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NSW GOVERNMENT
Department of Planning

Assessment of the Part 3A Application for Lot 11 DP 229784, Erskine Park

ECOLOGICAL ADVICE

- DRAFT
- 23 March 2009

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1. Introduction

Sinclair Knight Merz (SKM) has been commissioned by the NSW Department of Planning (DoP) to provide ecological advice on the Part 3A Application for Lot 11 DP 229784, Templar Road, Erskine Park (the Subject Site). The Subject Site is approximately 4.3 ha in size and bounded from the north and northwest by the Erskine Park Biodiversity Corridor and by the Sydney Water Supply Pipeline in the south (Figure 1).

An Environmental Assessment (EA) for the proposed development was prepared by JBA Urban Planning Consultants in July 2008. The proposed development includes complete redevelopment of the Subject Site to accommodate an industrial warehouse and associated infrastructure. The proposed development includes the following (JBA Urban Planning Consultants, July 2008):

- *Development of the site for employment/industrial purposes including the following elements:*
  - *a single storey warehouse with a floor area of 21,005m²;*
  - *a 1,285m² two storey office building adjoining the warehouse at its eastern façade;*
  - *a loading area in the western portion of the site with direct access to the warehouse facility via roller shutter doors at its western façade;*
  - *218 car spaces in an at-grade car parking on the eastern portion of the site; and*
  - *associated landscaping of the site.*
- *The construction of a road extension from Templar Road to the boundary of the subject site (including new drainage channel crossing) providing vehicular access to the site;*
- *Construction of utilities and services connections from adjacent locations to the site; and*
- *Stormwater, drainage, bulk earthworks and tree removal associated with the development of the site.*

Comments on the EA have been received from the Department of Environment and Climate Change (DECC) and Penrith Council. A number of issues specifically relating to the Erskine Park Biodiversity Corridor have been raised.

This report details a review of the documents related to the Part 3A application for the Subject Site, including a general literature review of the considerations for biodiversity corridors in terms of their use, width and connectivity, and the results of a brief site inspection. Conclusion is provided in respect to the level of assessment and accuracy provided in the EA.

Legend

Subject Site

Data Sources:
Aerial by AUSIMAGE 2007

0 400 800
meters

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Figure 1. Site Location

GDA 1994 MGA 56

Lot 11 DP 229784, Templar Road, Erskine Park
EN02602

24 February 2009

2. Review of Related Documents

The following review has been undertaken to assess aspects of the Part 3A project application specifically relating to biodiversity. The following documents have been included in this review:

- The Environmental Assessment (JBA Urban Planning Consultants, July 2008);
- Response to submissions on the Part 3A application (particularly the concerns of the Department of Environment and Climate Change and Penrith Council);
- The Penrith DCP 2006 ; and
- The Biodiversity Management Plan and the Biodiversity Management Strategy for the Erskine Park Employment Area.

2.1. Environmental Assessment

The Environmental Assessment (EA) for the Subject Site was prepared by JBA Urban Planning Consultants (2008). A number of Director-General requirements were to be addressed in the EA, including:

- *measures to minimise the impacts of the proposal on the recently approved Biodiversity Corridor in the Erskine Park Employment Area, particularly in relation to the proposed creek crossing*
- *consideration of the need to offset any clearing on site and to enhance the Biodiversity Corridor; and*
- *fire management procedures to minimise risks to the Biodiversity Corridor.*

The ecological information presented in the EA is based on a specialist flora and fauna assessment prepared for the Subject Site (refer Appendix D of JBA Urban Planning Consultants, 2008). According to this assessment the Subject Site is described as being generally clear of vegetation except for grasses and a number of scattered trees. It is also stated that “there are no tree hollows present”. Further, the vegetation remaining on the Subject Site is not considered to constitute remnant or “native” vegetation. Specifically, the conclusions of the report state that:

> *As no threatened biota is considered to be adversely affected by the proposed Project, there is no requirement to “mitigate” or “offset” any such impacts including clearing of vegetation. The subject site does not contribute in any relevant way to the Biodiversity Corridor which is being developed to the north of the site between the retained woodland vegetation to the west of the site and the north east. The Biodiversity Corridor has been identified in the BMP for the EPEA. There is no requirement for the subject site to provide any element of that BMP.*

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In the EA, the vegetation on the Subject Site was deemed not to constitute Cumberland Plain Woodland (CPW), an Endangered Ecological Community (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This is despite the fact that a total of 25 of the 57 characteristic CPW species (44%) were recorded during the EA including species from each major stratum. No assessment against the Scientific Committee's Final Determination for Cumberland Plain Woodland (Dickman 1997) was undertaken.

2.1.1. Potential Impacts of the Proposed Development

There are a number of potential impacts that the proposed redevelopment of the Subject Site may have on the environment (particularly in reference to the Erskine Park Biodiversity Corridor). These potential impacts are presented in Table 2-1.

Table 2-1 Potential Impacts of the Proposed Development

Proposed Action	Direct Impacts	Indirect Impacts	How addressed in the EA
Clearing of native vegetation	Clearing of remaining native vegetation from the Subject Site	Reduction in the width of the Erskine Park Biodiversity Corridor	EA specifies no native vegetation to be cleared, therefore no impacts have been assessed
Construction of a creek crossing and extension of Templar Road	Dissection of the Erskine Park Biodiversity Corridor	Reduction of fauna passage	A four section box culvert allows for fauna passage during periods of low-flow
Construction of warehouse, carparks and other hardstand areas	Increased stormwater velocity into the Erskine Park Biodiversity Corridor	Pollution, weed invasion	All stormwater to be captured on site, treated in bioretention swales and rain-gardens prior to discharge
Warehouse operation	Increased noise	Reduction in efficiency of the Erskine Park Biodiversity Corridor in respect to fauna passage	Preliminary noise assessment details no expected impact on sensitive receivers. Impacts on the Biodiversity Corridor not examined.
	Increased light	Reduction in efficiency of the Erskine Park Biodiversity Corridor in respect to fauna passage	All site lighting is to be contained within the Subject Site.

2.2. Response to Submissions on the Part 3A application

This section provides a review of comments received by the Department of Environment and Climate Change (DECC) and Penrith Council on the Part 3A application for the Subject Site.

2.2.1. Response from DECC dated 28 August 2008

The DECC has provided comments in a response to the proposed warehouse and distribution on the Subject Site which state:

> *The Erskine Park Employment Area has been the subject of considerable planning effort in the past, culminating in the development of the document "Biodiversity Management Plan Erskine Park Employment Area" (BMP – May 2006). While the Jacfin company and its representatives were not involved in the preparation of the BMP, it does set out the total offsets and conservation areas required for the development of the entire employment area, including the Jacfin site. Therefore, no additional offsets are required for the development of the subject site.*
>
> *While there are minimal biodiversity conservation values present on the subject site, its development has reduced the possible width and effectiveness of the biodiversity corridor that runs from east to west along its northern boundary. Therefore, it would be appropriate for Jacfin Pty Ltd to contribute financially to the offsets that are proposed in the BMP*

The DECC states that the BMP and its' associated clearing offsets were prepared for the entire Erskine Park Employment Area (Section 2.4), however the offset calculations presented in the BMP only account for vegetation to be cleared from landowners in the Erskine Park Landowners Group (EPLOG) which does not include Jacfin Pty Ltd.

The DECC also recognise the limiting width of the biodiversity corridor adjoining the Subject Site and recommend that Jacfin Pty Ltd contribute financially to the offsets proposed in the BMP which would assist in developing the corridor elsewhere in Erskine Park.

