared for Main Roads Western Australia.
- AECOM 2011, *Roe Highway Extension Kwinana Freeway to Stock Road: Vegetation and Flora Assessment Phase 2*. Report prepared for Main Roads Western Australia.
- AECOM 2012a, *Roe Highway Extension Flora, Vegetation and Fauna Management Plan*, report prepared for Main Roads Western Australia, 12 July 2012.
- AECOM 2012b, *Roe Highway Extension Rehabilitation Strategy*, prepared by AECOM for South Metro Connect Western Australia, 11 July 2012.
- Environmental Protection Authority (EPA) 2004, *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51* Environmental Protection Authority, Perth, Western Australia.
- Environmental Protection Authority (EPA) 2013, *Report and recommendations of the Environmental Protection Authority: Roe highway Extension*, Environmental Protection Authority, Perth.
- Hedde EM, Loneragan OW and Havel JJ 1980, *Darling System, Vegetation Complexes*, Forest Department, Perth.
- Keighery, BJ 1994, *Bushland Plant Survey – A Guide to Plant Community Survey for the Community Wildflower Society of WA (inc)*, Nedlands WA.
- South Metro Connect 2011, *Roe Highway Extension Public Environmental Review*, prepared for Main Roads Western Australia, 20 June 2011.
- South Metro Connect 2013, *Roe Highway Extension Response to Public Submissions*, prepared for Main Roads Western Australia, 31 May 2013.

**Appendix 1**  
**Monitoring sites**



Site ID	Location	Coordinates		Vegetation community
		Eastings	Northings	
3	Reference area	389246.5	6449886.6	ErMpH
4	Buffer area	389263.5	6449787.7	ErMpH
5	Reference area	389604.2	6449877.4	BXpW
6	Buffer area	389627.1	6449814.6	BXpW
7	Reference area	389742.9	6449881.9	MpKgS
8	Buffer area	389737	6449832.5	MpKgS
9	Reference area	389848.9	6449896.1	ErMpAfS
10	Buffer area	389856.4	6449881.7	ErMpAfS
11	Reference area	389945.9	6449896	ErMpAfS
12	Buffer area	389950.5	6449880.9	ErMpAfS
13	Reference area	390121.4	6449887.8	CcBKgS
14	Buffer area	390110.7	6449857	CcBKgS
15	Reference area	390261.5	6449871.4	EmKgS
17	Reference area	390059.2	6449714.5	ErCtS
18	Buffer area	390045.3	6449764.5	ErCtS
19	Reference area	389870	6449714.9	CcBKgS
20	Buffer area	389844.9	6449771.5	CcBKgS
21	Reference area	389651.8	6449681.2	BXpW
22	Buffer area	389636.4	6449739.5	BXpW
23	Reference area	389426.4	6449669.7	BiSiH
24	Buffer area	389423.3	6449712.4	BiSiH
25	Reference area	389344.9	6449681.6	EtKgS
26	Buffer area	389335.8	6449697.5	EtKgS
27	Reference area	386588.3	6448425.5	EmApS
28	Buffer area	386615.1	6448430.2	EmApS
31	Reference area	386241.8	6449292.3	EgXpS
32	Buffer area	386292.1	6449244.8	EgXpS
33	Reference area	385868.2	6449361.2	EgXpS
34	Buffer area	385899.5	6449412.9	EgXpS
35	Reference area	388775.8	6449489.4	CcXpDdS
36	Buffer area	388798.7	6449546.2	CcXpDdS
37	Reference area	391539.8	6448978.5	BaTs
38	Buffer area	391489.5	6448998	BaTs

39	Reference area	391878.8	6449151.7	BaTs
40	Buffer area	391933	6449197	BaTs
41	Buffer area	386640	6449183.1	CcXpMrS
42	Reference area	386617	6449180.5	CcXpMrS
43	Buffer area	387780.9	6449166.8	CcXpMrS
44	Buffer area	389764.2	6449824.1	BaNfW
45	Buffer area	390169.1	6449846.3	ErMpGeS
46	Reference area	390183.5	6449666.3	MpBaS
47	Reference area	390222.1	6449631	ErCtS
48	Buffer area	391676.4	6449193.8	MpBaS
49	Reference area	391692.7	6449132.8	MpBaS



**Appendix 2**  
**Indicator species**



Quadrat number	Indicator species	Vegetation community
3	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Melaleuca preissiana</i> <i>Muehlenbeckia adpressa</i>	ErMpH
4	<i>Corymbia calophylla</i> <i>Acacia longifolia</i> <i>Carpobrotus edulis</i> <i>Ehrharta longiflora</i> <i>Ehrharta calycina</i>	ErMpH
5	<i>Eucalyptus marginata</i> <i>Banksia attenuata</i> <i>Macrozamia fraseri</i> <i>Acacia pulchella</i> var. <i>glaberrima</i> <i>Hibbertia hypericoides</i>	BXpW
6	<i>Banksia menziesii</i> <i>Banksia attenuata</i> <i>Acacia pulchella</i> var. <i>glaberrima</i> <i>Kunzea glabrescens</i> <i>Hibbertia hypericoides</i>	BXpW
7	<i>Banksia attenuata</i> <i>Banksia menziesii</i> <i>Kunzea glabrescens</i> <i>Macrozamia fraseri</i> <i>Hibbertia hypericoides</i> <i>Dasypogon bromeliifolius</i>	MpKgS
8	<i>Banksia ilicifolia</i> <i>Banksia attenuata</i> <i>Nuytsia floribunda</i>	MpKgS
9	<i>Melaleuca preissiana</i> <i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Baumea articulata</i> <i>Pteridium esculentum</i> subsp. <i>esculentum</i> <i>Baumea</i> sp. <i>Baumea juncea</i>	ErMpAfS
10	<i>Melaleuca preissiana</i> <i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Pteridium esculentum</i> subsp. <i>esculentum</i>	ErMpAfS
11	<i>Melaleuca raphiophylla</i> <i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Taxandria linearifolia</i> <i>Baumea</i> sp. <i>Baumea articulata</i> <i>Pteridium esculentum</i> subsp. <i>esculentum</i>	ErMpAfS
12	<i>Melaleuca preissiana</i> <i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Pteridium esculentum</i> subsp. <i>esculentum</i> <i>Leucopogon australis</i> <i>Baumea</i> sp. <i>Tetraria</i> sp. <i>Chandala</i>	ErMpAfS

Quadrat number	Indicator species	Vegetation community
13	<i>Corymbia calophylla</i> <i>Kunzea glabrescens</i> <i>Macrozamia fraseri</i> <i>Xanthorrhoea preissii</i>	CcBKgS
14	<i>Corymbia calophylla</i> <i>Hibbertia racemosa</i> <i>Macrozamia fraseri</i> <i>Kunzea glabrescens</i> <i>Lepidosperma calcicola</i> <i>Dianella revoluta</i> var. <i>divaricata</i>	CcBKgS
15	<i>Banksia menziesii</i> <i>Allocasuarina fraseriana</i>	EmKgS
17	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Corymbia calophylla</i> <i>Pteridium esculentum</i> subsp. <i>esculentum</i> <i>Astartea scoparia</i> <i>Baumea</i> sp. <i>Dampiera triloba</i>	ErCtS
18	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Melaleuca preissiana</i> <i>Banksia littoralis</i> <i>Taxandria linearifolia</i> <i>Astartea scoparia</i> <i>Baumea</i> sp. <i>Dampiera triloba</i> <i>Baumea</i> sp.	ErCtS
19	<i>Banksia menziesii</i> <i>Nuytsia floribunda</i> <i>Xanthorrhoea preissii</i>	CcBKgS
20	<i>Nuytsia floribunda</i> <i>Kunzea glabrescens</i>	CcBKgS
21	<i>Banksia menziesii</i> <i>Eucalyptus marginata</i> <i>Banksia attenuata</i> <i>Xanthorrhoea preissii</i> <i>Macrozamia fraseri</i> <i>Acacia pulchella</i> var. <i>glaberrima</i> <i>Hibbertia hypericoides</i> <i>Desmocladius flexuosus</i>	BXpW
22	<i>Banksia attenuata</i> <i>Eucalyptus marginata</i> <i>Banksia menziesii</i> <i>Xanthorrhoea preissii</i> <i>Hibbertia hypericoides</i>	BXpW
23	<i>Kunzea glabrescens</i>	BiSiH
24	<i>Kunzea glabrescens</i>	BiSiH
25	<i>Kunzea glabrescens</i>	EtKgS
26	<i>Eucalyptus rudis</i> subsp. <i>rudis</i> <i>Kunzea glabrescens</i>	EtKgS

Quadrat number	Indicator species	Vegetation community
27	<i>Banksia attenuata</i> <i>Eucalyptus marginata</i> <i>Banksia menziesii</i> <i>Xanthorrhoea preissii</i> <i>Acacia pulchella</i> var. <i>glaberrima</i> <i>Mesomelaena pseudostygia</i>	EmApS
28	<i>Banksia attenuata</i> <i>Banksia menziesii</i> <i>Jacksonia furcellata</i> <i>Daviesia triflora</i> <i>Xanthorrhoea preissii</i> <i>Hibbertia hypericoides</i>	EmApS
31	<i>Banksia menziesii</i> <i>Allocasuarina fraseriana</i> <i>Xanthorrhoea preissii</i>	EgXpS
32	<i>Eucalyptus marginata</i> <i>Xanthorrhoea preissii</i> <i>Macrozamia fraseri</i> <i>Hardenbergia comptoniana</i>	EgXpS
33	<i>Acacia rostelifera</i> <i>Xanthorrhoea preissii</i>	EgXpS
34	<i>Eucalyptus gomphocephala</i> <i>Acacia rostelifera</i>	EgXpS
35	<i>Banksia attenuata</i> <i>Macrozamia fraseri</i> <i>Jacksonia furcellata</i>	CcXpDdS
36	<i>Corymbia calophylla</i> <i>Banksia grandis</i> <i>Eucalyptus marginata</i> <i>Macrozamia fraseri</i> <i>Jacksonia furcellata</i> <i>Hibbertia hypericoides</i>	CcXpDdS
37	<i>Banksia attenuata</i> <i>Banksia menziesii</i> <i>Xanthorrhoea preissii</i> <i>Regelia inops</i> <i>Melaleuca thymoides</i> <i>Hibbertia hypericoides</i> <i>Schoenus subfascicularis</i> <i>Patersonia occidentalis</i>	BaTs
38	<i>Banksia menziesii</i> <i>Xanthorrhoea preissii</i> <i>Beaufortia elegans</i> <i>Hibbertia hypericoides</i> <i>Dasyogon bromeliifolius</i> <i>Conostephium pendulum</i>	BaTs

Quadrat number	Indicator species	Vegetation community
39	<i>Banksia attenuata</i> <i>Banksia menziesii</i> <i>Allocasuarina humilis</i> <i>Beaufortia elegans</i> <i>Acacia pulchella</i> var. <i>glaberrima</i> <i>Hibbertia hypericoides</i> <i>Mesomelaena pseudostygia</i> <i>Stirlingia latifolia</i>	BaTs
40	<i>Banksia attenuata</i> <i>Banksia menziesii</i> <i>Nuytsia floribunda</i> <i>Allocasuarina humilis</i> <i>Melaleuca thymoides</i> <i>Jacksonia furcellata</i> <i>Hibbertia hypericoides</i> <i>Stirlingia latifolia</i> <i>Eremaea pauciflora</i>	BaTs
41	<i>Banksia attenuata</i> <i>Allocasuarina fraseriana</i> <i>Xanthorrhoea preissii</i> <i>Jacksonia furcellata</i> <i>Gompholobium tomentosum</i>	CcXpMrS
42	<i>Eucalyptus marginata</i> <i>Allocasuarina fraseriana</i> <i>Xanthorrhoea preissii</i> <i>Hakea prostrata</i> <i>Schoenus clandestinus</i>	CcXpMrS
43	<i>Corymbia calophylla</i> <i>Eucalyptus marginata</i> <i>Banksia attenuata</i> <i>Xanthorrhoea preissii</i> <i>Xylomelum occidentale</i> <i>Daviesia nudiflora</i> <i>Hibbertia hypericoides</i>	CcXpMrS
44	<i>Nuytsia floribunda</i>	BaNfW
45	<i>Banksia ilicifolia</i> <i>Kunzea glabrescens</i> <i>Xanthorrhoea preissii</i> <i>Desmocladius asper</i> <i>Dasyogon bromeliifolius</i>	ErMpGeS
46	<i>Melaleuca raphiophylla</i> <i>Melaleuca teretifolia</i> <i>Baumea</i> sp. <i>Baumea articulata</i>	MpBaS
47	<i>Melaleuca teretifolia</i> <i>Baumea</i> sp. <i>Cycnogeton huegelii</i>	ErCtS

Quadrat number	Indicator species	Vegetation community
48	<i>Banksia menziesii</i> <i>Banksia attenuata</i> <i>Xanthorrhoea preissii</i> <i>Allocasuarina humilis</i> <i>Jacksonia furcellata</i> <i>Hibbertia hypericoides</i> <i>Conostephium pendulum</i> <i>Lyginia imberbis</i>	MpBaS
49	<i>Eucalyptus gomphocephala</i> <i>Eucalyptus marginata</i> <i>Macrozamia fraseri</i> <i>Xanthorrhoea preissii</i> <i>Banksia attenuata</i> <i>Schoenus grandiflorus</i> <i>Desmocladius flexuosus</i>	MpBaS





**Appendix 3**  
**Vegetation Rehabilitation Plan**





intelligent outcomes | respected experience

# Roe Highway Extension

## Vegetation Rehabilitation Plan

Prepared for  
Main Roads  
by Strategen

December 2015



# **Roe Highway Extension**

## **Vegetation Rehabilitation Plan**

Strategen is a trading name of  
Strategen Environmental Consultants Pty Ltd  
Level 1, 50 Subiaco Square Road Subiaco WA 6008  
ACN: 056 190 419

