

**Keane Road Strategic Link  
Response to Submissions  
on Public Environmental Review**



**May 2014**

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## REPORT DETAILS

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# 1 INTRODUCTION

Keane Road is located approximately 20 km southeast of Perth and approximately 7 km northwest of the Armadale Strategic Regional Centre and connects the rapidly urbanising areas of Harrisdale, Piara Waters and Forrestdale. Keane Road is located within the City of Armadale and is made up of three distinct portions; two parts are constructed and a third central portion is not yet constructed but is partly cleared. The City has constructed Keane Road in stages over a period of many years. A dedicated road reserve has been previously set aside for all portions of the road, including the unconstructed portion. The Keane Road Strategic Link (KRSL) project entails the construction of the central portion of Keane Road, in order to link the currently constructed portions (Figure 1). This summary document responds to the key issues raised in submissions and identified by the Office of the Environmental Protection Authority (OEPA) as requiring responses and/or further clarifying information.

## 1.1 REPORT PURPOSE

This report documents:

- The submissions received on the KRSL Public Environmental Review (PER); and
- The City of Armadale's consideration of issues and responses to the submissions.

This report also provides:

- An overview of the KRSL project environmental factors, impacts and proposed management measures;
- An outline of the consultation activities undertaken;
- A discussion of project design changes; and
- The details of environmental impact assessment and management studies undertaken since the public release of the PER.

## 2 STAKEHOLDER CONSULTATION

A full list of the consultation conducted for this project, including consultation conducted, issues raised and responses/results is included in Appendix A.

### 2.1 CONSULTATION PROGRAM

#### 2.1.1 STAKEHOLDERS

The key stakeholders have been identified as follows and will continue to be consulted throughout the PER assessment process. Preliminary consultation has been through a range of mediums including letters, emails, phone calls, meetings and regularly updated information on website:

- Armadale Gosnells Landcare Group
- City of Armadale-North Forrestdale Planning Steering Group
- Conservation Council of Western Australia
- Department of Parks and Wildlife (DPaW, formerly DEC)
- Department of Education and Training
- Department of Environment (Commonwealth) (DoE)
- Department of Planning (DoP) (including its Bush Forever Unit section)
- Department of Water (DoW)
- Environmental Protection Authority (EPA)
- Forrestdale Community Association
- Friends of Forrestdale
- Jandakot Regional Park Community Advisory Committee
- Landowners within approximately 2 km of the project
- Metropolitan Redevelopment Authority (MRA)
- Public Transport Authority
- Swan River Trust
- Urban Bushland Council Inc.
- Water Corporation
- North Forrestdale Planning Steering Group (representing adjoining landowner/developers).

#### 2.1.2 PROCESS

The process utilised for stakeholder consultation includes:

- The development of a stakeholder database.
- Providing information to all stakeholders on the project.
- Seeking feedback from stakeholders on potential environmental and social impacts, impact management and project design.
- Documentation of all issues raised and how they have been considered during project development.
- Consideration of all issues raised in project design and management plans.

Methods used to facilitate consultation include:

- Letters
- Emails
- Phone Discussions
- Meetings and presentations
- Press releases and notices

- Posting information on the City of Armadale website including Project Summary and Project Updates
- Public meeting during advertising for formal submissions phase.

## 2.2 PREVIOUS CONSULTATION

The KRSL road reserve has been subject to several historical community consultation processes associated with the:

- Southern River Forrestdale Brookdale Wungong DSP formulated by the WAPC (2001)
- City of Armadale's TPS No. 4 (2005)
- Jandakot Regional Park Management Plan (Conservation Commission of Western Australia, 2010).

A summary of each historical consultation is provided below.

### 2.2.1 DISTRICT STRUCTURE PLAN

In 2001 the Western Australian Planning Commission (WAPC) set out the State government's land use planning framework for the suburbs of Southern River, Forrestdale, Brookdale and Wungong which involved a major transition from former rural uses to urban-residential development. In the DSP, Keane Road is identified as one of several key road system spines which is important in creating connectivity of planned urban land uses and liveable communities with access to facilities and services.

The formulation of the WAPC's DSP involved an extensive planning and community consultation process which commenced in November 1998 with the WAPC's employment of consultant Turner Master Planners. Community input and consultation was a significant part of the process and was sought at each stage of preparing the DSP. The consultation process involved holding three (3) Community Planning Workshops over 7 month period in which affected landowners/occupiers/community groups and the public were invited to participate in the workshops (invited groups from the Armadale community included the Friends of Forrestdale, Forrestdale Community Association, and Forrestdale Planning Advisory Committee):

- Workshop 1 identified issues such as land suitability, infrastructure, transport, employment as key issues.
- Workshop 2 canvassed 3 options for consideration. Options 1 and 3 included KRSL as a key movement spine system, whilst Option 2 specifically excluded KRSL.
- Workshop 3 proposed a composite preferred option amalgamating Options 1 and 3 (including KRSL) based on community feedback.

The Draft Southern River / Forrestdale / Brookdale / Wungong District Structure Plan (DSP) was advertised for public comment by a formal submissions period from 7<sup>th</sup> October 1999 to 21<sup>st</sup> January 2000. A Summary Brochure and Map of the preferred option which incorporated elements of Option 1 and Option 3 (ie both the options which had retained the Keane Road KRSL section to link the adjacent major urban cells) was published and widely circulated with all landowners/occupiers/ community groups invited to submit comments. After the assessment of public submissions by the WAPC the final DSP was adopted by the WAPC and released by Minister for Planning in January 2001.

## 2.2.2 TOWN PLANNING SCHEME NUMBER 4

Also in 1999-2000 and parallel to the District Structure Plan processes being overseen by the WAPC, the City of Armadale advertised a series of land use strategies as a forerunner to the City's review of its Town Planning Scheme.

In March to June 2004 draft Town Planning Scheme No. 4 was widely advertised for public comment. This process included providing all landowners within the City with a copy of the draft Scheme Map as part of a detailed Brochure about the proposed new Town Planning Scheme. Consistent with the preceding Scheme No.2 and earlier District Zoning Schemes, the detailed Brochure for Town Planning Scheme No. 4 identified the whole of the existing Keane Road dedicated road reserve including the currently unmade section termed the KRSL as a local road. All landowners were invited to comment upon the Scheme. No submissions were received on the subject of Keane Road and the November 2005 Gazettal of Town Planning Scheme No.4 made no modifications to the dedicated road reserve which, remains identified as a local road on the current Scheme Maps.

## 2.2.3 JANDAKOT REGIONAL PARK MANAGEMENT PLAN

In November 2004 the DEC (now DPaW) released a Jandakot Regional Park Draft Management Plan for a 3 month Public Comment period closing in February 2005. The Draft Management Plan canvassed closing and incorporating the unmade section of the dedicated Keane Road reserve into the conservation estate (i.e. this proposal accorded with Option 2 of the District Structure Plan which the WAPC had previously discarded from consideration in the District Structure Plan). However, following the assessment of public submissions the DEC dropped the recommendation for closure of the unmade section of Keane Road from final published Jandakot Regional Park Management Plan (Conservation Commission of Western Australia, 2010).

## 2.3 CONSULTATION DURING PER DEVELOPMENT PROCESS

The City of Armadale has carried out an extensive range of stakeholder consultation during the development of the PER as detailed with Appendix A.

## 2.4 CONSULTATION SINCE PUBLIC RELEASE OF THE PER

Since the public release of the PER the following additional stakeholder consultation has occurred (also detailed within Appendix A):

- A public meeting was held by City of Armadale on 22<sup>nd</sup> of January 2014 and was attended by approximately 150 people, including local residents, Friends of Forrestdale and other interest groups. Presentations were given at the meeting by City of Armadale to provide information on the project, the environmental impact assessment and management measures proposed. Questions were invited during the meeting and the City of Armadale encouraged attendees to make submissions to the EPA on the PER document.
- The City of Armadale met with Department of Parks and Wildlife (DPaW) to seek further feedback on key issues raised in their submission on the PER including ecological connectivity and edge effects.
- The City of Armadale met with the Office of the EPA (OEPA) to seek advice on the response to submissions document content and level of detail required.
- During the advertising process the City advised and notified all identified stakeholders that submissions were able to made on the PER (advised by letter and email and including all those persons and organisations that had made a formal submission to the City when the proposal was advertised between March and April 2013, under the EPBC Act 1999).

## 3 DESIGN CHANGES

### 3.1 DESIGN CHANGES SINCE REFERRAL TO THE EPA

Since referral of the PER, the City of Armadale has made a number of design changes to the project in order to minimise and mitigate environmental impacts as follows:

- Reduced the road width from 20 m (the width of the dedicated road reserve) to a final design width of 18.4 m (reducing the clearing footprint by approximately 0.24 ha) – Figure 3.
- Moved the majority of the road reserve alignment 5 m to the north, to ensure it includes the existing cleared firebreak for most of its length and aligning the road with other existing cleared areas wherever possible (reducing the clearing footprint by a further 0.86 ha) – Figure 4.
- Deviated the southern end of the alignment predominantly into private cleared farmland, to avoid disturbance of the TEC SCP10a (reducing the clearing footprint by a further 0.22 ha) – Figure 4.
- The road will be fenced, which will restrict access into the surrounding bushland from KRSL – Figure 3. Bushland users will be required to use other dedicated bushland access points. Reducing access to limited dedicated access points permitted or provided by the parkland manager is likely to reduce the opportunity for off road vehicle driving and arson
- Seven fauna underpasses will be installed along the KRSL alignment to allow for fauna movement and at least one underpass will be located in each major habitat type occurring along the road alignment to maintain a level of connectivity across all habitats (Figure 5).
- Identified surface water flow paths / areas of ponding will be maintained by a series of 300mm diameter pipe culverts. Each array of culverts will maintain the connectivity of these flow paths and ensure peak 100 year (Average Recurrence Interval events) flow rates are maintained without overtopping of the roadway.

### 3.2 DESIGN CHANGES SINCE PUBLIC RELEASE OF THE PER

Since the public release of the PER, based on submissions received, the following additional design changes have occurred.

#### 3.2.1 ROAD ALIGNMENT AND TEC BUFFER

The proposed road alignment has been changed slightly to increase the buffer to the Threatened Ecological Community (TEC) SCP10a (Figure 4 and 9). The City of Armadale have commissioned an Edge Effects Study (van Etten, 2014 – Appendix B) to determine a suitable buffer from the 18.4 m road disturbance area. The Edge Effects Study has predicted that edge effects from the managed sealed road are likely to extend no more than 3 m into adjacent dampland communities (such as TEC SCP 10a) – refer to Section 4.1.3 for further details. Therefore, the City has nominated a buffer of 5 m from the TEC SCP10a, to ensure that it is not affected by edge effects (such as weed invasion, hydrology impacts, dieback etc).

The revised alignment as shown in Figure 4 and 9 includes:

- A 5 m buffer from the TEC SCP10a thereby avoiding impacts on this community due to edge effects (edge effects are predicted to extend 3 m into dampland communities – van Etten, 2014).
- No change in overall vegetation clearing (total clearing is still 1.65 ha).
- No change to clearing predicted of priority flora.
- A reduction in the clearing of the two Priority Ecological Communities (PECs):
  - Clearing of the PEC SCP21c was reduced by 0.4% (or 300 m<sup>2</sup>)
  - Clearing of the PEC SCP22 was reduced by 0.1% (or 100 m<sup>2</sup>).

The revised road alignment clearing amounts for each native vegetation community are presented below in Table 1:

**Table 1: Clearing of Vegetation Communities Revised KRSL Alignment**

Code	Floristic Community Type	TEC/PEC Type	Size of Community within Study Area (ha)	Revised KRSL Clearing of this Community Type (ha)	Revised % Community Type to be cleared	Previous Road Alignment Clearing % (PER)	Change in % Clearing Resulting from Revised Road Alignment
SCP04	<i>Melaleuca preissiana</i> dampland	N/A	38.72	0.32	0.8	0.7	0.1
SCP05	Mixed shrub dampland	N/A	7.43	0	0	0	0
SCP10a	Shrublands on dry clay flat	TEC (Endangered)	4.47	0	0	0	0
SCP21a	Central <i>Banksia attenuata</i> - <i>Eucalyptus marginata</i> woodland	N/A	41.85	0.37	0.9	0.9	0
SCP21c	Low lying <i>Banksia attenuata</i> woodland or shrubland	PEC (Priority 3)	8.93	0.52	5.8	6.2	-0.4
SCP22	<i>Banksia ilicifolia</i> woodland	PEC (Priority 2)	5.78	0.09	1.6	1.7	-0.1
SCP23a	Central <i>Banksia attenuata</i> - <i>Banksia menziesii</i> woodland	N/A	23.94	0.35	1.5	1.5	0
<b>Total all Communities</b>			<b>131.12</b>	<b>1.65</b>	<b>1.26</b>	<b>1.26</b>	<b>0</b>

Total impacts to each vegetation community (including direct clearing and indirect edge effects) have been assessed in Appendix C.

### 3.2.2 FAUNA UNDERPASS DESIGN

A specialist review of fauna underpasses was undertaken to assess underpass design suitability for all species of vertebrate fauna which may occur on the site (Bamford Consulting Ecologists, 2014 – Appendix D). This review has been utilised to develop a revised underpass design as depicted in Figures 6 and 7 and outlined below:

- One 1200 mm x 1200 mm fauna underpass (box culvert) will be provided to maintain habitat connectivity for western grey kangaroos and wallabies, as well as other vertebrate fauna.
- Two 600 mm x 1200 mm fauna underpasses (box culverts) will be provided to maintain habitat connectivity for small female kangaroos and wallabies, as well as other vertebrate fauna.
- Four 450 x 1200 mm fauna underpasses (box culverts) will be provided to maintain habitat connectivity for other species of vertebrate fauna.

Increasing the heights of the underpasses including provision of one 1200mm x 1200mm underpass, will provide for the movement of the full suite of fauna potentially existing in Bush Forever 342 including the western grey kangaroo and brush wallaby (if present). Where required the battering of sections to natural ground level within the allocated road corridor will be augmented with masonry retention walling in appropriate sections of the road, in order to assist achieving the increased underpass height within the nominated clearing footprint.

As previously outlined within the PER:

- Underpass length will be confined to road footprint (18.4 m road width).
- Underpasses will be located in areas where they will not be inundated by surface water as far as practical (using the verified hydrology model to determine final placement location). Conceptual locations for fauna underpasses are shown in Figure 5.

The City of Armadale have also commissioned a Kangaroo Survey (Bamford Consulting Ecologists, 2014b) within Bush Forever Site 342, in order to gain further information regarding the size and status of the Western Grey Kangaroo population within the area, so that this can be considered as part of the environmental impact assessment and management proposed for the KRSL project. The resulting survey report is contained within Appendix E and is summarised in Section 4.2.3.

### 3.2.3 SURFACE WATER CULVERTS

Further hydrological assessment has been undertaken, in order to confirm the predicted hydrological impacts and refine recommended management measures for the project including:

- Review of modelling using LIDAR data (1 m contours) provided by Department of Water (DoW).
- Ground truthing of modelling using recent aerial photography clearly showing surface water inundation and associated rainfall data for the period (Water Technology, 2014 – Appendix F), refer to Section 4.3.3 for further information on model verification work undertaken.

This modelling has not resulted in major changes to predicted flow paths or areas of ponding on the existing site, which are created by existing low points and artificial tracks within the Bush Forever Site. Based on the additional model verification undertaken the proposed surface water design has been modified slightly as follows (Figure 8):

- Culvert designs for locations A and B are similar to those which were previously proposed involving six 300mm diameter pipe culverts installed in an array, to maintain existing hydraulic connectivity and downstream “diffuse” flow in these locations.
- Location C is near the existing Bailey Branch Drain which currently passes through 2 x 750mm diameter culverts at Keane Road. These culverts have a capacity of around 2.6m<sup>3</sup>/s. As detailed in previous government modelling (Department of Water, 2009) and shown in the current model results, ponding of water does already occur upstream of the proposed KRSL, south of the intersection of Keane Rd and Anstey Rd (in private farmland) under existing conditions for the 100 year ARI event. This existing upstream ponding within private farmland is connected to ponding downstream of the proposed KRSL alignment within native vegetation. Therefore instead of changing the capacity of the drain (which may change the current hydrology including ponding) it is proposed to provide a series of six 300mm diameter pipe culverts underneath KRSL near Bailey’s Branch drain, to maintain existing hydrological conditions including ponding on both sides of the KRSL under the 100 year ARI event.

## 3.3 SUMMARY OF ENVIRONMENTAL FACTORS, IMPACTS AND MANAGEMENT

Potential environmental impacts and proposed management measures for construction of the final section of Keane Road are summarised in Table 2 below. Changes to impacts and new management measures due to project changes made since public release of the PER are highlighted in blue text.

**Table 2: Summary of Potential Impacts, Proposed Management Measures and Predicted Environmental Outcomes**  
(blue text indicates changes to impacts and new management measures since public release of PER)

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
Flora and Vegetation	<p>Clearing of 1.65 ha</p> <p>Estimated indirect area of impact (edge effects) of 0.92 ha</p> <p>Total residual impact area is estimated to be 2.57 ha (less than 1% of the adjacent 368.89 ha of vegetation within Bush Forever Site 342)</p>	To maintain representation, diversity, viability and ecological function at the species, population and community level.	<p>1.65 ha of native vegetation will need to be cleared to complete the proposed road works. In addition the estimated indirect area of impact (edge effects) is 0.92 ha. Therefore the total residual impact area is estimated to be 2.57 ha (less than 1% of the adjacent 368.89 ha of vegetation within Bush Forever Site 342)</p> <p>Each vegetation type proposed to be cleared is well represented in the surrounding bushland. Two Priority Ecological Communities (PECs) have been identified within the proposed road clearing footprint (EnviroWorks Consulting, 2013a):</p> <ul style="list-style-type: none"> <li>SCP10a (WC Act Endangered, EPBC Act Critically Endangered TEC) does not intersect the proposed road clearing footprint and is not affected by estimated edge effects (indirect impacts). The 4.47 ha of this community estimated to occur within the study area would be better protected as a result of the KRSL project proposed, fencing and proposed rehabilitation offset.</li> <li>SCP21c (Priority 3 PEC) was found in this study in a number of quadrats across the study area including two quadrats intersecting the clearing footprint. It is generally found in slightly elevated positions above the <i>Melaleuca preissiana</i> heaths. Interpolation mapping has estimated that 0.52 ha of the total 8.93 ha SCP21c within the study area (or 5.8%), would be cleared as a result of the project. In addition it is estimated that 0.28 ha (or 3.14%) would be indirectly affected by edge effects. Therefore the total residual impact area is estimated to be 0.8 ha (8.96% of locally mapped community and very small proportion of total area of community on Swan Coastal Plain).</li> <li>SCP22 (Priority 2 PEC) was found within quadrats distributed centrally and mapping indicates this community intersects the clearing footprint as a strip between the <i>Banksia</i> woodlands and open heath communities. It is found fringing the <i>Banksia</i> woodlands on higher ground and occurs above the</li> </ul>	<ul style="list-style-type: none"> <li>Only the minimum area required will be cleared.</li> <li>The road width was reduced from 20 m to 18.4 m (reducing the clearing footprint by 0.24 ha).</li> <li>The clearing footprint has been planned to ensure any previously cleared areas, such as the existing cleared parts of the unsealed road reserve, fire break access tracks and fence lines are used wherever possible (reducing the footprint by 0.86 ha).</li> <li>The road has been re-aligned to move into private farmland to the south to further reduce the clearing footprint and protect the TEC, SCP10a. Further realignment of the road has also occurred to create a buffer from the road to the TEC of 5m.</li> <li>The clearing area will be clearly marked in the field and defined on plans using geographic coordinates. Contractors will be informed that only the delineated area is to be cleared.</li> <li>Unstabilised surfaces will not be left exposed for a long time.</li> <li>Pockets or strips of vegetation will be left undisturbed wherever possible.</li> <li>Clearing activities will be supervised by a City of Armadale Contract Manager to ensure clearing requirements are complied with.</li> <li>All construction personnel will be restricted to the road clearing footprint only – no driving or storage of equipment or vehicles outside the clearing footprint will be permitted.</li> <li>Only minimal clearing will occur of the PECs within the KRSL clearing footprint. Clearing will be limited to 0 ha (0%) of TEC SCP10a, 0.52 ha (5.8%) of PEC SCP21c and 0.09 ha (1.6%) of PEC SCP22. (further realignment of the road has occurred which decreased the clearing of the two PECs by 0.4% or 300 m<sup>2</sup> for PEC SCP21a and 0.1% or 100 m<sup>2</sup> for PEC SCP22).</li> <li>No Rare flora will be cleared by the project.</li> <li>Only minimal impact will occur to the Priority 4 flora species <i>Jacksonia sericea</i>. Less than 70 plants will be impacted, which is a small proportion (less than 3.5%) of the population (&gt; 2000 plants) found extensively in the area.</li> </ul>	<p>In total 1.65 ha of native vegetation clearing is required for the road. In addition the estimated indirect area of impact (edge effects) is 0.92 ha. Therefore the total residual impact area is estimated to be 2.57 ha. This residual impact of 2.57 ha represents less than 1% of the total area of 368.89 ha of bushland in the adjacent Bush Forever Site. The overall residual impact for the project is small in the context of the surrounding vegetation area therefore this vegetation loss is unlikely to result in significant impact to flora or vegetation.</p> <p>Only minimal clearing will occur of the PECs within the KRSL clearing footprint. Clearing will be limited to 0 ha (0%) of TEC SCP10a, 0.52 ha (5.8%) of PEC SCP21c and 0.09 ha (1.6%) of PEC SCP22.</p> <p>No Rare flora will be cleared by the project. Only minimal impact will occur to the Priority 4 flora species <i>Jacksonia sericea</i>. Less than 70 plants will be impacted, which is a small proportion (less than 3.5%) of the population (&gt; 2000 plants) found extensively in the area. No other clearing or indirect impact to priority flora will occur.</p>



Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
			<p><i>Melaleuca preissiana</i> heaths. Interpolation mapping has estimated that 0.09 ha of the total 5.78 ha SCP22 within the study area (or 1.6%) would be cleared as a result of the project. In addition it is estimated that 0.06 ha (or 1.04%) would be indirectly affected by edge effects. Therefore the total residual impact area is estimated to be 0.15 ha (2.6% of locally mapped community and very small proportion of total area of community on Swan Coastal Plain).</p> <p>Three species of flora listed by the DPaW as Priority Flora have been identified within Bush Forever Site 342, one of which occurs within the proposed road clearing footprint (EnviroWorks Consulting, 2013a):</p> <ul style="list-style-type: none"> <li>• <i>Jacksonia sericea</i> (Priority 4) – a large healthy population (&gt; 2000 plants) found extensively in the area. It is estimated that &lt;50 plants occur within the proposed clearing footprint and &lt;20 plants are within the area affected by predicted edge effects. In total residual impacts are estimated to be &lt;70 plants (less than 3.5% of the local population).</li> <li>• <i>Ornduffia submersa</i> (previously called <i>Villarsia submersa</i>) (Priority 4) – a localised population (of approximately 500 plants) not within the proposed clearing footprint or area of predicted edge effects. This population is currently threatened by ORV damage. The population will benefit from the additional protection provided by proposed fencing and increased community surveillance of the Bush Forever site.</li> <li>• <i>Stylidium longitubum</i> (Priority 3) - a large localised population (&gt; 1000 plants) in close proximity to the clearing footprint and area of predicted edge effects, but not intersecting them. This population is currently threatened by ORV damage. The population will also benefit from the additional protection provided by proposed fencing, access restriction and increased community surveillance (EnviroWorks Consulting, 2013a).</li> </ul>	<p>Drainage swales on each side of the road will ensure runoff is detained and contaminants are captured within the swale prior to water being infiltrated and available to surrounding vegetation.</p> <ul style="list-style-type: none"> <li>• Drainage swales will capture road side litter and will be cleaned out periodically by the City of Armadale.</li> <li>• The sealed road surface and stabilised, rehabilitated road embankment will prevent erosion.</li> <li>• It is likely unauthorised access by ORV will be reduced, as the current existing cleared unsealed road reserve, firebreak access track is one of the access points currently used. The firebreak will be replaced by a formed road which will increase passive surveillance and reduce access points.</li> <li>• The road boundaries will be fenced which will discourage access into the surrounding Bush Forever Site from the constructed sealed road.</li> <li>• Final rehabilitation will include seeding, planting, watering and other activities to revegetate any disturbed areas no longer required to be free of vegetation. For example the embankment sides and drainage swales will be rehabilitated.</li> <li>• Avoiding or minimising disturbance to areas with, or vulnerable to weed infestation where practicable.</li> <li>• Inspection of vehicles and machinery for soil and seeds during construction to ensure they are clean prior to arriving on-site. All mobile construction equipment shall be washed down and clean of mud, earth and seeds prior to site entry.</li> <li>• The City of Armadale will meet its ongoing requirements to control any declared weed species within the road reserve.</li> <li>• City of Armadale will liaise with the land manager for adjacent parkland in respect to undertaking on-going control of weeds along the road verge and in drainage swales to prevent spread of new weeds from the road into the surrounding areas.</li> <li>• Further sampling for dieback will be conducted prior to on-ground clearing construction works.</li> <li>• All vehicles and equipment will be free of soil and plant material before entering the site. If any dirt or plant material has been picked up, the vehicle must be brushed down with supplied bannister brushes. Hygiene procedures will be used for construction of the road in protectable dieback free</li> </ul>	<p>Indirect impacts will be limited to estimated areas (or less) via comprehensive weed, dieback, hydrology and access restriction measures as documented within this table and the PER.</p> <p>The EPA's environmental objective for Flora and Vegetation will be achieved through restricting clearing to the proposed road footprint and managing potentially adverse indirect impacts through the implementation of comprehensive management measures.</p> <p>Offsets have been proposed to counterbalance residual impacts.</p> <p>Keane Road will be completed as a district distributor road as planned to connect the existing constructed stages currently severed by the unsealed section of existing dedicated road reserve (KRSL). The completed road will provide the road network and access opportunities for adjacent business and residential communities to the schools, shops, recreation and business uses that have been put in place or allocated for future provision under the existing approved District Structure Plan and Town Planning Scheme. The completed movement corridor will foster social and economic development of the</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
			<p>Spread of weeds can impact native flora and vegetation by competing for space, nutrients and water. A total of 76 exotic species (weeds) have been identified at Bush Forever Site 342. Three Declared species are present. Activities associated with the project have the potential to cause:</p> <ul style="list-style-type: none"> <li>The introduction of additional weed species not already present in the project area.</li> <li>The spread of weeds that may already be present in the project area.</li> </ul> <p>Road construction could potentially spread dieback. Based on the dieback interpretation and sampling, it is concluded that there is a potentially 'protectable' dieback-free area (approximately 100 m in length) located in the northwest portion of the alignment. It should be regarded as 'protectable', which is an area for which the values at risk are significant and the benefits potentially sustained for more than a few decades. However, the disease front appears to have advanced up to 6 m in a northeasterly direction since November-December 2008, confirmed by sampling. It should be noted that as it is possible to obtain false negative results and therefore the dieback affected area may be larger than has been assessed based on the limited sample. Limited sampling is inconclusive and therefore it cannot be guaranteed the area is dieback free, given the short period and range of test conditions to date.</p> <p>Road construction could alter the existing pattern of fires which have been uncontrolled in the past or in future may be fuel reduction fires by the bushland manager. Any change in a natural fire regime of an area can have impacts on ecosystem functioning.</p>	<p>areas.</p> <ul style="list-style-type: none"> <li>Potentially dieback infested runoff from any cleaning down required will be contained.</li> <li>Training programs and inductions will be conducted for site personnel.</li> <li>Vegetated areas will be quarantined ahead of construction.</li> <li>All surface water will be contained on-site during construction. Runoff from the construction area will be contained, and not released into areas of native vegetation.</li> <li>Vehicles and machinery will be restricted to construction area and off-road driving will be prohibited. Excavation equipment will be restricted to the excavation area.</li> <li>Rehabilitated surfaces will be free-draining, and not provide water-logged conditions which can allow the pathogen to thrive.</li> <li>No soil or vegetation will be brought on-site, except that approved by the City of Armadale to be used in construction and rehabilitation.</li> <li>Any seedlings or plant stock brought on-site for rehabilitation will be sourced from nurseries with Nursery Industry Association wholesale accreditation, to ensure they are dieback-free.</li> <li>The road will be free-draining and hard-surfaced.</li> <li>The road will be fenced to prevent uncontrolled access to adjacent bushland, from the KRSL.</li> <li>Vehicles will be restricted to the operational area.</li> <li>Diesel fuel will be used rather than petrol vehicles where possible.</li> <li>An emergency muster area and communications will be provided.</li> <li>Site Safety Management Procedures will ensure fire risk is addressed.</li> <li>A site induction and training for workers, including fire protection and prevention measures, such as safe operating and waste disposal practices and restricted clearing within high fire risk areas will be provided.</li> <li>Ensure On-site water supplies will be available for potential fire-fighting use.</li> <li>Additional water will be available from the dedicated dust management water cart.</li> <li>Fire extinguishers will be supplied in vehicles.</li> <li>Unauthorised access will be prohibited by securing the site</li> </ul>	<p>Harrisdale and Forrestdale communities.</p> <p>The realigned reserve for Keane Road will provide an opportunity for utility service providers such as for sewer, water, energy and communications services to install future infrastructure without significant impact on vegetation including the adjacent TEC.</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
				<p>with fences and locked gates.</p> <ul style="list-style-type: none"> <li>Minimal hydrocarbons and no explosive will be stored on-site.</li> <li>The completed road will act as a fire break restricting fire movement between bushland north and bushland south of the road.</li> <li>Reticulated fire hydrants will be pre-installed in the road to act as strategic fire fighting points.</li> <li>The road will provide access for fire emergency management vehicles to fight fire breeding out in the Bush Forever bushland.</li> <li>The road will be fenced, which will restrict access into the surrounding bushland from KRSL. Bushland users, will be required to use other dedicated bushland access points. Reducing access to limited dedicated access points permitted or provided by the parkland manager is likely to reduce the opportunity for arson.</li> <li>Road embankments and drainage swales will act as a buffer reducing likelihood of accidental fire from road (due to any illegal littering of ignited materials such as cigarettes).</li> <li>Completion of Keane Road will increase passive community surveillance and foster a greater sense of local community "ownership" of the adjacent park bushland, which would improve fire reporting and emergency response times and may reduce arson.</li> </ul>	
Terrestrial Fauna	<p>Clearing of 1.65 ha</p> <p>Estimated indirect area of impact (edge effects) of 0.92 ha</p> <p>Total residual impact area is estimated to be 2.57 ha (less than</p>	To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.	<p>Direct mortality of common species during clearing is unavoidable but can be minimised. Vehicles on roads commonly collide with wildlife as many roads have not been designed with consideration of fauna. Fragmentation of habitat can also affect wildlife if not managed appropriately. Direct and on-going mortality (in particular from road collisions) may be a concern for the viability of species that occur at low population densities in areas adjacent to the project area. Roadkill may be a significant threat to species with viable populations such as the Quenda (Southern Brown Bandicoot) and other mammals, but impacts can be minimised with appropriate management.</p> <p>Loss of habitat creates additional pressure on fauna to compete for food, shelter, breeding habitat and other resources. The project will result in the loss of some</p>	<ul style="list-style-type: none"> <li>Clearing of fauna habitat will be minimised (refer to vegetation clearing management measures above).</li> <li>No clearing will occur of the following significant fauna habitats: <ul style="list-style-type: none"> <li>Waterfowl wetland habitat.</li> <li>Black cockatoo breeding habitat.</li> <li>Rainbow bee-eater breeding habitat.</li> <li>Megamouth bee (newly discovered species) breeding area.</li> </ul> </li> <li>Clearing of Carnaby's Black Cockatoo foraging habitat will be limited to 0.61 ha within the clearing footprint (estimated to be less than 1% of the available habitat within the adjacent Bush Forever Site).</li> <li>No clearing will occur of the Megamouth bee mapped breeding area.</li> <li>Clearing of Short Tongued native bee foraging plants will</li> </ul>	<p>In total 1.65 ha of clearing is required for the road. In addition the estimated indirect area of impact (edge effects) is 0.92 ha. Therefore the total residual impact area is estimated to be 2.57 ha. This residual impact of 2.57 ha represents less than 1% of the total area of 368.89 ha of bushland in the adjacent Bush Forever Site. The overall residual impact for the project is small in the context of the surrounding area therefore this habitat impact is unlikely to result in significant impact to fauna.</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
	1% of the adjacent 368.89 ha of vegetation /habitat within Bush Forever Site 342)		<p>fauna habitat (vegetation). However, the clearing footprint proposed for the project is small in the context of the surrounding available habitat (1% of surrounding bushland) therefore this habitat loss is unlikely to result in significant impact to fauna.</p> <p>Keane Road already exists as a partially cleared but unsealed road access and firebreak, however once constructed as a completed sealed road link it will present an additional physical barrier to terrestrial fauna movements across Bush Forever Site 342. This may isolate smaller fauna species, preventing genetic transference between fragmented populations and may restrict some species to particular habitat types.</p> <p>Other potential impacts include:</p> <ul style="list-style-type: none"> <li>• Competition or predation by feral animals</li> <li>• Interruptions of hydro-ecological processes</li> <li>• Fire impacts (loss of habitat and direct mortality)</li> <li>• Noise or lighting induced behavioural changes.</li> </ul>	<p>be limited to approximately 40 individual plants of the estimated population of 5000 individuals of known host plant species (0.8%) and approximately 66 individual plants of the estimated population of 9250 individuals of potential host plant species (0.7%).</p> <ul style="list-style-type: none"> <li>• Construction will only be during daylight hours.</li> <li>• Seven fauna underpasses will be installed along the KRSL alignment to allow for fauna movement and at least one underpass will be located in each major habitat type occurring along the road alignment to maintain a level of connectivity across all habitats.</li> <li>• Revised underpass design as follows: <ul style="list-style-type: none"> <li>○ One 1200 mm x 1200 mm fauna underpass (box culvert) will be provided to maintain habitat connectivity for western grey kangaroos and wallabies, as well as other vertebrate fauna.</li> <li>○ Two 600 mm x 1200 mm fauna underpasses (box culverts) will be provided to maintain habitat connectivity for small female kangaroos and wallabies, as well as other vertebrate fauna.</li> <li>○ Four 450 x 1200 mm fauna underpasses (box culverts) will be provided to maintain habitat connectivity for other species of vertebrate fauna.</li> <li>○ Underpass length will be confined to road footprint (18.4 m).</li> <li>○ Underpasses will be located in areas where they will not be inundated by surface water (using the verified hydrology model to determine final placement location).</li> </ul> </li> <li>• The fauna underpasses will be designed in accordance with current best practice design principles for fauna underpasses.</li> <li>• The City will monitor the road reserve and fauna underpasses quarterly and will liaise with DPaW on feral animal control methods if monitoring indicates evidence of problem predation.</li> <li>• The road boundary will be fenced to the specifications of DPaW, to guide fauna to underpasses and prevent them crossing the road directly. This will reduce roadkill risk.</li> <li>• A maximum speed limit of 70 km/h will be applied to the road and sign posted.</li> <li>• Signage indicating the area is a potential fauna crossing will be installed.</li> </ul>	<p>No clearing of significant habitat for waterfowl, black cockatoo breeding, rainbow bee-eater breeding or Megamouth bee (newly discovered species) breeding area will occur.</p> <p>Clearing of black cockatoo foraging habitat will be limited to 0.61 ha or less than 1% of surrounding available habitat.</p> <p>Clearing of short tongue native bee foraging plants will be limited to less than 1% of known and potential foraging plants in the local area.</p> <p>The EPA's environmental objective for Terrestrial Fauna will be achieved through restricting clearing to the proposed road footprint and managing potentially adverse indirect impacts through the implementation of comprehensive management measures.</p> <p>Offsets have been proposed to counterbalance residual impacts.</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
				<ul style="list-style-type: none"> <li>Rehabilitation of some disturbed areas will also provide new habitat.</li> <li>Road safety lighting at night will be directed inwards towards the road to minimise light overspill into the surrounding bushland.</li> <li>Land offsets will increase the net long term protection of fauna in the southern part of Forrestdale particularly around Forrestdale Lake.</li> </ul>	
Hydrological Processes	Road Alignment	To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.	<p>The road works proposed have some potential to change surface water flows as follows:</p> <ul style="list-style-type: none"> <li>Changes to the flow and/or capacity of the arterial drainage in the area leading to excessive flooding or drying of wetland or urban areas.</li> <li>Road embankments leading to excessive surface water ponding in the wetland on the southwest side of the section of road proposed to be constructed.</li> </ul> <p>Potential wetland impacts include:</p> <ul style="list-style-type: none"> <li>Change to natural hydrology (surface flows, inundation and surface/groundwater interaction) potentially leading to impacts on vegetation or wetland ecology.</li> </ul> <p>The above impacts have the potential to impact the Conservation Category Wetland which KRSL is proposed to cross (the Keane Anstey Wetland).</p>	<ul style="list-style-type: none"> <li>No changes will occur to the flow and/or capacity of the arterial drainage in the area leading to excessive flooding or drying of wetland or urban areas as a result of the KRSL project.</li> <li>The road has been designed as a single lane in each direction and will be unkerbed with a low profile drainage swale on each side which will be designed to maximise surface water infiltration, in order to mimic the pre-construction environment.</li> <li>Identified flow paths / areas of ponding will be maintained by a series of 300mm diameter pipe culverts. Each array of culverts will maintain the connectivity of these flow paths and ensure peak 100 year (Average Recurrence Interval events) flow rates are maintained without overtopping of the roadway.</li> <li>Bailey Branch Drain currently passes through 2 x 750mm diameter culverts at Keane Road. These culverts have a capacity of around 2.6m<sup>3</sup>/s. As detailed in previous government modelling (Department of Water, 2009) and shown in the current model results, ponding of water does already occur upstream of the proposed KRSL, north of the intersection of Keane Rd and Anstey Rd (in private farmland) under existing conditions for the 100 year ARI event. This existing upstream ponding within private farmland is connected to ponding downstream of the proposed KRSL alignment within native vegetation. Therefore instead of changing the capacity of the drain (which may change the current hydrology including ponding) it is proposed to provide a series of six 300mm diameter pipe culverts underneath KRSL near Bailey's Branch drain, to maintain existing hydrological conditions including ponding on both sides of the KRSL under the 100 year ARI event.</li> <li>Vegetation clearing has been minimised as far as</li> </ul>	<p>Road design includes the provision of culverts to maintain flow connectivity and the unkerbed profile with swale arrangement facilitates infiltration. There are no predicted impacts from the road to surface water flow paths and no impacts on groundwater level or flows. On this basis it is highly unlikely that the proposed project will have a detrimental effect on wetland hydro-ecology (Water Technology, 2013).</p> <p>Quantitative, ground truthed and verified modelling has shown that no impacts will occur to the hydrological processes of the Conservation Category Wetland which KRSL is proposed to cross as follows:</p> <ul style="list-style-type: none"> <li>There are three areas of ponding across the proposed road alignment.</li> <li>A series of 300m diameter pipe culverts will ensure the connectivity of areas of ponding underneath the proposed road and ensure there are no impacts on the local surface water ponding and flows.</li> <li>There are no impacts of the road on the local</li> </ul>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
				<p>practicable. The removal of 1.65 ha of native vegetation from the road alignment will tend to reduce the current rate of evapo-transpiration occurring in the corridor. However, the changes in hydrology from altered evapo-transpiration would be negligible due to the low biomass of native vegetation that will be removed to construct the road.</p> <ul style="list-style-type: none"> <li>Road designs include that runoff is captured in detention swales, which will encourage infiltration to ensure no change to pre-existing groundwater infiltration/recharge in the area from the impervious road surface.</li> <li>Excavation required for the project is minimal and will be conducted during minimum groundwater level period. Excavation below the groundwater table is unlikely and dewatering will not be required, therefore changes to groundwater hydrology are not likely and further management is not required.</li> <li>The City of Armadale also commit to the development and implementation of a Water Management Plan prior to road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include: <ul style="list-style-type: none"> <li>An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and</li> <li>Details of water management measures including but not limited to: <ul style="list-style-type: none"> <li>long-term maintenance of the drainage swales and culverts</li> <li>management actions for weed control in swales</li> <li>maintaining the vegetation on the road embankments and swales</li> <li>managing sedimentation from up gradient of the culverts; and</li> <li>maintenance and monitoring of the culverts and associated rock rip raps.</li> </ul> </li> </ul> </li> </ul>	<p>groundwater or surface water system as the road design allows for the provision of culverts to maintain flow connectivity; the un-kerbed profile with swale arrangement facilitates infiltration; and the use of the swale for water quality treatment along the alignment will minimise water quality impacts.</p> <ul style="list-style-type: none"> <li>As there are no impacts from the road to surface water flow paths and no impacts on groundwater level, flows or water quality, there will be no impacts to the hydrological regimes of groundwater and surface water including existing and potential uses and wetland groundwater dependent or surface water dependent vegetation or ecosystems.</li> </ul> <p>Direct and indirect impacts to wetland vegetation and fauna are covered above under the relevant sections of this table.</p> <p>The EPA's environmental objective for Hydrological Processes will be achieved through the implementation of comprehensive management measures.</p>
Inland Waters Environmental Quality	Road Alignment	To maintain the quality of groundwater and surface water,	<p>There is potential for water quality to be impacted as follows:</p> <ul style="list-style-type: none"> <li>Earthworks may cause sedimentation of water in</li> </ul>	<ul style="list-style-type: none"> <li>Earthworks will be planned and managed to ensure any runoff will be managed using an infiltration approach, thereby minimising mobilisation of sediment.</li> </ul>	<p>Water quality impacts within and adjacent to the Conservation Category Wetland will be prevented by:</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
		<p>sediment and biota so that the environmental values, both ecological and social, are protected.</p>	<p>arterial drains if not managed appropriately.</p> <ul style="list-style-type: none"> <li>Hydrocarbons or chemicals utilised by construction contractors have the potential to cause contamination of soil or water via spills or leaks.</li> <li>Runoff from the road surface (containing contaminants from vehicles) has the potential to cause contamination of soil or water.</li> <li>Potential for a major spill of fuel or oil from a vehicle accident.</li> </ul> <p>Potential wetland impacts include:</p> <ul style="list-style-type: none"> <li>Changes to surface/groundwater quality, including sedimentation or contamination leading to impacts on vegetation or wetland ecology.</li> </ul> <p>The above impacts have the potential to impact the Conservation Category Wetland which KRS� is proposed to cross (the Keane Anstey Wetland).</p>	<ul style="list-style-type: none"> <li>Hydrocarbons and chemicals utilised by construction contractors will be appropriately stored, transported, used and disposed to prevent contamination occurring.</li> <li>Road design principles will ensure runoff is captured in vegetated detention swales which will manage water quality.</li> <li>Culverts to maintain flow connectivity underneath the road including downstream rip rap to minimise erosion and water sedimentation related water quality impacts.</li> <li>In the case of a vehicle accident a fuel tank could be ruptured leading to an emergency spill. However given the road is a local road with no heavy vehicle traffic, large scale spills from fuel or chemical transport trucks will not occur. In the case of minor spill from a local residential vehicle fuel tank, the spill would be contained by the roadside swales to avoid release to the environment and emergency authorities would be contacted and the spill within the swale remediated appropriately.</li> <li>The City of Armadale also commit to the development and implementation of a Water Management Plan prior to road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include: <ul style="list-style-type: none"> <li>An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and</li> <li>Details of water management measures including but not limited to: <ul style="list-style-type: none"> <li>long-term maintenance of the drainage swales and culverts</li> <li>management actions for weed control in swales</li> <li>maintaining the vegetation on the road embankments and swales</li> <li>managing sedimentation from up gradient of the culverts; and</li> <li>maintenance and monitoring of the culverts and associated rock rip raps.</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>The provision of culverts to maintain flow connectivity including downstream rip rap to minimise erosion and water sedimentation;</li> <li>The un-kerbed road profile with swale arrangement which facilitates infiltration of road run-off; and</li> <li>The use of vegetated swales to capture and detain road runoff and achieve water quality treatment. The swales would also capture a spill if this occurred in the unlikely event of a local residential vehicle fuel tank rupture;</li> <li>Appropriate management of runoff, hydrocarbons and chemicals during road construction;</li> <li>Restricting use of the road to local residential vehicles only (no heavy vehicles with the exception of buses) which prevents the use of the road by fuel and chemical transport trucks and negates the risk of a large scale hazardous spill; and</li> <li>Appropriate response to any minor spills captured within swales (caused by local residential vehicle accidents).</li> </ul> <p>Given water quality impacts will be prevented, there will be no related impacts to the Conservation Category Wetland</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
					<p>water, sediment and biota quality including but not limited to groundwater dependent or surface water dependent vegetation or ecosystems.</p> <p>Direct and indirect impacts to wetland vegetation and fauna are covered above under the relevant sections of this table</p> <p>The EPA's environmental objective for Inland Waters Environmental Quality will be achieved through comprehensive management measures.</p>
Terrestrial Environmental Quality	Road Footprint	To maintain the quality of land and soils so that the environment values, both ecological and social, are protected.	<p>There can be potential impact from Acid Sulphate Soils (ASS) if acid generating material is exposed to oxygen, which can cause leaching of acidic materials and contaminate groundwater and surface water. This can be caused by excavation and dewatering activities.</p> <p>Based upon the results of the ASS investigation, ASS identified beneath the proposed road alignment are at depths of greater than 1.25 m. However, based on the planned road design, excavation below 1 m should not be required. In addition dewatering is not required. Therefore, disturbance of ASS or generation of acidic water through dewatering will not occur.</p> <p>Waste may be generated during construction of the road. If inappropriately managed, the disposal of waste streams has the potential to:</p> <ul style="list-style-type: none"> <li>• Degrade the environment through the contamination of soil, groundwater and surface water.</li> <li>• Cause resource wastage through inefficient recycling or over-ordering.</li> <li>• Pose a risk to human safety or health, potentially resulting in injury or the spread of disease.</li> <li>• Reduce the amenity of an area due to visual and</li> </ul>	<ul style="list-style-type: none"> <li>• Disturbance of ASS or generation of acidic water is considered unlikely given: <ul style="list-style-type: none"> <li>○ Excavation below 1 m (into potentially acid sulphate soils) is not likely to be required.</li> <li>○ Dewatering is not required given construction is not required below the water table.</li> </ul> </li> <li>• If excavation below 1 m is required (due to an unexpected problem, such as deep tree root etc.) then the ASS management plan, contained in the report by Douglas Partners (2009) will be utilised.</li> <li>• All solid waste placed in designated, secure storage area on-site.</li> <li>• Ensuring waste will not be directly or indirectly lost to the environment.</li> <li>• Minimising wastage including waste separation where possible.</li> <li>• Recycling and waste reduction encouraged on-site where possible.</li> <li>• Any hazardous material spilled will be cleaned up immediately and disposed of appropriately.</li> <li>• Hazardous or regulated wastes will be disposed of to a licensed waste facility by an appropriate contractor and associated documentation kept on file.</li> <li>• All site personnel will be made aware of waste management and site procedures via inductions.</li> </ul>	<p>Based on the extent of ASS and proposed road construction it is unlikely ASS will be disturbed.</p> <p>The EPA's environmental objective for Terrestrial Environmental Quality will be achieved through:</p> <ul style="list-style-type: none"> <li>• Managing potential ASS impacts through the implementation of a management plan should disturbance of ASS be required.</li> <li>• Comprehensive waste management measures.</li> <li>• Comprehensive hazardous materials management measures.</li> </ul>



Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
			<p>odorous impacts.</p> <p>If inappropriately managed, the transport, handling, storage and use of hazardous materials (including potential leaks and spills) have the potential to:</p> <ul style="list-style-type: none"> <li>Degrade the environment through the contamination of soil, groundwater and surface water.</li> <li>Pose a risk to human safety or health, potentially resulting in injury or the spread of disease.</li> </ul>	<ul style="list-style-type: none"> <li>If hazardous materials are required during construction, limiting storage to designated areas, which are appropriately signed, banded and contained.</li> <li>All substances labelled and stored in accordance with relevant codes and standards where applicable.</li> <li>All Material Safety Data Sheets (MSDS) maintained and easily accessible/located on-site for all fuels and chemicals on-site.</li> <li>Handling materials in line with associated documented procedures.</li> <li>Regular housekeeping and inspection to ensure that storage is appropriate.</li> <li>Implementation of spill response procedures and provision of appropriate emergency equipment (including spill kits) on-site.</li> <li>Refuelling completed at designated areas only.</li> <li>All personnel trained in hazardous substance management and spill response procedures.</li> <li>Copies of hazardous substance management and spill procedures available with spill kits and in designated hazardous substance storage areas.</li> </ul>	
Amenity	Neighbours to Road Alignment	To ensure that impacts to amenity are reduced as low as reasonably practicable.	<p>If noise regulatory requirements or guidance criteria are exceeded, this may lead to potential impacts on sensitive receptors (neighbours).</p> <p>Excessive dust can have adverse impacts on surrounding land user's welfare and amenity, as well as the health of surrounding vegetation. Dust may be generated during a number of processes, including clearing, stripping, excavation and earthworks. Imported fill and topsoil stockpiles, and topsoil spreading during rehabilitation may also generate windblown dust. Dust is only likely to be generated during construction of the road given it will be a sealed road once operational.</p> <p>Potential impacts from dust include:</p> <ul style="list-style-type: none"> <li>Impacts to sensitive receptors (neighbours).</li> <li>Impacts to surrounding vegetation.</li> </ul>	<ul style="list-style-type: none"> <li>Design to ensure average height of the road is approximately 1 m <a href="#">with fill of approximately 1.5m in locations appropriate to accommodate the recommended additional fauna underpass heights.</a></li> <li>Construct road in accordance with design parameters.</li> <li>Surface the new portion of KRSL with dense graded asphalt.</li> <li>Re-surface the existing portion of Keane Road with open graded asphalt.</li> <li>Plan stockpile locations to provide noise barriers between earthworks and residents.</li> <li>Maintain all mobile equipment in good condition, with efficient mufflers and noise shielding.</li> <li>Provide all workers with appropriate noise protection equipment.</li> <li>Fit warning lights rather than audible alarms to mobile equipment wherever possible.</li> <li>Conduct training programs and inductions for site personnel on noise minimisation and protection.</li> <li>Schedule activities for the least disruptive times, to minimise the likelihood of noise nuisance.</li> </ul>	<p>Road design, construction methods and operational control (including speed limits) will minimise potential negative impacts to land user amenity.</p> <p>The EPA's environmental objective for Amenity will be achieved through comprehensive management measures.</p> <p>The completed road will contribute to amenity to the Harrisdale and Forrestdale districts by overcoming the existing severance of the existing Keane Road dedicated reserve resulting from the section not yet fully constructed and sealed.</p>

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
				<ul style="list-style-type: none"> <li>• Limit speed to 70 km/h.</li> <li>• Monitor traffic numbers on KRSL. Before 6000 vehicles are using Keane Road daily: <ul style="list-style-type: none"> <li>◦ Reduce the speed limit to 60 km/h</li> <li>◦ Ensure Quiet House Design on adversely affected residences exceeding health standards.</li> <li>◦ Ensure installation of noise barriers.</li> </ul> </li> <li>• If the land along existing Keane Road is subject to future property development ensure via planning controls, that appropriate noise controls are implemented such as physical planning measures or buffers from the road, to ensure new residents do not receive noise levels above the relevant criteria as a result of traffic on the subject KRSL section of Keane Road.</li> <li>• Dust will be visually monitored daily to ensure control measures are effective.</li> <li>• Cleared areas will be limited and hydro-mulched if being left bare for an extended period. As much vegetation will be retained as possible.</li> <li>• Activities with high dust-causing potential, such as topsoil stripping, will not be carried out during adverse wind conditions.</li> <li>• When winds are sufficiently strong to negate the effects of dust management, operations will cease until conditions improve.</li> <li>• Dedicated water trucks will be used for all on-site dust suppression if necessary.</li> <li>• Stockpiles will be built to limit the height and slope, to reduce wind pickup and located in sheltered areas if possible.</li> <li>• Inductions will be conducted for site personnel on dust minimisation.</li> <li>• A complaints recording, investigation, action and reporting procedure will be provided.</li> </ul>	
Heritage	Road Footprint	To ensure that historical and cultural associations are not adversely affected.	A potential impact to cultural heritage, is disturbance of aboriginal heritage sites should they exist. The Cultural Heritage Study did not identify any Cultural Heritage Sites in the project development area. However, potentially an unknown site could be discovered during construction works.	<ul style="list-style-type: none"> <li>• An Aboriginal representative will be engaged to monitor ground-disturbing activity during earthworks.</li> <li>• All contractors and personnel will be aware of the potential for uncovering sub-surface Aboriginal cultural material during ground disturbing works and adopt a Cultural Material Contingency Plan (refer to Appendix P which contains this plan).</li> <li>• The City of Armadale will consider the concerns and</li> </ul>	The EPA's environmental objective for Heritage will be achieved through comprehensive management measures.

Factor	Relevant Area	EPA Objective	Potential Environmental Impacts	Management Measures	Predicted Outcome
				<p>requests raised by the Aboriginal representative, which include Aboriginal representative monitoring of ground disturbance works and impacting on the flora, fauna and wetland as little as possible.</p> <ul style="list-style-type: none"> <li>• All City of Armadale staff and contracting personnel will be made fully aware of their obligations under the <i>Aboriginal Heritage Act 1972</i>. To facilitate this, it is recommended that a copy of the <i>Aboriginal Heritage Act 1972</i> be available on-site for reference at all times.</li> <li>• In the event a cultural heritage site is identified and is unavoidable to disturb, a Section 18 Application under the <i>Aboriginal Heritage Act 1972</i> would be undertaken.</li> </ul>	

### 3.4 REVISED KEY CHARACTERISTICS TABLE

The table below outlines the revised project key characteristics including the design changes outlined in the Sections above. Figure 3 shows a typical road cross section for this project.

**Table 3: Key Characteristics of the Project**

Element	Description
<b>General</b>	
Construction Period	7–8 months approximately
Project Life	Indefinite assuming good road maintenance
<b>Proposed Road</b>	
Road design	A single carriageway (one lane for each direction) and dual use pathway
Length	1.5 km
Width	18.4 m (including road, drainage swales, footpath and fencing)
Speed limit	70 km/h
Height	0.8–1.5 m (on average 1 m) above natural ground level
Total footprint	2.75 ha (including cleared tracks)
Cleared areas within footprint (firebreak / tracks / farmland)	1.1 ha
Proposed total vegetation clearing	1.65 ha (areas already cleared for firebreak and tracks not included)
Estimated indirect area of impact (edge effects)	0.92 ha
Estimated total area of residual impact (direct clearing plus estimated edge effects)	2.57 ha (1.65 ha of clearing plus 0.92 ha of estimated edge effects)
Surface Water Culverts	18 x 300mm diameter pipe culverts in arrays of 6 culverts, at three mapped 100 year ARI flooding areas.
Fauna Underpasses	7 in total
Fauna Underpass Dimensions	Box culverts: <ul style="list-style-type: none"> <li>• One 1200 mm high x 1200 mm wide</li> <li>• Two 600 mm high x 1200 mm wide</li> <li>• Four 450 high x 1200 mm wide.</li> </ul>
Fill Material	Locally sourced Bassendean sand and crushed limestone sub-grade and road base material. This material will be certified as dieback free where required by the Dieback Management Plan for the road.
<b>Construction Support Infrastructure/Resources (temporary)</b>	
Construction Site	Equipment lay down area (temporary only) if required (no additional clearing required)
Construction Workforce	40–45 personnel
<b>Operation Support Infrastructure</b>	
Drainage	Drainage swales: broad, shallow (typically 0.2 m deep) swales with 1:4 (vertical:horizontal) side slopes
Signage	Speed limit and wildlife warnings
Footpath	Dual use for pedestrians and bicycles, 3 m width (2.4 m wide pavement plus 0.3 m shoulders each side)
Lighting	Energy efficient street lights
Fire water reticulation	Fire hydrants (pre-installed)

## 4 KEY ENVIRONMENTAL ISSUES ADDRESSED

Based on the submissions received the City of Armadale consider that the key potential impact to be addressed in this response to submissions document is fragmentation of a remnant vegetation area (Bush Forever Site 342). In particular, this document focusses on addressing the issue of ecological fragmentation with regard to:

- Flora and vegetation;
- Terrestrial fauna; and
- Hydrological processes.

These issues are discussed in greater detailed in the sub-sections below.

### 4.1 FLORA AND VEGETATION

#### 4.1.1 EPA OBJECTIVE

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

#### 4.1.2 RESIDUAL IMPACTS

Submissions have raised concerns that the residual impacts of the proposal may be greater than predicted in the Public Environmental Review (PER) document. The PER document predicts that the residual impacts are primarily determined by the 'footprint' of the proposal (1.65 Ha). However submissions have raised concerns that indirect impacts from threatening processes such as hydrological changes, spread of weeds and dieback may increase the extent of the residual impacts.

#### 4.1.3 FURTHER WORK CONDUCTED

Given the submissions raised, the City of Armadale has commissioned a further assessment, in order to assess the spatial and temporal extent of the residual impacts (both direct and indirect) after incorporating all the management measures in the PER document, and any additional measures proposed this response to submissions. This assessment completed by Dr Eddie van Etten (2014), has predicted a "zone of influence" for potential "edge effects" which may arise from the proposal including but not limited to hydrological changes, spread of weeds and dieback (Appendix B). On the basis of this zone on influence residual impacts have been re-assessed as described in Appendix C. Both appendices B and C have been used to respond to submissions raised as outlined in Section 5.

As outlined within Appendix C, total residual impacts are predicted to be 64% (4.8 ha) greater from the current situation involving the unmanaged unsealed track compared with the proposed managed and sealed Keane Road Strategic Link (van Etten, 2014). Total residual impacts from each situation are predicted as follows:

- Unmanaged and unsealed track: Direct Cleared Area of 0.85 ha, Likely Edge Effects of 6.69 ha (residual impacts of 7.54 ha in total).
- Managed and sealed road: Direct Cleared Area of 1.65 ha, Likely Edge Effects of 0.92 ha (residual impacts of 2.57 ha in total – 4.8 ha less than the unmanaged unsealed track) (van Etten, 2014).

In summary edge effects from the managed sealed road are predicted to extend into various vegetation types for the following distances either side of the road:

- Banksia woodland communities: 5 m
- Dampland communities: 3 m (van Etten, 2014).

Based on the above prediction:

- Given edge effects are likely to extend no more than 3 m into adjacent dampland communities the City has changed the KRSL alignment slightly to include a buffer of 5 m from the TEC SCP10a, to ensure that it is not affected by edge effects (Figure 9).
- Edge effects have been quantified for each vegetation community as outlined below in Table 4 and shown in Figure 10.

**Table 4: Areas of Floristic Community Types Effected by Edge Effects from Managed Sealed Road (van Etten, 2014)**

Code	Floristic Community Type	TEC/PEC Classification	Size of Community within Study Area (ha)	Edge Effects (ha)	% Community Type Impacted by Edge Effects
SCP04	<i>Melaleuca preissiana</i> dampland	N/A	38.72	0.11	0.28
SCP05	Mixed shrub dampland	N/A	7.43	0.00	0.00
SCP10a	Shrublands on dry clay flat	TEC (Endangered)	4.47	0.00	0.00
SCP21a	Central <i>Banksia attenuata</i> - <i>Eucalyptus marginata</i> woodland	N/A	41.85	0.23	0.55
SCP21c	Low lying <i>Banksia attenuata</i> woodland or shrubland	PEC (Priority 3)	8.93	0.28	3.14
SCP22	<i>Banksia ilicifolia</i> woodland	PEC (Priority 2)	5.78	0.06	1.04
SCP23a	Central <i>Banksia attenuata</i> - <i>Banksia menziesii</i> woodland	N/A	23.94	0.24	1.00
<b>Total all Communities</b>			<b>131.12</b>	<b>0.92</b>	<b>0.70</b>

Edge effects are predicted by van Etten (2014) to be larger if the Keane Road Strategic Link is not built, and the current unsealed track remains. Predicted edge effects for this scenario are as follows:

- Banksia woodland communities: 20 m
- Dampland communities: 40 m (van Etten, 2014).

This is due to the larger spread of edge effects likely from continued 4WD use of the unsealed track. Table 5 below quantifies edge effects likely from the unsealed track (van Etten, 2014) – also refer to Figure 11.

**Table 5: Areas of Floristic Community Types Effected by Edge Effects from Unmanaged Unsealed Track (Status Quo) (van Etten, 2014)**

Code	Floristic Community Type	TEC/PEC Classification	Size of Community within Study Area (ha)	Edge Effects (ha)	% Community Type Impacted by Edge Effects
SCP04	<i>Melaleuca preissiana</i> dampland	N/A	38.72	1.96	5.06
SCP05	Mixed shrub dampland	N/A	7.43	0.00	0.00
SCP10a	Shrublands on dry clay flat	TEC (Endangered)	4.47	1.25	27.96
SCP21a	Central <i>Banksia attenuata</i> - <i>Eucalyptus marginata</i> woodland	N/A	41.85	0.95	2.27
SCP21c	Low lying <i>Banksia attenuata</i> woodland or shrubland	PEC (Priority 3)	8.93	1.35	15.12
SCP22	<i>Banksia ilicifolia</i> woodland	PEC (Priority 2)	5.78	0.26	4.50
SCP23a	Central <i>Banksia attenuata</i> - <i>Banksia menziesii</i> woodland	N/A	23.94	0.92	3.84
<b>Total all Communities</b>			<b>131.12</b>	<b>6.69</b>	<b>5.10</b>

It is concluded that the EPA's objective for flora and vegetation “to maintain representation, diversity, viability and ecological function at the species, population and community level” can be met by the KRSL proposal given:

- Total residual direct and indirect impacts from the proposed managed and sealed Keane Road Strategic Link are predicted to be to be very small (2.57 ha). This level of impact is 64% (4.8 ha) less than the impacts predicted due to current situation involving the unmanaged unsealed track (van Etten, 2014).
- The current situation of the unsealed track, is predicted to cause significant ongoing chronic “edge effects” due to off road driving including degradation of 28% of the locally mapped extent of the TEC SCP10a, 15% of the PEC SCP21c and 4.5% of the PEC SCP22). However the proposed KRSL project is predicted to have no impact on the TEC and less impact on the PEC’s than the current unsealed track (van Etten, 2014). Therefore the KRSL project will result in a net environmental benefit compared with the current situation.
- Direct offset area proposed of approximately 121 ha, is 98% (or 118 ha) greater in size than the land area predicted to be impacted by the proposed KRSL project (2.57 ha directly and indirectly).
- Direct offset areas proposed (of approximately 121 ha) contain:
  - Vegetation types and habitats which are highly similar to those within the proposed KRSL area of impact;
  - Threatened and Priority Ecological Communities including large areas of the TEC and PECs which occur within Bush Forever Site 342 (TEC SCP10a and PECs SCP 21c and 22); and
  - A variety of conservation significant flora and fauna species.
- The indirect offset proposed, of \$150,000 of funding will be used for rehabilitating existing badly degraded areas of the TEC SCP10a within Bush Forever Site 342.
- The offsets proposed, will counterbalance the proposed KRSL residual impacts and provide an overall net environmental benefit as they will lead to the conservation of large areas of land with significant biodiversity, flora and fauna values.

## 4.2 TERRESTRIAL FAUNA

### 4.2.1 EPA OBJECTIVE

The EPA's objective for terrestrial fauna is to maintain representation, diversity, viability and ecological function at the species, population and assemblage level.

### 4.2.2 RESIDUAL IMPACTS

Submissions have raised concerns that the proposal may not fully meet the EPA's objective for maintaining the viability and diversity of terrestrial fauna at the assemblage level. This is because, while the inclusion of fauna underpasses would maintain connectivity between the two areas, the underpasses proposed within the PER were not originally designed to suit all species of vertebrate fauna, including the kangaroo or wallaby species and this therefore could have implications on the ecology of the area.

### 4.2.3 FURTHER WORK CONDUCTED

Given the submissions raised, the City of Armadale have commissioned Bamford Consulting Ecologists (2014a) to undertake a review of the fauna underpasses now proposed to assess their suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos). The resulting report is contained in Appendix D, and has been used to provide a fauna underpass re-design proposal as outlined in Section 3.2.2 and respond to submissions raised as outlined in Section 5.

The City of Armadale have also commissioned a Kangaroo Survey (Bamford Consulting Ecologists, 2014b) within Bush Forever Site 342, in order to gain further information regarding the size and status of the Western Grey Kangaroo population within the area, so that this can be considered as part of the environmental impact assessment and management proposed for the KRSL project. The resulting survey report is contained within Appendix E. The survey confirmed the presence of Grey Kangaroos and Brush Wallabies in small numbers. The Brush Wallaby population is very small, perhaps 10-20 animals, while the Grey Kangaroo population may be slightly larger (perhaps 15 – 30 animals) and is almost certainly shared with surrounding farmland. Such small populations are likely to be vulnerable to isolation with or without the KRSL project, and will almost certainly require management if they are to persist within the Bush Forever Site 342 (regardless of the proposed KRSL project). Road-kill is clearly an existing issue for Western Grey Kangaroos, especially if they are moving regularly from the bushland to nearby paddocks to forage. The presence of skeletal remains of two animals in bushland away from roads may have been the result of natural mortality, but there is the possibility of dog attacks and illegal shooting (Bamford Consulting Ecologists, 2014b).

To be conserved, such small and isolated or partly-isolated populations will require some on-going management irrespective of the KRSL project. Therefore populations of the Grey Kangaroo and Brush Wallaby within Bush Forever Site 342 will require management by the responsible authority for the site Department of Parks and Wildlife, (DPaW) to ensure they are viable in the long term. Issues to be managed are:

- Off road vehicle access to the site
- Shooting
- Inbreeding
- Dog attack
- Possible over-population and grazing pressure leading to degradation of native vegetation within the Bush Forever site (Bamford Consulting Ecologists, 2014b).



The key management issues for the KRSL road alignment regarding kangaroo and wallaby are to ensure that the road if constructed does not lead to local extinction, thereby resulting in a loss of biodiversity within Bush Forever site 342 through which the KRSL passes. This requires the management of the following issues by the City of Armadale:

- Preventing the road causing genetic and habitat based isolation of small populations primarily through road underpasses; and
- Preventing road kill primarily through appropriate fencing of the road (Bamford Consulting Ecologists, 2014b).

The underpasses proposed for the KRSL by the City of Armadale (one 1200 x 1200mm, two 600 x 1200mm and four 450 x 1200mm) will allow for movement of all fauna that might be adversely affected by fragmentation caused by the road itself. This includes Grey Kangaroos that can be expected to readily use the 1200mm high underpass, with some usage by smaller females of the smaller (600mm high) underpasses. The proposed underpasses should thus mitigate the risk that might otherwise be imposed upon fauna populations by the KRSL. Similarly fencing the KRSL road to the specification of DPaW will prevent road kill on this road (Bamford Consulting Ecologists, 2014b).

It is concluded that the EPA's objective for terrestrial fauna *"to maintain representation, diversity, viability and ecological function at the species, population and assemblage level"* will be met given:

- A wide range of fauna management measures are proposed to minimise and mitigate impacts to terrestrial fauna as outlined in Table 2.
- No clearing will occur of the following significant fauna habitats:
  - Waterfowl wetland habitat.
  - Black cockatoo breeding habitat.
  - Rainbow bee-eater breeding habitat.
  - Megamouth bee (newly discovered species) breeding area.
- Clearing of Carnaby's Black Cockatoo foraging habitat will be limited to 0.61 ha within the clearing footprint (estimated to be less than 1% of the available habitat within the adjacent Bush Forever Site).
- No clearing will occur of the Megamouth bee mapped breeding area.
- Clearing of Short Tongued native bee foraging plants will be limited to approximately 40 individual plants of the estimated local population of 5000 individuals of known host plant species (0.8%) and approximately 66 individual plants of the estimated local population of 9250 individuals of potential host plant species (0.7%).
- Seven fauna underpasses will be installed along the KRSL alignment to allow for fauna movement and at least one underpass will be located in each major habitat type occurring along the road alignment to maintain a level of connectivity across all habitats. As stated above these underpasses will be suitable for use by all species of terrestrial fauna within Bush Forever Site 342.
- Direct offset area proposed of approximately 121 ha, is 98% (or 118 ha) greater in size than the land area predicted to be impacted by the proposed KRSL project (2.57 ha directly and indirectly).
- Direct offset areas proposed (of approximately 121 ha) contain:
  - Terrestrial fauna habitats which are highly similar to those within the proposed KRSL area of impact; and
  - Conservation significant fauna species assemblages and habitat which is highly similar to those within the proposed KRSL area of impact and Bush Forever Site 342.