2.2.2. Response from DECC dated 11 December 2008

Additional comments from the DECC were received on 11/12/08 which endeavour to clarify a number of issues:

> *DECC has been involved over many years in supporting and negotiating a biodiversity conservation corridor for Erskine Business Park (EBP) in which the subject site is located, including working closely with Penrith Council and the Department of Planning*

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> *(DoP) on this matter. As DoP would be aware, the process reached the point of finalisation of a Biodiversity Management Plan (BMP) and Voluntary Planning Agreements.*
>
> *DECC's support for inclusion of the northern part of the Jacfin land in the corridor has remained despite its exclusion from the BMP as a result of the landowner's unwillingness to be part of the agreement.*
>
> *Although the Jacfin Land was not included in the final BMP, part of the subject land was identified as a crucial part of the EBP biodiversity corridor when combined with a similar area on adjoining land. Previously, (letter dated 8 April, 2005), DECC advised Penrith Council of the importance of retaining the corridor on the Jacfin site as follows: "the future of the Jacfin lands (Area 2e) is particularly critical. If these are not secured as part of the conservation corridor, the integrity of the east-west connection is significantly compromised."*

While not apparent in the initial response from DECC (Section 2.2.1), it is clear from this response that the DECC had intended for the inclusion of the northern part of the Jacfin land (approximately 1.8 ha) in the biodiversity corridor. The DECC state that the Jacfin land was excluded from the Biodiversity Management Plan primarily due to the unwillingness of Jacfin to be part of the agreement. The DECC also identify that the inclusion of the Jacfin land is essential to the long-term integrity of the biodiversity corridor.

2.2.3. Response from Penrith Council dated 15 September 2008

Penrith Council also provided comments in response to the proposed warehouse and distribution on the Subject Site which state:

> *Council has consistently supported the retention of the "biodiversity (conservation) area" within the northern portion of the Jacfin property since the adoption of EPEA DCP 2002 in December 2002. This Plan has been in force since 3 January 2003...*
>
> *...the Biodiversity Management Strategy recommended by the Biosis Report establishes the justification for retention of the northern portion of the Jacfin land as a "biodiversity area." It forms a critical part of the riparian and biodiversity conservation corridors linking the Ropes Creek and South Creek systems...*
>
> *... The statement in the EAR* [Environmental Assessment Report] *that the Biodiversity Strategy 2005 and BMP 2006 superceded EPEA DCP 2002 is incorrect for the Jacfin site. The Jacfin site was only excluded from the BMP 2005 as Jacfin was unwilling to participate with Council, DoP and DECC. Penrith DCP 2006 was the mechanism chosen*

> *by DoP (Land Management Branch), DECC and Council to protect that part of the corridor within the Jacfin site. The Jacfin site was included due to its conservation value and the need to secure this land as a critical biodiversity corridor...*
>
> *... The proposed development of the full Jacfin site will further impact on the viability of the Erskine Business Park riparian biodiversity corridor by severely narrowing the corridor and further degrading the water quality of this tributary.*

The response from Penrith Council supports the view of the DECC in that although the Subject Site has been excluded from the Biodiversity Management Plan, the Penrith Development Control Plan 2006 (Section 2.3) which includes the northern part of the Jacfin land still applies. Penrith Council also comments that the complete redevelopment of the Subject Site will compromise the integrity of the biodiversity corridor and impact on water quality.

2.2.4. Response from Penrith Council dated 25 September 2008

Additional comments from Penrith Council were received on 25/09/08 and identify another potential issue with the proposed development, namely:

> *The draft State Environmental Planning Policy (Western Sydney Employment Hub) 2008 nominates an E2 (Environmental Conservation) Zone throughout the Erskine Business Park, including the northern portion of the Jacfin property.*
>
> *The Jacfin proposal is therefore contrary to the E2 zone as shown nominated within the draft exhibited SEPP on the northern portion of the Jacfin property. It should be noted that this nominated land is exactly the same portion of land that is nominated as a "Biodiversity Area" within Penrith DCP 2006.*

The Draft State Environmental Planning Policy (Western Sydney Employment Hub) 2008 (SEPP WSEH) was on public exhibition until 28 April 2008. As mentioned above, the northern area of the Subject Site (approximately 1.8 ha) has been included in an E2 Environmental Conservation Zone which is equal to the Biodiversity Area specified in the Penrith DCP 2006. The objectives of the E2 Environmental Conservation Zone (DoP 2008) are as follows:

- *To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values, and*
- *To prevent development that could destroy, damage or otherwise have an adverse effect on those values.*

According to the Draft SEPP WSEH (2008), development permitted with consent within the E2 Environmental Conservation Zone includes: artificial waterbodies; environmental facilities; environmental protection works; flood mitigation works and roads.

As the SEPP is still a draft document, it does not apply to the Subject Site until it has been approved by the Minster for Planning.

2.3. Penrith Development Control Plan 2006

The Penrith DCP 2006 sets out to provide detailed guidance for people wishing to undertake development within the City of Penrith. Part 6.14 provides detailed site and specific area controls for the Erksine Park Employment Area including details on the Erskine Park Biodiversity Corridor. The objectives relating to biodiversity included in the DCP are:

- *To promote the conservation of urban bushland in accordance with the aims and objectives specified in Clause 2 of Penrith Local Environmental Plan 1994 (Erskine Park Employment Area);*
- *To protect and preserve native vegetation and biological diversity in the Erskine Park Employment Area in accordance with the principles of ecologically sustainable development;*
- *To retain native vegetation in parcels of a size and configuration which will enable the existing plant and animal communities to survive in the long term;*
- *Protect and enhance habitat for threatened species and endangered ecological communities; and*
- *Maintain and enhance corridors for fauna and flora.*

The Penrith DCP 2006 also includes a map of the Biodiversity Management Strategy for the Erksine Park Employment Area which clearly shows the northern part of the Subject Site as part of the “Biodiversity Area”. Requirements for “Biodiversity Areas” as determined by the DCP include: *“No clearing of native vegetation……. within biodiversity areas”* and *“Locally indigenous species should be used for revegetation and restoration of native bushland”*.

2.4. Biodiversity Strategy and Management Plan

The Erskine Park Biodiversity Strategy (the Strategy) and the Biodiversity Management Plan (the Plan) were developed by HLA-Envirosciences Pty Ltd in consultation with The Erskine Park Land Owners Group (EPLOG), Penrith City Council, the DoP and the DECC (HLA 2005 and 2006). The EPLOG comprises the following land owners: CSR, The Austral Tile Company, Fitzpatrick Investments Pty Ltd, ING Pty Ltd and the Trust Company of Australia Ltd.

The Strategy was developed to provide a strategic framework for the conservation of biodiversity within the EPEA. The strategy provides for an east-west biodiversity corridor which links the South Creek and Ropes Creek riparian corridors. Approximately 25% of the EPEA is to be included in this corridor, 113.4 hectares of which is under private ownership.

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Revegetation offset and conservation ratios were developed for the Erskine Park Biodiversity Corridor in order to achieve the objectives of the Strategy. These offset ratios are presented in Table 2-2.

- **Table 2-2 Revegetation Offset and Conservation Ratios**

Revegetation Offset and Conservation Ratios	Revegetation Offset and Conservation Targets	Actual Calculations
Total corridor area : cleared area within EPEA	6.0 : 1.0	Total corridor area (211.0 ha) : cleared area (34.3 ha) = 6.15 :1
Total revegetation area in corridor : cleared area within EPEA	3.5 : 1.0	Total revegetation area (120.1 ha) : cleared area (34.3 ha) = 3.5 : 1

The primary offset ratio (6.0:1.0) refers to the total amount of land required to be offset, while the secondary offset ratio (3.5:1.0) refers to land within the total offset requiring revegetation. For example if 10 ha of Cumberland Plain Woodland are to be cleared, 60 ha of land are required to be offset in total. Of this 60 ha, 25 ha is to be of remnant Cumberland Plain Woodland vegetation while 35 ha is to be revegetated to Cumberland Plain Woodland.