December 2015

## ***Limitations***

### **Scope of services**

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

### **Reliance on data**

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

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

### **Environmental conclusions**

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

## **Client: Main Roads**

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	A	For client review	D White, A Welker/ D Panickar, D Newsome	Electronic	15 May 2015
Draft Report	B	For client approval	D White / A Welker, D Goundrey	Electronic	2 July 2015
Final Draft Report	0	To submit to DPaW	D White/A Welker	Electronic	29 July 2015
Final Report	0	To submit to OEPA	D White/A Welker	Electronic	19 September 2015
Final Report	D	Client review	D White/A Welker, D Goundrey	Electronic	11 December 2015
Final Revised Report	1	To submit to OEPA	A Welker/ D Goundrey	Electronic	17 December 2015

Filename: MRO15099\_07 R002 Rev 1 - 17 December 2015

## Table of contents

<b>1. Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Purpose and scope of document	1
1.2.1 Statement 1008	1
<b>2. Existing environment</b>	<b>4</b>
2.1 Flora and vegetation	4
2.1.1 Regional	4
2.1.2 Previous studies	4
2.2 Fauna	6
<b>3. Rehabilitation program</b>	<b>7</b>
3.1 Rehabilitation objectives	7
3.2 Performance targets and indicators	1
3.3 Management actions	1
<b>4. Monitoring</b>	<b>5</b>
4.1 Monitoring plots	5
4.2 Rapid assessment areas	5
<b>5. Contingency actions</b>	<b>7</b>
<b>6. Completion criteria</b>	<b>8</b>
<b>7. Roles and responsibilities</b>	<b>9</b>
<b>8. Review and reporting</b>	<b>10</b>
8.1 Review and revision	10
8.1 Reporting	10
<b>9. Auditing</b>	<b>11</b>
<b>10. References</b>	<b>12</b>

## List of tables

Table 1: Vegetation complexes	4
Table 2: Priority Flora within the development envelope	5
Table 3: Vegetation condition within the development envelope	5
Table 4: Rehabilitation treatments	7
Table 5: Targets and indicators for rehabilitation objectives for the Project	1
Table 6: Rehabilitation management actions for temporarily cleared areas	2
Table 7: Monitoring actions	6
Table 8: Contingency actions	7
Table 9: Completion criteria	8

## List of figures

Figure 1: Project development envelope	3
Figure 2: Indicative revegetation areas	1
Figure 3: Rehabilitation treatments	1

## List of appendices

Appendix 1 Proposed planting list





# 1. Introduction

Main Roads Western Australia (Main Roads) proposes to construct the Roe Highway Extension as part of the Perth Freight Link project (the Project, Figure 1). This document outlines the approaches to be implemented for the rehabilitation of areas that have been temporarily disturbed by the Project.

The Project involves the construction of approximately 5 km of highway, extending Roe Highway from its current terminus at the Kwinana Freeway in Jandakot to Stock Road in Coolbellup. The proposed extension to Roe Highway is largely located within a primary regional road reserve which adjoins Beelihar Regional Park.

## 1.1 Background

The Project is located approximately 14 km south of Perth within the Swan Coastal Plain Bioregion. The Project is largely contained within the City of Cockburn, however, parts of the design extend northward in to the City of Melville along Murdoch Drive and Kwinana Freeway. Generally, the proposed Project is oriented east-west largely, within a road reserve that was set aside in the Metropolitan Region Scheme (MRS) in 1963. The alignment is between North and Bibra Lakes, which are part of the Eastern Chain of the Beelihar Wetlands.

The Project will consist of a dual carriageway with two lanes in each direction, separated by a concrete barrier in place of a median strip. The preferred design was selected following an extensive options analysis and consultative process. Once selected, the preferred design was optimised to avoid and minimise environmental impacts to the maximum extent possible.

In 2009 the Project was referred to the Environmental Protection Authority (EPA) under the Environmental Protection Act 1986 (EP Act), and to the then Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), now the Department of the Environment (DotE), under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The Project was set a level of assessment of Public Environmental Review (PER) and the bilateral agreement between the State and Commonwealth governments was enacted. The PER was released on 20 June 2011 for a 12 week public review period.

The Project was approved by the Minister for Environment in 2 July 2015, with the release of Ministerial Statement 1008 (Statement 1008) establishing conditions for the Project implementation

Statement 1008 Condition 10 established a “zone of indirect impacts” which is to contain any potential environmental effects of the Project. Immediately outside the “zone of indirect impacts” there is not to be any detectable adverse effects on flora and vegetation communities. Condition 10 further requires ongoing monitoring in order to monitor potential impacts as well as the implementation of a progressive rehabilitation program for areas within the final Roe Highway road reserve that have been temporarily disturbed for construction.

## 1.2 Purpose and scope of document

### 1.2.1 Statement 1008

This Vegetation Rehabilitation Plan (VRP) has been prepared to satisfy Condition 10-4 (7) of Statement 1008 which requires the Flora and Vegetation Monitoring and Management Plan (FVMMP) to include:

*‘a Vegetation Rehabilitation Plan consistent with the Rehabilitation Strategy – Roe Highway Extension (AECOM) dated 11 July 2012 for areas that have been temporarily cleared within the development envelope’*

Approximately 97.8 ha of native vegetation will be cleared for this project of which approximately 38 ha will be rehabilitated following construction. Indicative areas for revegetation are shown in Figure 2 and Figure 3; however, these areas are subject to detailed design and as such may be altered. This VRP outlines the approaches to be implemented for the rehabilitation of these temporarily disturbed areas, and has been prepared to be consistent with the Rehabilitation Strategy – Roe Highway Extension (AECOM) dated 11 July 2012.





**Figure 1: Project development envelope**

Scale 1:30,000 at A4  
 0 200 400 600 800 1,000 Meters  
 Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 3/12/2015  
 Author: DWhite  
 Source: Aerial image: ESRI, approx. 2010; Client 2015; Wetlands: DPaw 2015.



**Legend**

- Project development envelope
- Proposed construction footprint
- Wetlands





## 2. Existing environment

The PER (South Metro Connect 2011) details the existing environment within the Project development envelope (development envelope). Environmental values of relevance to the management of flora and vegetation are summarised below.

### 2.1 Flora and vegetation

#### 2.1.1 Regional

Regional vegetation mapping within the development envelope and adjacent land indicates the occurrence of four vegetation complexes (Heddle et al. 1980) which are summarised in Table 1.

Table 1: Vegetation complexes

Vegetation complex	Description
Bassendean Complex - Central and South	Woodland of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with well defined second storey of <i>Calytrix fraseriana</i> and <i>Banksia grandis</i> on the deeper soils and a closed scrub on the moister sites. The understorey species reflect similarities with the adjacent vegetation complexes.
Herdsmen Complex	Sedgelands and fringing woodland of <i>Eucalyptus rudis</i> and <i>Melaleuca</i> species.
Karrakatta Complex - Central and South	Predominantly open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> and woodland of <i>Eucalyptus marginata</i> and <i>Banksia</i> species.
Cottesloe Complex - Central and South	Mosaic woodland of <i>Eucalyptus gomphocephala</i> and open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i> ; closed heath on the limestone outcrops.

Source: Heddle et al. (1980)

A Level 2 flora and vegetation survey was undertaken within the development envelope in spring 2009 and spring 2010 (AECOM 2009; 2010) in accordance EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004) to provide preliminary baseline information regarding the flora and vegetation within the development envelope gain. Additional targeted flora surveys were undertaken after the preparation of the PER for the Project. A review of vegetation condition within the development envelope was carried out in accordance with advice from then DEC in March 2012 and it was determined that the condition of some areas of vegetation were under-rated in the original survey (South Metro Connect 2013). Vegetation condition ratings were revised in accordance with a condition rating scale adapted from Keighery (1994) and the Braun-Blanquet scale of cover abundance. Subsequently, the revised portions of the condition mapping were field verified on 16 March 2012. A summary of the results from all flora surveys undertaken for the Project are presented below.

#### 2.1.2 Previous studies

##### *Flora*

A total of 434 species from 244 genera and 80 families were recorded within the project area from the baseline assessment and subsequent seasonal monitoring events. Families with the highest representation were Myrtaceae, Fabaceae, Asteraceae and Poaceae, a floristic composition typical for the Swan Coastal Plain. A total of five Priority flora species were recorded within the development envelope of the project and are displayed in Table 2.

Table 2: Priority Flora within the development envelope

Flora	Priority	% of individuals to be impacted	No. of individuals to be impacted
<i>Dampiera triloba</i>	3	75.8	5404
<i>Cyathochaeta teretifolia</i>	3	6.5	38
<i>Jacksonia gracillima</i>	3	7.5	15
<i>Eryngium pinnatifidum</i> subsp. <i>palustre</i>	3	25.4	16
<i>Dodonaea hackettiana</i>	4	0.5	1

Three declared plant species listed under the *Biosecurity and Agricultural Management Act 2007* were also recorded within the Project area including:

- *Zantedeschia aethiopica* (Arum Lily)
- *Asparagus asparagoides* (Bridal Creeper)
- *Moraea flaccida* (One-leaf Cape Tulip).

### Vegetation

Vegetation within the development envelope is predominantly made up of Banksia woodland and areas of wetland vegetation with varying levels of disturbance and integrity. A total of 40 vegetation communities were recorded consisting of 25 woodlands, two shrublands, two herbland/sedgeland and eleven other classifications of mapped areas (excluding open water, tracks and roads).

None of the vegetation communities recorded within the development envelope have been determined to be equivalent to State Threatened Ecological Communities (TECs) under the DPaW listings or Commonwealth TECs protected under the EPBC Act. In addition, determination of the Floristic Community Types relevant to the recorded vegetation communities did not suggest that Priority Ecological Communities (PECs) are supported by the development envelope.

Eighteen vegetation communities are considered locally significant as they support populations of Priority Flora, regionally significant flora, significant flora of the Perth metropolitan region. Part of Bush Forever Site 244 also occurs within the development envelope. It includes vegetation associated with Bibra Lake, Roe Swamp and surrounding sumplands (UFIs 14425 and 15240), and Horse Paddock Swamp. The vegetation within the wetlands, wetland buffers and Bush Forever site is regionally significant in terms of its structural complexity, floristic assemblages and ecological patterns.

Vegetation condition within the development envelope and the proposed construction footprint (ranges from 'Excellent' to 'Completely Degraded'). Approximately 32.6% of the construction footprint is in 'Completely Degraded to Good' condition as displayed in Table 3.

Table 3: Vegetation condition within the development envelope

Condition	Development envelope		Construction footprint	
	Area (ha)	% of total area surveyed	Area (ha)	% of total area surveyed
Excellent	10.13	4.04	21.0	18.6%
Very Good to Excellent	5.30	2.11	13.0	11.5%
Very Good	14.28	5.69	30.8	27.2%
Good to Very Good	25.26	10.07	11.4	10.1%
Good	36.90	14.71	4.08	3.61%
Degraded to Good	27.10	10.80	18.9	16.7%
Degraded	29.57	11.78	7.46	6.60%
Degraded to Completely Degraded	52.17	20.79	5.19	4.59%
Completely Degraded	50.22	20.01	1.22	1.08%
<b>Total</b>	<b>250.92</b>	<b>100.00</b>	<b>113.1</b>	<b>100%</b>

## 2.2 Fauna

Clearing of vegetation and the installation of drainage basins will also result in the loss of up to 97.8 ha of fauna habitat. This includes the following fauna habitat types:

- *Eucalyptus/Banksia* woodland
- *Eucalyptus/Xanthorrhoea* woodland
- other native remnant vegetation, various other woodland types, rehabilitated vegetation, parklands and roadside verges that provide fauna habitat.

### 3. Rehabilitation program

#### 3.1 Rehabilitation objectives

Rehabilitation objectives established for temporarily disturbed areas include:

- vegetation is established to maintain roadside and road formation stability
- creation of fauna habitat within rehabilitated areas through species and structural diversity of the rehabilitation
- rehabilitation works improve the visual amenity
- rehabilitation is comprised of species that will survive and perpetuate with minimal ongoing maintenance in the form of watering and weed control
- species selection is suitable at a regional and local scales
- roadside revegetation meets community expectations related to amenity and aesthetics
- appropriate salvage operations are conducted during clearing operations to provide topsoil, mulch and habitat logs for rehabilitation.

A number of rehabilitation treatments will be incorporated into the rehabilitation program based on the pre-existing vegetation complex and the location of rehabilitation (Table 4, Figure 2 and Figure 3).

This Plan concentrates on the rehabilitation requirements and therefore the landscaping of the interchange nodes will be managed through a separate process. Where it is decided that an interchange shall not become a node, it will be rehabilitated as per the roadside batters treatment of that vegetation complex. The rehabilitation of Horse Paddock swamp and the control of the declared weed, Arum Lily, are also not included in this plan and will be managed through a separate process as indicated in Table 4. As a result this plan focuses on the nine treatments associated with roadside batters, redundant roads and drainage basins (Figure 2 and Figure 3).

Table 4: Rehabilitation treatments

Location	General site preparation and rehabilitation requirements	Proposed planting mix base on pre-existing vegetation complex.
Roadside batters	Site preparation works are likely to include: <ul style="list-style-type: none"> <li>• contouring if necessary</li> <li>• topsoil and mulch spreading</li> <li>• direct seeding and seedling planting.</li> </ul>	Bassendean Complex (see Appendix 1). Herdsman Complex (see Appendix 1). Karrakatta Complex (see Appendix 1). Cottesloe Complex (see Appendix 1).
Redundant roads	Site preparation works are likely to include: <ul style="list-style-type: none"> <li>• removal of pavement and/or bitumen</li> <li>• deep ripping of compacted areas</li> <li>• contouring if necessary</li> <li>• topsoil and mulch spreading</li> <li>• direct seeding and seedling planting.</li> </ul>	Bassendean Complex (see Appendix 1). Herdsman Complex (see Appendix 1). Karrakatta Complex (see Appendix 1). Cottesloe Complex (see Appendix 1).
Drainage basins	Areas where the rehabilitation methodology must take into account drainage requirements. Rehabilitation will therefore focus on seedling planting. Topsoil and mulch respreading as well as direct seeding will not be required.	Herdsman Complex (see Appendix 1).
Interchanges	These areas were identified in the Landscape and Urban Design Framework (LUDF) as significant features nodes and areas for feature formal planting. Where it is decided that an interchange shall not become a node, it will be rehabilitated as per the roadside batters treatment of that vegetation complex. Formal planting will utilise local provenance species, where possible.	
Horse Paddock Swamp	A Wetland Restoration Plan has been prepared which details the requirements for rehabilitation for this location (Strategen 2015b).	
Arum Lily areas	A separate Arum Lily Control Program (Strategen 2015a) has been prepared which details the requirements for rehabilitation for this location.	