## 4.3 HYDROLOGICAL PROCESSES

### 4.3.1 EPA OBJECTIVE

The EPA's objective for Hydrological Processes is to maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected.

### 4.3.2 RESIDUAL IMPACTS

Submissions have raised concerns that the proposal may not conclusively meet the EPA's objective for maintaining hydrological regimes in order to maintain ecosystems. Specifically, concerns have been raised that:

- The road may interrupt ecological processes and this could have implications on the ecology of the area;
- Modelling of hydrological systems requires further validation to ensure it is accurate.

### 4.3.3 FURTHER WORK CONDUCTED

Given the submissions raised, the City of Armadale has undertaken further hydrological assessment and model verification, in order to confirm the predicted hydrological impacts and recommended management measures for the project. This assessment by Water Technology (2014) has confirmed previous hydrological conclusions (Appendix F), and has been used to refine the proposed water culvert design as outlined in Section 3.2.3 and respond to submissions raised as outlined in Section 5.

Water Technology is an experienced well qualified hydrological consultancy and the 'TUFLOW' modelling software utilised is an industry best practice software package. TUFLOW software has advanced hydrological modelling capability suitable for modelling complex urban overland flow and urban drainage systems. It is used routinely by hydrological consultancies, infrastructure providers and government agencies for modelling of surface water systems in situations which are like the Keane Anstey dampland and associated Forrestdale Main Drain system. Examples of TUFLOW use in similar situations to the KRSL modelling project, where TUFLOW has been shown to accurately predict hydrological conditions include:

- *Jigalong Flood Investigation, Department of Planning, WA:* A TUFLOW flood model was constructed of for the Jigalong community near Newman. Broad scale flooding from Jigalong Creek and adjacent waterways was simulated based on catchment inflows developed from a catchment scale hydrologic model. Stormwater flooding on the town site was simulated using a rainfall on grid approach.
- *Stony Creek Flood Mapping Study:* An urban flood modelling and mapping project for the Stony Creek catchment (Melbourne Water). Project has developed and calibrated a TUFLOW hydraulic model of the entire Melbourne Water drainage network for this catchment.
- *Brockhoffs Drain and Damper Creek Flood Mapping Study:* This Melbourne Water flood mapping study is presently being undertaken to provide up-to-date flood information for a catchment in eastern Melbourne. The project involves detailed hydraulic modelling (TUFLOW) of the drainage and creek system for this area.

Specific model validation steps for the KRSL project TUFLOW model have included:

- Confirmation of hydrological assumptions used within the model and as the basis for recommendations including soil types and groundwater conditions.
- Re-running the model using finer scale topography (1 m Digital Elevation Model sourced from the Department of Water).
- Ground truthing the model via site inspection and aerial photography interpretation (using high resolution aerial imagery clearing showing surface water flooding after a series of recent rainfall events).

Refer to Appendix F for further detail regarding model verification (Water Technology, 2014).

To ensure the KRSL has no negative impact on the existing surface water systems (and where possible improves the existing degraded surface water systems) it is necessary to:

- Provide continued hydrological connectivity for the three flow paths / areas of ponding identified which coincide with the proposed KRSL alignment (locations A, B, and C).
- Ensure that existing ponding currently occurring upstream of the proposed KRSL alignment is not increased or decreased;
- Where possible, create diffuse flow (sheet flow) downstream of the KRSL alignment, in locations where current channelized flow is occurring un-naturally down artificial unsealed roads/tracks (Water Technology, 2014).

To achieve this, the following management measures are recommended by Water Technology (2014) and have been adopted by the City of Armadale for three locations where the verified TUFLOW model has predicted temporary water ponding after heavy rainfall (locations A, B and C):

- Provision of a series of aligned and adjacent small culverts or 'small culvert arrays' directing the flows horizontally underneath the road to ensure that:
  - Diffuse flow (sheet flow) is created downstream (i.e. channelised flow does not occur downstream of the road);
  - Ponding is not increased or decreased upstream (the small culvert array will allow water to flow underneath the road in an equivalent manner in terms of flow rates and volumes to pre-development)
- Appropriate design of the outflow of the culverts (such as rock rip rap, swales and riffle zones) is recommended to ensure diffuse flow is created downstream (Water Technology, 2014).

The recommended design features a series of 300mm diameter pipe culverts located at each of the identified flow paths / areas of ponding (locations A, B and C). Each array of culverts maintains the hydrologic connectivity and ensures peak 100 year flow rates are maintained without overtopping of the proposed KRSL roadway.

Recommendations for locations A and B are similar to those which were previously proposed (Water Technology, 2013) involving six 300mm diameter pipe culverts installed in an array, to maintain existing hydraulic connectivity and produce downstream "diffuse" flow in these locations.

Location C is near the existing Bailey Branch Drain which currently passes through 2 x 750mm diameter culverts at Keane Road. These culverts have a capacity of around 2.6m<sup>3</sup>/s. As detailed in previous government modelling (Department of Water, 2009) and shown in the current model results, ponding of water does already occur upstream of the proposed KRSL, south of the intersection of Keane Rd and Anstey Rd (in private farmland) under existing conditions for the 100 year ARI event. This existing upstream ponding within private farmland is connected to ponding downstream of the proposed KRSL alignment within native vegetation. Therefore instead of changing the capacity of the drain (which may change the current hydrology including ponding) it is proposed to provide a series of six 300mm diameter pipe culverts

underneath KRSL near Bailey's Branch drain, to maintain existing hydrological conditions including ponding on both sides of the KRSL under the 100 year ARI event (Water Technology, 2014).

The results of this assessment are consistent with the previous hydrological assessment (Water Technology, 2013) as follows:

- There are three overland flow paths / areas of ponding (locations A, B and C) across the proposed KRSL alignment.
- One artificial channelised flow path also exists across the proposed KRSL alignment – Bailey's Branch Drain (termed flow path D in the 2013 Water Technology report).
- A series of 300m diameter pipe culverts provided at locations A, B, and C will ensure the connectivity of these flow paths / areas of ponding across the proposed KRSL alignment.
- The inclusion of an adequate number of appropriately sized culverts at the three locations, as identified in this report, will ensure there are no impacts on the local surface water system.
- There are no impacts of the road on the local groundwater or surface water system as the road design allows for the provision of culverts to maintain flow connectivity; the un-kerbed profile with swale arrangement facilitates infiltration; and the use of the swale for water quality treatment along the alignment will minimise water quality impacts.
- As there are no impacts from the road to surface water flow paths and no impacts on groundwater level, flows or water quality, it is unlikely there would be impacts to groundwater dependent or surface water dependent vegetation or ecosystems (Water Technology, 2014).

The City of Armadale also commit to the development and implementation of a Water Management Plan prior to road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include:

- An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and
- Details of water management measures including but not limited to:
  - long-term maintenance of the drainage swales and culverts
  - management actions for weed control in swales
  - maintaining the vegetation on the road embankments and swales
  - managing sedimentation from up gradient of the culverts; and
  - maintenance and monitoring of the culverts and associated rock rip raps.

On the basis of the City of Armadale's commitment to install the recommended management measures (water connectivity culverts) and implementation of the above Water Management Plan, it is concluded the project can meet the EPA objective for Hydrological Processes: *To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected*

## 5 RESPONSE TO SUBMISSIONS

A total of 92 submissions were received during the public review period. Of the 92 submissions received, the EPA have identified nine key issues raised across the submissions which this response to submissions document is required address. The City of Armadale's responses to these key submission issues are discussed below.

### 5.1 THE PROPOSAL

#### 5.1.1 JUSTIFICATION/ALTERNATIVE PROPOSALS

##### 5.1.1.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Wetlands Conservation Society</li> <li>• Department of Planning</li> <li>• Peel Preservation Group</li> <li>• Members of the Public</li> </ul>	<ol style="list-style-type: none"> <li>1. The Keane road extension is not considered necessary as the completion of Skeet Road will provide a viable alternative for access for Forrestdale residents to Harrisdale High School and for Harrisdale residents to Armadale, without the ecological damage.</li> <li>2. There is concern regarding the lack of vehicle restrictions, e.g. size of trucks, volume of traffic specified for Keane road.</li> <li>3. The possibility of widening the road to four lanes in the future has not been ruled out.</li> <li>4. The City of Armadale is using Practice Note 18 of Bush Forever Site Implementation Guidelines (Appendix 3) (2000) as a reasoning for the road to proceed: "where roads identified in Town Planning Schemes are co-located with a Bush forever site, construction of the road is not precluded, however, it will require attention to design and management to protect bushland values where practical." Practice Note 18 is intended for 'Primary Regional Road' or 'Other Regional Road' reservations identified in the Metropolitan Region Scheme (MRS) or Town Planning Scheme (TPS), not a cadastre road as Keane road is identified. The relevance of Practice Note 18 is therefore questioned.</li> </ol> <p><b><u>Road alignment recommendation</u></b></p> <ol style="list-style-type: none"> <li>5. <b>Recommendation 12:</b> That more detail should be provided regarding northward shift of the existing road reserve, including the need for property purchases to accommodate the new alignment.</li> </ol>

##### 5.1.1.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The necessity of completing Keane Road has been endorsed by the findings of the two responsible planning authorities. After identifying the area of north Forrestdale as an urban investigation area in the late 1980's, the State government carried out examinations of the social needs and environmental constraints of the area which led to the 2001 Structure Plan for urban development (Western Australian Planning Commission, 2001).</p> <p>In 2001 the State government's District Structure Plan for Forrestdale identified Keane Road as one of the central spine and the only direct link between two adjacent Forrestdale Urban/Residential Cells (No.2 and No.3) that are now undergoing development. The District Structure Plan process which involved community workshops and extensive public consultation, examined several options and the one option which incorporated the road reserve into and expansion of the conservation area was discarded in both the final preferred and the final adopted plans (Western Australian Planning Commission, 2001).</p>

Submission and/or issue #	City of Armadale Response
	<p>The City of Armadale and the Department of Planning have both deemed the road to be necessary and the rapid settlement and development of Harrisdale in the last 7 years and predicted population for Forrestdale in the next 7 years supports that finding. Both authorities have endorsed the road in statutory and strategic plans based on a district road network specifically designed around existing roads, including Keane Road which has a unique linking role between Nicholson Road and Anstey Road. Over the past 7 years surrounding residential areas have been developed to accommodate thousands of incoming families and many businesses. These community stakeholders have a reasonable expectation that approved town planning will actually be implemented and that with due process being followed by the City, Keane Road will be able to function as the district link planned in the District Structure Plan and the Town Planning Scheme, TPS by the time the area is fully developed and traffic generation is at its peak.</p> <p>The road reservation for a completed Keane Road has been set aside in Armadale's District Zoning Scheme (Town Planning Scheme) since 1972. The City has accordingly constructed/upgraded Keane Road in stages over the past 40 years. The major land use change now transforming the Forrestdale/Harrisdale areas into Urban/ Residential and Industrial/commercial communities requires that Keane Road be upgraded to serve the District Distributer Road function and link that has been long planned by the City and confirmed by State government's Planning authority in the 2001 District Structure Plan (Western Australian Planning Commission, 2001).</p> <p>Completing Keane Road is also supported by the important urban design principle of permeability. The permeability principle holds that people should be able to access urban facilities without having to negotiate long circuitous journeys especially where this necessitates journeys principally by means of private cars (Bently, Alcock, Murrain, McGlynn and Smith, 1985).</p> <p>The 1500m unsealed sandy track section is no longer able to service the surrounding Urban Residential development as it had previously done for the former farming land uses. At that time only a few families lived in the area and there were no facilities or services that people needed to access on a regular basis. Soon there will be a High School on the corner of Keane and Skeet Roads immediately abutting the subject section of road. The High School opening in 2017 will have 1500 students and 100 staff drawn from a wide catchment. A few hundred metres along from the School on Keane Road a District level Commercial Town Centre is being built. The Harrisdale Town Centre also serves a wide catchment. A major District Recreation Facility is being constructed next to the High School and it also has a wide catchment area. An Industrial Business Park is being constructed on Keane Road adjacent to Anstey Road that will accommodate hundreds of businesses and a workforce of thousands.</p> <p>All residents, employees, businesses and recreational facility users need access to and between the above facilities and the completion of the last stage of Keane Road has been planned to perform that role. There are no other roads that can be utilised without incurring substantial increases in energy use for long circuitous trips, mostly by private motor vehicle and time penalties for the longer journey. These extra costs would be borne exclusively by residents and businesses in the local area and the urban design outcome envisaged by the State government in the District Plan or the City in the District Zoning Scheme would not be achieved to cater for the areas full development. Nor would it meet the expectations of residents and businesses that have invested and purchased property in the area.</p> <p>The alternative roads suggested in submissions are not considered suitable viable alternatives, due to the resulting increases in energy and time costs and also because the disconnect between otherwise adjacent communities that would result is socially undesirable for community relations and economically undesirable due to leakage of business clientele and would-be or potential customers to other centres. The consequential loss of local support and customer contribution to business viability can over time inhibit the performance of the local economy and limit the ability of local businesses to remain viable over the longer term so that they can continue to provide</p>

Submission and/or issue #	City of Armadale Response
	<p>local services to local communities.</p> <p>Porter Consulting's conservative prediction of traffic volumes after the year 2016 on Keane Road Strategic Link (KRSL) is 8,460 vehicles per day (vehicles/d) (Porter Consulting, 2009). More recent traffic modelling indicates a higher number of vehicles/d is likely. If KRSL is not constructed, these 8,460 plus vehicles/d will be forced to use other surrounding roads and would be likely to exacerbate local traffic congestion such as on Skeet, Nicholson Roads and particularly on the local roads around the shopping centre and Harrisdale High School.</p> <p>Similarly, residential traffic generated in Area 3, south-east of Anstey/Keane intersection will be forced to use the same roads designed for heavy haulage industrial traffic which will service the Forrestdale Business Park, even to source a carton of milk and this would require a comparatively long circuitous journey for these residents.</p> <p>As all the development plans for Harrisdale, Piara Waters and Forrestdale have been designed based on Keane Road functioning as a district distributor between adjacent residential and business areas, it is obvious that traffic would increase on other roads and this will have impacts on the local community with potential for increased traffic congestion resulting in negative consequences such as delays to emergency service vehicles (fire, ambulance and police). It is noted that effective access and choice of route availability is important for emergency vehicles where there are large assemblages of people such as at the schools, sporting venues and commercial centres which abut Keane Road and particularly due to the elevated hazard / high bush fire risk which is consequential to the large area of bushland vegetation extending between Armadale and Ranford Roads which would be provided with very little access for fire fighting and management purposes if Keane Road is not completed as planned through participatory community planning processes such as the District Structure Plan in 2001 and TPS in 2005.</p> <p>The City of Armadale Council is a single entity of governance that is charged by the Local Government Act to make decisions on the matters that come before it affecting the City of Armadale. Decisions are made democratically by vote which means an outcome or decision on a particular matter is determined by the democratically determined majority decision or outcome. Council's decisions that relate to Keane Road and the current EIA have been documented and include that Council:</p> <ul style="list-style-type: none"> <li>• Supported the 2001 District Structure Plan (which brings forth the community linking and accessibility role Keane Road can provide if completed along its full length).</li> <li>• Supported the 2005 TPS No.4 which retains the pre-existing dedicated reservation for Keane Road.</li> <li>• Opposed DPaW's 2005 (then CALM) recommendation to close the road in the draft management plan and in which Council stressed the need for Keane Road to be retained.</li> <li>• Decided to refer the matter for formal S38 EIA impact assessment and then in 2008 to prepare the PER; and</li> <li>• Continues to progress the EIA approvals processes for the KRSL project.</li> </ul>
2	<p>Keane Road is designated as a District Distributer Road and is intended to service local traffic only (including bus services). Heavy vehicle traffic will not be allowed to travel on it (Main Roads Department heavy vehicle restrictions will be applied to restrict the size of vehicles permitted on the road to less than 10 tonnes and the restriction will be sign-posted and enforced). The only exception will be the residential bus services to provide public transport to local residents and emergency vehicles.</p> <p>The area east of Anstey Road will have roads that are scaled and permitted to allow large industrial vehicles to access the major regional roads at Armadale Road, Ranford Road and Tonkin Highway. These routes will be much more attractive to large vehicles. The deterrence provided by the regulatory restriction and potential for prosecution and fines</p>

Submission and/or issue #	City of Armadale Response
	<p>for breaches, will limit access to the residential area west of Skeet Road to small vehicles servicing the local residences, facilities and businesses. Keane Road adjacent to the High School will be a designated School Traffic Zone (40 km per hour limit during morning and afternoon weekdays) and will likely have pedestrian crossings for the safety of children crossing which will further discourage heavy vehicles using the link. At other times the regulated speed limit will be 70 km per hour between Anstey and Skeet Road and 60 km per hour adjacent to the urban- residential and commercial development west of the Harrisdale High School.</p>
3	<p>Keane Road is designated as a road for local traffic use only. The City has no intention of widening or adding further lanes to Keane Road and is confident it can meet the district residential traffic and local movement functions envisaged in the plan to construct a single carriageway road.</p> <p>The road has been designed to accommodate predicted traffic volumes at full development of the adjoining areas in a single carriageway road with one lane in each direction plus a grade separated dual use path for pedestrians and cyclists. There are no plans to widen it to four lanes in the future as this would not be consistent with its objective as a local road servicing local traffic. A four lane road would have significant impacts on the adjacent conservation area and such a road could not be widened without further assessment and approval under environmental legislation.</p> <p>The single lane in each direction as proposed is based on traffic modelling to efficiently cater for the anticipated volume of traffic based on the residential population.</p> <p>The virtue of planned road networks where there are alternative routes available is that traffic volumes will balance among alternative routes to various attractors if one route experiences congestion. However, where one of the planned district road connections is fully closed off (such as proposed in some submissions), this virtue is lost and localised congestion hot spots are likely to emerge.</p>
4	<p>When the Bush Forever Policies, Principles and Practices were published in December 2000, the public (including local governments) were provided with assurances as to how Bush Forever was to be applied to Bush Forever Sites. These assurances included written explanations regarding situations where there were pre-existing commitments. It is quite clearly stated that the Bush Forever Site Implementation Guidelines were to apply to local and districts roads (and not restricted to Primary or Other Regional Roads only).</p> <p>Furthermore, the WAPC responses to local government and general submissions on Bush Forever MRS Amendment no.1082/33 (Volume 1 – Report on Submissions, June 2010, pp.60-63) reiterates that the status of local road reserves is recognised by Bush Forever policy. For example in response to the Town of Kwinana’s request for Bush Forever to recognise a planned extension of a local road the WAPC response was to support the proposal and WAPC accordingly advised:</p> <p><i>“...existing reserves and commitments and future requirements because of overriding social and economic factors are a consideration in future decision-making through the draft Bushland SPP. Local road reserves do not require an amendment to the MRS and may fall within a P&amp;R Reserve in the MRS. Notwithstanding this, any final designs for Sulphur Road can be accommodated and the road reserve removed from the P&amp;R.”</i></p> <p>These assurances were further supported by the WAPC MRS Amendment no.1082/33 responses to <i>General Issues</i> which addressed submissions making similar points as follows:</p> <p><i>“General Issue 2 – Bush Forever Protection Area Boundary Issues (p.5): Future boundary changes in the MRS may not be required prior to development where the development is in accordance with the overall purposes or intent of the underlying zone or reserve;</i></p> <p><i>General Issue 3/3A – Restrictions on Property/Legal Right to Impose Bush Forever Protection Area/Natural Justice (p.6): As some BFPA are unprotected, in private</i></p>



Submission and/or issue #	City of Armadale Response
	<p>ownership or have existing commitments and approvals, the Bushland SPP does not prevent appropriate subdivision and development that satisfies bushland protection considerations;</p> <p><i>General Issue 5 – Thinks BFPA means Reservation (p.9): The BFPA is not a rezoning or reservation or compulsory resumption, but a policy overlay in the scheme to protect bushland. The underlying zone or reservation remains such as Special Rural or Rural remains with all the existing restrictions.”</i> (Western Australian Planning Commission, 2010).</p> <p>The Practice Note 18 guidelines states on page 67 its <i>Application</i> (is to) <b>Bush Forever Sites affecting regional railway and road reserves identified in the MRS and local road reserves identified in a local TPS</b> (Bush Forever Site Implementation Guideline/Practice Notes, 2000, Vol. 1 Policies, Principles and Processes Appendix 3 p.67) (Western Australian Planning Commission, 2000b).</p> <p>The fact that it applies to <b>local road reserves identified in a local TPS</b> is expressly stated in the heading for this part of the document. To claim the document does not mean what it expressly states is not possible.</p> <p>The second dot point on page 67 of the Practice Note 18 guidelines also states that:</p> <p><i>“Existing Road/Railway Reserves within land reserved in the MRS or local TPS for roads or railway purposes, there shall be a presumption that the construction authority has a right to undertake the required works for transport and associated infrastructure (Bush Forever Site Implementation Guideline/Practice Notes, 2000, Vol. 1 Policies, Principles and Processes Appendix 3 p.67)</i> (Western Australian Planning Commission, 2000b).</p> <p>The relevant Practice Note 18 Summary Table extract directly from the Bush Forever Policies Volume 1 Principles and Practices (main report) (Western Australian Planning Commission, 2000b) is reproduced in full below in Insert 1.</p> <p>As stated in Insert 1 below, under “Application” Practice Note 18 applies where Bush Forever Sites affect both <b>“regional railway and road reserves identified in the MRS and local road reserves identified in a local TPS”</b> (Western Australian Planning Commission, 2000b)</p> <p>Practice Note 18 is therefore clearly applicable to Keane Road as it comprises of a local/district road reserved in the City of Armadale Town Planning Scheme (TPS) since 1972 (and pre-dating the Bush Forever policy overlay). Keane Road is an existing commitment of the kind described in the Practice Note and subsequent WAPC responses to local government submissions on the Bush Forever MRS Amendment. Notwithstanding that decisions by the EPA and Minister will determine whether conditions can be set so as the environmental impacts of works and operation of the road are acceptable, Bush Forever policy does not preclude construction of KRSL.</p> <p>The City of Amadale have consulted with the Department of Planning Bush Forever Unit on several occasions as outlined within the Consultation Log Appendix A (consultation dates 20/2/2009, 16/10/2009 and 22/10/2009).</p>
5	<p>The recommended northward shift of the existing road reserve of 5 metres in some sections of the KRSL alignment, is based on the City’s finding that this is the environmentally preferable alignment or the alignment with the least impacts. Constructing the road on the existing cleared areas minimises the area of total vegetation to be cleared. Department of Planning officers have supported the principle of preserving vegetation as far as practicable by using the cleared areas where possible. They have also indicated the northward road reserve boundary realignment that would facilitate moving the current road reserve into the already cleared areas is a relatively simple administrative matter (pers. comm. DOP on 22 October 2009).</p>

Submission and/or issue #	City of Armadale Response
	<p>The formal relocation of the existing road reserve is a simple administrative process which is similar to the process for land subdivision and amalgamation. This process merely involves modifications to the boundaries of the properties by moving them 5 metres. Given the liaison and concordance of the relevant department the submissions seeking to imply the City will need property purchases to accommodate the slight realignment to the north are not based on a sound understanding of the relevant processes which are well documented (refer to Appendix 10 of Introduction to the Western Australian Planning System (Western Australian Planning Commission, 2014).</p> <p>Re-alignment of the road reserve into private cleared farmland at the Anstey Road end of the KRSL has been proposed in order to reduce impacts on native vegetation as this private farmland has already been predominantly cleared of native vegetation. In addition this re-alignment allows a buffer to be maintained between the road and adjacent Threatened Ecological Community (TEC) – refer to Section 5.2.1 below. The realignment of this section of the KRSL from the existing dedicated road reserve to a new road reserve located on private freehold property will require the City of Armadale to purchase all or part of the land required, either by negotiation with the landowner or by compulsory acquisition. The City has been discussing with the landowners the potential need to purchase a portion of the private land since 2009, when it became apparent that the impact assessment could result in the need to acquire additional land. When the Keane Road existing dedicated road reserve was confirmed as crossing TEC vegetation and therefore had an environmental value worthy of retaining and protecting, these negotiations have commenced and the successive owners of the property have indicated their willingness to enter into negotiations with the City towards that end. Nevertheless, the landowners also indicated their preferences for the road to be constructed on the alignment that had already been put in place for that purpose in the form of the existing dedicated road reserve if possible. As processes for land transactions and land transfers from one owner to another are well documented and common legal procedures, it should not be necessary for the PER to document them further.</p> <p>The larger road reserve re-alignment onto private property to the south east and the minor realignments to move the road onto the cleared track to the north, further west along Keane Road are similar in that they accord with the policy recommendations of Bush Forever (Western Australian Planning Commission, 2000a).</p> <p>As stated below in Insert 1 under “Implementation Guidelines (IG) and Actions”, Action 15 states:</p> <p><i>“Where road/railway reserves have been subject to review and where options exist to modify the road reserve, the WAPC will undertake the required changes through an Amendment to the MRS and local governments will review local TPS accordingly.”</i> (Western Australian Planning Commission, 2000b).</p> <p>This action supports the re-alignment of the Keane Road Reserve in order to reduce impacts on native vegetation which is consistent with the stated “Objective” of Practice Note 18 (Insert 1):</p> <p><i>“To encourage the protection, where practical, of bushland and corridor values along existing road/railway reserves and to give due consideration to bushland protection in the design and location of future roads/railways.”</i> (Western Australian Planning Commission, 2000b)</p>

## Other Ownerships and Land Use Interests

Practice Note No.	Application	Objectives	Mechanisms	Implementation Guidelines (IG) and Actions
<b>18: ROAD AND RAILWAY RESERVES</b>	Bush Forever Sites affecting regional railway and road reserves identified in the MRS and local road reserves identified in a local TPS.	To encourage the protection, where practical, of bushland and corridor values along existing road/railway reserves and to give due consideration to bushland protection in the design and location of future roads/railways.	Assess design opportunities and constraints and conservation value to determine the scope for a review of existing road/railway reserves, subject to consideration of regional and local infrastructure requirements.  Bushland-sensitive design and management planning.	<p><i>IG 22</i> Bush Forever encourages responsible authorities to undertake a review of existing road reserves that affect Bush Forever Sites to identify the scope to accommodate bushland protection, where practical.</p> <p><i>IG 23</i> Where regional or local road or railway reserves are at an advanced stage of planning and/or reserved in the MRS or local TPS for road or railway purposes and no feasible alternative exists for a review of the alignment, the implementation of Bush Forever will be largely a design and management issue, to retain and protect the bushland values, where practical.</p> <p><i>IG 24</i> At the planning and concept design stage for constructed roads and railways, Bush Forever encourages responsible authorities to undertake verge management planning to protect significant vegetation identified in Bush Forever or in local bushland strategies.</p> <p><i>Action 15</i> Where road/railway reserves have been subject to review and where options exist to modify the road reserve, the WAPC will undertake the required changes through an Amendment to the MRS and local governments will review local TPS accordingly.</p>

**Insert 1: Practice Note 18, Extracted from Bush Forever Volume 1 Policies and Principles (Western Australian Planning Commission, 2000a)**

## 5.2 FLORA AND VEGETATION

### 5.2.1 THREATENED AND PRIORITY FLORA

#### 5.2.1.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Urban Bushland Council</li> <li>• Wetlands Conservation Society</li> <li>• Save Beelii Wetlands</li> <li>• Armadale City Rivercare Group</li> <li>• Wildflower Society of WA</li> <li>• Friends of Forrestdale</li> <li>• Jandakot Regional Park Community Advisory Committee</li> <li>• Canning Regional Greens WA</li> <li>• Members of the Public</li> </ul>	<ol style="list-style-type: none"> <li>1. The proposal will result in the loss of up to 50 individuals of <i>Jacksonia sericea</i> (Priority 4) which occurs within the proposed clearing footprint, and <i>Stylidium longitubum</i> (Priority 3) which occurs "within close proximity" to the clearing footprint. The detail of a buffer zone to protect these individuals is not specified.</li> <li>2. The proposal will result in the loss of 0.10 ha of Priority 2 SCP22 "<i>Banksia illicifolia</i> woodland", comprising 1.7% of the total community within the study area, and 0.55 ha Priority 3 SCP21c "Low lying <i>Banksia attenuata</i> woodland or shrubland", comprising 6.2% of the total community within the study area.</li> <li>3. The proposal will result in indirect impacts to the TEC SCP10a Shrublands on dry clay flats. Whilst the proposed alignment avoids the TEC, there is not provision of a buffer.</li> <li>4. Bush Forever (BF) Site 342 contains one of the largest and most intact remnants of the Southern River complex. Table 22 of the PER states that 'the Southern River complex is not currently considered threatened with approximately 20% (11,501 ha) of the pre-European extent remaining on the Swan Coastal Plain' (EnviroWorks Consulting 2013, p. 102). However, the Southern River complex can be considered regionally significant due to 2013 figures showing that only 2.88% complex remains formally protected in conservation areas (Local Biodiversity Program 2013).</li> <li>5. A number of species were not identified, including Priority Flora, <i>Verticordia lindleyi</i> (Priority 4), a number of plants were seen amongst <i>Verticordia densiflora</i> along with <i>Jacksonia gracillima</i> (Priority 3). Several other very common plants within the survey area were also missed e.g. Sand Bottlebrush <i>Beaufortia squarrosa</i> that covers about 2 ha and <i>Melaleuca lateriflora</i> with many shrubs over 2 m tall that is as evident as <i>Beaufortia squarrosa</i>.</li> <li>6. Fifteen plant species (listed below) that were not in the PER flora list within the study area which were identified on site are listed below,             <ul style="list-style-type: none"> <li>• <i>Melaleuca lateriflora</i></li> <li>• <i>M. lateritia</i></li> <li>• <i>M. seriata</i></li> <li>• <i>Beaufortia squarrosa</i></li> <li>• <i>Verticordia lindleyi</i></li> <li>• <i>Arnocrinum preissii</i></li> <li>• <i>Leschenaultia expansa</i></li> <li>• <i>Calothamnus lateralis</i></li> <li>• <i>Phlebocarya filifolia</i></li> <li>• <i>Evandra pauciflora</i></li> <li>• <i>Platysace filiformis</i></li> <li>• <i>Hovea trisperma</i></li> <li>• <i>Jacksonia gracillima</i></li> <li>• <i>Stylidium guttatum</i></li> <li>• <i>Meeboldina cana</i></li> </ul> </li> <li>7. The proposal will directly impact suitable habitat for the endangered <i>Diuris purdiei</i> through clearing.</li> </ol> <p><b>Flora recommendations</b></p> <ol style="list-style-type: none"> <li>8. <b>Recommendation 6:</b> That a site specific study is undertaken to determine an appropriate buffer to the threatened ecological community, 'shrublands on dry clay flats'</li> </ol>

## 5.2.1.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The following conservation priority species occur EnviroWorks (2013a):</p> <ul style="list-style-type: none"> <li>• <i>Jacksonia sericea</i> (Priority 4) – a large healthy population (&gt; 2000 plants) found extensively in the local area. It is estimated that &lt;50 plants (less than 2.5% of the local population) occurs within the proposed clearing footprint and &lt;20 plants occur within the area affected by predicted edge effects (less than 1% of the local population). In total residual impacts are estimated to be &lt;70 plants (less than 3.5% of the local population).</li> <li>• <i>Ornduffia submersa</i> (previously called <i>Villarsia submersa</i>) (Priority 4) – a localised population (of approximately 500 plants) not within the proposed clearing footprint. This population is currently threatened by ORV damage. The population will benefit from the additional protection provided by proposed fencing and increased community surveillance of the Bush Forever site.</li> <li>• <i>Stylidium longitubum</i> (Priority 3) - a large localised population (&gt; 1000 plants) in close proximity to the clearing footprint, but not intersecting it. This population is currently threatened by ORV damage. The population will also benefit from the additional protection provided by proposed fencing, access restriction and increased community surveillance.</li> </ul> <p>Significant buffer zones are provided between the populations of conservation priority species and the road 18.4 m disturbance corridor as follows (illustrated in Figure 12):</p> <ul style="list-style-type: none"> <li>• <i>Jacksonia sericea</i> (Priority 4) – a buffer of 85 m is provided to the next closest mapped population (excluding the population coinciding with the KRSL alignment as outlined above).</li> <li>• <i>Ornduffia submersa</i> (previously called <i>Villarsia submersa</i>) (Priority 4) - a buffer of 327 m is provided to the closest population.</li> <li>• <i>Stylidium longitubum</i> (Priority 3) – a buffer of 31 m is provided to the closest population.</li> </ul> <p>It is unlikely the above populations will be effected by “edge effects” (weeds, dieback, hydrological impacts) from KRSL, because of the design and management of the road and the significant buffer distances provided. As outlined within Appendix B, edge effects are predicted to be confined to a maximum of 3 - 5 m (depending on vegetation community type) (van Etten, 2014) and therefore would not extend to the nearest conservation priority flora populations with are greater than 5 m from the proposed road.</p> <p>Conservation priority species within Bush Forever Site 342 are likely to be better protected as a result of the proposed road design and management it will assist in reducing off road vehicle impacts to the Bush Forever Site through:</p> <ul style="list-style-type: none"> <li>• Fencing of the road which will prevent access to the Bush Forever Site from Keane Road.</li> <li>• An increase in surveillance and reporting of illegal off road driving by members of the local community using the road (predicted to be 8460 vehicles/day) (Porter Consulting Engineers, 2009).</li> </ul>
2	<p>In terms of buffer distance from the road, the design of the road does provide an inherent buffer of vegetation from the sealed road as follows:</p> <ul style="list-style-type: none"> <li>• On the Northern side of the bitumised road, a 5.7 m corridor occurs containing the dual use pedestrian and bicycle path (3 m) as well as the swale and fence (2.7 m).</li> <li>• On the Southern side of the bitumised road a 2.7 m corridor occurs containing the swale and fence.</li> </ul> <p>As described in Section 4.1.3, the revised KRSL alignment provides a reduction in the clearing of the two Priority Ecological Communities (PECs) as follows:</p>

