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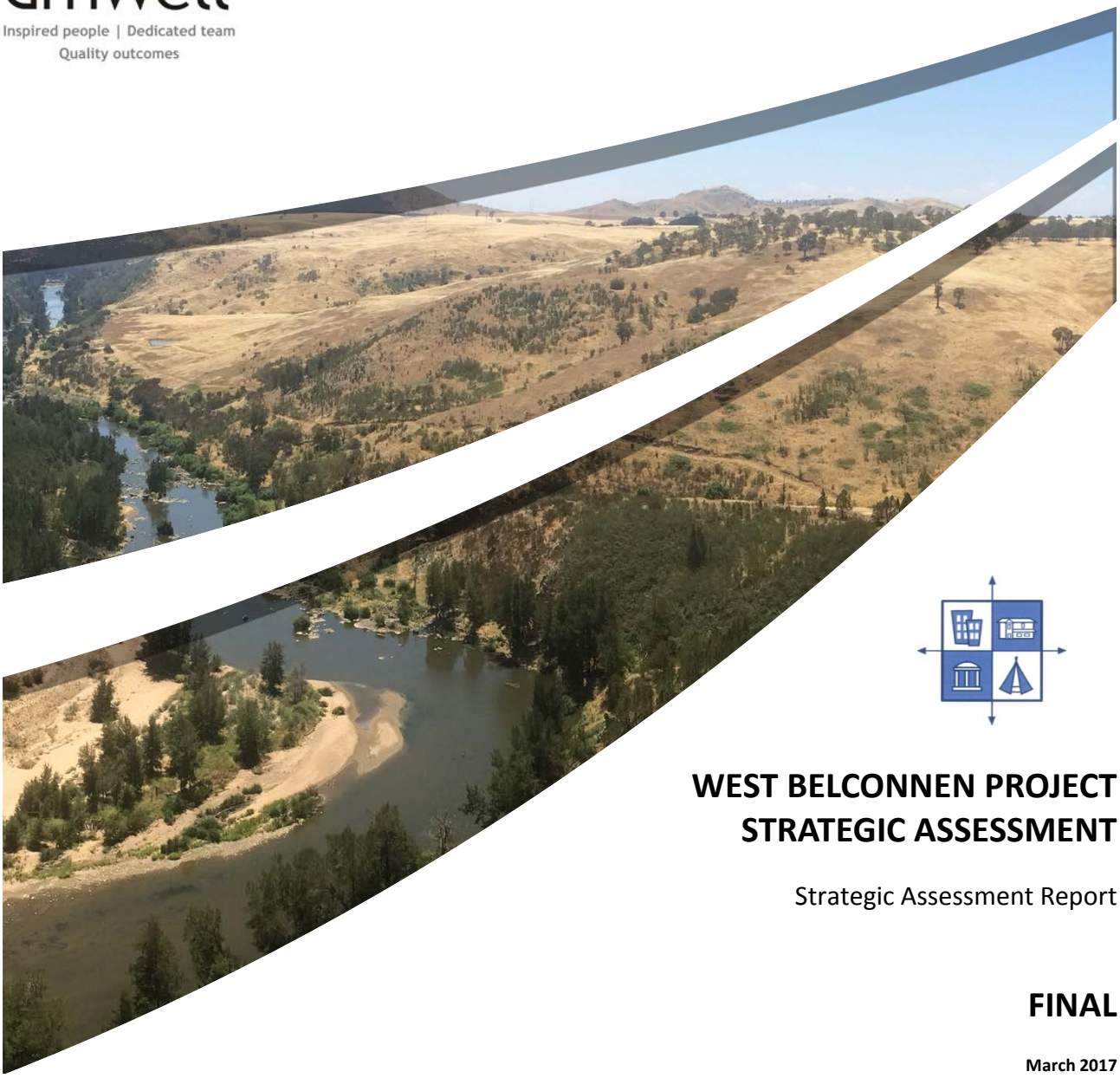

WEST BELCONNEN PROJECT STRATEGIC ASSESSMENT

Strategic Assessment Report

FINAL

March 2017

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on behalf of
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Executive Summary

A Strategic Assessment between the Commonwealth Government and Riverview Projects commenced in June 2014 under Part 10 of the *Environment Protection and Biodiversity Act 1999* (EPBC Act). The purpose of which was to seek approval for the proposed development of a residential area and a conservation corridor in west Belconnen (the Program).