Indicated planting mixes for each pre-existing vegetation complex proposed to be used in the rehabilitation program are detailed in Appendix 1. Rehabilitation areas that transition from one vegetation complex to another, such as the areas around Stock Road, may use the one base seed mix; however, the seed mix will only include species common to both vegetation complexes, with unique species introduced separately.



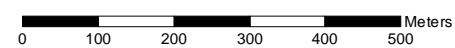


645000

645000

**Figure 2: Revegetation areas by vegetation complex- Part 1**

Scale 1:10,000 at A3



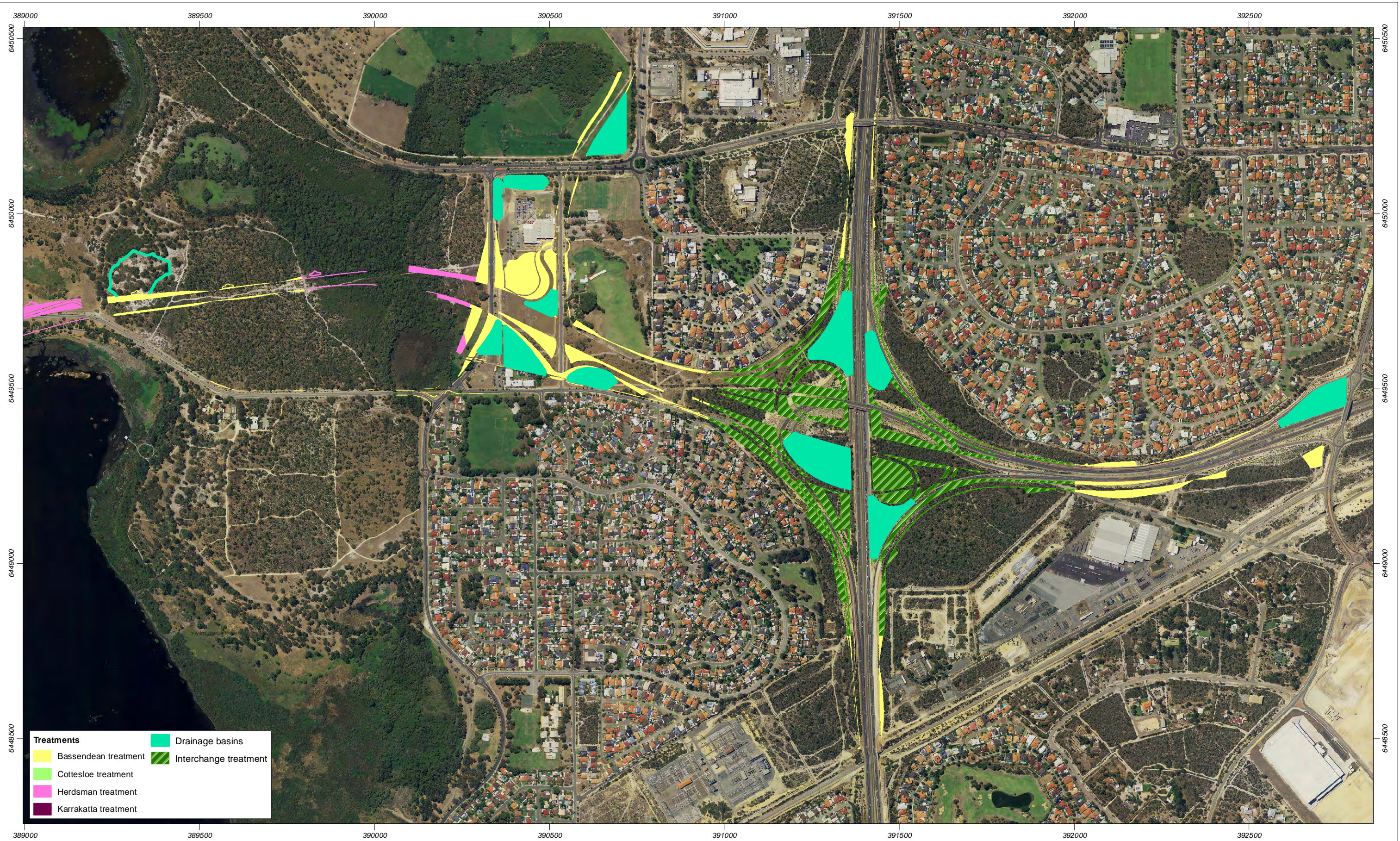
Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 17/12/2015  
 Author: JCrute  
 Source: Topography: Geoscience Australia 2011.

Path: Q:\Consult\2015\IMRO\IMRO15099\ArcMap\_documents\IMRO15099\_07\R002\MRO15099\_07 R002 Rev F F003.mxd









**Figure 3: Revegetation areas by vegetation complex- Part 2**

Scale 1:10,000 at A3

0 100 200 300 400 500 Meters

Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 17/12/2015  
 Author: JCrute  
 Source: Topography: Geoscience Australia 2011.

Path: Q:\Consult\2015\IMRO\IMRO15099\ArcMap\_documents\IMRO15099\_07\R002\MRO15099\_07 R002 Rev D F002.mxd





### 3.2 Performance targets and indicators

Rehabilitation targets and indicators have been developed for each rehabilitation objective, to enable rehabilitation performance to be measured. Performance indicators have been developed for each target to enable the appropriate measurement of rehabilitation performance against the completion criteria that are described in Section 6.

Table 5: Targets and indicators for rehabilitation objectives for the Project

Objective	Target	Indicators
Re-establish pre-existing vegetation types within temporarily cleared areas.	Species composition, structure and density of rehabilitated areas are similar to pre clearing vegetation complexes in that area.	Density and diversity of native species in rehabilitated areas meet completion criteria (Section 6).
Re-establish fauna habitat within rehabilitated areas.	Rehabilitated areas comprise mixed communities of local native species with a mixed structure appropriate to the site.	Density and diversity of native species in rehabilitated areas meet completion criteria (Section 6).
Establish native vegetation to maintain roadside and road formation stability.	Contour area prior to rehabilitation if required.	Rapid assessment monitoring indicates roadside and road formation is stable.
	Rehabilitate areas within 24 months of that area no longer being required for the purpose for construction.	Monitoring indicates rehabilitation has commenced in all temporarily cleared areas within 24 months of the areas no longer being required for construction.

### 3.3 Management actions

Management actions for the rehabilitation of temporary cleared areas are identified in Table 6.

Table 6: Rehabilitation management actions for temporarily cleared areas

Activity	Management action	Timing	Responsibility
<b>Site preparation and planning</b>	Develop maps indicating areas to be rehabilitated, including: <ul style="list-style-type: none"> <li>dieback status of each area</li> <li>Priority flora populations</li> <li>erosion risk areas / finished contours</li> <li>soil type</li> <li>topsoil management requirements</li> <li>rehabilitation treatment including target species list and planting pattern for each area based on a review of the existing Level 2 flora and vegetation studies that have been undertaken.</li> </ul>	Prior to rehabilitation	Construction contractor
	Undertake a broad scale weed spray over the rehabilitation sites to reduce initial weed loads prior to planting. The use of herbicides in the following areas and conditions, will be avoided where possible: <ul style="list-style-type: none"> <li>within close proximity to wetland areas</li> <li>within close proximity in areas of Priority flora populations</li> <li>during windy conditions.</li> </ul> If application in proximity to wetland areas is required, herbicides that are safe for local fauna will be used in consultation with DPaW.	Prior to planting/topsoil respread	Rehabilitation consultant
	Remove pavement and/or bitumen in areas proposed to be rehabilitated.	Prior to topsoil and mulch respread	Construction contractor
	Contour rehabilitation areas (if applicable) to reduce erosion and ensure stability of the surface.	Prior to topsoil and mulch respread	Construction contractor
	Deep rip redundant roads to the depth of compaction or to at least 500 mm to encourage seed germination, plant establishment and water drainage.	Prior to direct seeding and/or seedling planting	Construction contractor
Seed collection and plant propagation	Determine the quantity of seed and vegetative matter (if required) of various native flora species required for direct seeding for the correct treatment area as per Table 4.	Prior to rehabilitation	Rehabilitation consultant
	Engage a qualified seed and vegetative matter collector licensed by DPaW to undertake vegetative matter collection, seed collection (including seed banking if necessary) and/or sourcing other seed supplies (refer to recommended species list in Appendix 1), noting: <ul style="list-style-type: none"> <li>seed and vegetative matter should be collected from within 100 km of the project area to ensure local provenance</li> <li>quantity of seed required to be propagated for correct treatment area as per Table 4</li> <li>seed collection may need to be conducted over an extended period as seeds of different species mature at different times</li> <li>seasonal factors may limit availability of seed.</li> </ul>	Prior to rehabilitation	Rehabilitation consultant
	Ensure seed is stored appropriately including keeping the seed in a dry facility, out of direct sunlight and at an ambient temperature and humidity.	Prior to rehabilitation	Rehabilitation consultant
	Monitor native seed and maintain a register of volumes, species collected, locations and quantities.	Prior to rehabilitation	Rehabilitation consultant
	Place nursery orders with an accredited nursery which has stringent dieback, disease and weed management processes in place within an appropriate time frame to ensure adequate supply (refer to recommended species list in Appendix 1).	Prior to rehabilitation	Rehabilitation consultant



Activity	Management action	Timing	Responsibility
	Where necessary these nurseries will be inspected to ensure their management processes are in place and effective.		
Topsoil Management	Prepare a topsoil map for the development envelope that identifies: <ul style="list-style-type: none"> <li>• presence of Declared Plants, significant grassy weeds and other environmental weeds</li> <li>• presence of dieback</li> <li>• vegetation condition</li> <li>• vegetation complex</li> <li>• suitable areas of topsoil and mulch for rehabilitation. Suitable areas of topsoil will: <ul style="list-style-type: none"> <li>* contain no Declared Plants (e.g. Arum Lily), grassy weeds (e.g. Veldt Grass, African Lovegrass) or other environmental weeds</li> <li>* have vegetation condition ratings of very good or better as defined in Keighery (1994).</li> </ul> </li> </ul>	Prior to rehabilitation	Rehabilitation consultant
	Strip suitable topsoil to a depth of 100 mm and mulch suitable vegetation as described above.	During clearing	Construction contractor
	Where possible strip topsoil in dry conditions.	During clearing	Construction contractor
	Where possible store topsoil in dry conditions and for the absolute minimum length of time.	During clearing	Construction contractor
	Ensure topsoil and mulch is labelled in accordance with their vegetation complexes to ensure no mixing of stockpiles.	During clearing	Construction contractor
	Dispose of topsoil not suitable for rehabilitation offsite or by burying beneath at least 0.5 m of clean fill.	During clearing	Construction contractor
	If topsoil is required to be imported ensure it is certified as dieback and weed-free.	During clearing	Construction contractor
Ensure stockpiles are stabilised to prevent dust generation. Stabilisation methods may include wetting (through use of water trucks), application of hydromulch, use of chemical polymers (if required) or other sealing material.	During clearing	Construction contractor	
Implementation	Undertake rehabilitation progressively within 24 months of the cleared area no longer required for activities associated with the Project.	During rehabilitation	Rehabilitation consultant
	Spread the topsoil over the correct treatment area to a depth of 50 mm.	Late summer/early autumn prior to direct seeding/seedling planting	Construction contractor
	After topsoil respreading, spread the mulch over the correct treatment area to a maximum depth of 50 mm.	Late summer/early autumn prior to direct seeding/seedling planting	Construction contractor
	Undertake direct seeding within roadside batters and redundant roads noting that: <ul style="list-style-type: none"> <li>• native species favoured by Carnaby's Black Cockatoo for foraging (particularly <i>Banksia attenuata</i>, <i>Banksia menziesii</i>, <i>Corymbia calophylla</i>, <i>Eucalyptus marginata</i> and <i>Allocasuarina fraseriana</i>) should not be used within 10 m of the road edge to minimise the likelihood of vehicle strikes on the birds</li> <li>• a minimum of 4.5 kg of seed per hectare should be applied.</li> </ul>	During rehabilitation	Rehabilitation consultant
	Undertake tubestock planting within roadside batters, redundant roads and drainage basins noting that: <ul style="list-style-type: none"> <li>• tubestock are to be planted at a minimum rate of 1 plant per two square metres within roadside batters and redundant roads</li> </ul>	<i>Drainage Basins</i> –late summer/early autumn. <i>Other Areas</i> – winter	Rehabilitation consultant

Activity	Management action	Timing	Responsibility
	<ul style="list-style-type: none"> <li>• tubestock are to be planted at a minimum rate of 1 plant per square metre within the drainage basin above the low water mark only</li> <li>• Native tube-stock and seedlings may be artificially watered in the first summer to increase survival rates, as required.</li> </ul>		
	Install rehabilitation protection where grazing fauna (such as rabbits and kangaroos) are affecting the rehabilitation effort as per Table 8. This may include the installation of tree guards and/or fencing).	After direct seeding and/or seedling planting	Rehabilitation consultant
Maintenance/ plant establishment period	<p>Undertake post planting/seeding weed control on the advice of a revegetation expert in the form of spot spraying and/or herbicide wipe across all rehabilitation areas.</p> <p>The use of herbicides will be avoided where possible in the following areas and conditions:</p> <ul style="list-style-type: none"> <li>• within close proximity to wetland areas</li> <li>• within close proximity in areas of significant vegetation or flora populations</li> <li>• during windy conditions.</li> </ul>	<p>Twice a year in the revegetation areas:</p> <ul style="list-style-type: none"> <li>• late autumn/ early winter.</li> <li>• late winter/early spring prior to seed set</li> </ul>	Rehabilitation consultant
	<p>Implement supplementary management activities as determined by monitoring and contingency action (Sections 4 and 5), which may include:</p> <ul style="list-style-type: none"> <li>• weed control</li> <li>• infill planting (likely to be at least 20% of the initial planting density for the first two years)</li> <li>• pest management</li> <li>• use of tree guards and/or fencing</li> <li>• use of fertilisers and/or watering strategies.</li> </ul>	As required	Rehabilitation consultant
	Install and maintain signage for public awareness of rehabilitation areas and dieback control standards.	During rehabilitation	Rehabilitation consultant

## 4. Monitoring

A monitoring program will be implemented following the first spring after commencement of rehabilitation. The monitoring program will continue for five years following completion of construction. Monitoring sites will be established within rehabilitation areas and the following assessment will be undertaken:

- monitoring plots
- rapid assessment areas.