Submission and/or issue #	City of Armadale Response
	<ul style="list-style-type: none"> <li>• Clearing of the PEC SCP21c was reduced by 0.4% (or 300 m<sup>2</sup>)</li> <li>• Clearing of the PEC SCP22 was reduced by 0.1% (or 100 m<sup>2</sup>).</li> </ul> <p>The revised road alignment clearing amounts for each PEC are presented below:</p> <ul style="list-style-type: none"> <li>• Clearing of the PEC SCP21c is estimated to be 0.52 ha (5.8% locally mapped area 500 m either side of KRSL)</li> <li>• Clearing of the PEC SCP22 is estimated to be 0.09 ha (1.6% locally mapped area 500 m either side of KRSL).</li> </ul> <p>The edge effects study (van Etten, 2014) has estimated maximum edge effects impacting the two PEC's based on proposed management of KRSL indirect impacts as follows:</p> <ul style="list-style-type: none"> <li>• Maximum impact of edge effects on PEC SCP21c is estimated to be 0.28 ha (3.1% locally mapped area 500 m either side of KRSL)</li> <li>• Maximum impact of edge effects on PEC SCP22 is estimated to be 0.06 ha (1% locally mapped area 500 m either side of KRSL).</li> </ul> <p>When both direct clearing and indirect edge effects are considered the potential impact on the two PECs are as follows:</p> <ul style="list-style-type: none"> <li>• PEC SCP21c - 0.52 ha direct clearing plus 0.28 ha edge effects equates to 0.8 ha in total (9% of total area mapped locally – 500 m either side of proposed road).</li> <li>• PEC SCP22 - 0.09 ha direct clearing plus 0.06 ha edge effects equates to 0.15 ha in total (2.6% of total area mapped locally – 500 m either side of proposed road).</li> </ul> <p>As outlined in van Etten (2014) (Appendix B) it is likely that edge effects will have a far greater impact on two PEC's if KRSL is not built, with edge effects from the current unmanaged, unsealed track predicted to affect:</p> <ul style="list-style-type: none"> <li>• 1.35 ha of PEC SCP21c (or 15% of total area mapped locally 500 m either side of KRSL).</li> <li>• 0.26 ha of PEC SCP22 (or 4.5% of total area mapped locally 500 m either side of KRSL).</li> </ul> <p>To put the clearing of the PEC's in context, a significant number of occurrences are recorded across the Swan Coastal Plain within the DPaW TEC/PEC database:</p> <ul style="list-style-type: none"> <li>• 50 occurrences of PEC SCP21c</li> <li>• 46 occurrences of PEC SCP22.</li> </ul> <p>On this basis it is concluded that the proposed KRSL clearing and edge effects represent a very small proportion of the extent of these PEC communities on the Swan Coastal Plain.</p>
3	<p>SCP10a (WC Act Endangered, EPBC Act Critically Endangered TEC) does not intersect the road clearing footprint.</p> <p>In terms of buffer distance from the road, the design of the road does provide an inherent buffer from the sealed road as follows:</p> <ul style="list-style-type: none"> <li>• On the Northern side of the bitumised road, a 5.7 m corridor occurs containing the dual use pedestrian and bicycle path (3 m) as well as the swale and fence (2.7 m).</li> <li>• On the Southern side of the bitumised road a 2.7 m corridor occurs containing the swale and fence.</li> </ul> <p>In addition an additional buffer of 5 m has been provided from the road disturbance</p>

Submission and/or issue #	City of Armadale Response
	<p>corridor of 18.4 m to the TEC SCP10a.</p> <p>It is unlikely the TEC SCP10a will be effected by “edge effects” (weeds, dieback, hydrological impacts) from KRS�, because of the design and management of the road and the buffer distance provided. As outlined within Appendix B, edge effects are predicted to be confined to a maximum of 3 m within dampland communities (van Etten, 2014) and therefore edge effects should not extend into the TEC given the buffer of 5 m provided.</p> <p>No clearing or indirect impacts will occur to the TEC SCP 10a. The offsets proposed by City of Armadale involve the protection of TEC SCP10a as follows:</p> <ol style="list-style-type: none"> <li>1. Offset Number 1 includes 3.1 ha of TEC SCP10a which is proposed to be put into the conservation estate.</li> <li>2. Offset Number 6 involves the rehabilitation of 1.2 ha of a degraded area of TEC SCP10a adjacent to the KRS� road alignment.</li> <li>3. To put this in context, this 4.3 ha of TEC SCP10a (3.1 ha in offset 1 and 1.2 ha in offset 6) within the proposed offset package represents: <ul style="list-style-type: none"> <li>• 5% of the total mapped area of SCP10 a on the Swan Coastal Plain (89 ha of TEC SCP10a has been mapped across the Swan Coastal Plain within the DPaW TEC/PEC database).</li> <li>• 21% of the total mapped area of SCP10a within Bush Forever Site 342 (20.5 ha has been mapped across the entire Bush Forever Site 342 within the DPaW TEC/PEC database).</li> </ul> </li> <li>4. Therefore the proposed offsets will result in protection of a significant proportion (21%) of the TEC SCP10a locally.</li> </ol> <p>The 4.47 ha of this community estimated to occur within the study area (and 20.5 ha mapped by DPaW within Bush Forever Site 342) will be better protected as a result of the KRS� project proposed fencing and proposed rehabilitation offset as follows:</p> <ul style="list-style-type: none"> <li>• Fencing of the road which will prevent access to the Bush Forever Site from Keane Road.</li> <li>• An increase in surveillance and reporting of illegal off road driving by members of the local community using the road (predicted to be 8460 vehicles/day) (Porter Consulting Engineers, 2009).</li> <li>• The indirect offset proposed, a contribution of \$150,000 for rehabilitation of existing degraded areas within Bush Forever Site 342, is proposed to be used within an area of the TEC which is extremely degraded by current off road vehicle incursions.</li> </ul> <p>This community is also the location of the proposed offset number 6 involving contribution of \$150,000 to rehabilitate degraded areas of this TEC (refer to response to issue 8).</p> <p>As outlined in van Etten (2014) (Appendix B) it is likely that edge effects will have a far greater impact on TEC SCP10a if KRS� is not built, with edge effects from the current unmanaged, unsealed track predicted to affect 1.25 ha of the TEC (or 28% of the mapped area).</p>
4	<p>This Southern River is broadly circumscribed and includes a range of vegetation communities. Del Marco et al. (2004) consider that the complex is not currently threatened given 11,501 ha or 20% of its pre-european extent (57,979 ha) is remaining (Del Marco, Taylor, Clarke, Savage, Cullity and Miles, 2004).</p> <p>Perth Region Plant Biodiversity Project (PRPBP) has built on the knowledge base of plant biodiversity information that exists for Bush Forever Sites on the Swan Coastal Plain. The PRPBP has established Bush Forever Site reference sites and provides up to date plant species lists for these sites (Western Australian Local Government Authority , 2014) . Based on this information:</p>

Submission and/or issue #	City of Armadale Response
	<ul style="list-style-type: none"> <li>• At least 5 other Bush Forever Sites on the Swan Coastal Plain have a similar plant diversity to that recorded at Bush Forever Site 342.</li> <li>• At least 2 other Bush Forever Sites have a greater plant diversity than Bush Forever Site 342.</li> <li>• The survey detail applied to Bush Forever Site 342 at the KRSL project as part of the PER is very high (very detailed Level 2 Survey). By comparison much of the survey effort applied at the other Bush Forever Sites has involved lower detail surveys therefore the number of species actually present within these other Bush Forever Sites are likely to be under represented compared to KRSL surveys.</li> </ul> <p>The KRSL project has been designed and is proposed to be managed to avoid impacts on the biodiversity within Bush Forever Site 342 Anstey/Keane Dampland and includes offsets with high levels of biodiversity.</p> <p>The City of Armadale have recognised the significance of the environment which may be potentially impacted by the KRSL proposal, by referring the project to the Environmental Protection Authority for assessment under the Part IV of the <i>Environmental Protection Act, 1986</i>.</p>
5	<p>The Project Flora Survey (EnviroWorks Consulting, 2013a) methods follow the requirements for a Level 2 survey as outlined within EPA Guidance Statement 51: <i>Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia</i> and also adopt recommendations within EPA Number 10: <i>Level of Assessment for Proposals Affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region (2006)</i>. Survey methods were also discussed with the DEC Species and Communities Branch and based on guidelines they provided for vegetation surveys on the southern Swan Coastal Plain and their suggested methods to determine floristic community types (Department of Environment and Conservation: Species and Communities Branch, Jill Pryde, 2009).</p> <p>Guidance statement number 51 states that a Level 2 survey incorporates background research and a reconnaissance survey as preparation for more intensive survey that may range in form between “detailed” and “comprehensive survey”. This was completed during the 2008 flora study (Mattiske Consulting Pty Ltd, 2008) and during initial field surveys by EnviroWorks in 2009 as preparation for a more intensive 2010 and 2011 Detailed Survey as described below. Guidance statement number 51 states that the purpose of a Detailed Survey is to enhance the level of knowledge at the locality scale. This involves:</p> <ol style="list-style-type: none"> <li>i) One or more visit/s in the main flowering season and visit/s in other seasons.</li> <li>ii) Replication of plots in vegetation units, and greater coverage and displacement of plots over the target area.</li> </ol> <p>A detailed survey was undertaken for the project area as follows:</p> <ul style="list-style-type: none"> <li>• The study undertook multiple visits (including the reconnaissance) during Spring 2009 and 2010 and Winter 2011 (2 and 6 September 2009, 2, 5, 6, 16, and 24 October 2010 and 10 and 11 November 2010, 11 August 2011).</li> <li>• 48 (58 including Mattiske, (2008)) plots were established within a survey area 500 m either side of the proposed clearing footprint. This involved replication in communities.</li> </ul> <p>Guidance Statement number 10 (EPA, 2006) recommendations for floristic surveys on the southern Swan Sandplain indicate that a comparable data collection and analysis approach to that undertaken by Gibson <i>et al.</i> (1994) should be adopted. This study has adopted this recommendation. A 100 m<sup>2</sup> quadrat based assessment of species complement and consistency was analysed using multivariate methods which included:</p> <ul style="list-style-type: none"> <li>• Cluster analysis using WinTwin</li> <li>• Nearest neighbour comparison with the Gibson <i>et al.</i> data set using Sorensen’s similarity index.</li> </ul> <p>In terms of conservation significant flora, the survey focussed on identifying any such flora</p>



Submission and/or issue #	City of Armadale Response
	<p>within the clearing footprint and 50 m either side, given these are within or near the areas of the project impact. The survey within the remainder of the study area (500 m either side of the KRSL alignment) focussed on identification of flora within quadrat locations and other opportunistic flora observations/specimen collections.</p> <p>Guidance Statement 51 does not expect every inch of the Bush Forever Site to be surveyed in detail, particularly in areas outside the zone of impacts of the project. The Study Area for the flora survey (EnviroWorks Consulting, 2013a) did not cover the entire Bush Forever Site, it covered an area 500 m either side of the proposed KRSL road alignment with survey sampling intensity as recommended by Guidance Statement 51. Therefore some species occurring within the Bush Forever Site may not be recorded in the EnviroWorks Consulting, 2013a survey if they are some distance from the zone of project impact.</p>
6	Refer to response to issue 5 above.
7	<p><i>Diuris purdiei</i> is a spring ephemeral which flowers from September to October and survey times during September and October were planned to ensure this species would be identified if present within the areas of proposed impact. Given the intensity and timing of the flora survey it is considered highly unlikely to be present within areas of direct and indirect impacts. It should be noted that significant flora searches focussed on the proposed road alignment and 50 m either side to ensure conservation significant species would be identified in the potential areas of impact.</p> <p>The historical DPaW Record for <i>Diuris purdiei</i> (Rare) could not be relocated despite searching during the appropriate flowering times. This historical record is located in an area subject to significant damage from off road vehicles (approximately 50 m away from the proposed road alignment) and therefore may have been eradicated by vehicle damage.</p> <p>Whilst suitable habitat for this species may occur within Bush Forever Site 342, it is considered highly unlikely to occur within the areas of project impact, given the detailed significant flora searches which occurred with the proposed road alignment and 50 m either side during flowering times for this species. If this species does occur within Bush Forever Site 342, it will be better protected by the proposed road and fencing as follows:</p> <ul style="list-style-type: none"> <li>• Fencing of the road which will prevent access to the Bush Forever Site from Keane Road.</li> <li>• An increase in surveillance and reporting of illegal off road driving by members of the local community using the road (predicted to be 8460 vehicles/day) (Porter Consulting Engineers, 2009).</li> </ul>
8	<p>The City of Armadale has undertaken a further assessment, in order to confirm the spatial and temporal extent of the residual impacts of “edge effects” after incorporating all the management measures in the PER document, and any additional measures proposed this response to submissions.</p> <p>This assessment completed by Dr Eddie van Etten (2014), has predicted a “zone of influence” for potential “edge effects” which may arise from the proposal including hydrological changes, spread of weeds and dieback (Appendix B). On the basis of this zone of influence a buffer has been provided from the road disturbance corridor to the TEC of approximately 5 m. As outlined within Appendix B the design and management measures proposed for the road serve to limit edge effects, which are predicted to be confined to a maximum of 3 m (van Etten, 2014) and therefore will not impact TEC SCP10a.</p> <p>It should also be noted that the design of the road does provide an inherent buffer from the sealed road. On the Northern side of the bitumised road (adjacent to the TEC SCP 10a), a 5.7 m corridor occurs containing the dual use pedestrian and bicycle path (3 m) as well as the swale and fence (2.7 m). This will effectively increase the buffer from the TEC to the bitumised road to 10.7m</p> <p>It should be noted that the component of the TEC adjacent to this buffer is highly</p>

Submission and/or issue #	City of Armadale Response
	<p>degraded (by off road track clearing and damage) and cannot currently be considered to contain the TEC full species complement. This area will require significant rehabilitation efforts to bring it back to the TEC full species complement – such rehabilitation is proposed as part of the offsets package indirect offset contribution of \$150,000.</p> <p>TEC SCP 10a will be better protected by the proposed road and fencing as follows:</p> <ul style="list-style-type: none"> <li>• Fencing of the road which will prevent access to the Bush Forever Site from Keane Road.</li> <li>• An increase in surveillance and reporting of illegal off road driving by members of the local community using the road (predicted to be 8460 vehicles/day) (Porter Consulting Engineers, 2009).</li> </ul> <p>As outlined in van Etten (2014) (Appendix B) it is likely that edge effects will have a far greater impact on TEC SCP10a if KRSL is not built, with edge effects from the current unmanaged, unsealed track predicted to affect 1.25 ha of the TEC (or 28% of the mapped area).</p> <p>Potential edge effects to the PEC communities are discussed above in the response to issue 1.</p>

## 5.2.2 FRAGMENTATION

### 5.2.2.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Wetlands Conservation Society</li> <li>• Friends of Cockburn Wetland Education Centre</li> <li>• Urban Bushland Council</li> <li>• Members of the Public</li> </ul>	<ol style="list-style-type: none"> <li>1. The proposal is located within BF Site 342 and Jandakot Regional Park (JRP) and a Conservation Category wetland. The proposal would bisect both the BF site and the conservation category wetland, and fragment habitat as a result.</li> <li>2. This BF site is 311.6 ha and includes greater than 75% of vegetation in excellent to pristine condition and has a low edge to area ratio. The Anstey Keane BF site in its current undivided state is a rare example of a large urban remnant and Keane road will dissect this and open up the site to indirect impacts.</li> <li>3. The Keane Road extension would bisect a large, compact wetland reserve known as the Anstey-Keane wetland. This wetland is a rare example of a large clay pan wetland in the Metropolitan Area, in excellent condition. This is a very significant impact.</li> <li>4. The PER does not include the impacts of fragmentation as a 'residual impact'. This is a serious omission.</li> </ol>

### 5.2.2.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The KRSL project has been designed to ensure that it will not result in ecosystem or wetland fragmentation. The following measures proposed will maintain habitat ecological connectivity:</p> <ul style="list-style-type: none"> <li>• Fauna underpasses: note these fauna underpasses have been re-designed since the public release of the PER as described in Sections 3.2, 4.2 and Appendix D to ensure suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos). This will maintain connectivity between the two areas and prevent habitat fragmentation implications on the ecology of the area.</li> <li>• Surface water connection culverts: have been designed to be placed underneath</li> </ul>

Submission and/or issue #	City of Armadale Response
	<p>the road to ensure wetland connectivity as described in Sections 3.2, 4.3 and Appendix F. It should be noted that the existing hydrology of the area has been significantly modified by surrounding development and unsealed tracks throughout the Bush Forever Site, which now act as un-nature “quasi” drainage lines. The objective of the KRSL project is to provide more natural diffuse flows underneath the road via the proposed clusters and arrays of small culverts, to prevent channelized flow and create sheet flow which is more like the natural sheet flow that would be experienced by the wetland, if it was not crossed by numerous man-made unsealed tracks.</p> <ul style="list-style-type: none"> <li>• Groundwater connectivity will be maintained by ensuring the groundwater is not disturbed (i.e. no groundwater abstraction, no disturbance of groundwater flows, no disturbance of surface water flows or recharge) as described in Appendix F.</li> </ul>
2	<ul style="list-style-type: none"> <li>• Bush Forever Site 342 is divided by numerous unsealed, unmanged tracks and contains large areas that are being degraded by Off Road Vehicles tracks. It is also bisected by a major electrical infrastructure easement corridor and Water Corporation/Local Authority drains supported by infrastructure maintenance tracks. These infrastructures all have “edges” and together they do not indicate a Bush Forever Site that is currently “undivided”. A “low edge to area ratio” can only be demonstrated if a selective definition of “edge” is adopted that ignores the current artificial linear disturbances that already exist in the Bush Forever site.</li> <li>• KRSL will only directly impact a very small amount of native vegetation (1.65 ha). The maximum area of influence for predicted edge effects from the proposed KRSL project with effective management is 0.92 ha (van Etten, 2014). When combined with the direct clearing footprint of 1.65 ha, total impacts likely from the road are predicted to be 2.57 ha. This equates to less than 1% of the 368.89 ha of vegetation within the adjacent Bush Forever Site 342.</li> <li>• By comparison the unsealed vehicle track occupies a cleared area of 0.85 ha. The area of influence for predicted edge effects from the unsealed track with off road vehicle driving (status quo) is 6.69 ha at 10 years, with potential to continue to spread further after this time (van Etten, 2014). When combined with the direct clearing footprint of 0.85 ha, total impacts likely from the unsealed track are predicted to be 7.54 ha (at 10 years with potential to spread further). This is an area of impact almost three times larger than that predicted for the KRSL project.</li> <li>• The KRSL project is also likely to reduce edge effects on surrounding tracks within Bush Forever Site 342 which are currently subject to off road vehicle driving. Fencing of the road, and increased community surveillance will likely reduce off road driving on tens of kilometres of surrounding unsealed tracks and cleared areas which all have “edge effects” (refer to Figure 14 Vegetation Condition and Native Bee Nesting Area).</li> <li>• Ecological connectivity will be maintained across the bush forever site through re-designed fauna underpasses, surface water connection culverts and not disturbing groundwater as described in the response to issue 1 above.</li> </ul>
3	<p>Ecological connectivity will be maintained across the wetlands site through re-designed fauna underpasses, surface water connection culverts and not disturbing groundwater as described in the response to issue 1 above.</p> <p>Bush Forever Site 342 is a policy overlay known as the Anstey-Keane dampland which has been superimposed over the pre-existing Keane Road Reserve. Existing road infrastructure commitments were acknowledged in the published Bush Forever documentation and the Bush Forever policy overlay does not equate as a defacto “reservation” of the dedicated road. It should be noted that conservation reserves are a statutory ‘reservation’ which require approval by two houses of parliament, whereas Bush Forever is described by WAPC a policy overlay (refer to WAPC responses to local government and general submissions on Bush Forever MRS Amendment no.1082/33 (Volume 1 – Report on Submissions, June 2010, pp.60-63). The Anstey Keane Wetland has not been dedicated as a Conservation Reserve.</p>
4	<p>Fragmentation itself is not considered to be a residual impact due to the management measures provided particularly as ecological connectivity will be maintained. The Bush Forever Site area is fragmented by unsealed Off Road Vehicle tracks, a major electrical infrastructure corridor and Water Corporation drains and maintenance tracks (refer to</p>

Submission and/or issue #	City of Armadale Response
	<p>Figure 15 Vegetation Condition and Vehicle tracks).</p> <p>As described in Section 4.1, Appendix B and Appendix C total residual impacts from Keane Road Strategic Link can be summarised as follows:</p> <p>Direct Cleared Native Vegetation of 1.65 ha  <u>Likely Edge Effects of 0.92 ha (van Etten, 2014)</u>  <b>Total residual impacts of 2.57 ha</b></p> <p>This equates to less than 1% of the 368.89 ha of vegetation within the adjacent Bush Forever Site 342.</p>

## 5.2.3 DIEBACK

### 5.2.3.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Department of Planning</li> <li>• Conservation Commission of WA</li> <li>• Friends of Ellis Brook Valley</li> <li>• Canning Regional Greens WA</li> <li>• Members of the Public</li> </ul>	<ol style="list-style-type: none"> <li>1. Dieback has been identified in four out of eight locations in the Keane Road Strategic Link. An area near the Skeet Road end of the Keane road reserve has been identified as dieback-free.</li> <li>2. The proposal will result in the spread of dieback.</li> <li>3. The dieback hygiene management plan should address requirements such as eliminating the cross-contamination of dieback-infested and dieback-free vegetation and soil during the proposed removal of the surface topsoil and the proposed mulching then stockpiling of the cleared vegetation, and avoid ponding of water from watering for dust-suppression activities.</li> </ol> <p><b>Dieback Recommendations</b></p> <ol style="list-style-type: none"> <li>4. <b>Recommendation 7:</b> [Should approval be granted for this proposal] The City of Armadale to prepare and implement a hygiene management plan to the satisfaction of DPaW. The hygiene management plan should address requirements such as management actions to avoid introducing and spreading dieback to the adjacent bushland areas, eliminating the cross-contamination of dieback-infested and dieback-free vegetation and soil, and stockpile locations.</li> </ol>

### 5.2.3.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>Sampling has suggested it is likely there is a dieback-free 'protectable' area covering approximately 100 m of the proposed road alignment near Skeet Road. However, the disease front advanced up to 6 m in a northeasterly direction from 2008 to 2009, confirmed by sampling. As the study area is fairly flat, the accepted rate of spread is approximately 1 m/yr. At this rate of spread, at its narrowest point, the 'protectable' area could be infested within approximately 50 years. In addition, other disease vectors such as off road vehicles may also be causing disease spread at a faster rate (such as the 6 m rate of spread seen in one year confirmed by sampling). At a rate of 6 m per year the, at its narrowest point, the 'protectable' area could be infested within approximately 8 years. Further sampling will be undertaken prior to construction with a view to confirming the previous results and determining whether the disease front has spread further.</p> <p>If sampling confirms the protectable area remains dieback free, dieback management during road construction will be in accordance with the Dieback Management Plan contained in Appendix J of the PER document.</p> <p>Management measures are summarized below.</p> <p>During road construction:</p> <ul style="list-style-type: none"> <li>• All vehicles and equipment will be free of soil and plant material before entering the site. If any dirt or plant material has been picked up, the vehicle must be brushed down with supplied bannister brushes.</li> <li>• Potentially infested runoff from any cleaning down required will be contained.</li> <li>• Training programs and inductions will be conducted for site personnel.</li> <li>• Vegetated areas will be quarantined ahead of construction.</li> <li>• All surface water will be contained on-site. Runoff from the construction area will be contained, and not released into areas of native vegetation.</li> <li>• Light vehicles and machinery will be restricted to construction. Off-road driving will be prohibited. Excavation equipment will be restricted to the excavation area.</li> <li>• Rehabilitated surfaces will be free-draining, and not provide water-logged</li> </ul>

Submission and/or issue #	City of Armadale Response
	<p>conditions which can allow the pathogen to thrive.</p> <ul style="list-style-type: none"> <li>• No soil or vegetation will be brought on-site, except that to be used in rehabilitation.</li> <li>• Any seedlings or plant stock brought on-site for rehabilitation will be sourced from nurseries with Nursery Industry Association wholesale accreditation, to ensure they are dieback-free.</li> </ul> <p>After road construction:</p> <ul style="list-style-type: none"> <li>• The roads will be free-draining and hard-surfaced.</li> <li>• The road will be fenced to prevent uncontrolled access to adjacent bushland, from Keane Road.</li> </ul>
2	Based on the management measures as described in the response to Issue 1 above, the project will not result in the spread of dieback.
3	<p>The dieback hygiene management plan does address requirements such as eliminating the cross-contamination of dieback-infested and dieback-free vegetation and soil during the proposed removal of the surface topsoil and the proposed mulching then stockpiling of the cleared vegetation, and avoid ponding of water from watering for dust-suppression activities. Specific dieback management procedures covered within the plan are detailed below:</p> <p>General</p> <p>These first procedures are relevant to <u>all</u> local government staff who visit the protectable area, particularly staff working in planning, engineering, ranging, surveying and environmental health.</p> <ul style="list-style-type: none"> <li>• All vehicles, machinery, tools and equipment to be maintained in a condition that is free of all mud and soil.</li> <li>• Staff completing work in bushland reserves or bushland areas of high conservation value and little disturbance, must ensure that their footwear is free of mud and soil.</li> </ul> <p>Timing</p> <ul style="list-style-type: none"> <li>• Activities should be timed to occur in dry soil conditions if possible – i.e. scheduled between November and March.</li> <li>• Activities should be postponed during and following rainfall. A minimum rainfall amount can be chosen as a guideline, for example Alcoa World Alumina’s standard is 35 mm falling over a 24 hour period.</li> <li>• Grading of gravel roads can occur when the road is damp, but not wet.</li> </ul> <p>Materials</p> <ul style="list-style-type: none"> <li>• Gravel, soil or sand brought into the protectable area must be certified free of <i>P. cinnamomi</i>. These can be purchased suppliers who are accredited by the Nursery Industry Association.</li> <li>• Note the infested areas do not need to receive dieback-free material.</li> <li>• Gravel and other materials at the work site should be stored on a hard, dry, well-drained surface that does not drain towards vegetation, and is preferably already clear of vegetation.</li> </ul> <p>Soil Movement</p> <ul style="list-style-type: none"> <li>• Soil, gravel and plant material removed from infested areas should not be used in uninfested areas.</li> <li>• Topsoil should be stockpiled and returned to the site in preference to importing fill. All uninfested topsoil should remain within the protectable area, to maximize benefit.</li> <li>• When grading, grade from upslope to down slope (when applicable).</li> <li>• Grading equipment is to be clean before commencing work.</li> <li>• The angle of grader blade should be adjusted to avoid carrying soil/gravel long</li> </ul>

Submission and/or issue #	City of Armadale Response
	<p>distances.</p> <ul style="list-style-type: none"> <li>• Do not grade wider than prescribed.</li> <li>• No movement of vegetation or soil material is to be undertaken outside of designated clearing and construction boundaries.</li> <li>• All construction and clearing operations must be confined to designated boundaries.</li> <li>• All topsoil within the clearing and development footprint is to be utilised for rehabilitation works as close to practicable to original location of removal.</li> <li>• Where practicable all movement of soil should be down slope and remain within each section of construction development.</li> </ul> <p>Water</p> <p>Dieback spores can be present in groundwater and in streams. If any in-situ water is used, it must be sterilised. Currently no stated sterilization requirements are listed from the DEC, though some trials are currently underway investigating the potential for sterilizing agents. Current best practice is to ensure all plant, equipment, vehicles and machinery are completely free of soil and vegetative material before entry to site.</p> <ul style="list-style-type: none"> <li>• Scheme or bore water, or sterilized water must be used for washing equipment.</li> <li>• Hand tools, equipment and footwear can be sterilized by spraying with methylated spirits. Allow time for it to soak into all soil material (2 minutes is sufficient).</li> <li>• Other equipment can be sterilized by soaking in a disinfectant such as bleach (containing the active ingredient sodium hypochlorite). Dilute the bleach (1 part bleach to 10 parts water), soak the tools for 2 minutes, and then rinse (follow manufacturer's safety instructions).</li> <li>• To sterilize water, add 6 mL of sodium hypochlorite (eg. pool chlorine or bleach) to every 10 L of water (follow manufacturer's safety instructions). Note this will only kill spores in the water – it will not kill spores in present in the mud or soil. The soil must be physically removed.</li> </ul> <p>Quarantine Access</p> <p>Off road vehicles, motorcycles and horses are able to spread the pathogen by picking up infested soil in their tyres and hooves. Because the tracks in the surrounding area are all located in <i>P.cinnamomi</i> infested areas, horses and motorcycles entering the protectable area can introduce the disease. Horses and dirt bikes in particular often stray from tracks, and have the potential to pick up infested soil and spread it into the protectable area. Horses and motorcycles also cause other forms of environmental degradation such as damage to plants, erosion and the spread of pest plants.</p> <ul style="list-style-type: none"> <li>• All construction vehicles will stay within the clearing boundaries at all times.</li> <li>• Recreational off road vehicles, horses and dirt bikes should be excluded from the protectable area. In practice this is difficult to enforce. Erecting fences and gates around the protectable area may be cost prohibitive and is likely to be out of the City's jurisdiction. It is noted that horse riding is currently permitted for the land parcels either side of Keane Road by the DPaW Jandakot Regional Park Management Plan. However it is suggested that this issue is discussed with the Jandakot Regional Park Community Advisory Committee to determine if a collaborative solution may be found. Ways in which the City of Armadale may be able to contribute include: <ul style="list-style-type: none"> <li>○ Provide signage at the dieback boundaries to educate people.</li> <li>○ Support the prevention of horse and motorcycle entry to the Jandakot Regional Park, and assist in 'policing' this issue.</li> <li>○ Provide information when requested to horse riders and motorcyclists about where horse riding and motorcycle riding is appropriate.</li> </ul> </li> </ul> <p>Signage</p> <p>For the first time in Western Australia, an integrated signage system has been endorsed for all lands. Project Dieback has developed a Dieback Signage Protocol which covers details, procedures and costs. It is available at <a href="http://www.dieback.net.au/">http://www.dieback.net.au/</a> (Project Dieback, 2009).</p>

Submission and/or issue #	City of Armadale Response
	<ul style="list-style-type: none"> <li>• Provide signage at the dieback boundaries, based on the Dieback Signage Protocol.</li> </ul> <p>Mobile Equipment Washdown</p> <p>A rigorous clean on entry policy is a basic hygiene requirement for all vehicles and equipment that enter the protectable area of the proposed alignment during all activities that lead up to and including the establishment of a compacted limestone road base. The following are the main principles:</p> <ul style="list-style-type: none"> <li>• All plant, equipment, vehicles and machinery must be free of soil and vegetative material before entering the protectable area.</li> <li>• All plant, equipment, vehicles and machinery are to be visually inspected before entering the protectable area to confirm they are completely free of soil and vegetation material.</li> <li>• Records of inspections can be kept to confirm that plant, equipment, vehicles and machinery are completely free of soil and vegetation material. These can be recorded on a register, with hygiene declaration forms utilised to achieve this requirement.</li> </ul> <p>Clean down requirements will vary depending on the vehicle type and weather conditions, but will fall within the following parameters;</p> <ul style="list-style-type: none"> <li>• Clean down should occur at pre-determined points as identified in the field by the day-glo flagging tape at each end of the protectable section (erected by Dieback Treatment Services, 2009). More permanent signage should be erected at these locations prior to commencement of works on site.</li> <li>• Clean down should remove all soil, slurry and plant material from vehicles and equipment before entering protectable area.</li> <li>• Clean down stations will be designed to separate the vehicle from the effluent that is cleaned off. Runoff from cleaning down must drain <u>away</u> from the protectable area.</li> <li>• Clean down can be effectively performed with either a dry brush down under dry soil conditions or high pressure wash down with scheme or chlorinated water.</li> <li>• In wet soil conditions (when mud physically sticks to vehicles), a wash down must be performed.</li> </ul> <p>Drainage</p> <p>Drainage must be controlled to avoid runoff from entering the protectable area, which can carry dieback spores. All drainage will be designed to flow away from the protectable area of the proposed alignment.</p> <ul style="list-style-type: none"> <li>• The use of crushed limestone for construction batters and roads will not support the survival of dieback and is recommended if possible for use throughout the site.</li> <li>• If surface water drainage systems are required as a result of construction works or increased hard stand areas, these systems will be constructed where possible to not drain into uninfested vegetation areas as far as practicable.</li> <li>• Site management should address potential surface water runoff so that pooling of water outside the boundary of the clearing and construction site is avoided.</li> </ul>
4	<p>The Dieback Management Plan contained in Appendix J of the PER document has been developed in accordance with best practice and is proposed to be utilised if the area is confirmed to be dieback free. This existing management plan will effectively manage dieback, therefore a new management plan should not be necessary.</p> <p>If the Keane Road Strategic Link project is approved, the City of Armadale will implement the Dieback management plan and/or meet any modified requirements that may be specified under the Ministerial Statement.</p>



## 5.3 TERRESTRIAL FAUNA

### 5.3.1 FAUNA GENERAL

#### 5.3.1.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Spineless Wonders</li> <li>• Friends of Cockburn Wetland Education Centre</li> <li>• Armadale Gosnells Landcare Group</li> <li>• Members of the Public</li> <li>• Wetlands Conservation Society</li> </ul>	<ol style="list-style-type: none"> <li>1. Anstey Keane supports a rich diversity of wildlife. A road through this environment would devastate the wildlife.</li> <li>2. The proposal is likely to result in fauna road deaths, and may indirectly impact fauna due to potential changes in hydrology and fire regimes, and increased predation, the spread of weeds and dieback.</li> <li>3. There is concern that biodiversity in this species-rich site would diminish because of road kill caused by the proposed road.</li> <li>4. There is concern that street lighting and noise from the road has the potential to alter behaviour and communication of native fauna. Light pollution will be of particular impact on nocturnal insects, many of which are important pollinators of native plants. (McCall, et al 2010, <a href="http://www.ecologyandsociety.org/vol15/iss3/art27/">http://www.ecologyandsociety.org/vol15/iss3/art27/</a> )</li> <li>5. The PER does not clearly state the importance of the reserve and its faunal diversity within its overview.</li> </ol> <p><b>Fauna Recommendations</b></p> <ol style="list-style-type: none"> <li>6. <b>Recommendation 8:</b> [Should approval be granted for this proposal] The City of Armadale prepare and implement a fauna management plan to the satisfaction of DPaW. The fauna management plan should address requirements such as minimisation of fauna mortality and disturbance to fauna habitat during road construction, maintenance of the fauna underpasses, feral animal control (pre and post road construction of the fauna underpasses), long-term monitoring and intervention of the kangaroo population, and monitoring for the Brush wallaby.</li> <li>7. <b>Recommendation 9:</b> [Should approval be granted for this proposal] No street lighting should be installed between Anstey Road and Skeet Road along Keane Road because this will adversely affect the fauna in the regional park.</li> </ol>