The Strategy (HLA 2005) consists of two main phases. Phase one is to occur over a six-year period from the subdivision of the biodiversity corridor or when a restriction to user is placed on the title of the lots containing dedicated biodiversity areas. The Strategy nominates six years as a sufficient period of time for the biodiversity area to become self sustaining. Phase two is the maintenance period for the biodiversity area and is to continue in perpetuity. In this earlier document, the northern area of the Subject Site (approximately 1.8 ha) owned by Jacfin Pty Ltd was nominated to be dedicated to the Erskine Park Biodiversity Corridor.

The Plan (HLA 2006) follows on from the Strategy to provide further detail including the revised boundary of the Erskine Park Biodiversity Area, the revegetation and conservation offset ratios and the ownership, funding and management arrangements. A total of $4 M in land owner contributions has been agreed for the establishment and perpetual management of the Biodiversity Area. The Plan (HLA 2006) includes an updated map of the Erskine Park Biodiversity Corridor which supersedes the map prepared in the Strategy (HLA 2005). The new map does not include the Subject Site, nor has any clearing on the Subject Site been taken into consideration for the development of the revegetation and conservation offsets.

2.5. Literature Review

A review of recent literature on the importance of vegetated corridors for flora and fauna and in particular relating to the optimum width for maximising biodiversity has been provided in Appendix A. The review was conducted to present current knowledge in relation to the value of corridors retained in the landscape and some factors for consideration concerning appropriate widths and structure.

While an optimal biodiversity corridor should generally be greater than 100 metres in width, it is recognised that in this case, the most valuable ecological assets to the corridor (in the form of remnant Cumberland Plain Woodland) have already been cleared from the north of the Subject Site during the creek realignment. It is imperative that any future development of the Subject Site minimise the impact of development on the Erskine Park Biodiversity Corridor and the creek crossing.

3. Site Inspection

A brief site inspection was conducted in order to clarify a number of issues such as potential impacts on the biodiversity corridor which have arisen during the assessment of the Part 3A application. A meeting was held onsite with representatives of the DoP and Jacfin Pty Ltd on 16 February 2009.

Observations on the condition of the Subject Site, including remnant trees, native species, fauna habitats and potential impacts on the Erskine Park Biodiversity Corridor were made based on a brief inspection. There was no specific data collected in relation to detailed flora or fauna survey and the information presented is therefore based wholly on observations made at the time of the inspection.

Two large Forest Red Gums (*Eucalyptus tereticornis*) were observed in the north-western corner of the Subject Site (Plate 3-1). The two trees were approximately 25 m in height, had a number of large hollow cavities (exceeding 100 mm in diameter) and are therefore considered of potential habitat value for hollow-dependent fauna (Plate 3-2). A grid reference for each tree was marked with a GPS and can be seen on Figure 2.

There were approximately 18 trees in total present on the subject site during the inspection being dominated by Grey Box (*Eucalyptus moluccana*), with scattered Forest Red Gums and one Thin-leaved Stringybark (*Eucalyptus eugenioides*) which was observed growing on the decommissioned dam wall in the north-western corner of the Subject Site. The floristic structure of the Subject Site can best be described as grassland to open woodland (Specht and Specht 1999) on the basis of scattered trees generally between 10 and 20 m in height with less than 10% projected foliage cover and a predominantly native groundcover.

- **Plate 3-1 The Subject Site with two large habitat trees on the left of the photo**

Legend

Subject Site

Native Grassland

Habitat Tree

Decommissioned Farm Dam

Data Sources:
Aerial by AUSIMAGE 2007

0 400 800
meters

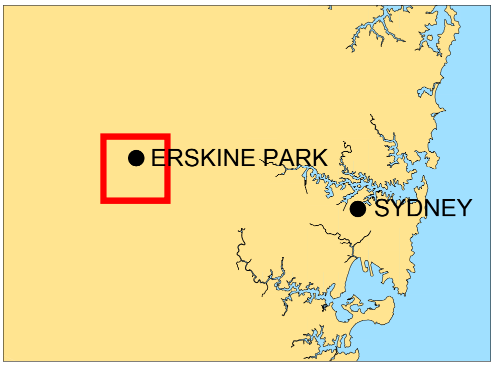

Figure 2. Native Grassland

GDA 1994 MGA 56

Lot 11 DP 229784, Templar Road, Erskine Park
EN02602

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- **Plate 3-2 Habitat tree showing large dead limbs and hollows**

Much of the original canopy and shrub layer vegetation on the Subject Site has been previously removed for agriculture, however significant areas of native grassland remain dominated by Kangaroo Grass (*Themeda australis*) with Wild Sorghum (*Sorghum leiocladum*), Weeping Grass (*Microlaena stipoides*) and Tall Windmill Grass (*Chloris ventricosa*) co-dominating different patches depending on variation in local topography and aspect (see Plate 3-3 and Plate 3-4). These areas of native grassland were preliminarily mapped during the inspection using a hand held GPS unit (Figure 2). The total area of native grassland mapped on the Subject Site is approximately 2.24 ha, or 51% of the Subject Site. Floristic diversity within the native grassland areas was considered moderately diverse despite the history of grazing and recent mowing undertaken on the Subject Site.

Regeneration of the following species was observed across the Subject Site: *Eucalyptus* spp. (see Plate 3-4 and Plate 3-5), Australian Boxthorn (*Bursaria spinosa*) and Spreading Bush-pea (*Pultenaea microphylla*). The Subject Site is dissected by an ephemeral drainage line (Plate 3-7) which generally flows from east to west. This drainage line is dominated by exotic groundcover species such as Paspalum (*Paspalum dilatatum*), Umbrella Sedge (*Cyperus eragrostis*), Spiny Rush (*Juncus acutus*) and Wild Aster (*Aster subulatus*). These species are typical of disturbed and modified drainage lines in western Sydney. A number of frogs were heard calling from the drainage line at the time of inspection, although the species were not identified.

- **Plate 3-3 Kangaroo Grass dominated native grassland along the northern boundary**

- **Plate 3-4 Kangaroo Grass dominated native grassland on the southern side of the ephemeral drainage line**

- **Plate 3-5 Kangaroo Grass dominated native grassland with regenerating eucalypts**

- **Plate 3-6 Regenerating eucalypts**

▪ **Plate 3-7 Ephemeral drainage line**

A remnant farm dam was observed in the north-western corner of the Subject Site (Plate 3-8). Even though the spillway had been pulled out more than a year ago, the dam still supported a diverse range of native flora including Tall Spike-rush (*Eleocharis sphacelata*), Water Primrose (*Ludwigia peploides* subsp. *montevidensis*), Slender Knotweed (*Persicaria decipiens*) and Juncus (*Juncus usitatus*). Frogs were also heard calling from the decommissioned dam which is also likely to provide potential habitat for a range of other native fauna such as birds, reptiles and mammals.

The Erskine Park Biodiversity Corridor which adjoins the Subject Site in the north is shown in Plate 3-9. At this early stage, there is limited connectivity with surrounding vegetation due to the relative infancy of the plantings. Plantings in the Erskine Park Biodiversity Corridor are relatively spaced out with the inter-planting spaces bare, except for a number of weedy species such as Tall Fleabane (*Conyza sumatrensis*). Given the time required for vegetation to establish from plantings, the biodiversity corridor would provide limited habitat for native fauna at present.