### 4.1 Monitoring plots

Monitoring plots will be established within rehabilitation areas to provide quantifiable data for assessment of rehabilitation against the rehabilitation targets. Depending on the final dimensions of the rehabilitation area, the monitoring plots will either be monitoring quadrats and/or transects with an overall monitoring area of 100 m<sup>2</sup>. At least one plot will be established for each treatment and at least one plot will be established for each hectare of rehabilitation.

The exact location and type of each vegetation monitoring plot will be determined as areas are identified for progressive rehabilitation. Each plot will record the following data for annual monitoring events:

- native species present
- weed species present
- number of stems of all native species present
- projected foliage cover of all native species present
- weed foliage cover

Only flora species recorded within monitoring plots that are of a size /form and or maturity that can be identified in the field will be identified.

### 4.2 Rapid assessment areas

A series of rapid assessment areas will be established and will be recorded using GPS to enable relocation of the points. A minimum of one rapid assessment area will be established for each hectare rehabilitated and will enable broad assessment of the visual appearance of rehabilitated areas. The rapid assessment will be established in areas not already identified as monitoring plots as per Section 4.1.

The rapid assessment will include visual assessment of:

- the visible health of maturing vegetation (classified as 'healthy', 'slightly stressed', 'stressed' or 'very stressed')
- observations of bare areas or erosion scours
- other observations including vandalism or grazing of vegetation
- a photograph taken at a designated point that can be compared to subsequent and/or previous photographs, to assess visible progress in maturing vegetation growth and visual aesthetics.

Rapid assessments are aimed at identifying areas within the rehabilitation works that require a priority for further works or maintenance activities such as weed control, erosion control and infill planting. Rapid assessments will be conducted twice a year.

Table 7: Monitoring actions

Parameter	Timing	Method	Purpose
Monitoring quadrats and transects: <ul style="list-style-type: none"> <li>• native species present</li> <li>• number of stems of each native species present</li> <li>• projected foliage cover of each native species present.</li> <li>• weed species present</li> <li>• weed foliage cover</li> </ul>	Initial monitoring first spring after planting, then annually before the end of summer for five years following the completion of construction.	Monitoring plots	<ul style="list-style-type: none"> <li>• to monitor the emergence of seedlings, species richness, rehabilitation species diversity, and number of seedlings/plants</li> <li>• to monitor establishment of vegetation and compare progress to completion criteria</li> <li>• to monitor weed species richness and weed foliage cover</li> <li>• to monitor weed growth in rehabilitation areas and compare to completion criteria.</li> </ul>
Rapid assessment areas: <ul style="list-style-type: none"> <li>• visible plant health</li> <li>• erosion</li> <li>• other observations i.e. fencing/plant guards, grazing, vandalism, bare earth.</li> </ul>	Twice yearly for five years following the completion of construction.	Rapid assessment	<ul style="list-style-type: none"> <li>• to trigger management actions including erosion control, weed control and infill planting.</li> </ul>

## 5. Contingency actions

In the event that annual monitoring outcomes reveal less than satisfactory progress towards reaching completion criteria, Main Roads will implement contingency actions as described in Table 8.

Table 8: Contingency actions

Trigger	Action
Monitoring indicates rehabilitation areas (roadside batters, redundant roads and drainage basins as per Table 4, Figure 2 and Figure 3) do not meet completion criteria described in Table 9 for native plant density, diversity, structure or survival rate.	<ol style="list-style-type: none"> <li>1. Determine missing vegetation components (via monitoring report).</li> <li>2. Identify likely cause of failure (e.g. weeds, lack of water, inappropriate timing of rehabilitation, lack of nutrients, poor soil condition, lack of water, insect/fungus attack, dieback, and predation by herbivores).</li> <li>3. Address cause of failure (this may involve weed control, fertilising, watering strategies, soil stabilisation, pest control, tree guards, fencing).</li> <li>4. Plan infill planting to compensate for missing vegetation components.</li> <li>5. Continue monitoring annually until completion criteria are met.</li> </ol>
Rehabilitation areas exceed weed density trigger levels.	<ol style="list-style-type: none"> <li>1. Undertake weed mapping of rehabilitation areas</li> <li>2. Determine the best treatment option for specific weeds on site.</li> <li>3. Plan and undertake weed treatment based on appropriate timing and with due regard to protecting existing native vegetation.</li> <li>4. Determine whether infill planting will be required.</li> <li>5. Continue monitoring annually until completion criteria are met.</li> </ol>
Site inspections note signs of land degradation (e.g. vandalism, grazing, bare earth, erosion and waterlogging).	<ol style="list-style-type: none"> <li>1. Determine the cause of land degradation issue.</li> <li>2. Plan and undertake site works as appropriate to treat land degradation.</li> <li>3. Determine whether infill planting will be required.</li> <li>4. Continue monitoring annually until completion criteria are met.</li> </ol>

## 6. Completion criteria

Completion criteria to ensure rehabilitation objectives are achieved are outlined in Table 9.

Table 9: Completion criteria

Parameter	Location	Completion criteria
Projected foliage cover excluding weeds (proportion of the ground covered by the vertical projection of vegetation and foliage).	All non-irrigated areas of planting (or direct seeding)	> 50% projected foliage cover (excluding any weeds).
	All irrigated areas of planting (or direct seeding)	> 70% projected foliage cover (excluding any weeds).
Mean foliage cover of weeds.	All areas	<10% projected foliage cover.
Weed control	All areas	<ul style="list-style-type: none"> <li>No new species of weeds (including declared plants and environmental weeds) are recorded within the rehabilitation areas.</li> <li>All declared plants and other high control priority species (as defined in the contractors control program and in consultation with DPaW) are eradicated or controlled from the site in accordance with the BAM Act.</li> <li>The presence of other nuisance weed species and their effect on new plant growth must be demonstrably manageable with minimum future maintenance requirements</li> </ul>
Species diversity.	All areas	Establish no less than 25 species throughout the rehabilitation area which includes a mixture of overstorey, mid storey and groundcover reflective of the vegetation complex detailed in Table 4, Figure 2 and Figure 3.
	All areas	Establish no less than 10 species within any 100 m <sup>2</sup> area
Vegetation condition	All areas	Vegetation is: <ul style="list-style-type: none"> <li>well formed and exhibits signs of healthy growth;</li> <li>free of disease symptoms (e.g. yellowing, wilting etc); and</li> <li>free from signs of insect pests.</li> </ul>
Number of bare areas per quadrat.	All non-irrigated areas of planting (or direct seeding)	No bare soil areas >10 m <sup>2</sup> .
	All irrigated areas of planting (or direct seeding)	No bare soil areas >5 m <sup>2</sup> .
Number of erosion gullies >200 mm in depth.	All areas	No erosion gullies >200 mm in depth.



## 7. Roles and responsibilities

This section provides a summary of the key personnel involved in implementation of the VRP and their roles and responsibilities.

Role	Responsibility
Main Roads	<ul style="list-style-type: none"> <li>• Main Roads has the overall responsibility for the implementation of this VRP</li> <li>• the roles below may be delegated to a contractor by Main Roads</li> <li>• if the roles are delegated, Main Roads has the responsibility to audit compliance and ensure any contingency actions are implemented.</li> </ul>
Environmental manager	<ul style="list-style-type: none"> <li>• overall accountability for auditing and compliance assessment with this VRP to ensure it is maintained and meets objectives and targets</li> <li>• provide technical support to all Project personnel to ensure this VRP is implemented correctly and complied with</li> <li>• implement and maintain this VRP, review its effectiveness and review the implementation as required</li> <li>• undertaking ongoing monitoring and documenting monitoring results</li> <li>• assess the performance against triggers</li> <li>• liaise with stakeholders and technical advisors for advice and resolution of management aspects/objectives as required</li> <li>• review and close out any contingency actions</li> <li>• report as required to regulating authorities</li> <li>• may delegate all or part responsibility to an appropriately qualified person</li> <li>• providing data to Main Roads for inclusion in the annual compliance report.</li> </ul>
Contractors	<ul style="list-style-type: none"> <li>• support the proponent's revegetation management initiative and culture</li> <li>• comply with all legal requirements and the requirements of this VRP</li> <li>• ensure staff employed are adequately trained in flora and vegetation management</li> <li>• ensure all personnel involved in the project will adhere to VRP requirements</li> <li>• seek advice from proponent when in doubt about requirements</li> <li>• undertake earthworks associated with the VRP</li> <li>• appoint appropriate consultants to undertake specific activities set out in the VRP if required.</li> </ul>
Dieback Consultant	<ul style="list-style-type: none"> <li>• support the proponent's revegetation management initiative and culture</li> <li>• comply with all legal requirements and the requirements of this VRP</li> <li>• undertake dieback mapping of areas targeted for topsoil harvesting and receipt.</li> </ul>
Rehabilitation consultant	<ul style="list-style-type: none"> <li>• support the proponent's revegetation management initiative and culture</li> <li>• comply with all legal requirements and the requirements of this VRP</li> <li>• developing rehabilitation maps</li> <li>• organising seedling propagation and seed collection</li> <li>• weed mapping and weed control</li> <li>• preparation of rehabilitation sites</li> <li>• seeding and infill planting</li> <li>• ongoing monitoring.</li> </ul>
All personnel	<ul style="list-style-type: none"> <li>• must receive induction prior to commencement of work on site</li> <li>• comply with all legal requirements and the requirements of this VRP</li> <li>• attend environmental inductions and any other training required on revegetation management</li> <li>• participate in toolbox meetings and suggest improvements to revegetation management.</li> </ul>

## **8. Review and reporting**

### **8.1 Review and revision**

The VRP will be reviewed on an annual basis to ensure that the plan takes into consideration amendments to operations, monitoring results, audits, continuous improvement and changes in regulatory and corporate requirements. Any proposed amendments to the plan will be undertaken in accordance with condition 10-6, 10-7 and 10-8 and provided to the CEO of the OEPA for approval prior to implementation.

### **8.1 Reporting**

A monitoring report will be prepared after each monitoring event, summarising the results produced prior to the preparation of the Annual Compliance Report.

## 9. Auditing

Auditing of the VRP shall be conducted in accordance with Main Roads Corporate Procedure 6707/044 Environmental Auditing.

Internal audits will be undertaken every three months during construction, and compliance audits will be undertaken annually during construction and annually for the first five years of operation.

An annual compliance report, detailing the results of the compliance audit, shall be provided to the CEO of the OEPA and the DPaW.

The Annual Compliance Report will include:

- location and size of areas to be rehabilitated (map, including ESRI shapefiles)
- description of the rehabilitation and rehabilitation activities undertaken within reporting period (including dates of activities)
- summary of the results of annual monitoring events
- comparison of monitoring results to trigger values
- documentation of any contingency actions undertaken.

## 10. References

- AECOM 2009, *Flora and Vegetation Spring Survey 2009*, prepared by AECOM for the Department of Main Roads.
- AECOM 2010, *Kwinana Freeway Third Lane: Flora and Fauna Survey*. Report prepared for Main Roads Western Australia.
- AECOM 2012, *Roe Highway Extension Rehabilitation Strategy*, prepared by AECOM for South Metro Connect Western Australia, 11 July 2012.
- CALM 2006, *Beeliar Regional Park Final Management Plan 2006*, prepared by CALM on behalf of the Conservation Commission of Western Australia.
- Environmental Protection Authority (EPA) 2004, *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51 Environmental Protection Authority*, Perth, Western Australia.
- Hedde EM, Loneragan OW and Havel JJ 1980, *Darling System, Vegetation Complexes*, Forest Department, Perth.
- South Metro Connect 2011, *Roe Highway Extension Public Environmental Review*, prepared by South Metro Connect for Main Roads Western Australia, 20 June 2011.
- South Metro Connect 2013, *Roe Highway Extension Response to Public Submissions*, prepared for Main Roads Western Australia, 31 May 2013.
- Strategen 2015a, *Roe Highway Extension Arum Lily Control Program*, prepared for Main Roads by Strategen Environmental Consultants.
- Strategen 2015b, *Wetland Restoration Plan*, prepared for Main Roads by Strategen Environmental Consultants, in preparation.