#### 5.3.1.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The Bamford Consulting Ecologists Fauna Assessment (2013) identified 262 native fauna species as potentially occurring in the area within which Keane Road is located. A total of 56 fauna species were recorded. The number of species potentially present reflects the availability of data and the interpretation of fauna habitats, and would be about the same for any site of similar size and habitats in the region. Sites with greater habitat richness, such as including large wetlands, would potentially support more species (Bamford Consulting Ecologists, 2013). Ecological connectivity will be maintained and the existing diversity of wildlife will not be likely to be “devastated” and will remain without significant affects from the road, in the adjacent areas even after the road works.</p> <p>Potential impacts on fauna will be managed as detailed within Section 10.5.2 of the PER and summarised below. With these management measures implemented, the EPA Objective for fauna will be met. Residual impacts will be counteracted via the proposed offsets strategy.</p> <p>Fauna management measures:</p> <ul style="list-style-type: none"> <li>• Clearing of fauna habitat will be minimised.</li> <li>• No clearing will occur of the following significant fauna habitats: <ul style="list-style-type: none"> <li>○ Waterfowl wetland habitat.</li> <li>○ Black cockatoo breeding habitat.</li> </ul> </li> </ul>

Submission and/or issue #	City of Armadale Response
	<ul style="list-style-type: none"> <li>○ Rainbow bee-eater breeding habitat.</li> <li>○ Megamouth bee (newly discovered species) breeding area.</li> <li>● Clearing of Carnaby's Black Cockatoo foraging habitat will be limited to 0.61 ha within the clearing footprint (estimated to be less than 1% of the available habitat within the adjacent Bush Forever Site).</li> <li>● Clearing of native bee foraging plants will be limited to approximately 40 individual plants of the estimated population of 5000 individuals of known foraging plant species (0.8%) and approximately 66 individual plants of the estimated population of 9250 individuals of potential foraging plant species (0.7%).</li> <li>● Construction will only be during daylight hours.</li> <li>● Seven fauna underpasses will be installed along the KRSL alignment to allow for fauna movement and at least one underpass will be located in each major habitat type occurring along the road alignment to maintain a level of connectivity across all habitats (refer to Sections 3.2, 4.2, Figures 5, 6, 7 and Appendix D for underpass details).</li> <li>● The fauna underpasses will be designed in accordance with current best practice design principles for fauna underpasses.</li> <li>● The City will monitor the road reserve and fauna underpasses quarterly and will liaise with DPaW on feral animal control methods if monitoring indicates evidence of problem predation.</li> <li>● The road boundary will be fenced to the specifications of DPaW, to guide fauna to underpasses and prevent them crossing the road directly. This will reduce roadkill risk.</li> <li>● A maximum speed limit of 70 km/h will be applied to the road and sign posted.</li> <li>● Signage indicating the area is a potential fauna crossing will be installed.</li> <li>● Rehabilitation of some disturbed areas will also provide new habitat.</li> <li>● Road safety lighting at night will be directed inwards towards the road to minimise light overspill into the surrounding bushland.</li> <li>● Land offsets will increase the net long term protection of fauna in the southern part of Forrestdale particularly around Forrestdale Lake.</li> </ul>
2	<p>Fauna road deaths will be minimised by road fencing and underpasses as follows:</p> <ul style="list-style-type: none"> <li>● The road boundary will be fenced to the specifications of DPaW, to guide fauna to underpasses and prevent them crossing the road directly.</li> <li>● Seven fauna underpasses will be installed along the KRSL alignment to allow for fauna movement and at least one underpass will be located in each major habitat type occurring along the road alignment to maintain a level of connectivity across all habitats (refer to Sections 3.2, 4.2, Figures 5, 6, 7 and Appendix D for underpass details).</li> </ul> <p>Hydrological impacts will be minimised as follows:</p> <ul style="list-style-type: none"> <li>● No changes will occur to the flow and/or capacity of the arterial drainage in the area leading to excessive flooding or drying of wetland or urban areas as a result of the KRSL project.</li> <li>● The road has been designed as a single lane in each direction and will be unkerbed with a low profile drainage swale on each side which will be designed to maximise surface water infiltration, in order to mimic the pre-construction environment.</li> <li>● Identified flow paths / areas of ponding will be maintained by a series of 300mm diameter pipe culverts. Each array of culverts will maintain the connectivity of these flow paths and ensure peak 100 year (Average Recurrence Interval events) flow rates are maintained without overtopping of the roadway. Eighteen 300mm culverts will be installed in arrays of six culverts across the three identified flow paths / areas of ponding (Water Technology, 2014) – refer to Figure 8.</li> <li>● Vegetation clearing has been minimised as far as practicable. The removal of 1.65 ha of native vegetation from the road alignment will tend to reduce the current rate of evapo-transpiration occurring in the corridor. However, the changes in hydrology from altered evapo-transpiration would be negligible due to the low biomass of native vegetation that will be removed to construct the road.</li> <li>● Road designs include that runoff is captured in detention swales, which will encourage infiltration to ensure no change to pre-existing groundwater infiltration/recharge in the area from the impervious road surface.</li> </ul>

Submission and/or issue #	City of Armadale Response
	<ul style="list-style-type: none"> <li>Excavation required for the project is minimal and will be conducted during minimum groundwater level period. Excavation below the groundwater table is unlikely and dewatering will not be required, therefore changes to groundwater hydrology are not likely and further management is not required.</li> </ul> <p>Fire risk will be minimised as described in Section 10.14.2 of the PER.</p> <p>Weeds will be managed as described in Section 10.2.2 of the PER.</p> <p>Dieback will be managed as described in Section 10.4.2 of the PER and as outlined in Section 5.2.3 of the Response to Submissions above.</p> <p>Risk of predation will be managed as described in Section 10.5.3.4 of the PER. The City of Armadale has committed to monitor the road reserve and fauna underpasses quarterly and will liaise with DPaW on feral animal control methods if monitoring indicates evidence of problem predation. DPaW manages a comprehensive program of problem and feral animal control on adjacent bushland under the Jandakot Regional Park Management Plan (Conservation Commission of Western Australia, 2010). The City of Armadale will monitor the road reserve and fauna underpasses quarterly and will liaise with DPaW on feral animal control methods if monitoring indicates evidence of problem predation.</p>
3	Fauna road kill will be minimised as described in the response to issue 2 above. Given the management measure proposed, it highly unlikely that road kill will diminish biodiversity on the site.
4	The City of Armadale proposes to meet minimum road safety lighting requirements and if contained in the Minister's Statement environmental conditions related to lighting will be implemented. However any lighting installed will be designed to be as low impacts as possible on fauna (minimum number of lights, low light intensity, specific frequency, and lights designed to only light the road – i.e. minimum light overspill). With the correct lighting design, impacts on fauna will be minimised.
5	<p>The Bush Forever is a policy overlay that is an additional consideration to the pre-existing gazetted road reserve and is not intended as a veto preventing road construction. The planning intent of the road reserve is reflected in the City of Armadale Town Planning Scheme and the State government's District Structure Plan. The consideration of the Bush Forever policy has been applied by the City through the formal environmental impact assessment processes being followed and the commitments to implement the road according to best environmental management practices. The Bush Forever policy and the Bush Forever Site does not equate with a Conservation Reserve, which can only be gazetted under the relevant legislation. It should be noted that conservation reserves are a statutory 'reservation' which require approval by two houses of parliament, whereas Bush Forever is described by WAPC a policy overlay (refer to WAPC responses to local government and general submissions on Bush Forever MRS Amendment no.1082/33 (Volume 1 – Report on Submissions, June 2010, pp.60-63) (Western Australian Planning Commission, 2010). The Anstey Keane Wetland has not been dedicated as a Conservation Reserve.</p> <p>The following conservation land classifications relevant to the project area are explained in detail in the PER under Section 4.3:</p> <ul style="list-style-type: none"> <li>Bush Forever</li> <li>Jandakot Regional Park</li> <li>Environmental Sensitive Area</li> <li>Wetland Classifications.</li> </ul> <p>Fauna diversity is discussed in detail under Section 10.15 of the PER Regional Significance, which discusses (amongst other things) faunal diversity.</p>
6	Fauna management measures within the PER are extensive as outlined in the response to issue 1 above and described detail within Section 10.5.2 of the PER – Fauna Management Plan. These documents already serve to form an extensive legally binding Fauna Management Plan. Development of a separate management plan is not necessary. The City will liaise with and seek cooperative solutions with the relevant neighbouring land manager agency (DPaW) to manage any impacts caused by the road,

Submission and/or issue #	City of Armadale Response
	<p>However, the impact assessment procedures are not intended to transfer to the City what are the normal fauna management responsibilities and functions of DPaW as the land manager for the Bush Forever Site, such as the management or “intervention of the kangaroo population” referred to. “Intervention of the kangaroo population” is not defined and kangaroo populations can fluctuate over time in response to a wide range of climatic and environmental conditions, such as for example through the chronic off road vehicle destruction of habitat which is currently occurring on the site. As stated within Appendix D (Bamford Consulting Ecologists, 2014a):</p> <p><i>“...if populations of Grey Kangaroo and/or Brush Wallaby occur within Bush Forever Site 342 they will likely require management by the responsible authority for the site (DPaW) to ensure the population is viable in the long term and manage issues such as:</i></p> <ul style="list-style-type: none"> <li>• <i>Off road vehicle access to the site</i></li> <li>• <i>Shooting</i></li> <li>• <i>Inbreeding</i></li> <li>• <i>Dog attack</i></li> <li>• <i>Possible over population and grazing pressure leading to degradation of native vegetation within the Bush Forever site.</i></li> </ul> <p><i>These management issues will exist within Bush Forever Site 342 regardless of whether KRSL is approved and constructed or not. Therefore, management of these issues is a separate matter which would need to be addressed by the authority responsible for the site (DPaW), regardless of whether or not the KRSL is constructed.</i></p> <p><i>The key management issues for the KRSL road alignment regarding kangaroo and wallaby are to ensure that the road if constructed does not lead to local extinction, thereby resulting in a loss of biodiversity within Bush Forever site 342 through which the KRSL passes. This requires the management of the following issues by the City of Armadale:</i></p> <ul style="list-style-type: none"> <li>• <i>Preventing the road causing genetic and habitat based isolation of small populations; and</i></li> <li>• <i>Preventing road kill (Bamford Consulting Ecologists, 2014a).”</i></li> </ul> <p>If the Keane Road Strategic Link project is approved and a Ministerial Condition is applied to it which requires modifications to the Fauna Management measures, the City of Armadale will meet its requirements under the Ministerial Statement.</p>
7	<p>Many public roads are adjacent to regional parks including many locations in the diverse land parcels that make up the Jandakot Regional Park and many such roads have street lighting. Members of the public that may be pedestrians, cyclists or motorists are entitled to expect their safety related needs for lighting of public roads will not be vetoed without any consideration.</p> <p>The City of Armadale proposes to meet minimum road safety lighting requirements and if contained in the Minister’s Statement environmental conditions related to lighting will be implemented. However any lighting installed will be designed to be as low impacts as possible on fauna (minimum number of lights, low light intensity, specific frequency, and lights designed to only light the road – i.e. minimum light overspill). With the correct lighting design, impacts on fauna will be minimised.</p>

## 5.3.2 THREATENED AND PRIORITY FAUNA

### 5.3.2.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Friends of Cockburn Wetland Education Centre</li> <li>• Friends of Forrestdale</li> <li>• Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>1. The PER has not referenced an adequate fauna survey. The PER identifies only 2 reptile and 3 frog species. This is likely to be far higher given that the nearby (and more degraded) Forrestdale Lake Reserve has 28 reptile and 7 amphibian species identified (Gaikhorst 2014). Therefore it is likely that significant fauna has been overlooked, for example the recently identified <i>Ctenotus ora</i> and <i>Diplodactylus polyopthalmus</i> which are likely to receive state listing.</li> <li>2. The breeding location of the newly discovered native bee “Megamouth Bee” <i>Leioproctus (Ottocolletes) muelleri</i> is only 200 metres from the Keane Rd alignment (and situated within the TEC). The potential impacts of this proposal on this species, although unlisted is of concern as it has been found in only one location.</li> <li>3. Potential impacts to the following Threatened Fauna: <ul style="list-style-type: none"> <li>• Concern over the loss of Carnaby’s Black Cockatoo vital foraging habitat and the potential cumulative impacts of this loss within the Perth Metropolitan area.</li> <li>• Concern over the impacts of habitat fragmentation on the movement of the Rainbow Bee-eater.</li> <li>• Potential impacts to the Short-tongued Bee (<i>Neopasiphae simplicior</i>) and three other threatened bee species which are considered to occur within this regional park: <i>Leioproctus douglasiellus</i>; <i>L. (glossurocolletes) bilobatus</i> and <i>L. contrarius</i> due to the presence of host and potential host plants within the Keane Road study area.</li> </ul> </li> <li>4. The PER document does not discuss the potential impacts from habitat loss and death by vehicles on the Southern Brown Bandicoot (<i>Isodon obesulus</i>).</li> </ol>

### 5.3.2.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The fauna assessment by Bamford Consulting Ecologists (2013) was conducted in accordance with EPA Guidance Statement 56 <i>Guidance for the assessment of environmental factors: Terrestrial fauna surveys for environmental impact assessment in Western Australia</i> and is considered appropriate for the impact assessment required. Guidance Statement 56 does not expect every inch of the Bush Forever Site to be surveyed in detail, particularly in areas outside the zone of impacts of the project. A comprehensive desktop assessment provides a robust list of the probable vertebrate fauna assemblage and this is explained within the Bamford Consulting Ecologists (2013a) report.</p> <p>A total of 10 species of amphibians were identified as potentially occurring within the Keane Road survey area as outlined in Table 1 of the Bamford Consulting Ecologists (2013) report. A total of 50 species of reptiles were identified as potentially occurring within the survey area as outlined in Table 2 of the Bamford Consulting Ecologists (2013a) report.</p> <p>The coastal plains skink (<i>Ctenotus ora</i>) is a recently described species, found on the Swan Coastal Plain south of Pinjarra, Western Australia. The species was described by Kay and Keogh (2012) as a distinct species and sister taxon to the threatened Lancelin Island skink (<i>Ctenotus lancelini</i>). This newly described species has not at this stage been listed for conservation and as it has not been recorded north of Pinjarra despite extensive fauna surveys in the Jandakot and Forrestdale areas (Kay and Heogh, 2012), it was not included in the expected fauna assemblage of the Bush Forever Site. Even if present it is unlikely to be impacted by the proposed road, given the fauna management measures proposed as outlined in Section 5.3.1.</p>

Submission and/or issue #	City of Armadale Response
	<p><i>Diplodactylus polyopthalmus</i> is a gecko which occurs on the swan coastal plain north of Perth in isolated populations and has been subject to a recent taxonomic revision (Doughty and Oliver, 2013). The nearest record is from Thornlie but all other records are north, as far as Mt Lesueur. It was not recorded in the expected fauna assemblage of the Bush Forever site because it has not been found in fauna surveys in the Jandakot and Forrestdale areas. Even if present it is unlikely to be impacted by the proposed road, given the fauna management measures proposed as outlined in Section 5.3.1.</p>
2	<p>The breeding location of the newly discovered native bee “Megamouth Bee” <i>Leioproctus (Ottocolletes) muelleri</i> is located 257 meters from the Keane Rd alignment (Figure 13). The bee breeding area is not situated within in the TEC SCP10a, it is located within SCP04 <i>Melaleuca preissiana</i> dampland.</p> <p>The 257 m buffer between Keane Road Strategic Link and the bee nesting site is sufficient to prevent impacts from the road on the next site. As described in van Etten (2014) Appendix B, edge effects from the road are predicted to only extend 3 m into the dampland communities. The bee nesting site is located in an area which is currently under threat from degradation cause via off road vehicle incursion as clearly shown on Figure 14. The bee nesting site will be better protected if the road is constructed due to:</p> <ul style="list-style-type: none"> <li>• Fencing to prevent access from Keane Road Strategic Link into the surrounding Bush Forever Site.</li> <li>• Increased passive surveillance by local community using the road, to assist in reporting and preventing illegal 4wd access to the Bush Forever Site.</li> </ul>
3	<p>As described in Section 10.5.1.1 of the PER:</p> <p>EnviroWorks Consulting (2012a) conducted an assessment of EPBC listed fauna habitat. Impacts to EPBC listed fauna are currently being assessed by the federal Department of Environment. Four EPBC fauna habitat identification and quantification tasks were undertaken with results summarised below.</p> <ul style="list-style-type: none"> <li>• <b>Assessment of the area of Carnaby’s Black Cockatoo foraging habitat:</b> 0.61 ha Carnaby’s Black Cockatoo foraging habitat is within the clearing footprint (estimated to be less than 1% of the available habitat within the adjacent Bush Forever Site).</li> <li>• <b>Assessment of the area of potential Carnaby’s Black Cockatoo breeding habitat:</b> There are no trees present in the clearing footprint which are sufficiently large in trunk diameter to support hollows suitable for Carnaby’s Black Cockatoo use nor likely to develop into sufficiently sized trees, due to the type of tree species present.</li> <li>• <b>Assessment of the area of Migratory Water Bird habitat:</b> The seasonal water present in the low damp heath areas and along the existing track is unsuitable for waterfowl habitat being too shallow and temporary.</li> <li>• <b>Assessment of the area of habitat for Rainbow Bee-eater (<i>Merops ornatus</i>):</b> There are no slopes of sufficient height to support Rainbow Bee-eater burrows. As the area is low lying and seasonally waterlogged in places, it is likely that much of it would be too wet for burrowing nests.</li> </ul> <p>Studies were conducted to determine the presence of four threatened native bee species, <i>Neopasiphae simplicior</i>, <i>Leioproctus douglasiellus</i>, <i>Leioproctus contrarius</i> and <i>Leioproctus (Glossurocolletes) bilobatus</i> (EnviroWorks Consulting, 2012d).</p> <p>EnviroWorks Consulting (2012d) collected one specimen of native bee, <i>Neopasiphae simplicior</i> approximately 200 m away from the proposed clearing footprint. EnviroWorks also identified several known and potential native bee host plant species within the clearing footprint. As outlined below in Table A below, between 0.93% and 1.33% of the known population of each host plant species would be cleared as a result of the KRSL project. This is considered a small proportion of the available host plants in the area and unlikely to significantly effect the bee species. Furthermore fencing of the road is likely to prevent further degradation by ORV access which currently threatens the bee species</p>

Submission and/or issue #	City of Armadale Response																																																
	<p>habitat.</p> <p><b>Table A: Estimated Population Size and Percentage Clearing of Native Bee Known and Potential Host Plant Species</b> (EnviroWorks Consulting, 2012d)</p> <table border="1" data-bbox="375 430 1417 965"> <thead> <tr> <th></th> <th>No. Plants in KRSL</th> <th>No. Plants Bush Forever Site 342</th> <th>% Cleared by KRSL</th> </tr> </thead> <tbody> <tr> <td colspan="4"><b>Known Host Species</b></td> </tr> <tr> <td><i>Goodenia pulchella</i></td> <td>0</td> <td>1000</td> <td>0</td> </tr> <tr> <td><i>Velleia trinervis</i></td> <td>0</td> <td>1000</td> <td>0</td> </tr> <tr> <td><i>Lobelia tenuior</i></td> <td>40</td> <td>3000</td> <td>1.33</td> </tr> <tr> <td><i>Total</i></td> <td>40</td> <td>5000</td> <td>0.80</td> </tr> <tr> <td colspan="4"><b>Potential Host Species</b></td> </tr> <tr> <td><i>Dampiera linearis</i></td> <td>38</td> <td>4000</td> <td>0.95</td> </tr> <tr> <td><i>Scaevola lanceolata</i></td> <td>0</td> <td>1500</td> <td>0</td> </tr> <tr> <td><i>Lechenaultia floribunda</i></td> <td>0</td> <td>750</td> <td>0</td> </tr> <tr> <td><i>Gompholobium tomentosum</i></td> <td>28</td> <td>3000</td> <td>0.93</td> </tr> <tr> <td><i>Total</i></td> <td>66</td> <td>9250</td> <td>0.7</td> </tr> </tbody> </table> <p>On the basis of the above information, it is concluded that the construction and operation of KRSL will not cause an unacceptable loss of significant fauna or habitat</p>		No. Plants in KRSL	No. Plants Bush Forever Site 342	% Cleared by KRSL	<b>Known Host Species</b>				<i>Goodenia pulchella</i>	0	1000	0	<i>Velleia trinervis</i>	0	1000	0	<i>Lobelia tenuior</i>	40	3000	1.33	<i>Total</i>	40	5000	0.80	<b>Potential Host Species</b>				<i>Dampiera linearis</i>	38	4000	0.95	<i>Scaevola lanceolata</i>	0	1500	0	<i>Lechenaultia floribunda</i>	0	750	0	<i>Gompholobium tomentosum</i>	28	3000	0.93	<i>Total</i>	66	9250	0.7
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4	<p>Southern Brown Bandicoot / Quenda (<i>Isoodon obesulus fusciventer</i> (Priority 5) was recorded during the survey by Bamford Consulting Ecologists (2013) as stated in Section 8.8.3 of the PER. Potential impacts to fauna including Bandicoot and proposed management measures are discussed in Section 10.5 of the PER.</p> <p>Habitat loss for this species has been predicted to be small based on the small amount of the Bush Forever Site to be impacted: Direct Cleared Area of 1.65 ha, Likely Edge Effects of 0.92 ha (residual impacts of 2.57 ha in total or less than 1% of the Bush Forever Site) (van Etten, 2014).</p> <p>Fauna road deaths (including Bandicoot) will be minimised by fencing and underpasses as described in Section 5.3.1 of this Response to Submissions above.</p>																																																

### 5.3.3 HABITAT FRAGMENTATION

#### 5.3.3.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>Wetland Conservation Society Inc.</li> <li>Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>The proposal would bisect a large, compact wetland reserve known as the Anstey-Keane wetland. It is the habitat for a wide range of flora and fauna, including several rare and threatened species. Severance of this habitat will inevitably lead to loss of biodiversity of fauna and this is not acceptable for such a unique and rare wetland.</li> <li>There is concern that the proposed road would create a barrier to the movement fauna such as kangaroos and wallabies and would decrease their chance of continuing a healthy population in the reserve; from loss of individuals from road mortality and genetic restriction. Habitat fragmentation and vehicle noise is likely to add to stresses on these populations. The potential impacts of this have not been discussed in the PER.</li> <li>There is concern that the fragmentation resulting from the Keane road extension will significantly impact on the <i>Varanus rosenbergi</i> population within the reserve.</li> </ol>

### 5.3.3.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The project has accordingly been designed to ensure that it will not result in ecosystem or wetland fragmentation. The following measures proposed will maintain habitat ecological connectivity:</p> <ul style="list-style-type: none"> <li>• Fauna underpasses: note the fauna underpasses have been re-designed since the public release of the PER as described in Sections 3.2, 4.2 and Appendix D to ensure suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos). This will maintain connectivity between the two areas and prevent habitat fragmentation implications on the ecology of the area.</li> <li>• Surface water connection culverts: have been designed to be placed underneath the road to ensure wetland connectivity as described in Sections 3.2, 4.3 and Appendix F. It should be noted that the existing hydrology of the area has been significantly modified by surrounding development and unsealed tracks throughout the Bush Forever Site, which now act as un-natural “quasi” drainage lines. The objective of the KRSL project is to provide more natural diffuse flows underneath the road via the proposed clusters and arrays of small culverts, to prevent channelized flow and create sheet flow which is more like the natural sheet flow that would be experienced by the wetland, if it was not crossed by numerous man-made unsealed tracks.</li> <li>• Groundwater connectivity will be maintained by ensuring the groundwater is not disturbed (i.e. no groundwater abstraction, no disturbance of groundwater flows, no disturbance of surface water flows or recharge) as described in Appendix F.</li> </ul>
2	<p>The Bush Forever Site 342 is confined by major regional and district roads and urban areas. It is a highly modified ecosystem with a wide range of existing artificial disturbances (unsealed tracks, powerline, artificial drainage etc). Vegetation Condition Mapping (Figure 15) shows that of the 369.5 ha of Bush Forever Site 342, 72 ha (or 20%) has been degraded by incursion by off road vehicles which are currently using existing unsealed roads/tracks within Bush Forever Site 342. This has created a number of smaller pockets of vegetation (33% of which is in very good condition and 47% of which is in good condition) as shown in Figure 15 (EnviroWorks Consulting, 2013a). It cannot be assumed that any kangaroo or wallabies that may or may not presently exist in the Bush Forever site represent the “healthy population” which it is implied the City should ensure continue. Refer to Appendix B for further discussion regarding this issue (Bamford Consulting Ecologists, 2014a).</p> <p>Notwithstanding the fauna underpasses proposed have been re-designed since the public release of the PER as described in Sections 3.2, 4.2 and Appendix D to ensure suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos). This will maintain connectivity between the two areas and prevent habitat fragmentation implications on the ecology of the area.</p> <p>Keane Road Strategic Link is proposed to be a local road, with limited speed and heavy vehicles will not be permitted by regulation and enforcement in addition to its design limitations that will discourage heavy vehicle traffic. Therefore road noise will be minimised and localised. Fauna can adapt to noise and it has not prevented kangaroos crossing regularly under the Roe Hwy as described in Appendix D (Bamford Consulting Ecologists, 2014a). Therefore, by providing adequate sized fauna underpasses, kangaroos and wallabies (if they exist or persist at the site) will be able to pass underneath the road, thereby enabling continued access to currently available foraging areas and allowing genetic transfer to continue over the BF site including across each side of the road post- construction (refer to Appendix B) (Bamford Consulting Ecologists, 2014a).</p>
3	<p>Rosenberg’s Goanna (<i>Varanus rosenbergi</i>) was noted as potentially present within the Bush Forever Site, although it was not recorded on site, by the Bamford Consulting Ecologist (2013) assessment. This species is not listed for conservation purposes under legislation or priority lists.</p>



Submission and/or issue #	City of Armadale Response
	<p>Impacts to this species if present will be minimised by proposed fauna management measures as detailed within Section 10.5.2 of the PER and summarised above in Section 5.3.1 of this Response to Submissions document.</p> <p>This species will be able to use fauna underpasses and it will not be able to pass through the fence onto the road (as there will be fine mesh at the bottom of the fence in accordance with DPaW specifications). Therefore this species is unlikely to be impacted by fragmentation of habitat.</p>

## 5.3.4 FAUNA UNDERPASSES

### 5.3.4.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Wildflower Society of WA,</li> <li>• Friends of Cockburn Wetland Education Centre,</li> <li>• Urban Bushland council</li> <li>• Friends of Paganoni Swamp</li> <li>• Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>1. Several of the proposed underpasses are in low-lying areas and therefore susceptible to inundation. However, there are statements that imply that the fauna underpasses will not be affected by water inundation, such as "Underpasses will not be positioned in areas likely to flood; ... it is not expected the underpasses will experience significant inundation..., some minor ponding may occur... it is not expected to be significant". The surface water &lt;0.1 m in depth has been dismissed as widespread sheetflow, and has not been shown in the modelling figures (Figure 20 and 21). This widespread sheet flow will of course affect ponding in the underpasses, especially as the road will be built across the very flat dampland and this barrier will only be bisected by three culverts and the fauna underpasses.</li> <li>2. The effectiveness, design and location of the fauna underpasses require further consideration and the proponent should clearly define its commitment to feral animal control within the BF site.</li> <li>3. The dimensions of the fauna underpass are not considered suitable for utilisation by the Western Brush Wallaby and other macropods such as kangaroos. The fauna management measures put forward do not address the impacts of the proposed road on kangaroos, nor have the changes to the ecosystem due to the loss of a population of large mammals been addressed.</li> <li>4. To adequately protect fauna it is recommended that the underpasses are designed to allow for immediate adjacent cover of habitat at underpass entrances. Without the provision of adequate cover, the fauna underpasses are inadequate and do not mitigate the impacts of the proposal on conservation significant fauna.</li> </ol>

### 5.3.4.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The validated surface water model (Water Technology, 2014 – Appendix F) has been used to determine the fauna underpass locations as shown in Figure 5. The locations which have been modelled by Water Technology as subject to inundation (blue circles on Figure 5) have been avoided and underpasses have been placed in areas which avoid flooding. Furthermore, the floor of the underpasses will be positioned so that they are located above the height of groundwater inundation. Therefore underpasses will not be subject to inundation.</p>
2	<p>The fauna underpasses proposed have been re-designed since the public release of the PER as described in Sections 3.2, 4.2 and Appendix D to ensure suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos).</p> <p>Risk of predation will be managed as described in Section 10.5.3.4 of the PER. The City of Armadale has committed to monitor the road reserve and fauna underpasses quarterly</p>

Submission and/or issue #	City of Armadale Response																							
	<p>and will liaise with DPaW on feral animal control methods if monitoring indicates evidence of problem predation. DPaW manages a comprehensive program of problem and feral animal control on adjacent bushland under the Jandakot Regional Park Management Plan (Conservation Commission of Western Australia, 2010). The City of Armadale will monitor the road reserve and fauna underpasses quarterly and will liaise with DPaW on feral animal control methods if monitoring indicates evidence of problem predation.</p> <p>The underpass design is in line with best practice design principles as described in Table B below extracted from Section 10.5 of the PER.</p>																							
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Cover	<ul style="list-style-type: none"> <li>Provide vegetation/rock pile cover at entrances to provide cover for fauna on approach to the structure.</li> </ul>	<ul style="list-style-type: none"> <li>Rock/log piles and vegetation to be placed (and rehabilitated) strategically near the entrance and exit of each underpass to create cover for fauna utilising the underpass.</li> </ul>																						
Distance to cover	<ul style="list-style-type: none"> <li>Maintain as much vegetation/rock pile cover as possible between the structure entrance and distance to cover.</li> </ul>	<ul style="list-style-type: none"> <li>Cover in terms of intact native vegetation areas will be a short distance from all underpasses.</li> <li>Additional cover (such as rock piles / vegetation) will be placed and rehabilitation occur near underpass entrances and exits.</li> </ul>																						
Divided highways	<ul style="list-style-type: none"> <li>Underpasses across divided highways should be in a straight line to provide unobstructed views.</li> </ul>	<ul style="list-style-type: none"> <li>Not relevant to Keane Rd</li> </ul>																						
Lighting conditions	<ul style="list-style-type: none"> <li>Avoid long, dark and narrow tunnels. If necessary install grates or skylights at medians</li> </ul>	<ul style="list-style-type: none"> <li>Underpass length has will be kept as short as possible, to ensure adequate natural light will penetrate from either end of the underpass (this is not a major issue for nocturnal species)</li> <li>The underpass length for Keane Rd (the road</li> </ul>																						

Submission and/or issue #	City of Armadale Response		
			width is 18.4 m) is relatively short compared with longer underpasses in place for other projects such as Roe Hwy.
	Substrate	<ul style="list-style-type: none"> <li>Maintain a natural substrate on the floor of the underpass (or cover with a natural substrate i.e. bury underpass about 17% to provide a natural substrate that promotes animal use).</li> <li>Consider placement of logs ("furniture") within the underpass if size permits without restricting movement.</li> <li>Rip Rap is difficult for some fauna to traverse, and should not be placed in front of or on the slopes adjacent to a passageway. If rip-rap is required, then it should be buried, back-filled with topsoil, and planted with native vegetation.</li> </ul>	<ul style="list-style-type: none"> <li>Underpasses floors will be covered with soil/sand during construction.</li> <li>Underpasses will be monitored and if necessary additional sand/soil will be placed in them to create additional natural substrate.</li> </ul>
	Water inundation	<ul style="list-style-type: none"> <li>Avoid areas that will be permanently inundated (water inundation and puddles usually prevent fauna movement; although may attract fauna in dry environments)</li> </ul>	<ul style="list-style-type: none"> <li>Underpasses will not be positioned in areas likely to flood.</li> <li>Given the road does not cross any major drainage lines it is not expected the underpasses will experience significant inundation.</li> <li>Some minor ponding may occur within them after rain, but this is not expected to be significant.</li> </ul>
	Human interaction	<ul style="list-style-type: none"> <li>Keep human interaction to a minimum.</li> </ul>	<ul style="list-style-type: none"> <li>Given there are no dedicated areas for traffic to stop in the area, and given the road will be fenced, it is not expected there will be significant human interaction in the underpass areas.</li> <li>A maximum speed limit of 70 km/h will be applied to assist in minimising noise and fauna mortality.</li> <li>Signage indicating the area is a potential fauna crossing will be installed.</li> </ul>
	Noise levels of traffic	<ul style="list-style-type: none"> <li>Reduce the noise levels of traffic by reducing speed limits where possible, and consider sound insulating construction materials (such as corrugated metal)</li> </ul>	<ul style="list-style-type: none"> <li>Concrete structural cover will be placed over the underpasses, which will reduce traffic noise.</li> <li>A maximum speed limit for the KRSL of 70 km/hour will be signposted (reducing noise and fauna mortality).</li> </ul>
	Fencing	<ul style="list-style-type: none"> <li>Consider the use of fencing to direct animals toward underpasses. Fencing should be tied into edges of underpasses with no gaps (ideally); fence tops should also bend away from the road to inhibit climbing and escape routes (e.g. ramps on the road side of the fence) should be included.</li> <li>To prevent animals from digging under fences, bury fences to a depth appropriate for the species in the area.</li> <li>Minimize "natural ladders" adjacent to the fence which could facilitate an animal climbing over the fence (e.g. trees, large bushes, etc.) and fences should be equipped with tops angled</li> </ul>	<ul style="list-style-type: none"> <li>Fencing or rock/vegetation placement will be provided at underpass entrances / exits where appropriate to guide fauna into the underpass and away from the road.</li> <li>The City of Armadale have committed to fence Keane Rd Strategic Link to the specification of the Department of Parks and Wildlife (), in order to guide fauna to underpasses and prevent fauna crossing the road.</li> <li>Fencing will incorporate closer mesh fencing 30 cm high to form a barrier at the bottom of fencing to aid prevention of smaller animals (such as South West Carpet Python and other reptiles) passing through the fence and directing them towards fauna underpasses.</li> </ul>