The limiting width of the entire Erskine Park Biodiversity corridor occurs at the north-western corner of the Subject Site (approximately 40 m). This limitation will be further compounded through the installation of a new access road and creek crossing at this location.

- **Plate 3-8 Decommissioned farm dam**

- **Plate 3-9 Erskine Park Biodiversity Corridor**

4. Cumberland Plain Woodland

4.1. Cumberland Plain Woodland Final Determination

As large areas of native grassland were observed on the Subject Site during the brief site inspection, the vegetation survey data presented in the EA (JBA Urban Planning Consultants, July 2008) was assessed against the Final Determination for Cumberland Plain Woodland (Scientific Committee 1997). This data was assessed in combination with observations made during the brief inspection.

The Scientific Committee has found that:

1. The Cumberland Plain Woodland is the accepted name for the plant community that occurs on soils derived from shale on the Cumberland Plain.

The Subject Site has been mapped as occurring on the Blacktown Soil Landscape which is described as consisting of Wianamatta Group Shales (Hazelton *et al*. 1989). From the brief site inspection, the soils of the Subject Site appear to have had little modification except for the construction of the farm dam in the north-western corner.

2. The Cumberland Plain Woodland is characterised by the following assemblage of plant species: [List of 57 species]

The total list of plant species which occur in the community is much larger, with many species occurring in one or a few sites, or in very low abundance. Not all species listed above occur in every single stand of the Community.

Twenty-five characteristic Cumberland Plain Woodland species were recorded at the Subject Site in the Environmental Assessment (EA). This accounts for 44% of the listed characteristic Cumberland Plain Woodland species. This represents a comparatively high number of characteristic species for such a small site, with previous studies in western Sydney suggesting that 33% is a significant number of "characteristic" Cumberland Plain Woodland species (Perkins 1999). While there is no set cut-off by which the vegetation on a site fails to meet the criteria, Paragraph 2 of the Final Determination states that "*Not all species listed...occur in every single stand of the Community*" which allows for site-specific variation. The characteristic Cumberland Plain Woodland species identified in the EA are presented in Table 4-1.

- **Table 4-1 Characteristic Cumberland Plain Woodland species identified in the EA**

Species	Common name
Aristida ramosa	Purple Wiregrass

Species	Common name
Aristida vagans	Threeawn Speargrass
Asperula conferta	Common Woodruff
Brunoniella australis	Blue Trumpet
Bursaria spinosa	Australian Boxthorn
Cheilanthes sieberi subsp. *sieberi*	Rock Fern
Chloris truncata	Windmill Grass
Commelina cyanea	Blue Spiderwort
Cyperus gracilis	Slender Sedge
Dichondra repens	Kidney-weed
Dillwynia sieberi	Prickly Parrot Pea
Echinopogon caespitosus	Tufted Hedgehog Grass
Entolasia marginata	Bordered Panic
Eragrostis leptostachya	Paddock Lovegrass
Eucalyptus eugenioides	Thin-leaved Stringybark
Eucalyptus moluccana	Grey Box
Eucalyptus tereticornis	Forest Red Gum
Glycine clandestina	Twining Glycine
Glycine tabacina	Variable Glycine
Hypericum gramineum	Small St Johns-wort
Microlaena stipoides	Weeping Grass
Pratia purpurascens	Whiteroot
Themeda australis	Kangaroo Grass
Vernonia cinerea	
Wahlenbergia gracilis	Sprawling Bluebell

3. The Cumberland Plain Woodland sites are characteristically of woodland structure, but may include both more open and more dense areas, and the canopy is dominated by species including one or more of the following: Eucalyptus moluccana, Eucalyptus tereticornis, Eucalyptus crebra, Eucalyptus eugenioides and Eucalyptus [Corymbia] *maculata.*

The Subject Site can be described as ranging from grassland to open woodland (Specht and Specht 1999) with scattered trees generally between 10 and 20 m in height with less than 10% projected foliage cover. The Subject Site has undergone significant modification to the vegetation structure over time and is likely to have consisted of the characteristic woodland structure in the past.

Grey Box is the most abundant species (approximately 16 trees) recorded on the Subject Site with two large Forest Red Gum adjoining the northern boundary and one Thin-leaved Stringybark which was observed on the dam wall in the north-western corner of the Subject Site.

4. The understorey is generally grassy to herbaceous with patches of shrubs, or if disturbed, contains components of indigenous native species sufficient to re-establish the characteristic native understorey.

80% of the characteristic Cumberland Plain Woodland species recorded in the EA as occurring on the site are understorey species.

Much of the original canopy and shrub layer vegetation on the Subject Site has been previously removed for agriculture, however significant areas of native grassland remain in the understorey (approximately 2.24 ha or 51% of the Subject Site). These native grasslands are dominated by Kangaroo Grass with Wild Sorghum, Weeping Grass and Tall Windmill Grass co-dominating different patches depending on variation in local topography and aspect (see Plate 3-3 and Plate 3-4). Floristic diversity within the native grassland areas was considered well represented despite the history of grazing and recent mowing undertaken on the Subject Site.

Generally sites that are disturbed less frequently become dominated by fewer but more competitive species. In the case of the Subject Site it would appear that the native grasslands are being assisted by periodic disturbance (such as light grazing and mowing).

5. The Cumberland Plain Woodland includes regrowth which is likely to achieve a near natural structure or is a seral stage towards that structure.

While the majority of the trees on the site constitute regrowth, two large Forest Red Gums approximately 25 m in height were observed which had a number of large hollow cavities (exceeding 100 mm in diameter) and are therefore considered of potential habitat value for hollow-dependent fauna (Plate 3-2).

Regeneration of the following species was observed across the Subject Site during the brief site inspection: *Eucalyptus* spp. (see Plate 3-4 and Plate 3-5), Australian Boxthorn and Spreading Bush-pea.

At present, the areas of native grassland present on the Subject Site appear natural, however the whole Subject Site is in an early succession stage of regrowth in respect to trees (Grey Box and Forest Red Gum) and shrubs (Australian Boxthorn and Spreading Bush-pea). Given the abundance of regenerating trees and shrubs and large areas of native grassland, if grazing and slashing are removed from the Subject Site it is likely that the vegetation would regenerate towards a near natural structure over time.

6. The Community has been reported as occurring in the local government areas of Auburn, Bankstown, Baulkham Hills, Blacktown, Camden, Campbelltown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta, Penrith and Wollondilly.

The Subject Site is located within the Penrith Local Government Area.

The Scientific Committee noted that a more detailed description of the community is provided in:

Benson (1992) The natural vegetation of the Penrith 1:100,000 map sheet. See particularly p. 556-7, p. 558, p. 566-575.

In addition, general information on the Cumberland Plain Woodland is also provided in:

Benson, D. & Howell, J. 1990. 'Taken for Granted - The Bushland of Sydney and its Suburbs'. Kangaroo Press, Kenthurst

Benson, D., Howell, J., and McDougall, L., 1996, Mountain Devil to Mangrove: a guide to the natural vegetation in the Hawkesbury-Nepean Catchment. Royal Botanic Gardens, Sydney

Benson (1992) mapped a small area of vegetation south of the Subject Site as "Map Unit 10 c - Grey Box Woodland" which corresponds to Cumberland Plain Woodland. This area of vegetation occurs south of the Sydney Water Supply Pipeline.