**Appendix 1**  
**Proposed planting list**





Table A 1: Suggested species list for rehabilitation in Bassendean Vegetation Complex

Scientific name	Description
<i>Acacia huegelii</i>	-
<i>Acacia pulchella</i>	-
<i>Acacia saligna</i>	-
<i>Acacia stenoptera</i>	-
<i>Allocasuarina fraseriana</i>	-
<i>Allocasuarina humilis</i>	-
<i>Amphipogon turbinatus</i>	Propagate through vegetative material where possible
<i>Anigozanthos humilis</i>	-
<i>Anigozanthos manglesii</i>	-
<i>Austrostipa compressa</i>	-
<i>Banksia attenuata</i>	-
<i>Banksia dallanneyi</i>	-
<i>Banksia grandis</i>	-
<i>Banksia ilicifolia</i>	-
<i>Banksia menziesii</i>	-
<i>Beaufortia elegans</i>	-
<i>Boronia crenulata</i>	-
<i>Boronia ramosa</i>	-
<i>Bossiaea eriocarpa</i>	-
<i>Brachyscome iberidifolia</i>	-
<i>Burchardia congesta</i>	-
<i>Calothamnus sanguineus</i>	-
<i>Calytrix angulata</i>	-
<i>Calytrix flavescens</i>	-
<i>Calytrix fraseri</i>	-
<i>Conostylis aculeata</i>	-
<i>Conostylis juncea</i>	-
<i>Conostylis setigera</i>	-
<i>Corymbia calophylla</i>	-
<i>Dampiera linearis</i>	Propagate through vegetative material where possible
<i>Dasypogon bromeliifolius</i>	Propagate through vegetative material where possible
<i>Daviesia divaricata</i>	-
<i>Daviesia nudiflora</i>	-
<i>Daviesia triflora</i>	-
<i>Desmocladius flexuosus</i>	Propagate through vegetative material where possible
<i>Dianella revoluta</i>	-
<i>Dodonaea hackettiana</i>	As per DPaW recommendation minimal planting of this species is proposed.
<i>Eremaea asterocarpa</i>	-
<i>Eremaea pauciflora</i>	-
<i>Eucalyptus marginata</i>	-
<i>Eucalyptus todiana</i>	-

Scientific name	Description
<i>Gastrolobium capitatum</i>	-
<i>Gompholobium tomentosum</i>	-
<i>Hakea ruscifolia</i>	-
<i>Hardenbergia comptoniana</i>	-
<i>Hemiandra pungens</i>	Propagate from seed collected from the local area where possible.
<i>Hibbertia huegelii</i>	Propagate through vegetative material where possible
<i>Hibbertia racemosa</i>	Propagate through vegetative material where possible
<i>Hibbertia subvaginata</i>	Propagate through vegetative material where possible
<i>Hovea pungens</i>	-
<i>Hovea trisperma</i>	-
<i>Hypocalymma robustum</i>	-
<i>Hypolaena exsulca</i>	Propagate through vegetative material where possible
<i>Jacksonia furcellata</i>	-
<i>Jacksonia sternbergiana</i>	-
<i>Kennedia prostrata</i>	-
<i>Kunzea glabrescens</i>	As per DPaW recommendation minimal planting of this species is proposed.
<i>Lechenaultia floribunda</i>	Propagate through vegetative material where possible
<i>Lepidosperma</i> spp.	Propagate through vegetative material where possible
<i>Lobelia tenuior</i>	-
<i>Lomandra hermaphrodita</i>	Propagate through vegetative material where possible
<i>Lomandra nigricans</i>	Propagate through vegetative material where possible
<i>Lyginia barbata/imberbis</i>	Propagate through vegetative material where possible
<i>Macrozamia fraseri</i>	-
<i>Melaleuca preissiana</i>	Plant only in low-lying (damp) areas, where possible
<i>Melaleuca raphiophylla</i>	-
<i>Melaleuca seriata</i>	-
<i>Melaleuca thymoides</i>	-
<i>Melaleuca trichophylla</i>	-
<i>Mesomelaena pseudostygia</i>	Propagate through vegetative material where possible
<i>Nuytsia floribunda</i>	-
<i>Patersonia occidentalis</i>	-
<i>Persoonia saccata</i>	-
<i>Petrophile linearis</i>	-
<i>Phlebocarya ciliata</i>	Propagate through vegetative material where possible
<i>Podolepis gracilis</i>	-
<i>Regelia inops</i>	-
<i>Rytidosperma occidentale</i>	-
<i>Schoenus curvifolius</i>	Propagate through vegetative material where possible
<i>Scholtzia involucrata</i>	-
<i>Stirlingia latifolia</i>	-
<i>Xanthorrhoea brunonis</i>	-
<i>Xanthorrhoea preissii</i>	-

Source: AECOM (2012) and as per recommendation by DPaW

Table A 2: Suggested species listed for the Herdsman Vegetation Complex

Scientific name	Description
<i>Acacia cyclops</i>	-
<i>Acacia pulchella</i>	-
<i>Acacia saligna</i>	-
<i>Anigozanthos humilis</i>	-
<i>Astartea scoparia</i>	-
<i>Austrostipa compressa</i>	-
<i>Banksia ilicifolia</i>	-
<i>Banksia littoralis</i>	-
<i>Baumea articulata</i>	-
<i>Baumea juncea</i>	-
<i>Beaufortia elegans</i>	-
<i>Bolboschoenus caldwellii</i>	-
<i>Brachyscome iberidifolia</i>	-
<i>Carex appressa</i>	-
<i>Carex fascicularis</i>	-
<i>Centella asiatica</i>	-
<i>Corymbia calophylla</i>	-
<i>Dampiera linearis</i>	Propagate through vegetative material where possible
<i>Dianella revoluta</i>	-
<i>Dodonaea hackettiana</i>	As per DPaW recommendation minimal planting of this species is proposed.
<i>Eucalyptus rudis</i>	Propagate from seed collected from the local area where possible.
<i>Gastrolobium ebracteolatum</i>	-
<i>Hakea prostrata</i>	-
<i>Hakea varia</i>	-
<i>Hypocalymma angustifolium</i>	-
<i>Hypolaena exsulca</i>	Propagate through vegetative material where possible
<i>Isolepis cernua</i>	-
<i>Jacksonia furcellata</i>	-
<i>Jacksonia sternbergiana</i>	-
<i>Juncus pallidus</i>	-
<i>Kunzea glabrescens</i>	As per DPaW recommendation minimal planting of this species is proposed.
<i>Lepidosperma longitudinale</i>	Propagate through vegetative material where possible
<i>Lobelia alata</i>	-
<i>Logania vaginalis</i>	-
<i>Macrozamia fraseri</i>	-
<i>Melaleuca preissiana</i>	Plant in the drier areas of the Herdsman area, where possible
<i>Melaleuca raphiophylla</i>	-
<i>Melaleuca teretifolia</i>	-
<i>Melaleuca thymoides</i>	-
<i>Myoporum caprarioides</i>	-
<i>Nuytsia floribunda</i>	-

---

<i>Opercularia hispidula</i>	Propagate through vegetative material where possible
<i>Patersonia occidentalis</i>	Propagate from seed collected from the local swamp form rather than the upland form where possible.
<i>Regelia ciliata</i>	-
<i>Schoenoplectus validus</i>	-
<i>Viminaria juncea</i>	-
<i>Xanthorrhoea preissii</i>	-

Source: AECOM (2012) and as per recommendation by DPaW

Table A 3: Suggested species listed for the Karrakatta Vegetation Complex

Scientific name	Description
<i>Acacia cyclops</i>	-
<i>Acacia huegelii</i>	-
<i>Acacia pulchella</i>	-
<i>Acacia saligna</i>	-
<i>Acacia stenoptera</i>	-
<i>Allocasuarina fraseriana</i>	-
<i>Allocasuarina humilis</i>	-
<i>Anigozanthos humilis</i>	-
<i>Anigozanthos manglesii</i>	-
<i>Austrostipa compressa</i>	-
<i>Banksia attenuata</i>	-
<i>Banksia dallanneyi</i>	-
<i>Banksia grandis</i>	-
<i>Banksia ilicifolia</i>	-
<i>Banksia menziesii</i>	-
<i>Bossiaea eriocarpa</i>	-
<i>Burchardia congesta</i>	-
<i>Caesia micrantha</i>	Propagate through vegetative material where possible
<i>Calothamnus quadrifidus</i>	-
<i>Calothamnus sanguineus</i>	-
<i>Chamaescilla corymbosa</i>	-
<i>Conostylis aculeata</i>	-
<i>Conostylis setigera</i>	-
<i>Corymbia calophylla</i>	-
<i>Dampiera linearis</i>	Propagate through vegetative material where possible
<i>Daviesia divaricata</i>	-
<i>Desmocladus flexuosus</i>	Propagate through vegetative material where possible
<i>Dianella revoluta</i>	-
<i>Dodonaea hackettiana</i>	As per DPaW recommendation minimal planting of this species is proposed.
<i>Eremaea asterocarpa</i>	-
<i>Eremaea pauciflora</i>	-
<i>Eremophila glabra</i>	Propagate from seed collected from the local area where possible as there is much variability in this species.
<i>Eucalyptus gomphocephala</i>	As per DPaW comments less tuarts will be planted in this area here than jarrah (compared to the Cottesloe complex)
<i>Eucalyptus marginata</i>	-
<i>Eucalyptus todtiana</i>	-
<i>Gastrolobium capitatum</i>	-
<i>Gompholobium tomentosum</i>	-
<i>Grevillea crithmifolia</i>	-
<i>Hakea lissocarpa</i>	-
<i>Hakea prostrata</i>	-
<i>Hakea ruscifolia</i>	-
<i>Hardenbergia comptoniana</i>	-
<i>Hemiandra pungens</i>	Propagate from seed collected from the local area where possible.
<i>Hibbertia huegelii</i>	Propagate through vegetative material where possible

Scientific name	Description
<i>Hibbertia racemosa</i>	Propagate through vegetative material where possible
<i>Hovea trisperma</i>	-
<i>Hypocalymma robustum</i>	-
<i>Hypolaena exsulca</i>	Propagate through vegetative material where possible
<i>Isolepis cernua</i>	Plant only in low-lying (damp) areas, where possible
<i>Isotropis cuneifolia</i>	Propagate through vegetative material where possible
<i>Jacksonia furcellata</i>	-
<i>Jacksonia sericea</i>	-
<i>Jacksonia sternbergiana</i>	-
<i>Kennedia prostrata</i>	-
<i>Kunzea glabrescens</i>	-
<i>Lepidosperma</i> spp.	Propagate through vegetative material from local species where possible
<i>Lomandra caespitosa</i>	Propagate through vegetative material where possible
<i>Lomandra hermaphrodita</i>	Propagate through vegetative material where possible
<i>Lomandra nigricans</i>	Propagate through vegetative material where possible
<i>Lomandra preissii</i>	Propagate through vegetative material where possible
<i>Lomandra suaveolens</i>	Propagate through vegetative material where possible
<i>Lyginia barbata/imberbis</i>	Propagate through vegetative material where possible
<i>Macrozamia fraseri</i>	-
<i>Melaleuca preissiana</i>	Plant only in low-lying (damp) areas, where possible
<i>Melaleuca seriata</i>	-
<i>Melaleuca systema</i>	-
<i>Melaleuca thymoides</i>	-
<i>Melaleuca trichophylla</i>	-
<i>Mesomelaena pseudostygia</i>	Propagate through vegetative material where possible
<i>Microlaena stipoides</i>	-
<i>Nuytsia floribunda</i>	-
<i>Orthrosanthus laxus</i>	-
<i>Patersonia occidentalis</i>	-
<i>Persoonia saccata</i>	-
<i>Petrophile linearis</i>	-
<i>Phlebocarya ciliata</i>	-
<i>Podolepis gracilis</i>	-
<i>Regelia inops</i>	-
<i>Rytidosperma occidentale</i>	-
<i>Scholtzia involucreta</i>	-
<i>Sowerbaea laxiflora</i>	-
<i>Stirlingia latifolia</i>	-
<i>Tetralix octandra</i>	Propagate through vegetative material where possible
<i>Xanthorrhoea preissii</i>	-

Source: AECOM (2012) and as per recommendation by DPaW



Table A 4: Suggested species listed for the Cottesloe Vegetation Complex

Scientific name	Description
<i>Acacia cyclops</i>	-
<i>Acacia huegelii</i>	-
<i>Acacia lasiocarpa</i>	As per recommendation from DPaW seed from will be collected from <i>Acacia lasiocarpa</i> var. <i>lasiocarpa</i> , where possible.
<i>Acacia pulchella</i>	-
<i>Acacia saligna</i>	-
<i>Acacia stenoptera</i>	-
<i>Allocasuarina fraseriana</i>	-
<i>Allocasuarina humilis</i>	-
<i>Anigozanthos humilis</i>	-
<i>Anigozanthos manglesii</i>	-
<i>Austrostipa compressa</i>	-
<i>Banksia attenuata</i>	-
<i>Banksia dallanneyi</i>	-
<i>Banksia grandis</i>	-
<i>Banksia menziesii</i>	-
<i>Bossiaea eriocarpa</i>	-
<i>Brachyscome iberidifolia</i>	-
<i>Burchardia congesta</i>	-
<i>Caesia micrantha</i>	Propagate through vegetative material where possible
<i>Calothamnus quadrifidus</i>	-
<i>Chamaescilla corymbosa</i>	-
<i>Conostylis aculeata</i>	-
<i>Conostylis setigera</i>	-
<i>Corymbia calophylla</i>	-
<i>Daviesia divaricata</i>	-
<i>Desmocladius flexuosus</i>	Propagate through vegetative material where possible
<i>Dianella revoluta</i>	-
<i>Dodonaea hackettiana</i>	As per DPaW recommendation minimal planting of this species is proposed.
<i>Eremaea pauciflora</i>	-
<i>Eucalyptus gomphocephala</i>	As per DPaW comments more tuarts will be planted in this area here than jarrah (compared to in the Karrakatta complex)
<i>Eucalyptus marginata</i>	-
<i>Eucalyptus todiana</i>	-
<i>Gastrolobium capitatum</i>	-
<i>Gompholobium tomentosum</i>	-
<i>Grevillea crithmifolia</i>	-
<i>Hakea lissocarpha</i>	-
<i>Hakea prostrata</i>	-
<i>Hakea ruscifolia</i>	-
<i>Hakea trifurcata</i>	-
<i>Hardenbergia comptoniana</i>	-
<i>Hibbertia huegelii</i>	Propagate through vegetative material where possible