Submission and/or issue #	City of Armadale Response	
		<p>away from the road.</p> <ul style="list-style-type: none"> <li>• Fencing should extend on either side of the structure just beyond a natural break in an animal's ability to traverse the landscape and guide them to the underpass.</li> <li>• Escape ramps should be constructed when extensive fencing is utilized on one or both sides of a underpass to prevent animals from being trapped on the road.</li> <li>• Appropriate types and sizes of fencing should be selected based on species in the area; mesh-size should be used to accommodate all species size-classes (i.e. mesh-sizes small enough to prevent the smallest species from breaching the fence or getting stuck).</li> </ul>
	Feral Animal Control	<ul style="list-style-type: none"> <li>• While fauna will use underpasses, the effectiveness of such structures can be limited by predation.</li> <li>• Feral animal control should be considered to increase effectiveness.</li> </ul> <ul style="list-style-type: none"> <li>• The City of Armadale has committed to implement feral animal control initiatives.</li> <li>• As the managing authority for the Keane Road dedicated road reserve, the City has committed to liaise with the DWP on managing any feral animals on the road reserve including the native fauna underpasses.</li> <li>• The City will monitor the road reserve and fauna underpasses quarterly and will liaise with DWP on feral animal control methods if monitoring indicates evidence of problem predation.</li> </ul>
3	<p>The fauna underpasses proposed have been re-designed since the public release of the PER as described in Sections 3.2, 4.2 and Appendix D to ensure suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos).</p> <p>The project has been designed to ensure that it will not result in ecosystem or wetland fragmentation as described in Section 5.3.3. of this Response to Submissions.</p>	
4	<p>The fauna underpasses have already been designed with adequate cover at the entrance as outlined in Table B above: 'Rock/log piles and vegetation to be placed (and rehabilitated) strategically near the entrance and exit of each underpass to create cover for fauna utilising the underpass.' This is also clearly shown in Figure 6.</p>	

## 5.4 WETLANDS, GROUNDWATER AND SURFACE WATER

### 5.4.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Wetlands Conservation Society</li> <li>• Wetlands Research Association</li> <li>• Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>1. Chemical spills are highly possible and would contaminate the conservation category wetland, which the road cuts across.</li> <li>2. EPA Guidance Statement No. 33 states that wetlands that are to be protected require a minimum buffer of 50 metres. At the southern end of the proposed road, there is no buffer proposed between the road and the state and EPBC listed TEC. The drainage patterns associated with these surface waters and therefore with the hydrology of the TEC at a local scale could be potentially impacted by the proposed road.</li> <li>3. Appendix F of the PER document concludes that “the vegetation adjacent to the project is unlikely to be affected by hydrological or hydrogeological changes resulting from the proposal. However, the proposal traverses a wetland and is adjacent to a TEC. The report focuses on regional scale impacts. The assessment of the significance of local scale changes needs to be based upon an analysis of the effects on local ecology rather than regional hydrology.</li> <li>4. Appendix G of the PER accurately summarises potential hydro-ecological impacts but doesn’t make the linkage that there could be changes to the groundwater system due to the blockage of surface water flow up gradient of the road. This may lead to ponding of surface water.</li> <li>5. The proposal documents do not conclusively demonstrate that the proposed road would not alter patterns of surface flow and ponding.</li> <li>6. The recurring statement that the proposed road alignment is located upon sandy soils has not been demonstrated.</li> <li>7. The installation of a culvert at location C (Figure 20) is likely to create a channelized flow down gradient that would alter the hydrological regime of the wetland. Any channelized flow in this vicinity would directly impact the TEC, priority flora and threatened fauna.</li> <li>8. The PER indicates that baseline monitoring associated with this proposal has yet been undertaken. Absence of this baseline monitoring will prevent the true hydrological impacts of the development being recognised and therefore mitigated.</li> <li>9. The proponent has not demonstrated how the drainage swales will be maintained to ensure weeds do not infest the surrounding wetland.</li> <li>10. Natural bio-remediation is identified as the management measure to address wetland contamination, but no details are provided regarding the effectiveness of this process in this sensitive environment.</li> <li>11. The terrain is not described in terms of landforms (e.g., star dunes), stratigraphy, and hydrology, indicating that the consultants do not know or do not understand the significance of these features to conservation and environmental management. In terms of landforms and wetlands, in its vegetation state, this wetland complex is of high conservation significance, a factor not recognised nor addressed by the consultants.</li> <li>12. The wetlands were not classified. For instance, a sumpland has different management to a dampland and a single wetland basin can have three separate management categories within it but the stratigraphic hydrological bases for its impact assessment and its management will be constant.</li> </ol> <p><b><u>Hydrological recommendations</u></b></p> <ol style="list-style-type: none"> <li>13. <b>Recommendation 1:</b> That a detailed on-site monitoring program is developed to establish the pre-existing hydrological conditions and an ongoing monitoring program implemented to establish whether construction is impacting the wetland [and subsequently the threatened ecological community]. Preparation of a contingency plan that can be enacted, should wetland monitoring indicate any adverse impacts from the project, is recommended.</li> </ol>

	<p>14. <b>Recommendation 2:</b> Ground-truthing during rainfall events is recommended to be undertaken to validate the modelling. Additional 2D modelling with fine scale topographic data and fine scale soil mapping is recommended, in consultation with DPaW.</p> <p>15. <b>Recommendation 3:</b> The City of Armadale to undertake a site specific environmental impact assessment to demonstrate that natural bioremediation will address the pollutants that would be deposited, including hydrocarbons and heavy metals.</p> <p>16. <b>Recommendation 4:</b> [Should approval be granted for this proposal] The City of Armadale to prepare and implement management plans for the long-term maintenance of the drainage swales and culverts, in consultation with DPaW. The management plan should address requirements such as management actions for weed control, maintaining the vegetation on the embankments and swales, managing sedimentation from up gradient of the culverts, and maintenance and monitoring of the culverts and associated rock rip raps.</p> <p>17. <b>Recommendation 5:</b> The City of Armadale provide details on the proposed sewer and water infrastructure to be installed, so that the collective impacts can be assessed.</p>
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## 5.4.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response										
1	<p>During construction the storage of fuels and chemicals on site will be limited. General requirements for the storage of hazardous substance within the project area will include:</p> <ul style="list-style-type: none"> <li>• Ensuring only minimal quantities of fuels and oils will be stored on site.</li> <li>• No bulk chemicals will be stored on site.</li> <li>• Limiting storage to designated areas, which are appropriately signed, bunded and contained.</li> <li>• All substances labeled and stored in accordance with relevant codes and standards where applicable.</li> <li>• All Material Safety Data Sheets (MSDS) maintained and easily accessible/located on-site for all fuels and chemicals on-site.</li> <li>• Handling materials in line with associated documented procedures.</li> <li>• Regular housekeeping and inspection to ensure that storage is appropriate.</li> <li>• Implementation of spill response procedures and provision of appropriate emergency equipment (including spill kits) on-site.</li> </ul> <p>Construction management measures are further detailed in Table C below.</p> <p style="text-align: center;"><b>Table C: Management Measures for Hazardous Substances</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #4CAF50; color: white;"> <th style="width: 35%;">Activity</th> <th>Management Measure</th> </tr> </thead> <tbody> <tr> <td>Refuelling Activities</td> <td> <ul style="list-style-type: none"> <li>• All personnel trained in refuelling procedures.</li> <li>• Completed at designated areas only.</li> </ul> </td> </tr> <tr> <td>Containment and Controlled Discharge</td> <td> <ul style="list-style-type: none"> <li>• All hazardous substances stored in accordance with regulations and in designated areas on-site.</li> <li>• All spills immediately contained and cleaned up. All wastes from clean-up appropriately stored and disposed.</li> </ul> </td> </tr> <tr> <td>Housekeeping and Inspections/Monitoring</td> <td> <ul style="list-style-type: none"> <li>• All hazardous substances and wastes to be stored in designated areas, which are to be maintained clean and tidy to minimise potential for spill or littering.</li> <li>• All bins on-site secured and regularly emptied.</li> <li>• Site inspections to ensure bins and storage areas maintained accordingly and that all hazardous substances appropriately stored and signed if applicable.</li> </ul> </td> </tr> <tr> <td>Emergency Response</td> <td> <ul style="list-style-type: none"> <li>• Spill kit available for the clean-up of minor spills.</li> <li>• Contractor to provide Spill Response Procedure details and</li> </ul> </td> </tr> </tbody> </table>	Activity	Management Measure	Refuelling Activities	<ul style="list-style-type: none"> <li>• All personnel trained in refuelling procedures.</li> <li>• Completed at designated areas only.</li> </ul>	Containment and Controlled Discharge	<ul style="list-style-type: none"> <li>• All hazardous substances stored in accordance with regulations and in designated areas on-site.</li> <li>• All spills immediately contained and cleaned up. All wastes from clean-up appropriately stored and disposed.</li> </ul>	Housekeeping and Inspections/Monitoring	<ul style="list-style-type: none"> <li>• All hazardous substances and wastes to be stored in designated areas, which are to be maintained clean and tidy to minimise potential for spill or littering.</li> <li>• All bins on-site secured and regularly emptied.</li> <li>• Site inspections to ensure bins and storage areas maintained accordingly and that all hazardous substances appropriately stored and signed if applicable.</li> </ul>	Emergency Response	<ul style="list-style-type: none"> <li>• Spill kit available for the clean-up of minor spills.</li> <li>• Contractor to provide Spill Response Procedure details and</li> </ul>
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Submission and/or issue #	City of Armadale Response
	<div data-bbox="331 248 663 360" style="border: 1px solid black; width: 208px; height: 50px; margin-bottom: 10px;"></div> <div data-bbox="663 248 1453 360" style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>contingencies for the clean-up of hydrocarbon spills.</p> <ul style="list-style-type: none"> <li>• All site personnel will receive training on this procedure.</li> <li>• Copies of procedure available with spill kits and in designated storage areas.</li> </ul> </div> <p>Chemical spills are considered highly unlikely during road operation given:</p> <ul style="list-style-type: none"> <li>• The road is a local road and heavy vehicles will not be allowed to use the road by regulation. The only large vehicles allowed to use the road will be local buses to provide public transport to the community.</li> <li>• The only source of a spill would be fuel carried in the fuel tank of a vehicle, if an accident occurred and the fuel tank ruptured.</li> <li>• The spill would be captured in the drainage swales on the road side and would not enter the surrounding environment.</li> <li>• In this instance emergency services would carry out their normal spill containment and clean up procedures including removal of any contaminated soil from drainage swales.</li> </ul>
2	<p>EPA Guidance Statement 33 (attachment B4-3) states (EPA, 2008):</p> <p><i>“A site-specific buffer requirement may be determined. The extent of the buffer around a particular wetland should be based on an assessment of:</i></p> <ul style="list-style-type: none"> <li>• <i>the wetland’s values</i></li> <li>• <i>the activities, land uses or development near the wetland, existing and proposed</i></li> <li>• <i>the threats posed by the adjacent activities, land uses or development.</i></li> </ul> <p><i>Studies should typically involve site investigations and identify:</i></p> <ul style="list-style-type: none"> <li>• <i>the wetland, and key wetland attributes, for example, vegetation and flora, fauna, hydrology, soils, topography, landscape features, functions and values</i></li> <li>• <i>the wetland management category and management objectives</i></li> <li>• <i>threatening processes near the wetland (existing and potential), for example, changes to the water regime, weeds, inappropriate recreational use</i></li> <li>• <i>the separation and management required to meet management objectives, and the extent to which these can be achieved</i></li> <li>• <i>the proposed buffer and key management measures.</i></li> </ul> <p><i>A methodology is being prepared for the Wetlands Coordinating Committee and a draft has been released for public comment “Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005)”. When finalised and endorsed this methodology will form the basis for determining wetland buffers.”</i></p> <p>Although the above WAPC guideline has not been finalised, the draft contains a methodology aligned with EPA Guidance Statement 33 and recommends that proposals with potential to impacts Conservation Category Wetlands should be referred to the EPA. The City of Armadale have followed this recommendation by referral of the Keane Road project to the EPA and undertaking an Environmental Impact Assessment including assessment of impacts to hydrological processes and wetlands (the Keane Road Strategic Link PER).</p> <p>Based on the results of the EIA, as documented within the PER and this response to submissions, it has been concluded that the Keane Road project, does not consist of significant threatening processes and is unlikely to have significant impacts on wetland hydrological processes or ecology. Therefore a buffer to the wetland has not been proposed. Instead a variety of management measures have been proposed to prevent impacts to the wetland and hydrological processes as follows:</p> <ul style="list-style-type: none"> <li>• No changes will occur to the flow and/or capacity of the arterial drainage in the area leading to excessive flooding or drying of wetland or urban areas as a result of the KRSL project.</li> <li>• The road has been designed as a single lane in each direction and will be unkerbed with</li> </ul>

Submission and/or issue #	City of Armadale Response
	<p>a low profile drainage swale on each side which will be designed to maximise surface water infiltration, in order to mimic the pre-construction environment.</p> <ul style="list-style-type: none"> <li>• Identified flow paths / areas of ponding will be maintained by a series of 300mm diameter pipe culverts. Each array of culverts will maintain the connectivity of these flow paths and ensure peak 100 year (Average Recurrence Interval events) flow rates are maintained without overtopping of the roadway. Eighteen 300mm culverts will be installed in arrays of six culverts across the three identified flow paths / areas of ponding (Water Technology, 2014).</li> <li>• Location C is near the existing Bailey Branch Drain which currently passes through 2 x 750mm diameter culverts at Keane Road. These culverts have a capacity of around 2.6m<sup>3</sup>/s. As detailed in previous government modelling (Department of Water, 2009) and shown in the current model results, ponding of water does already occur upstream of the proposed KRSL, north of the intersection of Keane Rd and Anstey Rd (in private farmland) under existing conditions for the 100 year ARI event. This existing upstream ponding within private farmland is connected to ponding downstream of the proposed KRSL alignment within native vegetation. Therefore instead of changing the capacity of the drain (which may change the current hydrology including ponding) it is proposed to provide a series of six 300mm diameter pipe culverts underneath KRSL near Bailey's Branch drain, to maintain existing hydrological conditions including ponding on both sides of the KRSL under the 100 year ARI event (Water Technology, 2014).</li> <li>• Vegetation clearing has been minimised as far as practicable. The removal of 1.65 ha of native vegetation from the road alignment will tend to reduce the current rate of evapo-transpiration occurring in the corridor. However, the changes in hydrology from altered evapo-transpiration would be negligible due to the low biomass of native vegetation that will be removed to construct the road and by management measures that minimise the extent of indirect or edge effects of the road.</li> <li>• Road designs include that runoff is captured in detention swales, which will encourage infiltration to ensure no change to pre-existing groundwater infiltration/recharge in the area from the impervious road surface.</li> <li>• Excavation required for the project is minimal and will be conducted during minimum groundwater level period. Excavation below the groundwater table is unlikely and dewatering will not be required, therefore changes to groundwater hydrology are not likely and further management is not required.</li> <li>• Earthworks will be planned and managed to ensure any runoff will be managed using an infiltration approach, thereby minimising mobilisation of sediment.</li> <li>• Hydrocarbons and chemicals utilised by construction contractors will be appropriately stored, transported, used and disposed to prevent contamination occurring.</li> <li>• Road design principles will ensure runoff is captured in vegetated detention swales which will manage water quality.</li> <li>• In the case of a vehicle accident a fuel tank could be ruptured leading to an emergency spill. In the case of a large scale spill, emergency authorities would be contacted and the spill remediated appropriately.</li> </ul>
3	<p>Appendix F to the PER "Review of Existing Hydrology and Hydrogeology" (EnviroWorks Consulting, 2012c) was intended as a review of the extensive existing available information for the local catchment (Forrestdale Main Drain Catchment). The area has been extensively studied over the last 20 years with a large amount of relevant information available. Appendix G to the PER "Keane Road Strategic Link Hydrologic Study" was conducted as a follow up study in order to undertake a detailed local scale hydrology assessment of the local area and assess impacts from construction of the Keane Road Strategic Link.</p>
4	<p>The City of Armadale has undertaken further hydrological assessment, in order to confirm the predicted hydrological impacts and recommended management measures for the project. This assessment by Water Technology (2014) (Appendix F) has confirmed previous hydrological conclusions, and has been used to refine the proposed water culvert design. The report has further assessed the potential for blockage of surface water flow up gradient of the road and concluded that this will not occur due to the array of surface water culverts proposed which will serve to create diffuse water flow underneath the road. This will actually restore flows to a more natural state than is currently the case. The dampland is currently highly modified by 4wd tracks which have become un-natural man made drainage channels.</p>



Submission and/or issue #	City of Armadale Response
	These 4wd tracks currently cause un-natural surface water blockage, ponding and channelized flow in areas of the wetland which would have previously received natural sheet flow (diffuse flow) prior to human modification via the construction of unsealed tracks and ongoing use of these tracks for off road driving (Water Technology, 2014 – Appendix F).
5	As stated above the proposed road and culvert design will actually restore flows to a more natural state than is currently the case. The dampland is currently highly modified by 4wd tracks which have become un-natural man made drainage channels. These 4wd tracks currently cause un-natural surface water blockage, ponding and channelized flow in areas of the wetland which would have previously received natural sheet flow (diffuse flow) prior to human modification via the construction of unsealed tracks and ongoing use of these tracks for off road driving (Water Technology, 2014 – Appendix F).
6	<p>The City of Armadale has undertaken further assessment, in order to confirm the recurring statement that the proposed road alignment is located upon sandy soils and the associated hydrology model assumptions (Water Technology (2014) Appendix F). As stated in Section 2.2 of Appendix F (Water Technology, 2014):</p> <p><i>“...a series of 15 soil bores were drilled along the Keane Road alignment by Douglas Partners in November 2008 (full soil bore logs were provided in Appendix D of the KRSL PER document). The bore logs show the presence of fine to medium grained sand along the full length of the alignment, as shown in Figure 2-3.</i></p> <p><i>The sand layer has a minimum thickness of 0.6 m. Clayey sand underlying the sand layer is present along some sections of the alignment, and generally corresponds to the Swamp &amp; Lacustrine and Guildford Clay geology in Figure 2-2.</i></p> <p><i>The Forrestdale Main Drain Arterial Drainage Strategy (FMDADS) by the Department of Water (2009) states that the superficial geology of the Forrestdale catchment (which includes the Anstley-Keane Wetlands) consists of degraded, low dunes of Bassendean Sand with low-lying interdunal areas. The superficial formations generally consist of sandy sediments (a thin layer of Bassendean sand overlying Gngangara sand) with small isolated pockets of clayey sediments (Guildford clay) (Rockwater 2005). The report also notes that the average hydraulic conductivities of the superficial formations have been estimated as ranging from 1.1-8.9 m/d in the area underlain by Gngangara sand (and Ascot formation), and 0.5-5.3 m/d in areas of Guildford clay (Rockwater, 2005).</i></p> <p><i>Although the soil conditions show the presence of a highly permeable surface sand layer, the modelling assumption adopted in the Water Technology (2013) modelling for the Keane Road project (and in this report) was for no initial loss of rainfall to groundwater. This is conservative, as it assumes a fully saturated groundwater condition (described in the following section) and therefore does not include any infiltration of rainfall into the sand layer.”</i></p> <p>The revised modelling has also used these same conservative assumptions (Water Technology, 2014) – Appendix F.</p>
7	<p>It was not proposed to install a single culvert at location C, but rather an array of six 300 mm culverts, which would serve to create diffuse flow in order to restore more natural water flows (instead of the current situation of channelized flow down man made tracks) (Water Technology, 2013).</p> <p>Based on the recent further hydrologic assessment (Water Technology, 2014), a similar culvert design has been proposed at point C including six 300 mm culverts, which will serve to create diffuse flow and restore a more natural system than is currently the case (Water Technology, 2014 – Appendix F).</p>
8	<p>There is a large amount of baseline water monitoring data already available for the area as described in Appendix G of the PER “Review of Existing Hydrology and Hydrogeology” (EnviroWorks Consulting, 2012c) and also within the Water Technology Reports (Water Technology, 2013) and (Water Technology, 2014).</p> <p>As outlined in Section 4.3.3 of this Response to Submissions document the City of Armadale also commit to the development and implementation of a Water Management Plan prior to</p>

Submission and/or issue #	City of Armadale Response
	<p>road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include:</p> <ul style="list-style-type: none"> <li>• An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and</li> <li>• Details of water management measures including but not limited to: <ul style="list-style-type: none"> <li>○ long-term maintenance of the drainage swales and culverts</li> <li>○ management actions for weed control in swales</li> <li>○ maintaining the vegetation on the road embankments and swales</li> <li>○ managing sedimentation from up gradient of the culverts; and</li> <li>○ maintenance and monitoring of the culverts and associated rock rip raps</li> </ul> </li> </ul>
9	<p>As outlined in Section 10.3.2 of the PER:</p> <p>Weeds will be controlled through prevention, monitoring and early eradication as follows.</p> <p>During construction:</p> <ul style="list-style-type: none"> <li>• Avoiding or minimising disturbance to areas with, or vulnerable to, weed infestation where practicable.</li> <li>• Inspection of vehicles and machinery for soil and seeds during construction to ensure they are clean prior to arriving on-site. All mobile construction equipment shall be washed down and clean of mud, soil and seeds prior to site entry.</li> <li>• All equipment will be inspected prior to entry to the site to ensure they are clean.</li> </ul> <p>Once the road is constructed:</p> <ul style="list-style-type: none"> <li>• The City of Armadale will meet its ongoing requirements to control any declared weed species within the road reserve.</li> <li>• City of Armadale will liaise with the land manager for adjacent parkland in respect to undertaking on-going control of weeds along the road verge and in drainage swales to prevent spread of new weeds from the road into the surrounding areas.</li> </ul> <p>Management of weeds in drainage swales will be managed using the following methods:</p> <ul style="list-style-type: none"> <li>• Low toxicity weed sprays; and</li> <li>• Physical removal.</li> </ul>
10	<p>Vegetated swales provide an effective stormwater filtration and groundwater infiltration system (Water Technology, 2013). One significant advantage of swale drains is that flow velocities are retarded, thus protecting stream banks from erosion (Austroads, 2003). This also allows heavier fractions of the suspended particles to settle out. Grass and other vegetation in the drains act as a filtering device and reported removal efficiencies of suspended solids are up to 90% (Fletcher, Pelgio and Fielding, 2001).</p> <p>Establishing dense vegetation along the base of the swale drain will improve its pollutant trapping efficiencies. Studies in the United States of America have shown that vegetated swales are capable of removing many pollutants found in stormwater with reported removal efficiencies of 83% for sediment, 75% for hydrocarbons, 67% for lead, 63% for zinc and 63% for aluminium (Yousef, Wanielista, Harper, Pearce and Tolbert, 1985).</p> <p>Work undertaken by Driscoll et al. (1990) found differences between the concentration of pollutants generated from road surfaces of different traffic volumes. The Event Mean Concentration (EMC) of pollutants can be up to four times as high on highways with traffic volume greater than 30,000 vehicles per day compared to those highways with lesser traffic volumes (Driscoll, Shelley and Streker, 1990). A stormwater quality study in Perth, WA, quantified a range of pollutants in road runoff across a range of Perth roads, and found that</p>

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	<p>most pollutants were in the lower range compared to studies of roads overseas (Davies, Vukomanovic, Yan and Goh, 2000). Given the Keane Road Strategic Link is a local road with residential traffic expect to be in the order of 8,460 vehicles per day (Porter Consulting Engineers, 2009), pollutants from the road surface are not expected to be high.</p> <p>As stated in the Edge Effects Study (Appendix B), the edge effects due to chemical modification of the surrounding environment from road pollutants are expected to be very low given the drainage swale design adopted (van Etten, 2014).</p>
11	<p>The following conservation land classifications relevant to the project area are explained in detail in the PER under Section 4.3:</p> <ul style="list-style-type: none"> <li>• Bush Forever</li> <li>• Jandakot Regional Park</li> <li>• Environmental Sensitive Area</li> <li>• Wetland Classifications.</li> </ul> <p>Detailed topography and landforms (1 m contours) as well as stratigraphy (soil profile from bore logs) has been included in the revised hydrology modelling (Water Technology, 2014 – Appendix F) and therefore used in the impact assessment, to ensure that the wetland is well understood and impacts are accurately predicted and managed.</p>
12	<p>EnviroWorks Consulting previously classified the Anstey Keane Wetland as “Dampland” however in its feedback on a previous draft of the PER DPaW (previously DEC) requested that that word “Dampland” be removed from the draft PER and therefore this classification was removed.</p> <p>Appendix F of this Response to Submissions document, provides this classification again as follows (Water Technology, 2014):</p> <p><i>“The Keane Road wetland area is classified as a “dampland” wetland system in the Wetland Atlas for the Swan Coastal Plain (Hill et al, 1996), as shown in Figure 2-1 (refer to Appendix F for figure). A dampland is defined in the Atlas as a seasonally waterlogged basin, based on the geomorphic classification of wetlands for the Perth-Bunbury region (Semeniuk and Semeniuk, 1995)</i></p> <p><i>For such a wetland system, the soils/substrate is saturated with water, but the water does not inundate the soil surface across the majority of the wetland (at their most wet under prevailing conditions). They are saturated to the extent that they develop wetland characteristics, such as wetland soils, wetland plants, and distinct communities from surrounding dryland. The water is present in between sediments as interstitial waters, also known as sediment pore waters (Department of Environment and Conservation, 2012). In the case of the Keane Road wetland complex the wetlands are seasonally waterlogged.”</i></p> <p>This type of wetland classification has been considered in the management measures recommended in Appendix F (Water Technology, 2014) as adopted by the City of Armadale.</p>
13	<p>As outlined in Section 4.3.3 of this Response to Submissions document the City of Armadale also commit to the development and implementation of a Water Management Plan prior to road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include:</p> <ul style="list-style-type: none"> <li>• An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and</li> <li>• Details of water management measures including but not limited to: <ul style="list-style-type: none"> <li>○ long-term maintenance of the drainage swales and culverts</li> <li>○ management actions for weed control in swales</li> <li>○ maintaining the vegetation on the road embankments and swales</li> <li>○ managing sedimentation from up gradient of the culverts; and</li> <li>○ maintenance and monitoring of the culverts and associated rock rip raps.</li> </ul> </li> </ul>

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14	<p>Ground truthing of the hydrology has been undertaken by Water Technology using detailed aerial imagery for a recent rainfall event and associated rainfall data, as outlined within Appendix D (Water Technology, 2014). As stated in Section 3.3.2 of Appendix F:</p> <p><b>“Validation against October 2013 Rainfall event</b>  <i>The 10 year ARI map, Figure 3-5 (refer to Appendix F for figure) also includes the aerial imagery from October 2013. There had been a series of rainfall events prior to when the image was captured (refer to Figure 3-8 Appendix F) and local surface water ponding is visible as well as lower topographic features associated with drainage basins (indicated by the presence of greener vegetation). The surface water distribution across the site visible in the image is well represented in the model results (Water Technology, 2014)”</i></p>
15	<p>As stated in the response to issue 10 above vegetated swales provide an effective stormwater filtration and groundwater infiltration system. Given the Keane Road Strategic Link is a local road with residential traffic expect to be a maximum of 8,460 vehicles per day (Porter Consulting Engineers, 2009), pollutants from the road surface are not expected to be high. As stated in the Edge Effects Study (Appendix B), the edge effects due to chemical modification of the surrounding environment from road pollutants are expected to be very low given the drainage swale design adopted (van Etten, 2014).</p> <p>As outlined in Section 4.3.3 of this Response to Submissions document the City of Armadale also commit to the development and implementation of a Water Management Plan prior to road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include:</p> <ul style="list-style-type: none"> <li>• An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and</li> <li>• Details of water management measures including but not limited to: <ul style="list-style-type: none"> <li>○ long-term maintenance of the drainage swales and culverts</li> <li>○ management actions for weed control in swales</li> <li>○ maintaining the vegetation on the road embankments and swales</li> <li>○ managing sedimentation from up gradient of the culverts; and</li> <li>○ maintenance and monitoring of the culverts and associated rock rip raps.</li> </ul> </li> </ul> <p>Ongoing monitoring of water quality as part of this management plan will include monitoring of contaminants within road runoff (captured in roadside swales). If monitoring indicates a build up of contaminants in swale sedimentation, they will be periodically cleaned out and the material will be disposed of appropriately.</p>
16	<p>As outlined in Section 4.3.3 of this Response to Submissions document the City of Armadale also commit to the development and implementation of a Water Management Plan prior to road construction. The management plan objective is to maintain pre-construction water flows and water quality, established through appropriate baseline monitoring. The management plan will include:</p> <ul style="list-style-type: none"> <li>• An appropriate and outcome based water monitoring program including baseline and ongoing monitoring of water flows and quality; and</li> <li>• Details of water management measures including but not limited to: <ul style="list-style-type: none"> <li>○ long-term maintenance of the drainage swales and culverts</li> <li>○ management actions for weed control in swales</li> <li>○ maintaining the vegetation on the road embankments and swales</li> <li>○ managing sedimentation from up gradient of the culverts; and</li> <li>○ maintenance and monitoring of the culverts and associated rock rip raps.</li> </ul> </li> </ul>
17	<p>There are currently no utility underground services in the subject unmade section of Keane Road. The City has only considered installing standard water hydrant outlets at a location close to the Skeet Road and Anstey Road, Keane Road intersections to provide better fire protection for the adjoining bushland and development areas. Hydrant installations are very minor components that can be preinstalled as part of road construction or upgrade works and</p>

Submission and/or issue #	City of Armadale Response
	<p>would not change the road footprint or predicted impacts.</p> <p>The Keane Road Strategic Link project, does not involve any main sewer or water infrastructure installation or planning. Whilst it is understood that the Water Corporation has long planned and is anticipating a sewer installation in the Keane Road infrastructure corridor in the next few years there is currently no formal proposal to do so.</p> <p>Any plans for utility service mains located in gazetted road reserves is the responsibility of the relevant corporation or government department. The Water Corporation will be required to obtain environmental approval for its own projects and a local government cannot be expected to assume the responsibility for environmental approvals for any infrastructure planned by unrelated State agencies or corporations. Accordingly no detailed information about the Water Corporation’s regional sewer plans is included in the PER or this response to submissions.</p> <p>While it is understood that the Water Corporation planning includes installing future sewer infrastructure there is currently no formal proposal from Water Corporation. Notwithstanding and irrespective of the outcome of the City’s proposal to complete construction of Keane Road to link adjacent communities, the City will seek to work cooperatively with the Water Corporation and/or any other utility service provider to minimise the environmental impacts of their project installations of main infrastructure in any gazetted road alignment within the City of Armadale including in Keane Road.</p> <p>Should the realignment of the gazetted Keane Road to minimise vegetation clearing and provide a setback to TEC vegetation be approved under the City’s current proposal for KRSL, utility providers such as Water Corporation will be encouraged to use the same alignment. However, the City of Armadale is not in a position to provide further details on sewer and water infrastructure being considered by Water Corporation given:</p> <ul style="list-style-type: none"> <li>• There is no current formal proposal or documentation provided in any public approval process, for such infrastructure by Water Corporation; and</li> <li>• The City of Armadale is not the proponent for any such infrastructure.</li> </ul>

## 5.5 OFFSETS

### 5.5.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Friends of Cockburn Wetland Education Centre</li> <li>• Armadale Gosnells Landcare Group</li> <li>• Jandakot Regional Park Community Advisory Committee</li> <li>• Wetlands Conservation Society</li> <li>• Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>1. The appropriateness of the proposed offsets needs to be considered. The offsets offered are either of poor quality e.g. No's. 3, 4, 5 or the areas are protected under another authority i.e. No's. 1, 2, 6.</li> <li>2. There are no other similar wetlands available outside the conservation estate that could be purchased to replace its functions. What the City offers instead is a grab bag of inappropriate fragments, some of which are already protected through other mechanisms. These clearly fail to meet the EPA's offsets policy and they should be rejected as inadequate and inappropriate.</li> <li>3. The City's commitment of \$150,000 for weed control is considerably undervalued.</li> </ol> <p><b>Offset recommendations</b></p> <ol style="list-style-type: none"> <li>4. <b>Recommendation 10:</b> That the EPA reviews the appropriateness of the direct offsets proposed by the City of Armadale.</li> <li>5. <b>Recommendation 11:</b> [Should approval be granted for this proposal] The indirect offset works proposed by the City of Armadale would need to be clearly identified within a Rehabilitation Plan. The preparation and implementation of the Rehabilitation Plan should be to the satisfaction of DPaW.</li> </ol>

### 5.5.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>As detailed within Section 13.4.2 and Appendix T of the PER, the land the City of Armadale proposes to relinquish control over and transfer to the conservation estate in Forrestdale by Direct Offset represents an area in excess of 50 times the area of natural vegetation anticipated to be cleared for constructing the unmade section of Keane Road. It comprises of more than 100 ha of predominantly natural <i>Banksia</i> woodland vegetation and community types similar to the land within the dedicated road reserve for Keane Road.</p> <p>The land in Offsets 3 and 4 is in the care and control of the City of Armadale and is potentially available for future road connections and infrastructure corridors. The linear Offsets 3 and 4 have potential to further fragment an existing conservation area on each side of the road, or a conservation area that is planned on each side of the road for land assembly over time, given that the MRS Reservation for Parks and Recreation signifies that private land in private ownership adjacent to the road will in future be acquired. Offset 5 is land with some environmental values and which provides an opportunity to extend the buffer distance to the adjoining conservation assets forming part of the RAMSAR listed Forrestdale Lake buffer.</p> <p>In the case of Offsets 3 to 5 the question of strategic location in relation to other conservation assets would seem of more importance to future long term conservation outcomes than the current vegetation condition or quality, which is indeed variable over the 3 land parcels. By embarking on formal road closure procedures for these 3 parcels the City's offer in support of long term land assembly for conservation purposes at the landscape level is considered a reasonable offset for residual impacts predicted for the KRSL project. As these offsets can achieve a "consolidation" of a wider conservation area for the future, the City considers these would be appropriate offsets, given the community would otherwise retain the options for use of the land for road or infrastructure connections.</p> <p>It is noted that objectors to Keane Road seek a similar objective of "consolidation" of a</p>