Benson (1992) mentions work conducted by Phillips (1947) during his Masters of Science Thesis who described Kangaroo Grass as being typical of undisturbed sites together with Shorthair Plumegrass (*Dichelachne micrantha*) and Wild Sorghum. Kangaroo Grass is the most dominant groundcover species at the Subject Site with patches of Wild Sorghum. These observations suggest that only mild grazing has been undertaken at the Subject Site.

The Scientific Committee has found that:

7. The Community, as defined by the proposal, satisfies the definition of an Ecological Community under the Act, i.e. an assemblage of species occupying a particular area.

No additional comments.

8. Only 6% of the original extent of the community remained in 1988 (Benson, D. & Howell, J. 1990 Proc. Ecol. Soc. Aust. 16, 115-127) in the form of small and fragmented stands. Although some areas occur within conservation reserves, this in itself is not sufficient to ensure the long term conservation of the Community unless the factors threatening the integrity and survival of the Community are ameliorated.

No additional comments.

9. Threats to the survival of the community include clearance for agriculture, grazing, hobby and poultry farms, housing and other developments, invasion by exotic plants, and increased nutrient loads due to fertiliser run off from gardens and farmland, dumped refuse or sewer discharge.

The Subject Site is not currently grazed but was previously grazed according to the EA (JBA Urban Planning Consultants, July 2008). Given the presence of two grazing sensitive species on the Subject Site, namely Kangaroo Grass and Wild Sorghum, the level of grazing undertaken is likely to have been minimal.

A drainage line which traverses the Subject Site from east to west is dominated by exotic species such as *Paspalum dilatatum* (Paspalum), *Cyperus eragrostis* (Umbrella Sedge), *Juncus acutus* (Spiny Rush) and *Aster subulatus* (Wild Aster). These species are typical of disturbed drainage lines in western Sydney.

10. In view of the substantial reduction in the area occupied by the Community, its fragmentation and the numerous threats to the integrity of the Community, the Scientific Committee is of the opinion that the Cumberland Plain Woodland is likely to become extinct in nature in New South Wales unless the factors threatening its survival cease to operate.

No additional comments.

Conclusion

The native grasslands observed on the Subject Site during the brief site inspection (approximately 2.24 ha or 51% of the Subject Site) appear to meet the listed criteria for Cumberland Plain Woodland, on the basis of the diversity of characteristic native species (44%) at the site and the evidence of sucessional regeneration of both characteristic canopy and shrub species.

4.2. Cumberland Plain Woodland Benchmarks

The methodology applied below forms part of the standard site assessment component for BioMetric: Terrestrial Biodiversity Tool for the NSW Property Vegetation Planning System (DECC 2008c) and is the foundation for BioBanking which was introduced into the TSC Act in 2008. Use of this methodology provides a rigorous and scientifically valid approach to determining vegetation condition. Use of this methodology on a site where no specific plot data (400 m^2) is available has limitations which are considered in the conclusions of the analysis.

Vegetation data from the EA was categorised into vegetation types according to the Vegetation Types Database (DECC 2008a) and then compared against the Vegetation Type Benchmarks

(Table 7-1 in Appendix B, DECC 2008b) to develop an accurate condition score for the Subject Site.

The data for each site attribute (such as native species, native cover, exotic cover, tree hollows) was compared against the relevant benchmark for "*Cumberland Shale Plains Woodland* ", scored and then ranked using the matrix in Table 7-2 in Appendix B (Gibbons *et al.* 2008). The final score for the Subject Site was then assigned a condition rating based on this assessment (low = < 32, medium= 33 to < 66, high = > 66).

The resulting Final Score and Vegetation Condition are presented in Table 4-2. The only data available from the EA for use in this assessment was plant species richness as no observations were made on the structure or projected foliage of any of the other site attributes listed in Table 4-2. As no plot data (400 m^2 plots) is available in the EA, the number of native plant species specified in Table 4-2 is the total number of native species recorded on the Subject Site, rather than a mean or average. All other site attributes were visually estimated on-site during the brief site inspection and are considered conservative.

Table 4-2 Final Score and Vegetation Condition

Site Attribute	EA	Brief Site Inspection	SCORE (Maximum Score =3)	Maximum Weighting per attribute	FINAL SCORE
Native Plant Species Richness (total for the Subject Site)	63	-	3	25	25
Native Over-storey Cover (%) - Estimated	-	5	1	10	3.3
Native Mid-storey Cover (%) - Estimated	-	0	0	10	0
Native Ground Cover-grasses (%) - Estimated	-	40	2	2.5	1.65
Native Ground Cover-shrubs (%) - Estimated	-	1	3	2.5	2.5
Native Ground Cover-other (%) - Estimated	-	1	0	2.5	0
Exotic Plant Cover (%) - Estimated	-	10	2	5	3.3
Number of Trees with Hollows - Estimated	-	2	3	20	20
Over-storey Regeneration - Estimated	-	1	3	12.5	12.5
Total Length of Fallen Logs (m)	-	0	0	10	0
FINAL Score					**68 (out of 100)**
Condition Rating					**HIGH**

Note: "EA" refers to Environmental Assessment as prepared by JBA Urban Planning Consultants (2008).

Conclusion

The results from this assessment show that overall, the native grasslands on the Subject Site are in “High” condition. Considering that the data from the EA is for the whole Subject Site, it is difficult to quantify the precise condition rating as the methodology presented in this section is usually applied on a 400 m^2 plot. This is particularly true for “Number of trees with Hollows” attribute, as this would only apply to a plot located in the north-western corner of the Subject Site.

Given that the condition assessment has resulted in a relatively high score (68 out of 100), even significant modification to the site variables would result in a final condition rating of at least “Moderate”. It is likely that the result achieved here would also be achieved through systematic plot-based sampling.

5. Conclusions

Based on review of the documents relating to the Part 3A application, it is evident that while the Erskine Park Biodiversity Corridor, Management Strategy and Management Plans do not specifically identify the Subject Site, the intention of the corridor, as detailed in the Penrith DCP 2006 and as implied by DECC and Penrith Council, would apply to the Subject Site. Accordingly the Penrith DCP 2006 identifies approximately 1.8 ha of the northern portion of the Subject Site as part of the regional biodiversity corridor.

The requirements provided in the DCP with respect to landowner responsibility within the Biodiversity Corridor area are considered appropriate to the Subject Site given its strategic location in the landscape and corridor, the diversity of native flora and the presence of fauna habitat. The requirements refer to a prohibition on clearing of native vegetation and the use of locally indigenous species in revegetation and restoration to maintain and increase the value of the corridor to provide long term flora and fauna connectivity.

From a review of the requirements of native flora and fauna in respect to biodiversity corridors and particularly appropriate widths, it is likely that a corridor width of only 40 m adjoining the Subject Site would limit the long-term effectiveness of the biodiversity corridor. This limitation will be further compounded through the installation of a new access road and creek crossing at this location. While some native fauna species are likely to utilise the corridor in the short-term, they will generally be more common species and edge specialists rather than threatened or declining fauna which require the greatest protection in western Sydney. Given the highly constrained nature of the existing corridor, the best option is to maximise the use of available space adjoining the corridor. In order to maximise the effectiveness of the corridor, an extension of the corridor onto the Subject Site along the northern boundary is considered appropriate.