Scientific name	Description
<i>Hibbertia racemosa</i>	Propagate through vegetative material where possible
<i>Hovea trisperma</i>	-
<i>Hypocalymma robustum</i>	-
<i>Hypolaena exsulca</i>	Propagate through vegetative material where possible
<i>Isotropis cuneifolia</i>	Propagate through vegetative material where possible
<i>Jacksonia furcellata</i>	-
<i>Jacksonia sericea</i>	-
<i>Jacksonia sternbergiana</i>	-
<i>Kennedia prostrata</i>	-
<i>Lepidosperma</i> spp.	Propagate through vegetative material from local species where possible
<i>Lomandra caespitosa</i>	Propagate through vegetative material where possible
<i>Lomandra hermaphrodita</i>	Propagate through vegetative material where possible
<i>Lomandra nigricans</i>	Propagate through vegetative material where possible
<i>Lomandra preissii</i>	Propagate through vegetative material where possible
<i>Lomandra suaveolens</i>	Propagate through vegetative material where possible
<i>Lyginia barbata/imberbis</i>	Propagate through vegetative material where possible
<i>Macrozamia fraseri</i>	-
<i>Melaleuca systema</i>	-
<i>Melaleuca trichophylla</i>	-
<i>Mesomelaena pseudostygia</i>	Propagate through vegetative material where possible
<i>Microlaena stipoides</i>	-
<i>Nuytsia floribunda</i>	-
<i>Orthrosanthus laxus</i>	-
<i>Patersonia occidentalis</i>	-
<i>Persoonia saccata</i>	-
<i>Petrophile linearis</i>	-
<i>Phlebocarya ciliata</i>	Propagate through vegetative material where possible
<i>Podolepis gracilis</i>	-
<i>Rytidosperma occidentale</i>	-
<i>Sowerbaea laxiflora</i>	-
<i>Stirlingia latifolia</i>	-
<i>Tetralix octandra</i>	Propagate through vegetative material where possible
<i>Xanthorrhoea preissii</i>	-

Source: AECOM (2012) and as per recommendation by DPaW

**Appendix 4**  
**Baseline Vegetation and Flora**  
**Condition Survey Scope**





intelligent outcomes | respected experience

## Roe Highway Extension

### Scope of Works for Baseline Flora and Vegetation Condition Survey

Prepared for  
Main Roads  
by Strategen

September 2015



# **Roe Highway Extension**

## **Scope of Works for Baseline Flora and Vegetation Condition Survey**

Strategen is a trading name of  
Strategen Environmental Consultants Pty Ltd  
Level 1, 50 Subiaco Square Road Subiaco WA 6008  
ACN: 056 190 419

September 2015



## ***Limitations***

### **Scope of services**

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

### **Reliance on data**

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

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

### **Environmental conclusions**

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

## **Client: Main Roads**

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	A	For review by client	D White, D Panickar/ A Welker, D Newsome	Electronic	1 May 2015
Final Draft Report	B	For review by client	D White / A Welker D Goundrey	Electronic	19 May 2015
Final Report	0	To submit to DPaW	D White / A Welker D Goundrey	Electronic	1 July 2015
Revised Report	D	For review by client	A Welker, D White/ D Goundrey	Electronic	3 August 2015
Revised Report	E	For client approval	A Welker, D White/ D Goundrey	Electronic	10 August 2015
Revised Report	1	For submission to OEPA	A Welker, D White/ D Goundrey	Electronic	14 August 2015
Revised Report	2	For submission to OEPA	A Welker, D White/ D Goundrey	Electronic	7 September 2015

Filename: MRO15099\_06 R001 Rev 2 - 7 September 2015

## Table of contents

<b>1. Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Purpose and objectives	2
<b>2. Flora and Vegetation</b>	<b>4</b>
2.1 Regional	4
2.2 Previous studies	4
2.2.1 Flora	4
2.2.2 Vegetation	5
<b>3. Baseline Flora and Vegetation Condition Survey</b>	<b>6</b>
3.1.1 Vegetation monitoring	15
3.1.2 Soil moisture	15
3.2 Timing	16
3.3 Reporting and review process	16
<b>4. References</b>	<b>17</b>

## List of tables

Table 1: Vegetation complexes	4
Table 2: Flora values within the development envelope	4
Table 3: Numbers of monitoring sites per vegetation community	7
Table 4: Baseline monitoring sites	13

## List of figures

Figure 1: Project development envelope	3
Figure 2: Proposed baseline monitoring sites – Section 1	9
Figure 3: Proposed baseline monitoring sites – Section 2	11



# 1. Introduction

Main Roads Western Australia (Main Roads) proposes to construct the Roe Highway Extension (the Project, Figure 1) which is part of the Perth Freight Link project. This document presents the flora and vegetation monitoring and management scope of works to manage the potential impacts of the Project on flora and vegetation.

The Project involves the construction of approximately 5 km of highway, extending Roe Highway from its current terminus at the Kwinana Freeway in Jandakot to Stock Road in Coolbellup. The proposed extension to Roe Highway is largely located within a primary regional road reserve which adjoins Beeliam Regional Park.

## 1.1 Background

The Project is located approximately 14 km south of Perth within the Swan Coastal Plain Bioregion. The Project is largely contained within the City of Cockburn, however, parts of the design extend northward in to the City of Melville along Murdoch Drive and Kwinana Freeway. Generally, the proposed Project is oriented east-west; largely within a road reserve that was set aside in the Metropolitan Region Scheme (MRS) in 1963. The alignment is between North and Bibra Lakes, which are part of the Eastern Chain of the Beeliam Wetlands.

The Project will consist of a dual carriageway with two lanes in each direction, separated by a concrete barrier in place of a median strip. The preferred design was selected following an extensive options analysis and consultative process. Once selected, the preferred design was optimised to avoid and minimise environmental impacts to the maximum extent possible.

In 2009 the Project was referred to the Environmental Protection Authority (EPA) under the Environmental Protection Act 1986 (EP Act), and to the then Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), now the Department of the Environment (DotE), under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The Project was set a level of assessment of Public Environmental Review (PER) and the bilateral agreement between the State and Commonwealth governments was enacted. The PER was released on 20 June 2011 for a 12 week public review period.

The Project was approved by the Minister for Environment in 2 July 2015, with the release of Ministerial Statement 1008 (Statement 1008) establishing conditions for the Project implementation.

Statement 1008 Condition 10 established a “zone of indirect impacts” which is to contain any potential environmental effects of the Project. Immediately outside the “zone of indirect impacts” there is not to be any detectable adverse effects on flora and vegetation communities. Condition 10 further requires ongoing monitoring in order to monitor potential impacts as well as the implementation of a progressive rehabilitation program for areas within the final Roe Highway road reserve that have been temporarily disturbed for construction.



## 1.2 Purpose and objectives

This document provides the scope of works that addresses the requirement for a Baseline Flora and Vegetation Condition Survey (the study) required under condition 10-2 of Statement 1008 dated 2 July 2015.

Condition 10-2 of Statement 1008 dated 2 July 2015 states:

*The proponent shall undertake a Baseline Flora and Vegetation Condition Survey prior to commencement of construction to the requirements of the CEO on advice from the Department of Parks and Wildlife. The Baseline Flora and Vegetation Condition Survey shall:*

*(1) use plot based surveys of the area outside the 'zone of indirect impacts', including immediately outside the 'zone of indirect impacts', and reference site locations;*

*(2) identify the indicators of flora and vegetation health including the condition and composition of flora and vegetation communities and correlative environmental parameters including soil moisture within the survey area; and*

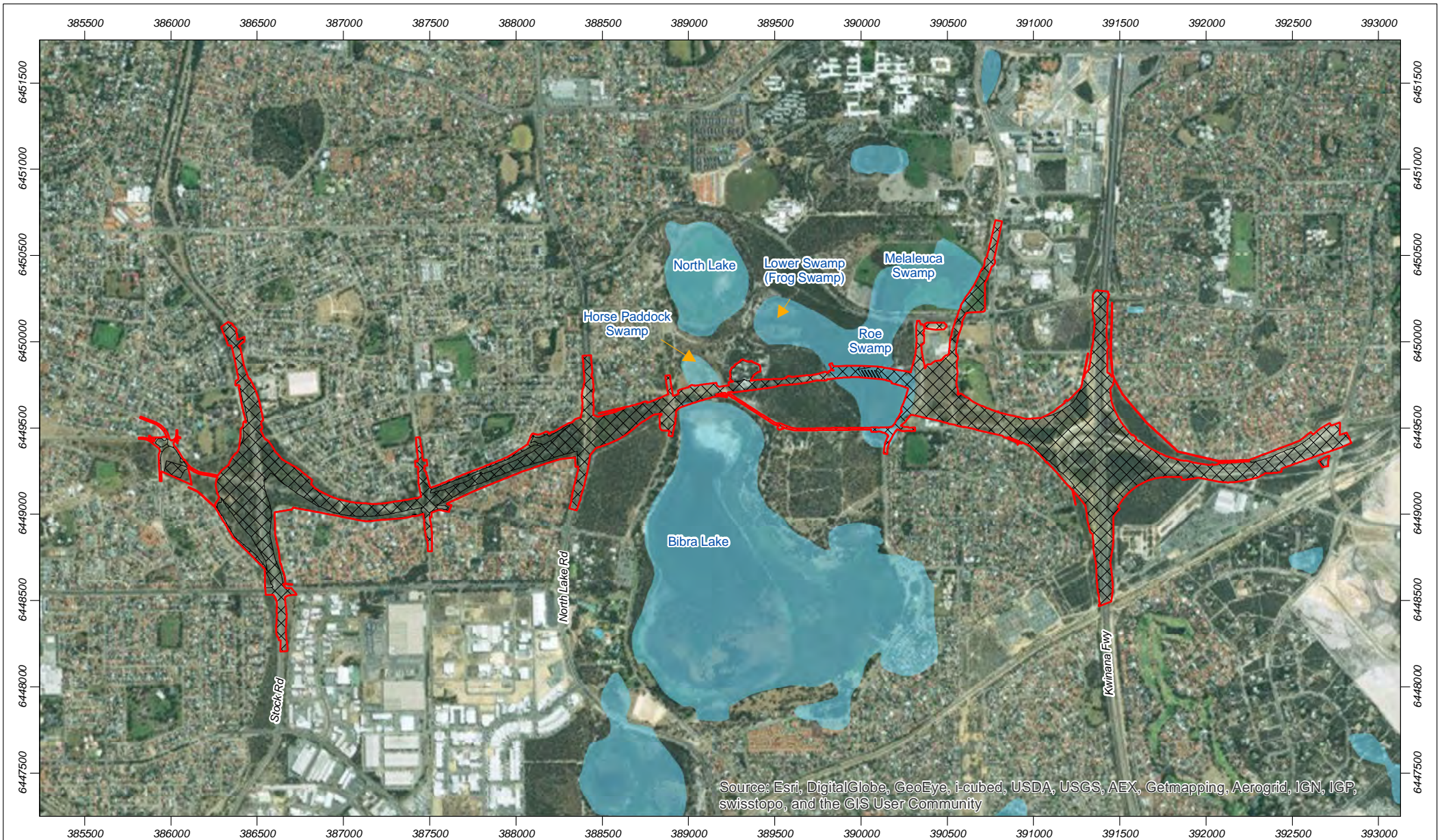
*(3) include protocols to measure the indicators of flora and vegetation health including duration, timing and frequency.*

The objective of this baseline flora and vegetation condition survey is to establish a baseline of vegetation condition indicators outside the zone of indirect impact, that are proposed to be monitored during the implementation of the Project, and establish appropriate contingency trigger levels. Ongoing monitoring will be undertaken consistent with the requirements of the Flora and Vegetation Monitoring and Management Plan, as required by condition 10-4 of Statement 1008.

The baseline vegetation condition scope of works will:

1. Ensure compliance with EPA ministerial statement condition 10-2 outlined above.
2. Establish a methodology to determine indicators for flora and vegetation health adjacent to the zone of indirect impact and within reference sites.
3. Establish a baseline methodology to ensure sufficient baseline data is available to enable the development of appropriate trigger levels as required by condition 10-4 of Statement 1008.





**Figure 1: Project development envelope**

Scale 1:30,000 at A4  
 0 200 400 600 800 1,000 Meters  
 Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 30/07/2015  
 Author: DWhite  
 Source: Aerial image: ESRI, approx.2010; Client 2015; Wetlands: DPaW 2015.



- Legend**
- Project development envelope
  - Proposed construction footprint
  - Wetlands





## 2. Flora and Vegetation

### 2.1 Regional

Regional vegetation mapping within the Project development envelope (development envelope) and adjacent land indicates the occurrence of four vegetation complexes (Hedde et al. 1980). These vegetation complexes are summarised in Table 1.

Table 1: Vegetation complexes

Vegetation complex	Description
Bassendean Complex - Central and South	Woodland of <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> with well defined second storey of <i>Calytrix fraseriana</i> and <i>Banksia grandis</i> on the deeper soils and a closed scrub on the moister sites. The understorey species reflect similarities with the adjacent vegetation complexes.
Herdsmen Complex	Sedgeland and fringing woodland of <i>Eucalyptus rudis</i> and <i>Melaleuca</i> species.
Karrakatta Complex - Central and South	Predominantly open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> and woodland of <i>Eucalyptus marginata</i> and <i>Banksia</i> species.
Cottesloe Complex - Central and South	Mosaic woodland of <i>Eucalyptus gomphocephala</i> and open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i> ; closed heath on the limestone outcrops.