Submission and/or issue #	City of Armadale Response
	<p>wider conservation area and therefore the situation of the land is very much like for like.</p> <p>Offsets 1 and 2 are lands vested and managed by the City which has been granted powers to lease these land parcels. They are part of the City's portfolio of land resources and they have potential alternative land uses and therefore an attributable financial value which the Armadale community may wish to draw upon at some time in the future. While they may be subject to Conservation Commission "recommendations" through its Forrestdale Lake and Jandakot Regional Park management plans, this does not signify the ownership implied by the claim they are "protected under another authority". Nor does it veto or obviate the City's rights to use the land or retain the land for purposes for which it was given to the Armadale community which is generally recreation and more significantly in the case of Offset 1 for the ultimate development of potentially a 27 to 36 hole golf course.</p> <p>The City retains the management of these lands which are areas that are accessed and used by the Armadale community and members of the public primarily for passive recreation. As the legal vested authority the City of Armadale bears all legal liability for public and community safety concerning use of these lands. As these offsets achieve a "consolidation" of a wider conservation area for the future at the landscape level the City considers them appropriate offsets and there is no basis to the claim they do not meet the EPA Offsets Policy.</p> <p>Offset number 6 proposed by the City of Armadale involves the rehabilitation of areas of the TEC SCP10a within the Anstey Keane Wetland which are currently severely degraded due to existing off road driving within the wetland.</p> <p>Most of the parcels put forward as Direct Offsets have high conservation values identified through management plans prepared by DPaW and adopted by the Conservation Commission of WA. The current legal Reserve "Purpose" under the <i>Land Administration Act 1997</i> for the majority of the direct offsets is the wide general category of "Recreation" (or the more specific "Road Reserve" category) and the "Vested Authority" is the "City of Armadale". The City has a high demand for recreational land for a variety of active and passive recreational pursuits and also has a significant shortage of land to meet this demand.</p> <p>This means the legal rights for future use of the land are potentially in conflict with the high conservation values. The City has to meet a wide range of community social and economic objectives and has a fiduciary duty to manage its financial, including land assets, responsibly. These mandates could potentially involve conflicts with the management and protection of high conservation values of the sites over the longer term.</p> <p>A Reserve "Purpose" of Recreation over which the City has "Power to Lease" provides a future Council with scope to use or lease the land for a variety of purposes. While environmental values would no doubt also have to be considered, the breadth of uses that potentially fall within the legal definition of "Recreation" effectively mean the land area and the historically approved use for a golf course for which a first stage has been developed for 9 hole course, is a significant community and financial asset which should not be relinquished lightly.</p> <p>For illustration purposes only, the uses permitted which fall under a reserve purpose of recreation, while retaining partly under bushland, could include horse riding and off road vehicle use areas. The City has an increasing level of demand for making areas available for these and other purposes however, if they were implemented over the longer term these uses could have significant impacts on conservation values such that rededication of these lands specifically to conservation purposes as part of an offset negotiation is considered to have merit.</p> <p>It should be noted that these land holdings are also at risk of on-going and chronic current degradation processes similar to those of the Anstey Keane blocks, including off road vehicle intrusions, rubbish dumping and weed invasion. Therefore even aside from the</p>

Submission and/or issue #	City of Armadale Response
	<p>potential for a future Council administration to lease the land to third parties or provide alternative uses, the chronic degradation pressure the land is currently sustaining is not consistent with preservation of the high conservation values of the proposed offset site's over the long term.</p> <p>The City has not previously objected to the recommendations of management plans endorsed by DPaW and/or the Conservation Commission of WA, however as stated above, the recreation land is and remains under the legal control of and is managed by the City of Armadale which has the power to lease it for recreational purposes.</p> <p>Whilst the Conservation Commission and DPaW have recommended they negotiate with the City for much of this land to be set aside for conservation, the legal changes and procedures to change the Reserve vestings and Purposes require initiation and support by the City and this has been taken on board through the PER and associated offset proposals.</p> <p>The Forrestdale locality has been subject to on-going release of State land use planning and environmental policies and strategies over a ten year period which only now makes discussion, negotiation of, agreement and a schedule of actions possible with a view to the City implementing Conservation Commission recommendations. The issues and circumstances affecting Forrestdale can now be discussed with a level of certainty of the future planning and environmental requirements and this is what the City is proposing through the Offset Commitments. The City is proposing a specific agreement on how and when the legal changes and land transfers surrounding Forrestdale Lake and in the wider Forrestdale area would be implemented to achieve significant long term environmental benefits at the landscape level.</p> <p>As described above the offset areas (including Nos. 1, 2 and 6) are not protected for conservation purposes under another authority, because they are recreation and road reserves which are vested with and managed by the City of Armadale. The City has the power to lease these reserves for recreation purposes or develop them in ways which may not be consistent with conservation management.</p> <p>The offset areas are not of poor quality and they contain significant environmental values which warrant their inclusion as offsets and provide merit to the City's proposal. As described in Appendix T of the PER "Keane Road Strategic Link Environmental Offset Report" an assessment of the vegetation and fauna values of the offset areas has been conducted (contained in Appendix C of the Offset Report). The offset areas contain a wide range of significant fauna and flora species:</p> <ul style="list-style-type: none"> <li>• 32 species of conservation listed significant fauna are likely to utilise habitat within the offset areas;</li> <li>• 12 species of threatened flora are known or likely to occur within the offset areas;</li> <li>• Offset area 1 contains two Threatened Ecological Communities (TECs) which are listed under the EPBC Act as "Endangered" : <ul style="list-style-type: none"> <li>○ Herb Rich Shrublands in Clay Pans (SCP08 – Swan Coastal Plain Community type 8); and</li> <li>○ Shrublands on Dry Clay Flats (SCP10a – Swan Coastal Plain Community type 10a).</li> </ul> </li> </ul> <p>If the offset areas were of poor quality and not worthy of conservation, then the Conservation Commission and DPaW would not have made recommendations (via management plans) that these areas are be negotiated for future transfer into a formal legislated I conservation tenure. Council has outlined the rationale of its retention of Keane Road in the PER and in its previous submissions on the draft Jandakot Management Plan which is based on prior planning and community needs for movement between facilities and adjoining urban cells</p>
2	Refer to the response to issue 1 above which outlines the conservation values and the merits and appropriateness of the offsets offered. More detail is contained in Appendix T



Submission and/or issue #	City of Armadale Response
	<p>of the PER.</p> <p>As outlined in Section 5.4 of this Response to Submissions document, the proposed Keane Road Strategic Link project will not impact the functions of the Keane Anstey Wetland. Therefore it should not be necessary to purchase a similar wetland to replace the functions of the Keane Anstey Wetland as an offset particularly given the extent to which mitigation actions are provided as part of the proposal. Mitigation includes a major land acquisition to facilitate an environmental preferred realignment of Keane Road to protect TEC vegetation, additional construction costs to accommodate grey kangaroo in fauna culverts and numerous practices and ongoing efforts to maintain the existing environmental conditions of the Bush Forever site abutting the road.</p> <p>It should also be noted that offset number 1 is listed as a Conservation Category Wetland and it contains the same dampland Threatened Ecological Community (TEC SCP10a) as identified within the Anstey Keane Road Wetland. It should also be noted that the City of Armadale is not proposing to impact this TEC community via the Keane Road Strategic Link and has ensured there is a 5 m buffer from it, to avoid it being effected by edge effects (refer to Section 5.2.1 of this Response to Submissions document).</p>
3	<p>As detailed within Section 13.4.3 and Appendix T of the PER, 1.65 ha of native vegetation is required to be cleared for construction of Keane Road Strategic Link. In addition to the transfer of vested land to the Conservation Commission proposed as a Direct Offset, the City of Armadale also proposes Offset proposal 6 which is funding of a project or projects up to \$150,000 in value as an Indirect Offset. However, this is additional to the City's separate commitment to control weeds within the road area and the Offset proposal 6 does not relate specifically to weed control.</p> <p>The City's Indirect Offset funding is anticipated to provide for rehabilitation/re-vegetation of an area equivalent to the vegetation clearing required for the road focusing on the adjacent area of TEC within the Anstey Keane Wetland which is currently severely degraded due to existing off road driving within the wetland. The rehabilitation is proposed on land in Bush Forever Site No.342 which has been impacted by various chronic degradation processes currently affecting the Bush Forever Site No. 342, including inappropriate usage for Off Road Vehicles and rubbish dumping. In consultation with the Regional Park manager (DPaW) the City has identified a high priority area designated as Offset No. 6 for rehabilitation. This site is near the Anstey Road end of the Keane Road Strategic Link and it is anticipated that this site will form the main focus of the City's Indirect Offset rehabilitation works.</p> <p>In discussion with the Jandakot Regional Park Manager it is anticipated that rehabilitation would involve replanting with local provenance native vegetation and/or associated site protection measures implemented on public land within the Conservation Estate (refer to Map of Bush Forever Site No.342). While the funding is calculated on an area of up to a 2 ha rehabilitation area, the City considers the funding commitment can be expended on a variety of rehabilitation or vegetation protection techniques or improvements such as additional access restriction. These will be determined in more detailed ongoing discussion with DPaW the park manager.</p> <p>If possible the City may also seek to leverage its Offset funding with third party grant applications potentially available to assist rehabilitation/re-vegetation of a larger area within Bush Forever Site No.342.</p> <p>The City considers Offset No.6 provides a benefit which along with the direct offset package compensates for clearing required for road construction. The relationship between the City and DPaW will nevertheless be long term and the City would expect to be able to assist and augment Park management in a spirit of cooperation with the Park manager over the long term.</p> <p>It should also be noted that the City's proposed Keane Road alignment requires acquisition of private land and the compensation to the private landowner would represent a further significant cost to the City. Together with the costs of other mitigation efforts the</p>

Submission and/or issue #	City of Armadale Response
	additional costs of land acquisition should be taken into account in State and Commonwealth assessments and consideration of the proposal in respect to offset policies, given that the City already has a dedicated road reserve in place for the KRSL infrastructure.
4	The City of Armadale understands and welcomes that the EPA will review the appropriateness offsets as part of its Report and Recommendations to the Minister for Environment. In that regard the City's proposal contains substantial measures based on mitigation principles of minimising impacts and is also based on achieving a wider public benefit in terms of access to schools, recreation and commercial areas. Rather than being motivated primarily by private profit which would therefore perhaps justify a different calculus of offsets for these private proposals, the City believes its offset considerations proposed are more than adequate trade-offs for any residual impacts that occur as a result of the road.
5	The indirect offset works proposed to be completed by the \$150,000 contribution by the City of Armadale will be clearly identified within a Rehabilitation Plan and the initial defining of Offset 6 was done in liaison with DPaW. Therefore the preparation and implementation of the Rehabilitation Plan will also be done to the satisfaction of DPaW as the park manager for the land adjacent to the Keane Road proposal in this location.

## 5.6 CUMULATIVE IMPACTS

### 5.6.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Department of Planning</li> <li>• Wildflower Society</li> <li>• SERCUL</li> <li>• Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>1. The potential cumulative effects of the indirect impacts of the proposed road, such as, weeds, road kill, dieback, pollution, fauna movement and fragmentation have not been addressed in the PER.</li> <li>2. The proponent should provide details on the proposed sewer and water infrastructure to be installed, so that collective impacts can be assessed.</li> </ol>

### 5.6.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>Each of these issues has been considered and management measures proposed with the PER as follows:</p> <ul style="list-style-type: none"> <li>• Weeds – Sections 8.6.6, 10.3 and Appendix I of the PER</li> <li>• Road Kill - Section 10.5 and Appendix K of the PER</li> <li>• Dieback– Sections 8.7, 10.1.2.7 and Appendix J of the PER</li> <li>• Pollution – Sections 10.6, 10.7, 10.8, 10.10, 10.11, 10.12, 10.13 and 10.16 of the PER</li> <li>• Fauna Movement - Section 10.5 and Appendix K of the PER</li> <li>• Fragmentation – Refer to Sections 5.2.2 and 5.3.3 of this Response to Submissions document.</li> </ul> <p>Given management measures proposed, impacts are considered minimal and therefore cumulative impacts are considered low.</p> <p>As described in Section 4.1 and Appendix C of this Response to Submissions Document:</p> <p>City of Armadale has also undertaken a further assessment, in order to confirm the spatial and temporal extent of the residual impacts (both direct and indirect) after incorporating all the management measures in the PER document, and any additional measures proposed this response to submissions. This assessment completed by Dr Eddie van Etten (2014), has predicted a cumulative “zone of influence” for potential “edge effects” which may arise from the proposal including hydrological changes, spread of weeds and dieback (Appendix B). On the basis of this zone on influence residual impacts have been re-assessed as described in Appendix C. Both appendices B and C, have been used to respond to submissions raised as outlined in Section 5.</p> <p>In summary edge effects from the managed sealed road are predicted to extend into various vegetation types for the following distances either side of the road:</p> <ul style="list-style-type: none"> <li>• Banksia woodland communities: 5 m</li> <li>• Dampland communities: 3 m (van Etten, 2014).</li> </ul> <p>Based on the above prediction, edge effects have been quantified for each vegetation community as outlined in Table 3 and shown in Figure 10.</p> <p>As outlined within Appendix C, total residual impacts are likely to be greater from the current situation involving the unmanaged unsealed track compared with the proposed managed and sealed Keane Road Strategic Link (van Etten, 2014). Total cumulative residual impacts from each situation are described as follows:</p>

Submission and/or issue #	City of Armadale Response
	<ul style="list-style-type: none"> <li>• Unmanaged and unsealed track: Direct Cleared Area of 0.85 ha, Likely Edge Effects of 6.69 ha (residual impacts of 7.54 ha in total).</li> <li>• Managed and sealed road: Direct Cleared Area of 1.65 ha, Likely Edge Effects of 0.92 ha (residual impacts of 2.57 ha in total) (van Etten, 2014).</li> </ul>
2	<p>Sewer and water infrastructure is not part of the Keane Road Strategic Link project and therefore is not included in the PER or this response to submissions. As the proponent for any sewer and water infrastructure the Water Corporation will be required to obtain environmental approval for its own projects. A local government cannot be expected to assume the responsibility for environmental approvals for any infrastructure planned by unrelated State agencies or corporations.</p> <p>While the Water Corporation have indicated they are considering such infrastructure, there is currently no formal proposal from Water Corporation being assessed as part of formal approvals processes and this matter is unrelated to City's staged construction of Keane Road. Further discussion of this issue is provided in the Response to issues section concerning Wetlands, Groundwater and Surface Water above (Section 5.4), which raises the same issue.</p> <p>The City of Armadale is accordingly not in a position to provide further details on sewer and water infrastructure being considered by Water Corporation given:</p> <ul style="list-style-type: none"> <li>• There is no current formal proposal for such infrastructure by Water Corporation;</li> <li>• The City of Armadale is not the proponent for any such infrastructure.</li> <li>• Any plans for installation of utility service mains in gazetted road reserves is the responsibility of the relevant corporation or government department.</li> </ul>

## 5.7 CONSULTATION

### 5.7.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>Canning Regional Greens WA</li> <li>Members of the public</li> </ul>	<p>1. There is concern over the potential acquisition of private land (Lot 111) required for the alignment to avoid the TEC. It is understood that no approach had yet been made by the Council to purchase any of that block to allow for a slight deviation of the road alignment thus alleviating the need to clear any native vegetation from the last 400 metres of the road's length. This deviation is clearly indicated on all the figures in which the road alignment is shown.</p>

### 5.7.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The realignment of this section of Keane Road from the existing dedicated road reserve to a new road reserve located on private freehold property will require compensation for all or part of the land requirement, either by negotiation of purchase with the landowner or by compulsory acquisition.</p> <p>It is not correct to claim that “no approach had yet been made by the Council to purchase any of that block” The City has been discussing the potential need to purchase a portion of the private lot with the consecutive landowners of Lot 101 since 2009, when it became apparent that the impact assessment could result in the need to acquire additional land.</p> <p>When the Keane Road existing dedicated road reserve was confirmed as impacted by TEC vegetation and therefore had an environmental value worthy of retaining and protecting, these negotiations commenced more formally with the letter the City sent to the owner of the land on 9th of January 2012 advising that the deviation of the road alignment onto their property was likely to be the most environmentally acceptable option and this would require the City to purchase a portion of their land for the road deviation. The owner confirmed their understanding of the letter and indicated that the sale of the land was being considered. Nevertheless, the landowners also indicated their preferences for the road to be constructed on the alignment that had already been put in place for that purpose in the form of the existing dedicated road reserve if possible.</p> <p>Since that time the City has had meetings with and written to the successive owners of the property which changed hands in October 2012. The City also advised the owners of the advertising of the PER and inviting their attendance at the Public Meeting that was held by the City at Bakers House HARRISDALE on the 22 January 2014. The new owner has also indicated a willingness to enter into negotiations with the City towards agreement over compensation for the Keane Road land requirements. As the processes for land transactions and land transfers from one owner to another and the dedication of gazetted roads or road realignments are well documented and are common legal procedures governed under separate legislation, the City does not consider it necessary for the PER to document them further.</p> <p>The road reserve re-alignment onto private property to the south east accords with the policy recommendations of Bush Forever to minimise environmental impacts of road infrastructure as far as practicable.</p> <p>As outlined above and within Appendix S of the PER “Consultation Log”, the City sent a letter to the owner of the land on 9<sup>th</sup> of January 2012 advising that the deviation of the road alignment onto their property was likely.</p> <p>The City’s consultation with the new owner is outlined above and within the revised consultation log (Appendix A to this Response to Submissions document) and the City</p>

Submission and/or issue #	City of Armadale Response
	<p>understands the new owner is aware that an alignment on which the road can be constructed is pending the outcome of the current environmental processes and following that, compensation negotiations for the land required to deviate Keane Road onto private farmland zoned Rural in the MRS and located outside of the Bush Forever Site near the corner of Anstey Road will be required if the Keane Road Strategic Link project receives the environmental approvals necessary for it to be implemented. The City will subsequently continue liaison with the owner to this end. In the event a negotiated outcome cannot be reached the City can consider the compulsory acquisition and arbitration procedures available to it under legislation.</p>

## 5.8 CONSTRUCTION AND ONGOING MANAGEMENT/MAINTENANCE

### 5.8.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Armadale Gosnells Landcare Group</li> <li>• Friends of Paganoni Swamp</li> <li>• Spineless wonders</li> <li>• Members of the public</li> </ul>	<ol style="list-style-type: none"> <li>1. The proposed road is likely to increase access points to the bushland, greatly increasing the cost of maintenance, such as, weed control, fencing, fauna underpasses, rubbish control and compliance to already stretched resources.</li> <li>2. There is concern over the proponents' abilities to manage these ongoing issues.</li> </ol>

### 5.8.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The construction of Keane Road Strategic Link will reduce undesirable/antisocial access to Bush Forever Site 342 as follows:</p> <ul style="list-style-type: none"> <li>• Fencing of the road on both sides will prevent access to the Bush Forever Site from Keane Road Strategic Link. Currently this land is an unsealed 4WD track which provides numerous 4WD access points via side roads into other parts of the Bush Forever Site 342. These side access roads coming off the current unsealed track will no longer be accessible, given the unsealed track is proposed to be replaced with a fully fenced sealed road.</li> <li>• There will be increased passive surveillance by local community using the Keane Road Strategic Link, which will allow the local community assist in reporting to the local police and ranger observations of illegal 4WD access to the Bush Forever Site. This passive surveillance and reporting by the local community will assist in reducing illegal off road driving in the Bush Forever Site.</li> </ul>
2	<p>The City of Armadale will continue to assist in restricting access to the Bush Forever Site through:</p> <ul style="list-style-type: none"> <li>• Maintenance of the fence on either side of Keane Road Strategic Link and management of drains, culverts and the road reserve generally.</li> <li>• The City has a number of service areas including environment staff and rangers services, which can be a contact point for the local community if they have concerns.</li> </ul> <p>Restriction of access to the Bush Forever Site and management of the land included in the Jandakot Regional Park other than Keane Road Strategic Link is formally the responsibility of the Park manager DPaW. The relationship between the City and DPaW will nevertheless be long term and the City would expect to be able to assist and augment Park management in a spirit of cooperation with the Park manager over the long term. Therefore if DPaW requests the City's assistance in access restriction and management programs, the City would assist DPaW where it could reasonably do so.</p>

## 5.9 EXISTING POLICY

### 5.9.1 KEY SUBMISSIONS / ISSUES

Submitter	Submission and/or issue
<ul style="list-style-type: none"> <li>• Department of Parks and Wildlife</li> <li>• Jandakot Regional Park Advisory Committee</li> <li>• Armadale City River Care Group</li> <li>• Save Beeliar Wetlands</li> <li>• Members of the public</li> </ul>	<p>1. The proposal in its current form does not appear to be consistent with the recently released 'EPA Bulletin No. 20 Protection of naturally vegetated areas through planning and development' includes the guideline to 'protect large consolidated naturally vegetated areas.' The bulletin goes on to state that 'large consolidated naturally vegetated areas have been shown to be the most resilient in protecting biodiversity in the long term.'</p> <p>2. The design of the proposal has not been considered in accordance with this bulletin and fails to achieve design guidelines 3 and 6.</p>

### 5.9.2 CITY OF ARMADALE RESPONSES

Submission and/or issue #	City of Armadale Response
1	<p>The EPA website states:  <i>"Environmental Protection Bulletins (EPBs) – formerly Position Statements – outline the view of the EPA on various environmental or procedural matters. EPBs are not statutory documents. They are fairly brief documents designed to be read by a general audience and do not contain comprehensive methodologies or implementation details.</i></p> <p><i>EPA bulletin 20 sets out the EPA's views and expectations for the design of urban and peri-urban development proposals in order to protect naturally vegetated areas. It will help planners and developers in the integration and consideration of naturally vegetated areas during all stages of the planning process, to meet the EPA's environmental objectives for vegetation and flora, and terrestrial fauna.</i></p> <p><i>This bulletin applies to strategic planning, structure plans, new schemes and scheme amendments, subdivision and development proposals, in urban and peri-urban areas of Western Australia."</i></p> <p><i>'EPA Bulletin No. 20 Protection of naturally vegetated areas through planning and development' outlines the need for statutory land use planning processes to protect naturally vegetated areas. Insert 2 below is a summary diagram extracted from EPA Bulletin No. 20 which describes each stage of the statutory planning process and the associated Environmental Impact Assessment (EIA) and level of detail required at each stage.</i></p> <p>The EIA requirements of EPA Bulletin No. 20 have been met as part of the planning process undertaken for the Forrestdale area, within which the Keane Road Strategic Link Project falls. An EIA was carried out at each stage of the statutory planning process with EPA review and EPA advice given as summarised below:</p> <p><b>District Structure Plan (DSP)</b></p> <ul style="list-style-type: none"> <li>• In the <i>Southern River Forrestdale Brookdale Wungong District Structure Plan (DSP)</i> (Western Australian Planning Commission, 2001) the suburb which was then referred to as "Forrestdale" was expanded to include the development of new suburbs of Harrisdale and Piara Waters to the north (Figure 2). Bush Forever Site 342 is recognised in the DSP - it is located in between the older suburb of Forrestdale and</li> </ul>



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	<p>the new suburbs of Harrisdale and Piara Waters (Figure 2). This Bush Forever Site was planned during the same period as the DSP, by the State Government as part of its regional bushland strategy for the Perth Swan Coastal Plain “Bush Forever” (Western Australian Planning Commission, 2000a).</p> <ul style="list-style-type: none"> <li>• In the DSP, Keane Road is identified as a key road system spine which is important in creating connectivity of urban land uses and liveable communities with access to facilities and services. The DSP used the existing base network of dedicated roads as spines with provision for additional or realigned new access roads to be created through land subdivision processes. Keane Road is one of the base spine roads which establishes the basic district structure for traffic movements required for the currently establishing population of 30,000 people in the new suburbs of Harrisdale and Piara Waters.</li> <li>• The EIA conducted as part of the DSP planning process included the following environmental assessments: <ul style="list-style-type: none"> <li>○ Southern River Structure Plan. A Report of Investigations on Nutrient Export. Draft Report prepared for the Department of Environmental Protection (Acacia Springs Environmental, 2000a).</li> <li>○ National Pollutant Inventory - An Aggregated Emissions Inventory of Nitrogen and Phosphorus in Runoff from Coastal Catchments of the Swan-Canning Estuary. A report to the Western Australian Department of Environmental Protection (Acacia Springs Environmental, 2000b).</li> <li>○ Forrestdale/Southern River Structure Plan Hydrological Report. Prepared for the Ministry for Planning (Davies, 1999).</li> <li>○ Forrestdale-Southern River Structure Plan Kennel Noise Study. Report to the Department of Environmental Protection (ERM Mitchel McCotter, 1999).</li> <li>○ Forrestdale-Southern River Structure Plan Kennel Zone Noise Management Strategy, Draft Report for Department of Environmental Protection (ERM Mitchell McCotter, 2000).</li> <li>○ Evaluation of wetland conservation issues: Southern River Planning Study. Prepared for the Ministry for Planning (Muir, 1999).</li> </ul> </li> <li>• The draft DSP was provided to the Environmental Protection Authority (EPA) by the Western Australian Planning Commission (WAPC) prior to finalisation. The resulting advice received from the EPA to WAPC under Section 16(j) of the <i>Environmental Protection Act 1986</i>, on the draft DSP is summarised below: <ul style="list-style-type: none"> <li>○ <i>“The Southern River-Forrestdale-Brookdale-Wungong Draft Structure Plan (WAPC 1999) has been prepared to provide guidance and direction to future development in the area. The draft Structure Plan has identified indicative development areas, major road networks, major community facilities and a neighbourhood structure.</i></li> <li>○ <i>The DEP has been involved in the development of the draft Structure Plan through membership on a Steering Committee associated with its development which was convened by the Ministry for Planning (MfP).</i></li> <li>○ <i>The draft Structure Plan identifies the numerous and significant environmental constraints and opportunities which occur in the locality. The draft Structure Plan seeks to coordinate and plan the development of the area cognisant of the environmental constraints, conservation, physical and social infrastructure, community and neighbourhood objectives.</i></li> <li>○ <i>When finalised the Structure Plan will form the basis of subsequent amendments to the Metropolitan Region Scheme, local town planning schemes, subdivision and development.</i></li> <li>○ <i>Before finalising the Structure Plan, the EPA recommends that the following issues are satisfactorily resolved: demonstration that the proposed landuse changes can be managed to meet the objectives and targets for the Swan-Canning system; demonstration that the landuse changes can be managed to avoid adverse impacts on wetlands, watercourses and the Swan-Canning system due to changes in hydrology; the satisfactory completion of an overall drainage, nutrient and hydrological strategy for the area and establishment of acceptable implementation mechanisms; and finalisation and agreement on Bushplan site boundaries.”</i></li> </ul> </li> <li>• The advice from the EPA was considered by the WAPC in finalising the DSP as</li> </ul>

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	<p>follows:</p> <ul style="list-style-type: none"> <li>○ Demonstration that the proposed landuse changes can be managed to meet the objectives and targets for the Swan-Canning system was carried out through: <ul style="list-style-type: none"> <li>▪ <i>The Southern River/Forrestdale/Brookdale, Wungong DSP Urban Water Management Strategy</i> (JDA, 2002)</li> <li>▪ <i>The Forrestdale Main Drain Arterial Drainage Strategy</i> (Department of Water, 2009).</li> <li>▪ <i>Southern River Integrated Land and Water Management Plan</i> (Department of Water, 2009).</li> </ul> </li> <li>○ Demonstration that the landuse changes can be managed to avoid adverse impacts on wetlands, watercourses and the Swan-Canning system due to changes in hydrology was carried out through JDA (2002) and Department of Water (2009) as above.</li> <li>○ The satisfactory completion of an overall drainage, nutrient and hydrological strategy for the area and establishment of acceptable implementation mechanisms was completed by JDA (2002) and Department of Water (2009) as above.</li> <li>○ Finalisation and agreement on Bushplan site boundaries was carried out through the Bush Forever Strategy and delineation of the boundary of Bush Forever Site 342 (Western Australian Planning Commission, 2000a).</li> <li>○ Numerous referrals to the EPA, of Scheme Amendments to the MRS and TPS since 2004 concerning implementing the DSP for Harrisdale and Forrestdale and conferring rights to developed for urban purposes and none of which has been considered to require a formal environmental assessment by the EPA.</li> </ul> <p><b>Town Planning Scheme</b></p> <ul style="list-style-type: none"> <li>• The City of Armadale Town Planning Scheme (TPS) (2005) was developed as guided by the DSP. The TPS caters for an urban design, road network and land use layout which was planned to function in accordance with the TPS with the Keane Road Strategic Link completed in order to link the urbanised areas of Harrisdale/Piara Waters and Forrestdale. In the TPS, Keane Road is identified as a key road system spine which is important in creating connectivity of urban land uses and liveable communities with access to facilities and services for the population of 30,000 people.</li> <li>• The EIA conducted as part of the TPS planning process included the following environmental assessments and management plans: <ul style="list-style-type: none"> <li>○ An Environmental Review which was prepared in addition to the Local Planning Strategy and focussed on specific environmental features and management measures which were subsequently incorporated into the TPS.</li> <li>○ Identification of Special Control Areas (for the protection of surface water and groundwater).</li> <li>○ Identification of Special Land Quality/Land Use Areas (for protection of land conservation values and environmental assets such vegetation, flora and fauna).</li> <li>○ Soil capability mapping (for land use planning of developments to determine the soils capability and likelihood of soil related impacts from those developments).</li> </ul> </li> <li>• The draft TPS was referred to the Environmental Protection Authority (EPA) prior to finalisation. The EPA responded that the TPS did not require formal assessment by the EPA, but instead gave written advice to the City of Armadale on the TPS. The resulting advice received from EPA on the draft TPS is included in full as Appendix G. It should be noted that the EPA's consideration of the Town Planning Scheme only focused zoning changes and modifications to scheme text that would allow land use change. The EPA advice provided the City of Armadale with guidance that projects such as KRSL should be individually referred to the EPA for assessment – this advice has been followed by the City of Armadale and is the subject of the KRSL PER. In summary the advice from EPA includes the following points: <ul style="list-style-type: none"> <li>○ <i>“Overall, the City of Armadale should be commended for Town Planning Scheme (TPS) No. 4. The EPA Service Unit (EPASU) is encouraged by the approach taken by Council to the identification and management of significant environmental features within the Local Authority boundary. In particular the</i></li> </ul> </li> </ul>

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	<p><i>Scheme Maps identifying Special Control Areas (surface water and groundwater), Development Areas, Special Land Quality/Land Use Areas and Soil Capability mapping are likely to provide Council with valuable land use planning information. In reviewing TPS 4, the EPASU has liaised closely with the Water and Rivers Commission (WRC) and has incorporated their advice and recommendations into the advice provided below where appropriate.”</i></p> <ul style="list-style-type: none"> <li>○ <i>“Officers of the EPA can provide assistance to the Shire in advising on whether specific proposals should be referred to the EPA. However, proposals would generally be of interest to the EPA if they were likely to lead to the following environmental impacts: Clearing of significant areas of native vegetation; Clearing of areas likely to contain rare flora or fauna; Impacts on nature reserves, National Parks or conservation reserves; Impacts on wetlands or waterways; Impacts on public water source areas; The generation of gases, noise, dust, odour or effluent, which may have off-site impacts or may require licensing under the EP Act; Land degradation; or Significant soil or groundwater contamination”.</i></li> <li>○ <i>“The Environmental Review that has been prepared in addition to the Local Planning Strategy (LPS) to focus on specific environmental features and initiatives within the City of Armadale is well structured and comprehensive. Its inclusion with the LPS and TPS for consideration of significant environmental features in land use planning is strongly supported. In particular the explanations provided for environmental protection mechanisms such as buffers and setbacks are considered generally consistent with the EPA’s objectives for land use planning in identified environmentally sensitive areas.”</i></li> <li>● <i>The submission from the EPA was considered by the City of Armadale in finalising the TPS and proposing the development of the Keane Road Strategic Link as follows:</i> <ul style="list-style-type: none"> <li>○ <i>Through the PER Section 38 referral to the EPA the City has investigated the potential environmental impacts of implementing the construction of the Keane Road Strategic Link as planned by the DSP and TPS.</i></li> <li>○ <i>The City is proposing to implement appropriate environmental management measures to minimise potential environmental impacts.</i></li> <li>○ <i>The City is proposing a range of offsets in order to counteract residual environmental impacts likely from the road.</i></li> <li>○ <i>The City of Armadale recognises the ecological significance of the bushland and wetlands in the Forrestdale area which Keane Road is planned to serve and has accordingly referred the project to the EPA for assessment under Part IV of the <i>Environmental Protection Act, 1986</i> (the subject of the Keane Road Strategic Link PER and this Response to Submissions).</i></li> </ul> </li> <li>● <i>Development under the DSP and TPS has been focussed on low productive pasture land that was cleared or degraded and the location of the proposed KRSL road has been similarly located by deviation of the recommended alignment onto cleared and degraded areas.</i></li> </ul>
2	<p><b>The EPA Website states:</b> <i>“Environmental Protection Bulletins (EPBs) – formerly Position Statements – outline the view of the EPA on various environmental or procedural matters. EPBs are not statutory documents. They are fairly brief documents designed to be read by a general audience and do not contain comprehensive methodologies or implementation details.”</i></p> <p><b>Design Guideline 3 from EPA Bulletin 20 states:</b>  <i>“3. Protect large consolidated naturally vegetated areas  Large consolidated naturally vegetated areas have been shown to be the most resilient in protecting biodiversity in the long term and generally have lower management requirements (costs) than smaller and fragmented areas of vegetation (Government of WA, 1995). Development should be designed to retain naturally vegetated areas in large consolidated blocks which are representative of the biodiversity values in the area, to avoid fragmentation or isolation. Large consolidated blocks should:</i></p> <ul style="list-style-type: none"> <li>● <i>include the best condition naturally vegetated areas on site and ensure that they are representative of the area.</i></li> <li>● <i>have a low edge to area ratio, which is determined based on the size and shape of the consolidated block. Large naturally vegetated areas are preferred over long</i></li> </ul>