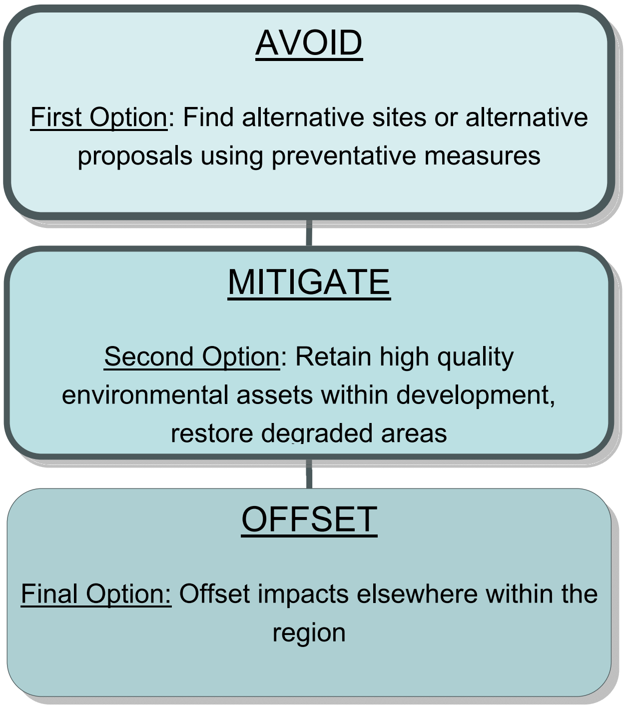
From the brief site inspection and analysis of the data presented in the Environmental Assessment, it can be seen that the Subject Site contains areas of moderately diverse native grassland (2.24 ha equal to 51% of the total area of the Subject Site) which appear to meet the listed criteria for Cumberland Plain Woodland, on the basis of the diversity of characteristic native species and the evidence of sucessional regeneration of both characteristic canopy and shrub species. The Subject Site also contains a number of fauna habitat features such as two large habitat trees and a large decommissioned farm dam.

The proposed Part3A development of the Subject Site in its current form would require the direct removal of 2.24 ha of Cumberland Plain Woodland and the removal of two large fauna habitat trees.

6. Recommendations

The proposed development of the Subject Site is required to follow the principles of Environmental Impact Assessment (Figure 6-1), namely:

1) *Avoid impacts* – Firstly the redevelopment of the Subject Site should avoid impacts on sensitive environmental areas as far as practicable using preventative measures;
2) *Mitigate or minimise impacts* – Where impacts cannot be avoided, areas in which impacts can be mitigated/minimised should be identified – such as the inclusion of native grasslands in a vegetated setback; and
3) *Offset impacts* – Where the remaining impacts cannot be avoided or mitigated, impacts must be offset.



▪ **Figure 6-1 Principles of Environmental Impact Assessment**

A number of options are available for the Subject Site which follow these principles, these include:

1) Complete retention of the Subject Site and incorporation into the Erskine Park Biodiversity Corridor. The Subject Site should be allowed to naturally regenerate to its pre-clearance

condition with some minor intervention required along the weedy drainage line. The Subject Site may then be used as an offset for clearing elsewhere in the region; or

2) Retain the area in the north of the Subject Site (1.8 ha) as specified in the Penrith DCP 2006 and allow development in the remainder of the Subject Site provided suitable offsets are developed for clearing of the remaining native grassland. This option would also enable the retention of the two large habitat trees present along the northern boundary; or
3) Retain and enhance a 10 m wide buffer along the northern boundary fence. This 10 m wide buffer must be suitably rehabilitated with Cumberland Plain Woodland species (groundcovers, shrubs and trees) and be contiguous with the Erskine Park Biodiversity Corridor. All property fences and stormwater control measures should be located to the south of the 10 m buffer to ensure habitat connectivity. This option would enable the retention of the two large habitat trees present along the northern boundary as well as approximately 0.27 ha of Cumberland Plain Woodland. Suitable offsets should be developed for clearing of the remaining native grassland.

In respect to developing suitable offsets for vegetation clearing on the Subject Site, it is recommended that the ratio for clearing specified in Table 2-2 be applied to the Subject Site. These offset ratios have been developed for all other landowners in the Erskine Park Employment Area and are considered appropriate for clearing on the Subject Site.

Each habitat tree which may be cleared during the redevelopment of the Subject Site must be inspected by a suitably qualified fauna ecologist and supervised during clearing to ensure any fauna present is captured and relocated into the surrounding bushland. The offset ratio of 6:1 should also be applied to the clearing of habitat trees, with the corresponding number of nest boxes of various sizes installed in the Erskine Park Biodiversity Corridor to enhance fauna habitat.

As the limiting width of the Erskine Park Biodiversity Corridor occurs in the location of the proposed creek crossing, it is recommended that alterations to the design be made to minimise the width of the crossing and access road.

In addition to these recommendations, site specific controls specified in the EA in respect to the impacts of light and noise must be implemented. All site lighting is to be contained within the Subject Site and directed away from the Erskine Park Biodiversity Corridor.

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7. References

Baum, K.A., Haynes K L,. Dillemuth F.P, and Cronin J,T. (2004). *The matrix enhances the effectiveness of corridors and stepping stones*. Ecology **85**. 2671–2676

Beier, P. and Noss, R.F. (1998). *Do habitat corridors provide connectivity?* Conversation Biology **12** 1241-1251

Bennett, A. F. (2003). *Linkages in the landscape: the role of corridors and connectivity in wildlife conservation*. World Conservation Union, Gland, Switzerland, and Cambridge, United Kingdom.

Bennett, A. F., Henein, K. and Merriam, G. (1994). *Determinants of corridor quality: chipmunks and fencerow in a farmland mosaic*. Biological conservation **54**: 263–267

Benson, D.H. (1992). *The natural vegetation of the Penrith 1:100 000 map sheet*. Cunninghamia 2(4), 541-596.

Catterall, C. (1990). *A Natural Area Conservation Strategy for Brisbane City Council*. Report to the Brisbane Plan, Brisbane City Council

Clark S. A. and Richardson B, J. (2002) *Spatial analysis of genetic variation as a rapid assessment tool in the conservation management of narrow range endemics.* Invertebrate systematic **16**: 583-587

Cook, E.A. (2002). *Landscape structure indices for assessing urban ecological networks.* Landscape Urban Planning. **58**: 269–280.

DECC (2008a). *Vegetation Types Database.* [online]. http://www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm. NSW Department of Environment and Climate Change, Hurstville NSW.

DECC (2008b). *Vegetation Types Benchmarks.* [online]. http://www.environment.nsw.gov.au/biobanking/vegbenchmarkdatabase.htm. NSW Department of Environment and Climate Change, Hurstville NSW.

DECC (2008c). BioMetric: Terrestrial Biodiversity Tool for the NSW Property Vegetation Planning System [online]. http://www.environment.nsw.gov.au/projects/BiometricTool.htm. NSW Department of Environment and Climate Change, Hurstville NSW.

DECC (2009a). *Atlas of NSW Wildlife*, NSW Department of Environment and Climate Change, Hurstville NSW.

DECC (2009b) *Threatened Species Profile Search* [online] http://www.threatenedspecies.environment.nsw.gov.au, NSW Department of Environment and Climate Change, Hurstville NSW

Scientific Committee (1997) *Cumberland Plain woodland - endangered ecological community listing*. NSW Scientific Committee – Final Determination.

DoP (2008). *Draft State Environmental Planning Policy (Western Sydney Employment Hub) 2008*, NSW Department of Planning, Sydney.

Gibbons, P., Ayers, D., Seddon, J., Doyle, S. and Briggs, S. (2008). *Biometric 2.0 – A Terrestrial Biodiversity Assessment Tool for the NSW Native Vegetation Assessment Tool: Operation Manual.* NSW Department of Environment and Climate Change, Sydney.

Hazelton, P.A., Bannerman, S.M. and Tille, P.J. (1989). *Soil Landscapes of the Penrith 1:100 000 map sheet*, Soil Conservation Service of NSW, Sydney.