Source: Hedde et al. (1980)

### 2.2 Previous studies

A Level 2 flora and vegetation survey was undertaken of the development envelope in spring 2009 and spring 2010 (AECOM 2009; 2010) in accordance EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004). Additional targeted flora surveys were undertaken after the preparation of the PER for the Project. A review of vegetation condition within the development envelope was carried out in accordance with advice from then DEC in March 2012 and it was determined that the condition of some areas of vegetation were under-rated in the original survey (South Metro Connect 2013). Vegetation condition ratings were revised in accordance with a condition rating scale adapted from Keighery (1994) and the Braun-Blanquet scale of cover abundance. Subsequently, the revised portions of the condition mapping were field verified on 16 March 2012. A summary of the results from all flora surveys undertaken for the Project are presented below.

#### 2.2.1 Flora

A total of 434 species from 244 genera and 80 families were recorded within the development envelope from the baseline assessment and subsequent seasonal monitoring events. Families with the highest representation were Myrtaceae, Fabaceae, Asteraceae and Poaceae, a floristic composition typical for the Swan Coastal Plain. A total of five Priority flora species were recorded within the development envelope of the Project and are displayed in Table 2.

Table 2: Flora values within the development envelope

Flora	Priority	% of individuals to be impacted	No. of individuals to be impacted
<i>Dampiera triloba</i>	3	75.8	5404
<i>Tetralia</i> sp. Chandala (G.J. Keighery 17055)	2	0.00	1
<i>Cyathochaeta teretifolia</i>	3	6.5	38
<i>Jacksonia gracillima</i>	3	7.5	15
<i>Eryngium pinnatifidum</i> subsp. <i>palustre</i>	3	25.4	16
<i>Dodonaea hackettiana</i>	4	0.5	1

Three declared plants listed under *Biosecurity and Agricultural Management Act 2007* were also recorded within the development envelope including:

- \**Zantedeschia aethiopica* (Arum Lily)
- \**Asparagus asparagoides* (Bridal Creeper)
- \**Moraea flaccida* (One-leaf Cape Tulip).

### 2.2.2 Vegetation

Vegetation within the development envelope is predominantly made up of Banksia woodland and areas of wetland vegetation with varying levels of disturbance and integrity. A total of 40 vegetation communities were recorded consisting of 25 woodlands, two shrublands, two herbland/sedgeland and eleven other classifications of mapped areas (excluding open water, tracks and roads).

None of the vegetation communities recorded within the development envelope have been determined to be equivalent to State Threatened Ecological Communities (TECs) under the DPaW listings or Commonwealth TECs protected under the EPBC Act. In addition, determination of the Floristic Community Types relevant to the recorded vegetation communities did not suggest that Priority Ecological Communities (PECs) are supported by the Project area.

Eighteen vegetation communities are considered locally significant as they support populations of Priority Flora, regionally significant flora, significant flora of the Perth metropolitan region. Part of Bush Forever Site 244 also occurs within the development envelope. It includes vegetation associated with Bibra Lake, Roe Swamp and surrounding sumplands (UFIs 14425 and 15240), and Horse Paddock Swamp. The vegetation within the wetlands, wetland buffers and Bush Forever site is regionally significant in terms of its structural complexity, floristic assemblages and ecological patterns. Vegetation condition within the development envelope and the proposed construction footprint ranges from 'Excellent' to 'Completely Degraded'.

### 3. Baseline Flora and Vegetation Condition Survey

A Baseline Flora and Vegetation Condition Survey is required under Condition 10-2 of Statement 1008 dated 2 July 2015. The baseline survey will utilise the results of the AECOM (2011) study and will focus on surveying areas outside of the 'zone of indirect impacts' as per Condition 10-2(1). The survey will establish vegetation monitoring sites to determine baseline flora and vegetation condition within a 'buffer area' and 'reference area' as defined in Figure 2.

The 'buffer area' comprises a 15 m wide 'band' occurring outside the 'zone of indirect impacts' while the reference sites will be located outside of the buffer area and further from the 'zone of indirect impacts' (Figure 2). Degraded and non-native vegetation communities were excluded from the baseline monitoring program. The remaining fifteen vegetation communities will be monitored as part of the baseline flora and vegetation condition survey.

Due to the different sizes of each vegetation communities to be monitored, varying numbers of monitoring sites will be established within each community type as outlined in Table 3. The current number of monitoring sites equates approximately to one site per half hectare for each vegetation community. Each monitoring site will contain:

- one vegetation monitoring quadrat
- a soil moisture sampling point.

The location of each vegetation monitoring site within these vegetation communities is indicated on Figure 2 and the details of these monitoring sites are provided in Table 4.

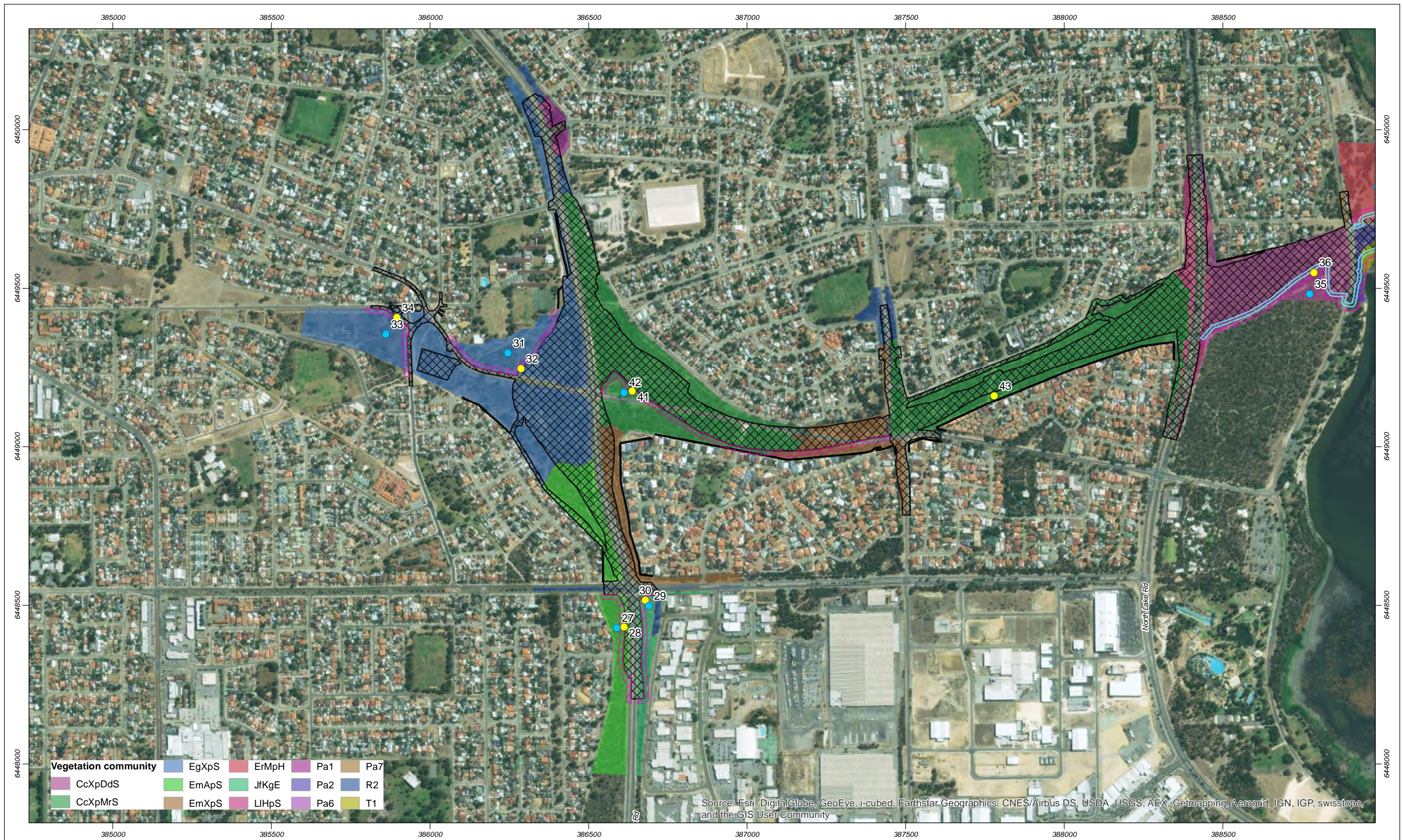


Table 3: Numbers of monitoring sites per vegetation community

Vegetation community	Number of buffer sites	Number of reference sites	Vegetation community description	Upland or wetland vegetation
BaNfW	1	0	Low Woodland of <i>Banksia attenuata</i> and <i>Nuytsia floribunda</i> with occasional <i>Banksia ilicifolia</i> over a Low Open Shrubland of <i>Xanthorrhoea preissii</i> with emergent <i>Kunzea glabrescens</i> over an Open Herbland of <i>Zantedeschia aethiopica</i> on grey-brown sandy loam.	Upland
BaTs	2	2	Low Open Woodland of <i>Banksia attenuata</i> and <i>Banksia menziesii</i> with occasional <i>Eucalyptus marginata</i> over an Open -Heath of <i>Allocasuarina humilis</i> , <i>Conostephium minus</i> and <i>Eremaea pauciflora</i> over an Open Grassland/Sedgeland of <i>Amphipogon turbinatus</i> and <i>Mesomelaena pseudostygia</i> on grey sand.	Upland
BiSiH	1	1	Low open woodland of <i>Banksia ilicifolia</i> over a tall open shrubland of <i>Kunzea glabrescens</i> over an open herbland of <i>Scholtzia involucreta</i> and <i>*Carpobrotus edulis</i> on grey sand.	Wetland
BXpW	2	2	Low open woodland of <i>Banksia attenuata</i> and <i>Banksia menziesii</i> with occasional <i>Eucalyptus marginata</i> over an open heath of <i>Hibbertia hypericoides</i> and <i>Xanthorrhoea preissii</i> over an open sedgeland of <i>Mesomelaena pseudostygia</i> on grey sand.	Upland
CcBKgS	2	2	Low open forest of <i>Corymbia calophylla</i> , <i>Banksia attenuata</i> and <i>Banksia ilicifolia</i> over a tall shrubland of <i>Kunzea glabrescens</i> over a low shrubland of <i>Xanthorrhoea preissii</i> with occasional <i>Macrozamia riedlei</i> over a herbland of <i>Lomandra</i> sp. and <i>Dasyopogon bromeliifolius</i> on grey sand.	Upland
CcXpDdS	1	1	Open Woodland of <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i> over a Low Open Shrubland of <i>Xanthorrhoea preissii</i> , <i>Macrozamia riedlei</i> , <i>Daviesia divaricata</i> and <i>Hibbertia hypericoides</i> over an Open Grassland of <i>*Ehrharta calycina</i> on grey sand over yellow sand.	Upland
CcXpMrS	2	1	Woodland to Open Woodland of <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i> over an Open to Low Shrubland of <i>Xanthorrhoea preissii</i> , <i>Macrozamia riedlei</i> and <i>Hibbertia hypericoides</i> over an Open Herbland of <i>*Oxalis pes-caprae</i> and <i>Sowerbaea laxiflora</i> over an Open Grassland of <i>*Briza maxima</i> and <i>*Ehrharta calycina</i> on brown sandy loam.	Update
EgXpS	2	2	Open Woodland of <i>Eucalyptus gomphocephala</i> and <i>Eucalyptus marginata</i> over a Low Open Woodland of <i>Banksia attenuata</i> over a Tall Open Shrubland of <i>Xanthorrhoea preissii</i> over an Open Sedgeland of <i>Mesomelaena pseudostygia</i> on yellow sand.	Upland
EmApS	1	1	Open Woodland to Low Open Woodland of <i>Eucalyptus marginata</i> and <i>Banksia attenuata</i> over Low Shrubland of <i>Acacia pulchella</i> , <i>Hibbertia hypericoides</i> , <i>Macrozamia riedlei</i> and <i>Xanthorrhoea preissii</i> over <i>*Briza maxima</i> on yellow sand.	Upland
EmKgS	1	1	Low woodland of <i>Eucalyptus marginata</i> with occasional <i>Corymbia calophylla</i> and <i>Banksia menziesii</i> over a tall shrubland of <i>Kunzea glabrescens</i> with occasional <i>Allocasuarina fraseriana</i> over a closed herbland of <i>*Carpobrotus edulis</i> on grey sand.	Wetland
ErCtS	1	2	Low woodland to open forest of <i>Eucalyptus rudis</i> , <i>Banksia attenuata</i> and <i>Melaleuca preissiana</i> over low open shrubland of <i>Taxandria linearifolia</i> , <i>Gastrolobium ebracteolatum</i> and <i>Pteridium esculentum</i> over closed sedgeland of <i>Cyathochaeta teretifolia</i> (P3) on brown sandy loam.	Wetland
ErMpAfS	2	2	Low open forest of <i>Eucalyptus rudis</i> and <i>Melaleuca preissiana</i> over a tall open shrubland of <i>Astartea fascicularis</i> and <i>Kunzea glabrescens</i> over an open shrubland of <i>Pteridium esculentum</i> over a sedgeland of <i>Lepidosperma</i> sp. on brown clayey-loam flats.	Upland
ErMpGeS	1	0	Low Open Forest of <i>Eucalyptus rudis</i> and <i>Melaleuca preissiana</i> with occasional <i>Banksia attenuata</i> over a Tall Shrubland of <i>Gastrolobium ebracteolatum</i> and <i>Kunzea glabrescens</i> over a Low Open Shrubland of <i>Taxandria linearifolia</i> over a Sedgeland of <i>Baumea preissii</i> subsp. <i>laxa</i> on black clay flats.	Upland