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	<p><i>or irregular shaped retained naturally vegetated areas.</i></p> <ul style="list-style-type: none"> <li><i>use hard edges (such as roads) to buffer naturally vegetated areas rather than having housing lots immediately adjacent to retained naturally vegetated areas. The location of roads and public areas near naturally vegetated areas improves surveillance, deters vandalism and arson, and avoids individual properties advancing into retained naturally vegetated areas. Roads also provide a fire break, reducing the impact of hazard reduction activities on naturally vegetated areas.</i></li> </ul> <p><i>Fragmentation of larger naturally vegetated areas into smaller pockets of vegetation results in the loss of habitat values and degradation of vegetation. Small areas of vegetation have low viability, higher management costs to maintain their condition and are more susceptible to weeds, pest invasion and other degrading processes.”</i></p> <p>The above stated criteria for a “large consolidated area” are not met by Bush Forever Site 342 as follows:</p> <ul style="list-style-type: none"> <li><u><i>“Large consolidated blocks should include the best condition naturally vegetated areas on site and ensure that they are representative of the area.”</i></u> The site does not include the best condition naturally vegetated areas within the local area, due to the extensive network of off road vehicle tracks causing degradation of vegetation within Bush Forever Site 342. Vegetation Condition Mapping (Figure 15) shows that of the 369.5 ha of Bush Forever Site 342, 72 ha (or 20%) has been degraded by incursion by off road vehicles which are currently using existing unsealed roads/tracks within Bush Forever Site 342. This has created a number of smaller pockets of vegetation (33% of which is in very good condition and 47% of which is in good condition) as shown in Figure 15 (EnviroWorks Consulting, 2013a). By comparison, offset area number 1 (which is 103 ha in area), adjacent to the RAMSAR listed Forrestdale Lake contains better condition areas of native vegetation and the same TEC and PEC’s which also occur within Bush Forever Site 342.</li> <li><u><i>“Large consolidated blocks should have a low edge to area ratio, which is determined based on the size and shape of the consolidated block.”</i></u> Due to the extensive network of unsealed tracks throughout Bush Forever Site 342 there is a very high edge to area ratio as follows: <ul style="list-style-type: none"> <li>The total length of edges of tracks within bush forever site 342 is 79.54 km.</li> <li>The total area of Bush Forever Site 342 is 369.5 ha or 3.695 km<sup>2</sup>.</li> <li>Therefore the edge to area ratio is 21.5 to 1. That is there are 21.5 km of edges for every 1 km<sup>2</sup> of naturally vegetated area.</li> </ul> </li> </ul> <p>By comparison, offset area number 1 which is 103 ha in area and adjacent to the protected RAMSAR listed Forrestdale Lake has fewer off road vehicle tracks and a lower edge to area ratio.</p> <p>Whilst the above criteria are not met by Bush Forever Site 342, it should be noted that the Bulletin’s statement as follows is aligned with the KRSL proposal <i>“use hard edges (such as roads) to buffer naturally vegetated areas....The location of roads and public areas near naturally vegetated areas improves surveillance, deters vandalism and arson, and avoids individual properties advancing into retained naturally vegetated areas. Roads also provide a fire break, reducing the impact of hazard reduction activities on naturally vegetated areas.”</i></p> <p>EPA Bulletin number 20 (Guideline 3) cannot be used as a guideline to automatically veto the KRSL project given:</p> <ul style="list-style-type: none"> <li>Bush Forever Site 342 does not meet the guideline’s stated criteria for a “large consolidated area”;</li> <li>As stated on the EPA website, EPA Bulletin number 20 is not a statutory document – it is a fairly brief document designed to be read by a general audience and does not contain comprehensive methodologies or implementation details. Therefore it cannot be assumed to be automatically applicable to the KRSL project and does not have legal precedence over the statutory</li> </ul>

Submission and/or issue #	City of Armadale Response
	<p>requirements of the Environmental Protection Act, which requires a project specific environmental impact assessment of the KRSL project; and</p> <ul style="list-style-type: none"> <li>• Under Part IV of the Environmental Protection Act, the City of Armadale have a statutory right for the KRSL proposal to be assessed on its merits to determine if the environmental impacts can be managed to an acceptable level via a suite of appropriate environmental management measures and offsets. This assessment also needs to take into account the existing situation (unsealed track) which is predicted overall to have greater environmental impacts than the proposed managed sealed KRSL road.</li> </ul> <p>The design of the proposed Keane Road Strategic Link has been considered in great detail in order to ensure it meets relevant EPA Objectives as detailed within the PER and this Response to Submissions document, including the requirements of maintaining ecological connectivity and avoiding further ecological fragmentation.</p> <p>As outlined in Sections 5.2.2 and 5.3.3 and 5.4.2 of this response to submissions document, the proposal has been designed to avoid:</p> <ul style="list-style-type: none"> <li>• Flora and vegetation ecosystem fragmentation;</li> <li>• Fauna habitat fragmentation; and</li> <li>• Hydrological system fragmentation.</li> </ul> <p>The following measures proposed will maintain habitat ecological connectivity:</p> <ul style="list-style-type: none"> <li>• Fauna underpasses: note these fauna underpasses have been re-designed since the public release of the PER as described in Sections 3.2, 4.2 and Appendix D to ensure suitability for all species of vertebrate species which may occur on the site (including large mammal species such as wallabies and kangaroos). This will maintain connectivity between the two areas and prevent habitat fragmentation implications on the ecology of the area.</li> <li>• Surface water connection culverts: have been designed to be placed underneath the road to ensure wetland connectivity as described in Sections 3.2, 4.3 and Appendix F. It should be noted that the existing hydrology of the area has been significantly modified by surrounding development and unsealed tracks throughout the Bush Forever Site, which now act as un-nature “quasi” drainage lines. The objective of the KRSL project is to provide more natural diffuse flows underneath the road via the proposed clusters and arrays of small culverts, to prevent channelized flow and create sheet flow which is more like the natural sheet flow that would be experienced by the wetland, if it was not crossed by numerous man-made unsealed tracks.</li> <li>• Groundwater connectivity will be maintained by ensuring the groundwater is not disturbed (i.e. no groundwater abstraction, no disturbance of groundwater flows, no disturbance of surface water flows or recharge) as described in Appendix F.</li> </ul> <p>Total impacts from the sealed, managed Keane Road are likely to be much smaller than from the current unsealed unmanaged road, which is a major access point for off road driving. As described in Section 4.1, Appendix B and Appendix C total residual impacts from each situation can be summarised as follows:</p> <ul style="list-style-type: none"> <li>• Unmanaged and unsealed track: Direct Cleared Area of 0.85 ha, Likely Edge Effects of 6.69 ha (impacts of 7.54 ha in total).</li> <li>• Managed and sealed road: Direct Cleared Area of 1.65 ha, Likely Edge Effects of 0.92 ha (impacts of 2.57 ha in total) (van Etten, 2014).</li> </ul> <p>Bush Forever Site 342 and the Anstey Keane Wetland is currently fragmented into a number of smaller areas via the extensive network of unsealed roads/tracks which run through the Bush Forever Site as shown on Figure 15 including the subject portion of Keane Road which is currently a partially cleared but existing gazetted/dedicated road reserve between Skeet Road and Anstey Road. In accordance with design principle 3 of EPA Bulletin 20, the Keane Road Strategic Link project proposes design measures which will help restore the currently fragmented ecosystem connectivity within Bush Forever Site 342 as follows:</p> <ul style="list-style-type: none"> <li>• The construction of Keane Road Strategic Link will reduce undesirable 4WD</li> </ul>

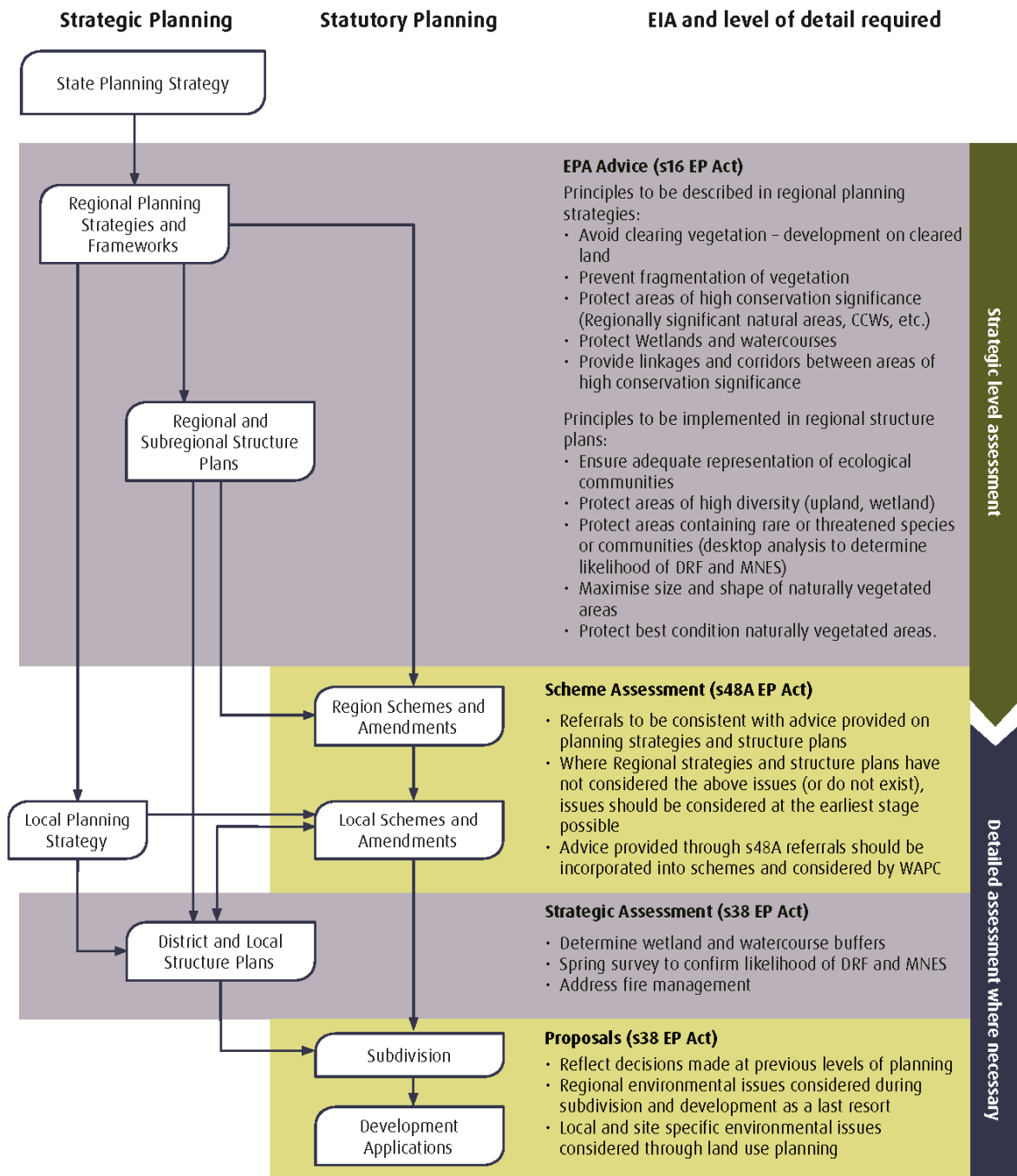
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	<p>access and associated degradation of Bush Forever Site 342 via:</p> <ul style="list-style-type: none"> <li>○ Fencing of the road on both sides will prevent access to the Bush Forever Site from Keane Road Strategic Link. Currently this land is an unsealed 4WD road/track which provides numerous 4WD access points via side roads into other parts of the Bush Forever Site 342. These side access roads coming off the current unsealed track will no longer be accessible, given the unsealed track is proposed to be replaced with a fully fenced sealed road.</li> <li>○ There will be increased passive surveillance by local community using the Keane Road Strategic Link, which will allow the local community assist in reporting to the local police and ranger observations of illegal 4WD access to the Bush Forever Site. This passive surveillance and reporting by the local community will assist in reducing illegal off road driving in the Bush Forever Site.</li> </ul> <ul style="list-style-type: none"> <li>● The Anstey Keane dampland (Bush Forever Site 342) is currently highly modified by 4wd tracks which have become un-natural man made drainage channels. Vegetation Condition Mapping (Figure 15) shows that of the 369.5 ha of Bush Forever Site 342, 72 ha (or 20%) has been degraded by incursion by off road vehicles which are currently using existing unsealed roads/tracks within Bush Forever Site 342. This has created a number of smaller pockets of vegetation (33% of which is in very good condition and 47% of which is in good condition) as shown in Figure 15 (EnviroWorks Consulting, 2013a). The 4wd tracks currently cause un-natural surface water blockage, ponding and channelized flow in areas of the dampland which would have previously received natural sheet flow (diffuse flow) prior to human modification via the construction of unsealed tracks and ongoing use of these tracks for off road driving (Water Technology, 2014 – Appendix F). The array of small surface water culverts proposed under the Keane Road Strategic Link, will serve to create diffuse water flow underneath the road and re-create sheet flow downstream. Ponding of water upstream of the alignment will not be increased due to the arrays of numerous surface water culverts proposed Therefore Keane Road Strategic Link will restore surface water flows to a more natural state than is currently the case (Water Technology, 2014 – Appendix F).</li> <li>● Currently fauna habitat within Bush Forever Site 342 is being impacted by off road driving. Anecdotal reports from the local community indicate: <ul style="list-style-type: none"> <li>○ The area is being used for shooting of fauna; and</li> <li>○ Off road driving is leading to fauna road kill on the current network of unsealed roads through the Bush Forever Site.</li> </ul> <p>As described above these activities will be reduced by the fencing of Keane Road and increased passive surveillance by the community. Measures to avoid impacts of the Keane Road Strategic Link on fauna and habitat including fauna underpasses have been described in Section 3.2.2, 5.3 and Appendix D of this Response to Submissions document.</p> <p>Overall development under the DSP and TPS has been located on degraded areas between large consolidated vegetated blocks and where possible, linkages have been provided by design features such as multiple use corridors developed as living streams. Large consolidated naturally vegetated areas are also protected north and south of the existing Keane Road dedicated reservation (and some ecological linkages exist to the west) and fauna underpasses in the Keane Road final stage design provide ecological linkages between abutting vegetated areas.</p> <p><b>Design Guideline 6 from EPA Bulletin 20 states:</b></p> <p><i>“6. Infrastructure should not be located within consolidated retained naturally vegetated areas</i></p> <p><i>Services and infrastructure, including roads and other transport corridors, should not be located within or through consolidated naturally vegetated areas. Infrastructure within naturally vegetated areas disrupts the connectivity of these areas and reduces the</i></p> </li> </ul>

Submission and/or issue #	City of Armadale Response
	<p><i>environmental values and long term viability of the area through fragmentation and edge effects.”</i></p> <p>As stated above the criteria for a “large consolidated area” are not met by Bush Forever Site 342 as follows:</p> <ul style="list-style-type: none"> <li>• <u>“Large consolidated blocks should include the best condition naturally vegetated areas on site and ensure that they are representative of the area.”</u> The site does not include the best condition naturally vegetated areas with the local area, due to the extensive network of off road vehicle tracks causing degradation of vegetation within Bush Forever Site 342. Vegetation Condition Mapping (Figure 15) shows that of the 369.5 ha of Bush Forever Site 342, 72 ha (or 20%) has been degraded by incursion by off road vehicles which are currently using existing unsealed roads/tracks within Bush Forever Site 342. This has created a number of smaller pockets of vegetation (33% of which is in very good condition and 47% of which is in good condition) as shown in Figure 15 (EnviroWorks Consulting, 2013a). By comparison, offset area number 1 (which is 103 ha in area), adjacent to the RAMSAR listed Forrestdale Lake contains better condition areas of native vegetation including the TEC and PEC’s which also occur within Bush Forever Site 342.</li> <li>• <u>“Large consolidated blocks should have a low edge to area ratio, which is determined based on the size and shape of the consolidated block.”</u> Bush Forever Site 342 does not have a low edge to area ratio determined by the size and shape of the block. Due to the extensive network of unsealed tracks throughout Bush Forever Site 342 there is a very high edge to area ratio as follows: <ul style="list-style-type: none"> <li>○ The total length of edges of tracks within bush forever site 342 is 79.54 km.</li> <li>○ The total area of Bush Forever Site 342 is 369.5 ha or 3.695 km<sup>2</sup>.</li> <li>○ Therefore the edge to area ratio is 21.5 to 1. That is there are 21.5 km of edges for every 1 km<sup>2</sup> of naturally vegetated area.</li> </ul> </li> </ul> <p>The area is clearly not an example of a consolidated retained natural vegetated area as referred to in the Bulletin 20 design guidelines 3 and 6. The Australian Concise Oxford Dictionary definition of consolidated is to – “combine (territories etc) into one whole”. The area of vegetation which a section of Keane Road is located cannot be described as an area that has been combined “into one whole”.</p> <p>EPA Bulletin number 20 (Guideline 6) cannot be used as a guideline to automatically veto the KRSL project given:</p> <ul style="list-style-type: none"> <li>• Bush Forever Site 342 does not meet the guideline’s stated criteria for a “large consolidated area”;</li> <li>• As stated on the EPA website, EPA Bulletin number 20 is not a statutory document – it is a fairly brief document designed to be read by a general audience and does not contain comprehensive methodologies or implementation details. Therefore it cannot be assumed to be automatically applicable to the KRSL project and does not have legal precedence over the statutory requirements of the Environmental Protection Act, which requires a project specific environmental impact assessment of the KRSL project; and</li> <li>• Under Part IV of the Environmental Protection Act, the City of Armadale have a statutory right for the KRSL proposal to be assessed on its merits to determine if the environmental impacts can be managed to an acceptable level via a suite of appropriate environmental management measures and offsets. This assessment also needs to take into account the existing situation (unsealed track) which is predicted overall to have greater environmental impacts than the proposed managed sealed KRSL road.</li> </ul> <p>In addition, to the existing environmental fragmentation of Bush Forever Site 342, the site is not consolidated from a Land Tenure point of view. Keane Road is a legal land parcel in the form of an existing dedicated road reserve which is under the care and control of the City of Armadale. The Department of Parks and Wildlife has previously acknowledged</p>

Submission and/or issue #	City of Armadale Response
	<p>that the Jandakot Regional Park abuts Keane Road and Keane Road itself is not part of the park. The Bush Forever site 342 which the road in part traverses has the status of a policy overlay which is part of the MRS, however, it is not a “consolidated” area in land tenure. Bush Forever is a policy guideline and the City has followed the Bush Forever policy provisions in examining the environmental impacts and management of constructing the final section of Keane Road.</p> <p>The characterisation of the proposal design as failing to achieve design guidelines 3 and 6 is an incorrect assertion because the submissions misapply the Bulletin to this proposal. Furthermore, the submissions only quote the Bulletin selectively.</p> <p>Total impacts from the sealed, managed Keane Road are predicted to be much smaller than edge effects from the current unsealed unmanaged road, which is a major access point for off road driving. As described in Section 4.1, Appendix B and Appendix C total impacts from each situation can be summarised as follows:</p> <ul style="list-style-type: none"> <li>• Unmanaged and unsealed track: Direct Cleared Area of 0.85 ha, Likely Edge Effects of 6.69 ha (impacts of 7.54 ha in total).</li> <li>• Managed and sealed road: Direct Cleared Area of 1.65 ha, Likely Edge Effects of 0.92 ha (impacts of 2.57 ha in total) (van Etten, 2014).</li> </ul> <p>It is concluded that EPA Bulletin number 20 cannot be used as a guideline to automatically veto the statutory right of the City of Armadale to have the KRSL proposal assessed on its merits to determine if the environmental impacts can be managed to an acceptable level via a suite of appropriate environmental management measures and offsets, in comparison to the existing situation (unsealed track) which is predicted to have greater overall environmental impacts.</p>



## Environmental Assessment and the Planning Framework



CCW: Conservation Category Wetlands  
 DRF: Declared Rare Flora  
 MNES: Matters of National Environmental Significance

### Insert 2: Environmental Assessment Required at Each Stage of Planning Process

## 6 CONCLUSION

This response to submissions report has documented and responded to the submissions received on the PER for Keane Road Strategic Link and outlines City of Armadale's responses to the submissions.

The City of Armadale has considered all the issues arising from the submissions and provided a written response to key issues.

In consideration of these responses, it is proposed that the Project as described in the PER and as altered in the design changes identified in Section 3, as well as further work carried out as described in Section 4, should be submitted for determination.

## 7 GLOSSARY

### 7.1 UNITS, SYMBOLS AND PREFIXES

#### 7.1.1 UNITS

g	Gram; a unit used to express weight
L	Litre; a unit used to express volume
m	Metre; a unit used to express length
bcm	Bank cubic meters; a unit used to describe the volume of in-situ rock
dB	Decibel; unit used to express sound intensity
h	Hour; a unit used to express time
ha	Hectare; a unit used to express area
m <sup>2</sup>	Square metre; a unit used to express area
m <sup>3</sup>	Cubic metre; unit used to express volume.
V	Volt; a unit used to express the potential difference across a conductor
VA	Volt-amp; a unit used to express apparent power; is equal to voltage applied multiplied by current drawn
VPD	Vehicles per day
yr	Year
s	Second; a unit used to express time
ppm	Parts per million; a unit used to express concentration
ppt	Parts per thousand; a unit used to express concentration
T	Tonne

#### 7.1.2 SYMBOLS

%	percentage (proportion out of one hundred)
/	Per
p	per
\$	Australian dollars
a	annum; year
°C	degree Celsius

#### 7.1.3 PREFIXES

G	10 <sup>9</sup>
M	10 <sup>6</sup>
k	10 <sup>3</sup>
d	10 <sup>-1</sup>
c	10 <sup>-2</sup>
m	10 <sup>-3</sup>
μ	10 <sup>-6</sup>
N	10 <sup>-9</sup>

## 7.2 WORDS AND ABBREVIATIONS

Term	Definition/Expansion
acid	Substance with a pH less than 7.0; the lower the pH the higher the corrosive ability of the substance.
acidic	Having a pH less than 7.0.
AHD	Australian Height Datum
ALARP	As low as reasonably practicable.
amenity	The desirability of an area.
amphibians	Animals (such as frogs) adapted to live both on land and in water.
ARI	Average recurrence interval; a measure of the rarity of a rainfall event.
artefact	Anything made by human workmanship, particularly by previous cultures (such as chipped and modified stones used as tools).
background	The conditions (e.g., noise levels, bird populations) already present in an area before the commencement of a specific activity (e.g., a mining operation).
best practice	A best practice is a process, technique, or use of technology, equipment or resource that has a proven record of success.
bioregion	A complex land area composed of a cluster of interacting ecosystems that are repeated in similar form. It describes the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation. It is based on the Interim Biogeographic Regionalisation for Australia (see IBRA).
biodiversity	The diversity of different species of plants, animals and microorganisms, including the genes they contain, in the ecosystem of which they are part.
bore	A well, usually of less than 20 cm diameter, sunk into the ground and from which water is pumped.
bund	An earth, rock, or concrete embankment constructed to prevent the inflow or outflow of liquids or the transmission of noise.
catchment	The entire land area from which water (e.g., rainfall) drains to a specific water course or waterbody.
clay	A discrete mineral species, belonging to the layered silicate group of less than 2 microns in diameter.
compaction	The process of close packing of individual grains in a soil or sediment as a response to pressure.
concentration	The amount of a substance per unit of mass or volume of the medium in which it occurs.
conservative	A prediction, assumption, or measurement that errs on the side of safety.
contractor	Specialist brought in to perform a specific task, such as the construction of mine infrastructure or the excavation (mining) of the open pit.
DER	Department of Environment Regulation
DEPaW	Department of Parks and Wildlife
density	The mass of a substance divided by its volume.
DIA	Department of Indigenous Affairs
DoCEP	Department of Consumer and Employment Protection.
DoE	Department of Environment (commonwealth)
DoW	Department of Water.
DOP	Department of Planning
DRF	Declared Rare Flora.
DSP	District Structure Plan
ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
emission	A discharge of a substance (e.g., dust) into the environment.
endemic	Native to, or restricted to, a certain country or area.

Term	Definition/Expansion
environment	A general term for all the conditions (physical, chemical, biological and social) in which an organism or group of organisms (including human beings) exists.
EPA	Environmental Protection Authority.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
erosion	The wearing away of the land surface (whether natural or artificial) by the action of water, wind and ice.
fauna	A general term for animals (birds, reptiles, marsupials, fish etc.), particularly in a defined area or over a defined time period.
feed	Material being fed into a process.
flora	A general term for plants, particularly those found in a defined area or characteristic of a defined time period.
foraging	Searching for food over a wide area.
grade	The concentration of metal, e.g., iron either in an individual rock sample or averaged over a specified volume of rock.
gradient	Rate of change of a given variable (such as temperature or elevation) with distance.
greenhouse gases	Carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulfur hexafluoride.
ground vibration	Vibration transmitted through the ground following blasting.
groundwater	All waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.
habitat	The particular local environment occupied by an organism.
hydrology	The study of water, particularly its movement in streams, rivers, or underground.
infrastructure	The supporting installations and services that supply the needs of a project.
introduced	Introduced to a particular environment; exotic.
invertebrates	Commonly, animals without a backbone (jellyfish, worms, molluscs, etc.).
irrigation	The artificial flooding of agricultural land to promote cultivation.
landform	A specific feature of a landscape (such as a hill) or the general shape of the land.
load	The amount of a substance discharged into a body of water (e.g., salt or sediment); usually expressed as mass over a specified time (e.g., tonnes per year).
MBGL	Meters Below Ground Level
model	A mathematical simulation of a natural system (such as the variation of particulate levels within a lake) used to predict how the system will change with time, particularly where external changes have been imposed upon it (such as from mining operations).
monitoring	Systematic sampling and, if appropriate, sample analysis to record changes over time caused by impacts such as mining.
native	Belonging to, or found naturally, in a particular environment.
natural	Existing in, or formed by, nature (generally excludes anything obviously modified by human beings).
neutral	Neither acidic nor basic (e.g., a pH equal to 7.0).
nutrients	Generally refers to nitrogen and phosphorus, which are essential for biological growth.
operations	Mining and ore processing activities.
ORV	Off Road Vehicles.
passive	Performing a function without electrical or mechanical action or movement.
PER	Public environmental review.
pH	Percentage hydrogen; a measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral and 14 is most basic (alkaline).
Prescribed	A premise that falls into the categories prescribed in Schedule 1 of the Environmental

Term	Definition/Expansion
Premise	Protection Regulations 1987.
project area	the total area covered by the project, including pit, processing plant, stockpiles, haul road, rail siding, port facilities etc.
quadrat	A square measuring area used in ecological studies such as the distribution of plants or animals in an area. Quadrats can vary in size depending largely on the focus of the study.
receptor	A designated place at which an impact may occur (e.g., a dwelling).
recharge	The addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.
rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
reptiles	Cold-blooded vertebrates, including lizards, snakes, turtles, and crocodiles.
reserve	The calculated tonnage and grade of ore which can be extracted profitably from a mineral deposit; classified according to the level of confidence that can be placed in the data.
residual impacts	Impacts from an activity (e.g., mining) that remain after mitigation measures.
resource	The calculated amount of material in a mineral deposit, based on exploration drilling information.
richness (of fauna or flora)	A measure of the number of species in a given area or assemblage.
runoff	That portion of precipitation (rain, hail and snow) that flows from a specific area as water.
sand	Siliceous group of particles within the size range 63 microns to 2 millimetres.
silt	Sediment with particles finer than sand and coarser than clay, i.e., 2 to 63 microns.
species	A taxonomic grouping of organisms that is able to interbreed with each other but not with members of other species.
stockpile	A pile used to store material (such as low-grade ore) for future use.
stockpiled	Stored in a stockpile.
stripping	Removal of vegetation and topsoil.
surface water	Water flowing over, or contained on, a landscape (e.g., runoff, streams, lakes, etc.).
taxa	Plural of taxon.
taxon	A group or category, at any level, in a system for classifying plants or animals. Animal or plant group having natural relations.
TEC	Threatened Ecological Community.
topography	Physical relief and contour of a region.
topsoil	Upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.
TPS	Town Planning Scheme
variable	Not constant, subject to change.
vibration	Oscillating movement.
WAPC	Western Australian Planning Commission
WAWC Act	WA Wildlife Conservation Act, 1950
water balance	The sum of the inputs and outputs and changes in storage levels of water in a given locality.
water quality	Degree of the lack of contamination of water.
watertable	The surface of the groundwater, below which soil and rock are saturated.
watercourse	Stream or river, running water.
weed	Any plant (in particular an herbaceous one) that survives in an area where it is harmful or troublesome to the desired land use.
wetland	A low-lying area regularly inundated or permanently covered by shallow water.

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## 9 GIS DATASET CITATIONS

Table 6: GIS Dataset Citations

Reference No.	Dataset (short name)	Citation
4A	Australia TOPO250K Layers	GEODATA TOPO 250K Series 3 Topographic Data, Geoscience Australia. Publication date June 2006.
4E	WA Townsites (LGATE-007)	WA Townsites, Landgate. Publication Date 22/06/2010
4J	Topo Server Datasets: Hydro (Line) (LGATE-018), Inland Flat (Polygon) (LGATE-099)	Topography Database datasets, Landgate. Accessed 29/02/2012.
7A	Bush Forever Sites	Bush Forever 2007, Department for Planning and Infrastructure Western Australia. Publication date 19/03/2007.
8A	Cadastre	Spatial Cadastre Database (SCDB) Datasets, Landgate. Accessed 14/12/2011.
9A	Digital Elevation Model Australia	1 second SRTM Derived Digital Elevation Models (DEM, DEM-S, DEM-H) Version 1.0, Geoscience Australia. Published 2011.
10A	(ESA) Environmentally Sensitive Areas	Clearing Regulations – Environmentally Sensitive Areas (ESA), Department of Environment and Conservation Western Australia. Publication date 12/05/2011.
10F	DEC Managed Lands	DEC Managed Lands and Waters, Department of Environment and Conservation Western Australia. Publication date 05/10/2011.
10I	DEC Search - Flora	Threatened (Declared Rare) Flora Database, WA Herbarium Specimen Database, and Declared Rare and Priority Fauna List, Searches. Department of Environment and Conservation, WA. Search request reference number 82a-1010 for “City of Armadale Keane Road Strategic Link”. Data received 12/11/2010.
10J	DEC Search – TECs	Threatened and Priority Ecological Community Buffers in WA, Department of Environment and Conservation, WA. Search request for “City of Armadale Keane Road Strategic Link”. Search buffer requested: 5 km around project area. Data received 20/10/2010.
11E	Interpreted bedrock geology 1:500,000	1:500 000 Interpreted bedrock geology of Western Australia, 2008 update, Department of Mines and Petroleum, Western Australia. Publication date 15/02/2008. Download date 31/01/2011.
13I	Metro Central 2011	Metro Central 2011 Mosaic, Landgate. Accessed 28/09/2011.
13F	Streetsmart Directory	Streetsmart Directory 2009, Landgate. Accessed 22/2/2012.
17A	Roads – Main Roads – Centreline (WA)	Main Roads Western Australia Road Centreline Network, Main Roads Western Australia. Accessed 22/09/2011.
17C	Roads (LGATE-012)	WA Road Network, Geographic Services, Landgate. Accessed 16/01/2012.
17D	Roads Processed (LGATE-073)	WA Road Network, Geographic Services, Landgate. Accessed 14/12/2011.

Reference No.	Dataset (short name)	Citation
18A	Acid Sulphate Soils	Atlas of Australian Acid Sulphate Soils, CSIRO Land and Water. Download date September 2009.
21U	Subcatchments	Hydrographic Subcatchments, Department of Water, WA. Download date 04/08/2010.
21W	Drainage (Gravity – WCORP-003)	Gravity Drainage, Water Corporation Western Australia via Landgate. Accessed 24/02/2012.
21AB	Geomorphic Wetlands (Swan Coastal Plain)	Geomorphic Wetlands, Swan Coastal Plain, Department of Environment and Conservation, WA. Publication date 31/12/2009.
21AC	Nationally Important Wetlands	Directory of Important Wetlands Spatial Database including Wetlands Type and Criteria, Australian Government Department of the Environment, Water, Heritage and the Arts. Download date 19/05/2009.
21AD	RAMSAR Sites (Australia)	Australia's Ramsar Sites, Department of Environment and Conservation, WA. Download date 14/07/2010.
21AF	DoW Linear Hydrography	DoW Linear Hydrography, Department of Water, WA. Download date 04/10/2011.
22	City of Armadale Datasets/Sources	Keane Road Strategic Link; Proposed Environmental Offsets, City of Armadale. Accessed 13/12/2011.
		City of Armadale (2009) District Strategy Harrisdale, Piara Waters and Forrestdale (Adapted from District Structure Plan).
		City of Armadale (2009) Town Planning Scheme Number 4.
		City of Armadale (2010) District Strategy Harrisdale, Piara Waters & Forrestdale with Predicted Population.
		City of Armadale (2010) Figure 15: Keane Road Strategic Link, Typical Cross Section.
		DEC (2010) Jandakot Regional Park Management Plan 2010.
23A	Stephen Connell Dataset	Floristic Community Quadrats; Interpolated Floristic Community Types; Significant Flora identified by EnviroWorks (2011); Threatened and Priority Ecological Communities identified by EnviroWorks (2011), Stephen Connell (EnviroWorks Consulting). Access date 19/01/2012.



## APPENDIX A. STAKEHOLDER CONSULTATION LOG

**APPENDIX B. KRSL ASSESSMENT OF EDGE EFFECTS (VAN ETTEN, 2014)**

**APPENDIX C. KRSL ASSESSMENT OF RESIDUAL IMPACTS TAKING INTO ACCOUNT EDGE EFFECTS (ENVIOWORKS CONSULTING, 2014)**

**APPENDIX D. KRSL ASSESSMENT OF REVISED FAUNA CROSSING DESIGN (BAMFORD CONSULTING ECOLOGISTS, 2014A)**

**APPENDIX E. KRSL PROJECT KANGAROO SURVEY (BAMFORD CONSULTING ECOLOGISTS, 2014B)**



**APPENDIX F. KRSL HYDROLOGICAL ASSESSMENT VALIDATION AND  
RESPONSE TO SUBMISSIONS (WATER TECHNOLOGY, 2014)**

**APPENDIX G. EPA ADVICE GIVEN ON CITY OF ARMADALE TOWN  
PLANING SCHEME**