HLA (2005). *Biodiversity Strategy 2005: Erskine Park Employment Area*. Report prepared for CSR, HLA-Envirosciences Pty Limited, Gordon.

HLA (2006). *Biodiversity Management Plan: Erskine Park Employment Area*. Report prepared for CSR, HLA-Envirosciences Pty Limited, Gordon.

Hobbs, R.J and Saunders, D. A, (1993). *Effects of landscape fragmentation in agricultural areas.* In: Moritz, C.,Kikkawa, J (eds), Conservation biology in Australia and Oceania, Surrey Beatty and Sons , chipping Norton, Sydney, Australia, pp, 77-95

JBA Urban Planning Consultants (2008). *Environmental Assessment Report Part 3A Project Application (No. 07_0153): Templar Road Erskine Park, Industrial Warehouse Development.*Wollongong, NSW.

Kavanagh, R, P. (1987). *Foraging behaviour of the yellow-bellied glider*, Petaurus austrlis *(Marsupialia Petauridae) near Eden, NSW.* Australian Mammalogy **10**, 37-39

Law, B. S., Anderson, S. and Childel, M. (1999). *Bat communities in a fragmented forest landscape on the south west slopes of NSW, Australia*. Biological conservation **88:** 333-345

Leury, A.M. and Brown, R.D. (1997). *A framework for the design of wildlife conservation corridors with specific application to Southwestern Ontario.* Landscape Urban Planning . **37**: 163–186.

Lloyd, A., Law, B. and Goldingay, R. (2006). *Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers*. *Biological Conservation* **129**: 207-220

Lindenmayer, D.B. (1994). *Wild life corridors and the mitigation of logging impacts in wood production forests in south-eastern Australia: a Review*. Wildlife research **21**: 323-40

Lindenmayer, D.B. and Nix, H.A. (1993). *Ecological principles for the design of wildlife corridors*. Conversation Biology: **7**: 627-630

Lonsdale, W. M. (1999). *Global patterns of plant invasions and the concept of invasibility*. Ecology **80**, 1522–36

Marzluff, J.M. and Ewing. K. (2001). *Restoration of fragmented landscapes for the conservation of birds: a general framework and specific recommendations for urbanizing landscapes*. Restoration. Ecology. **9**, 280–292.

McIntyre, S., McIvor, J.G. and Heard K.M (2002). *Managing and Conserving Grassy Woodlands.* CSIRO Publishing, Collingwood, Victoria, pp 125-127.

Murcia, C. (1995). *Edge effects in fragmented forests: implications for conservation*. Trends in Ecology and Evolution **10**, 58–62.

Parker, K.A., Head, L., Chisholm, L. and Feneley (2008). *A conceptual model of ecological connectivity in the Shellharbour Local Government Area, New South Wales, Australia*. Landscape and Urban Planning **86**: 47-59

Perkins, I. (1999) *Flora Assessment of disputed areas of Western Shale Woodlands*. Report to the Australian Heritage Commission.

Schiegelow, F. K. A., Machtan, C. S. & Hannon, S. J. (1997). *Are boreal birds resilient to forest fragmentation? An experimental study to short term community response*. Ecology **78**: 1914-1932

Specht, R.L. and Specht A. (2002). *Australian Plant Communities : Dynamics of Structure, Growth and Biodiversity*. Oxford University Press.

Appendix A Review of Literature on Biodiversity Corridors

The following literature review has been conducted of available scientific literature to determine aspects of biodiversity corridors which are relevant to the Subject Site, specifically corridor width. The review examines different aspects of biodiversity corridors and aims to advise on an appropriate corridor width required to capture the greatest amount of diversity.

7.1. Introduction to Biodiversity Corridors

Conservation of biodiversity is under threat by habitat loss and fragmentation. Anthropogenic factors of urbanisation have lead to fragmentation of habitats and greater local pressure on biodiversity (Marzluff and Ewing 2001). This pressure is derived from the difference in urbanised environment and pre-existing natural conditions.

Biodiversity corridors are recognised as key components to conservation of biodiversity. These corridors provide plants and animals a mechanism for dispersal and migration which are essential for their persistence in a fragmented landscape (Bennett 2003).

An effective corridor width for general fauna is based on a range of parameters such as dietary requirements, foraging and dispersal behaviour, social structure, home range movement, mobility and migration (Lindenmayer 1994). Furthermore, biodiversity corridors that span several different topographic areas provide a greater diversity of food, resources and habitats for fauna, than single topographic areas (Lindenmayer 1994).

7.2. Corridor Connectivity

Biodiversity corridor connectivity is vital to ensure that dispersal and migration processes between populations remain uninterrupted (Cook 2002, Parker *et al.* 2008). Physical barriers, such as roads, fences and powerlines, or gaps, such as cleared areas between habitats, can increase the difficulty and risk of dispersal and migration by forcing individuals to enter inhospitable zones (Cook 2002, Parker *et al.* 2008). Animals with low dispersive patterns can become isolated from source population, and local extinction may occur (Baum *et al.* 2004).

7.3. Corridor Width

Determining the optimal width of a biodiversity corridor has numerous issues and constricting factors associated with it. A corridor should be wide enough to provide shelter, resources and facilitate passage between habitat patches (Fleury and Brown 1997), however this width can be limited by surrounding urban areas, for example roads and infrastructure. It is generally accepted that wider corridors are more effective than narrow corridors (Harris 1984, Murcia 1995,

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Schmiegelow *et al.* 1997 Beier & Noss 1998, Parker *et al.* 2008). There a number of advantages of a wide biodiversity corridor such as:

- The interiors of the corridor are sheltered from edge effects, increased light and wind (Harris 1984, Lindenmayer 1994);
- There is a greater potential for a range of habitats (Lindenmayer 1994); and
- There is a higher probability of supporting resident animals (Bennet *et al.* 1994).

Narrower biodiversity corridors provide habitats for species adapted for edge and disturbance, while being highly susceptible to weed invasion which can damage the integrity of the biodiversity corridor (Lonsdale, 1999). Edge effects such as increased light and air movement generally extend up to or greater than fifty metres from a forest edge, hence narrow biodiversity corridors are not sufficient to provide habitat for specialist forest inhabitants (Murcia, 1995). Biodiversity corridors greater than 100 m wide are likely to have reduced weed invasion and have potential to reduce management and weed maintenance costs (Catteral, 1990).While determining precisely how is wide is "wide enough" requires much research, it is recommended that corridor design should aim to maximise available space and pre-existing habitat in urban environments to minimise edge effects (Parker *et al.* 2008).

7.4. Threatened Species and Endangered Ecological Communities

Erskine Park contains two EECs which are protected under the TSC Act, namely 'Cumberland Plain Woodland' and 'River-flat Eucalypt Forest'. There is currently a preliminary determination to list 'Cumberland Plain Woodland' as Critically Endangered under the TSC Act and that the outcome of this listing will have implications for the Erskine Park Employment Area. This is evident in terms of potentially increasing the extent of Cumberland Plain Woodland on the site via the inclusion of open grassy habitats which previously were not classified as the woodland community under the current conservation listing. Cumberland Plain Woodland is also listed as endangered under the EPBC Act.