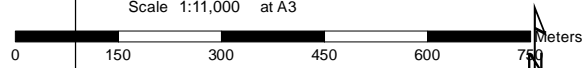
Vegetation community	Number of buffer sites	Number of reference sites	Vegetation community description	Upland or wetland vegetation
ErMpH	2	2	Open woodland to low open woodland of <i>Eucalyptus rudis</i> and <i>Melaleuca preissiana</i> over open herbland of <i>*Carpobrotus edulis</i> , <i>*Zantedeschia aethiopica</i> and <i>*Oxalis pes-caprae</i> on grey sand.	Upland
EtKgS	1	1	Low open woodland of <i>Eucalyptus todtiana</i> with occasional <i>Eucalyptus rudis</i> over a tall open shrubland of <i>Kunzea glabrescens</i> over an open herbland of <i>*Carpobrotus edulis</i> on grey sand.	Wetland
JfKgE	1	1	Tall Open Scrub of <i>Jacksonia furcellata</i> and <i>Kunzea glabrescens</i> over introduced grasses including <i>*Ehrharta longiflora</i> , <i>*Ehrharta calycina</i> and <i>*Briza maxima</i> in disturbed roadside areas.	Wetland
MpBaS	1	1	Open Forest of <i>Corymbia calophylla</i> , <i>Eucalyptus rudis</i> and <i>Banksia littoralis</i> over a Tall Shrubland of <i>Melaleuca preissiana</i> and <i>Kunzea glabrescens</i> with occasional <i>Melaleuca raphiophylla</i> over a Closed Sedgeland of <i>Baumea articulata</i> fringing wetlands on brown sandy loam.	Wetland
MpKgS	1	1	Low open woodland of <i>Melaleuca preissiana</i> and occasional <i>Eucalyptus rudis</i> over a closed tall scrub of <i>Kunzea glabrescens</i> over occasional <i>Lepidosperma</i> sp. over an Open Herbland of <i>*Zantedeschia aethiopica</i> over <i>*Aira caryophyllea</i> and <i>*Gallium murale</i> on brown sandy-loam.	Upland
	<b>25</b>	<b>24</b>		





**Figure 2: Proposed baseline monitoring sites - Section 1**

Scale 1:11,000 at A3



Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 7/09/2015  
 Author: DWhite  
 Source: Aerial image: ESRI, approx. 2010; Construction footprint: Client 2015.  
 Path: Q:\Consult\2015\MRO\MRO15099\ArcMap\_documents\MRO15099\_06\R0011\Rev 2\MRO15099\_06 R001 Rev2 F002\_A3.mxd

**Legend**

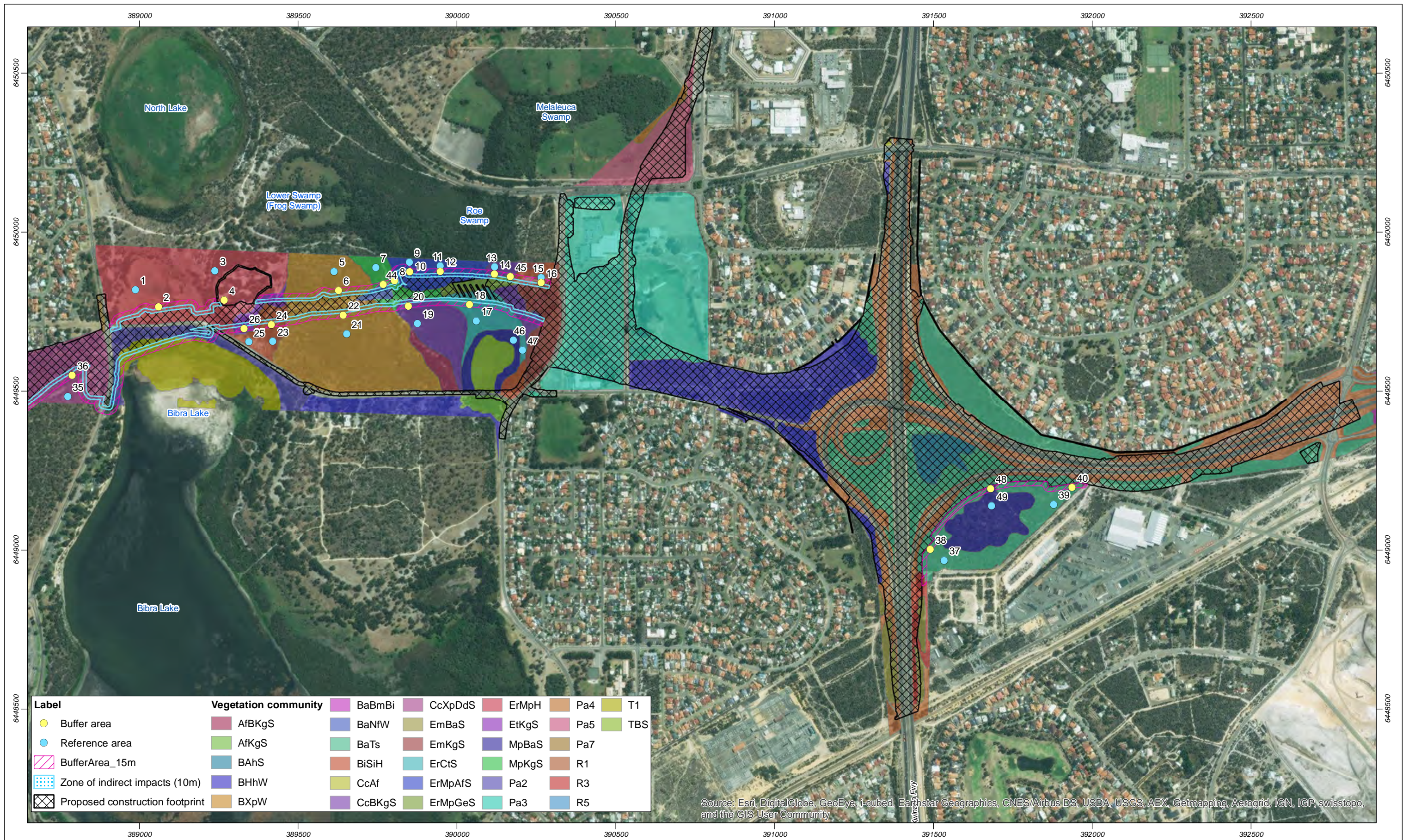
- Buffer area
- Reference area
- Zone of indirect impacts (10m)
- Buffer areas (15m)
- Proposed construction footprint











**Figure 3: Proposed baseline monitoring sites - Section 2**

Scale 1:11,000 at A3

0 100 200 300 400 Meters

Coordinate System: GDA 1994 MGA Zone 50  
 Note that positional errors may occur in some areas  
 Date: 7/09/2015

Author: DWhite  
 Source: Aerial image: ESRI, approx. 2010; Construction footprint: Client 2015.

Path: Q:\Consult\2015\MRO\MRO15099\ArcMap\_documents\MRO15099\_06\10011\Rev 2\MRO15099\_06 R001 Rev2 F003\_A3.mxd





Table 4: Baseline monitoring sites

Site ID	Location	Coordinates		Vegetation community
		Eastings	Northings	
1	Reference area	388987.77	6449818.85	ErMpH
2	Buffer area	389060.43	6449764.71	ErMpH
3	Reference area	389238.22	6449878.42	ErMpH
4	Buffer area	389267.48	6449785.70	ErMpH
5	Reference area	389613.31	6449876.68	BXpW
6	Buffer area	389627.00	6449816.47	BXpW
7	Reference area	389744.18	6449888.32	MpKgS
8	Buffer area	389744.51	6449831.86	MpKgS
9	Reference area	389850.75	6449905.46	ErMpAfS
10	Buffer area	389851.71	6449874.88	ErMpAfS
11	Reference area	389947.36	6449893.42	ErMpAfS
12	Buffer area	389947.36	6449876.63	ErMpAfS
13	Reference area	390119.42	6449890.62	CcBKgS
14	Buffer area	390118.03	6449868.23	CcBKgS
15	Reference area	390264.96	6449856.74	EmKgS
16	Buffer area	390264.96	6449841.25	EmKgS
17	Reference area	390061.31	6449721.00	ErCtS
18	Buffer area	390039.69	6449771.71	ErCtS
19	Reference area	389875.88	6449711.98	CcBKgS
20	Buffer area	389846.63	6449767.51	CcBKgS
21	Reference area	389652.97	6449679.49	BXpW
22	Buffer area	389642.39	6449738.13	BXpW
23	Reference area	389420.12	6449656.49	BiSiH
24	Buffer area	389415.76	6449708.76	BiSiH
25	Reference area	389345.22	6449654.32	EtKgS
26	Buffer area	389330.43	6449696.17	EtKgS
27	Reference area	386588.76	6448428.61	EmApS
28	Buffer area	386612.54	6448430.97	EmApS
29	Reference area	386690.05	6448498.24	JfKgE
30	Buffer area	386678.97	6448515.65	JfKgE
31	Reference area	386245.81	6449295.46	EgXpS

32	Buffer area	386287.22	6449246.02	EgXpS
33	Reference area	385860.96	6449355.11	EgXpS
34	Buffer area	385896.05	6449407.25	EgXpS
35	Reference area	388774.55	6449481.77	CcXpDdS
36	Buffer area	388788.61	6449549.11	CcXpDdS
37	Reference area	391533.81	6448966.89	BaTs
38	Buffer area	391490.16	6449001.52	BaTs
39	Reference area	391878.67	6449142.93	BaTs
40	Buffer area	391936.46	6449196.18	BaTs
41	Buffer area	386638.62	6449175.12	CcXpMrS
42	Reference area	386612.16	6449171.15	CcXpMrS
43	Buffer area	387779.74	6449160.41	CcXpMrS
44	Buffer area	389767.82	6449835.47	BaNfW
45	Buffer area	390168.53	6449859.70	ErMpGeS
46	Reference area	390177.69	6449660.02	MpBaS
47	Reference area	390206.30	6449628.59	ErCtS
48	Buffer area	391680.54	6449192.43	MpBaS
49	Reference area	391682.99	6449138.43	MpBaS

### 3.1.1 Vegetation monitoring

Vegetation monitoring sites will be permanently established by recording locations with a GPS unit and marked. Each vegetation monitoring site will contain one 10 x 10 m quadrat. Data will be collected from within the quadrat and will include:

- GPS location
- vegetation composition
- plant density (plants/m<sup>2</sup>)
- plant/weed foliage cover (%)
- vegetation condition
- a photograph taken at a designated point that can be compared to subsequent and/or previous photographs, to assess visible progress in maturing vegetation growth and visual aesthetics.

The locations of each vegetation monitoring site within these vegetation communities are indicated on Figure 2 and the details of these monitoring sites are provided in Table 4. All flora species occurring within monitoring quadrats will be identified. Flora species that are unidentifiable in the field will be systematically collected, pressed, dried and fumigated in accordance with the requirements of the West Australian Herbarium. These plant species will be identified via comparison with pressed specimens housed at the herbarium, and using taxonomic keys and other references. Key indicator species for flora and vegetation health will also be identified during baseline monitoring, and these will be used to monitor potential impacts as per the Flora and Vegetation Monitoring and Management Plan.

Vegetation condition will be determined using the measurements taken in each quadrat (i.e. percentage increase in weed cover and potential decrease in native vegetation cover). This will also consider disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure, site ecology and other relating factors.

Vegetation health will be determined by data collected from the monitoring plots. Vegetation composition, plant density and foliage cover will indicate if native plants are declining in occupied area which could potentially indicate vegetation stress and decline. Soil moisture sampling as described in section 3.1.2 will identify if any potential decline in vegetation health can be attributed to changes in groundwater.

### 3.1.2 Soil moisture

Vegetation may obtain water from groundwater, unsaturated soil above the groundwater table or a mixture of both. Therefore any potential reduction in available water within the soil has the potential to impact the health of vegetation.

Soil moisture content in the unsaturated zone can be affected by a number of factors including:

- soil type (coarse grained sandy soils are less effective at holding moisture than clayey soils)
- depth to groundwater (soil below the groundwater table is saturated, while soils above this display varying soil moisture contents)
- water inputs to soil, through precipitation or irrigation
- plant water uptake.

Soil moisture samples shall be taken from an approximate depth of 1 m within each vegetation monitoring plot. The sampling process will consist of:

- obtaining a soil sample from an approximate depth of 1 m using an appropriate soil core sampler
- placing the sample in a sealed bag (with as much air as possible removed)
- placing the sealed bag inside another similarly sealed bag
- analysis for soil moisture at a NATA accredited laboratory.

Soil corers shall be of a small diameter (maximum diameter 50 mm) to limit impacts to plant roots. Soil moisture samples shall be kept cool during transport to prevent evaporation.

Duplicate samples shall be taken at a rate of one duplicate sample per ten holes.

### **3.2 Timing**

The timing of vegetation monitoring for the baseline scope will include:

- baseline vegetation survey in spring 2015

Soil moisture sampling will be undertaken at the same time as vegetation data is collected.

### **3.3 Reporting and review process**

A monitoring report will be prepared following the conclusion of the baseline survey and after all subsequent monitoring events, summarising the results produced. The monitoring report will be submitted to the CEO of OEPA prior to construction commencing.



## 4. References

- AECOM 2009, *Flora and Vegetation Spring Survey 2009*, prepared by AECOM for the Department of Main Roads.
- AECOM 2010, *Kwinana Freeway Third Lane: Flora and Fauna Survey*. Report prepared for Main Roads Western Australia.
- AECOM 2011, *Roe Highway Extension Kwinana Freeway to Stock Road: Vegetation and Flora Assessment Phase 2*. Report prepared for Main Roads Western Australia.
- Environmental Protection Authority (EPA) 2004, *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. No. 51 Environmental Protection Authority*, Perth, Western Australia.
- Environmental Protection Authority (EPA) 2013, *Roe Highway Extension Report and Recommendations of the Environmental Protection Authority*, EPA Report 1489. Government of Western Australia, Perth.
- Hedde EM, Loneragan OW and Havel JJ 1980, *Darling System, Vegetation Complexes*, Forest Department, Perth.
- Keighery, BJ 1994, *Bushland Plant Survey – A Guide to Plant Community Survey for the Community Wildflower Society of WA (inc)*, Nedlands WA.
- South Metro Connect 2011, *Roe Highway Extension Public Environmental Review*, prepared by South Metro Connect for Main Roads Western Australia, 20 June 2011.