Two endangered fauna species are known to occur, have suitable habitat or have been previously recorded in the Erskine Park area (DECC 2009a, 2009b) including the Cumberland Plain Land Snail (*Meridolum corneovirens*) and the Green and Gold Bell Frog (*Litoria aurea*). A number of vulnerable bat species are also predicted to occur, such as the Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), the Eastern Bentwing-bat (*Miniopterus schreibersii*), the Eastern Freetail-bat (*Mormopterus norfolkensis*) and the Large-footed Myotis (*Myotis macropus*). Erskine Park contains habitat for a wide range of other native flora and fauna with predicted arboreal marsupial species in the area including the Sugar Glider (*Petaurus breviceps*), the Common Brush-tail Possum (*Trichosurus vulpecula*) and Common Ring-tail Possum (*Pseudocheirus peregrinus*). With nearly 300 native fauna species previously recorded in the Penrith LGA (DECC 2009a), the

Erskine Park biodiversity corridor is likely to provide habitat or foraging resources for a wide range of these species.

7.5. Key Findings for Species in Biodiversity Corridors

7.5.1. Cumberland Plain Land Snail

The Cumberland Plain Land Snail lives in association with Cumberland Plain Woodland and River-flat Eucalypt Forest under litter of bark, leaves and logs and is a fungal specialist (DECC 2009b). The Cumberland Plain Land Snail is sensitive to habitat fragmentation as it has a highly structured population within a two meter radius and is a poor disperser (Clark and Richardson 2002). Spatial analysis of Cumberland Plain Land Snail populations shows a genetic neighbourhood approximately 350 m in radius (Clark and Richardson 2002). This indicates that a population greater than 350 m apart from source population is likely to be genetically isolated.

7.5.2. Threatened Bat Species

The Eastern False Pipistrelle roosts in eucalypt hollows, but is also found under loose bark on trees or in buildings (DECC 2009b). The Eastern False Pipistrelle forages at night on flying insects above or just below the tree canopy. The Eastern False Pipistrelle is sensitive to forest fragmentation, as they prefer to forage in continuous forest (Law *et al.* 1999). Although this species is highly mobile it does not exclude it from being sensitive to forest fragmentation (Law *et al.* 1999). In the case of the Yellow-plumed Honeyeater (*Lichenostomus ornatus*) of Western Australian, Hobbs and Saunders (1993) found that habitat fragmentation in this highly mobile species declined populations to local extinction.

The Eastern Bentwing-bat primarily roost in caves, and forages at night on moths and flying insects in the tree canopy (DECC 2009b). It is somewhat tolerant to habitat fragmentation as it travels hundreds of kilometres to roost in caves (Law *et al.* 1999).

The Eastern Freetail-bat roosts in tree hollows and buildings, is active over open areas at night and forest gaps (Lloyd *et al.* 2006) and is likely to be tolerant of fragmented landscape, provided foraging resources still exist in the landscape.

The Large-footed Myotis roosts in caves and tree hollows (DECC 2009b). It is associated with and forages in riparian zones (Lloyd *et al.* 2006). There is currently no evidence regarding the effects of fragmentation on this species.

In terms of understanding the role of biodiversity corridors in conservation, it is important to appreciate that useful tree hollows can take over 100 years to form, with hollows suitable for possums, owls or cockatoos taking 200 years or more (McIntyre *et al.* 2002).

7.5.3. Arboreal Marsupials

Species more commonly found in biodiversity corridor are likely to be large solitary marsupials, for example Common Brushtail Possums, which feed on readily available food such as flowers, fruit and leaves (Lindenmayer and Nix 1993). Lindenmayer and Nix (1993) also found that predicted threatened species, such as Sugar gliders and Yellow Bellied Gliders, were less commonly found in corridors. The Yellow Bellied Glider regularly moves between topographic areas which may be the reason for rarely being spotted in biodiversity corridors (Kavanagh 1987).

This highlights the importance of habitat connectivity between topographic areas for some species. Colonial/social arboreal marsupials are less likely to be found in corridors as they consume a range of food such as insects, plants and animals (Lindenmayer and Nix 1993). Narrow, linear shaped corridors are shown to disadvantage social arboreal marsupials as predicted by central place foraging theory (Lindenmayer and Nix 1993).

7.6. Conclusion

It is important to recognise that it is not possible to specify a definitive width for a biodiversity corridor which will capture all the biodiversity within a region. However it is generally recognised that a biodiversity corridor width greater than 100 m in width is required to have any significant benefit (Catteral, 1990, Murcia 1995, Schmiegelow *et al.* 1997, Beier & Noss 1998).

Biodiversity corridors in the range of 20 to 50 meters in width would be highly affected by edge effects, such as increased light and wind. Narrower corridors have been found to be more susceptible to invasive weeds and pest species which prefer edge habitats. Ensuring a continuous biodiversity corridor is essential to Cumberland Plain Land Snail and Eastern False Pipistrelle populations as they are poor dispersers over open plains and may become geographically isolated from other populations through corridor gaps. Biodiversity corridors that cover a range of topographic area can support a greater diversity of species and are important for species such as the Yellow-bellied Glider (Lindenmayer 1994). It is important to also note the significance of tree hollows as a wide range of species such as bats and arboreal marsupial roost or rest in them.

Wider biodiversity corridors are more likely to provide dietary requirements, foraging and dispersal behaviour, social structure, home range movement, mobility and migration required by the diversity of biota that use the corridor.

As stated by Parker *et al.* (2008), the best option for biodiversity corridors is to maximise the available space which is present in urban environments.

Appendix B Vegetation Benchmarks

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Table 7-1 Vegetation Type Benchmarks for Cumberland Shale Plains Woodland

Veg Type		Cumberland Shale Plains Woodland
Keith Formation Name		Grassy Woodlands
Keith Class (2004)		Coastal Valley Grassy Woodlands
Native plant species richness	**Richness**	28.8
Native over-storey cover	**Lower**	20.5
	Upper	25.5
Native mid-storey cover	**Lower**	25.5
	Upper	30.5
Native ground cover (grasses)	**Lower**	26.8
	Upper	30.8
Native ground cover (shrubs)	**Lower**	0
	Upper	5
Native ground cover (other)	**Lower**	14.8
	Upper	18.8

Table 7-2 Scoring and weighting of the site attributes (adapted from Table 3. of Gibbons *et al.* 2008)

Site Attribute	Site Attribute Score (see notes below)				Weighting for site attribute score
	0	1	2	3	
Native Plant Species Richness	0	>0 – <50% of benchmark	50–<100% of benchmark	≥ benchmark	25
Native Over-storey Cover (%)	0–10% or >200% of benchmark	>10–<50% or >150–200% of benchmark	50–<100% or >100–150% of benchmark	within benchmark	10
Native Mid-storey Cover (%)	0–10% or >200% of benchmark	>10–<50% or >150–200% of benchmark	50–<100% or >100–150% of benchmark	within benchmark	10
Native Ground Cover-grasses (%)	0–10% or >200% of benchmark	>10–<50% or >150–200% of benchmark	50–<100% or >100–150% of benchmark	within benchmark	2.5
Native Ground Cover-shrubs (%)	0–10% or >200% of benchmark	>10–<50% or >150–200% of benchmark	50–<100% or >100–150% of benchmark	within benchmark	2.5
Native Ground Cover-other (%)	0– 10% or >200% of benchmark	>10–<50% or >150–200% of benchmark	50–<100% or >100–150% of benchmark	within benchmark	2.5

Site Attribute	Site Attribute Score (see notes below)				Weighting for site attribute score
	0	1	2	3	
Exotic Plant Cover (%)	>66%	>33–66%	>5–33%	0–5%	5
Number of Trees with Hollows	0 (unless benchmark includes 0)	>0–<50% of benchmark	50–<100% of benchmark	≥ benchmark	20
Proportion of over-storey species occurring as regeneration	0	>0–<50%	50–<100%	1	12.5
Total Length of Fallen Logs (m)	0–10% of benchmark	>10–<50% of benchmark	50–<100% of benchmark	≥ benchmark	10