The Project Area for the Strategic Assessment straddles the Australian Capital Territory (ACT) and New South Wales (NSW) border; encompassing land west of the Canberra suburbs of Holt, Higgins, and Macgregor through to the Murrumbidgee River, and between Stockdill Drive and Ginninderra Creek.

The need for urban development in the ACT region has been identified in numerous planning documents. Population projections for the region indicate that approximately 55,000 new houses would be required before 2050. The Program aims to provide a portion of these by extending the residential areas within the Belconnen district that successfully balances ecological, economic, and social values.

Planning for the Program has been driven by community and expert consultation, targeted studies for the Project Area (including ecological, heritage, and infrastructure), Walter Burley Griffin's planning legacy for Canberra, and the criteria for the Green Building Council of Australia's Green Star Community pilot rating program (with the goal of achieving a six star rating: 'a world leader in sustainability').

The Program is comprised of two key components: the urban development component and the west Belconnen Conservation Corridor (WBCC).

The proposed urban development includes the provision of 11,500 dwellings, with associated services and infrastructure (including the provision of sewer mains, an extension of Ginninderra Drive, and upgrade works to three existing arterial roads). It will extend the existing Canberra town centre of Belconnen to become the first cross border development between NSW and the ACT. A network of open space has also been incorporated to link the WBCC to the residential component and encourage an active lifestyle for the community.

The aim of the WBCC is to protect the conservation values of the Project Area from the impacts of urban development. Ecological studies were conducted early in the planning phase so that areas of high environmental value could act as a constraint on development from the outset. In addition to its conservation role, the WBCC will also provide bushfire mitigation and recreational values for the community, adding to the sense of place and community vitality. These activities as well as the associated infrastructure provision will be managed by the environmental management trust (EMT) through the WBCC Reserve Management Plan (RMP).

The Project Area also contains a portion of the land that was included in the Molonglo Strategic Assessment. As such, the relevant commitments of the Molonglo Strategic Assessment are incorporated into the Program.

This Strategic Assessment analyses the impacts of the Program on matters of national environmental significance (MNES) and its outcomes in relation to the requirements of the EPBC Act. It comprises two reports which should be read in conjunction with each other:

1. The *Program Report* which sets out the planned development and associated works, actions, and management, and funding arrangements that will achieve appropriate outcomes for MNES.

2. The *Strategic Assessment Report* (this document) which analyses the potential impacts and outcomes of the Program in relation to the requirements of the EPBC Act.

Existing Environment

Land within the Project Area is predominantly defined by the riparian corridors and associated gorges, and its history of agricultural land use.

Vegetation that occurs on the gentler topography in the eastern two thirds of the Project Area predominantly consists of exotic grassland, with some small and isolated patches of native pasture. A history of grazing and pasture improvement has resulted in highly degraded ecosystems that no longer hold much environmental value.

Due to the steep topography, much of the woodland and forest communities within the riparian corridors remain. Grazing has occurred within accessible areas, degrading the quality of these communities to varying degrees, though other areas are relatively undisturbed. It is within these areas that most of the environmental values of the Project Area occur. MNES and their habitat which occur within the riparian corridors and contiguous woodland and forest are:

- A nationally important population of pink-tailed worm-lizard (*Aprasia parapulchella*) (vulnerable) is known to occur within 162.8 hectares of rocky habitat within the Murrumbidgee River Corridor.

- EPBC Act listed 'white box – yellow box – Blakely's red gum grassy woodland and derived native grassland' (box gum woodland) (critically endangered) is contiguous with riparian communities and occurs across 68.2 hectares of land to the west of the Strathnairn Arts Association property and approximately 3.8 hectares along the Drake Brockman Drive upgrade area in the south of the Project Area.

- The forest and woodland within the riparian corridors provides habitat for the following threatened bird species:

    - superb parrot (*Polytelis swainsonii*) (vulnerable);

    - regent honeyeater (*Anthochaera phrygia*) (endangered);

    - swift parrot (*Lathamus discolor*) (endangered); and

    - painted honeyeater (*Grantiella picta*).

- The aquatic and wetland habitat within the Murrumbidgee River and Ginninderra Creek provide habitat (known and potential) for the following threatened bird, fish, and amphibian species:

    - Australian painted snipe (*Rostratula australis*) (an endangered bird);

    - Macquarie perch (*Macquaria australasica*) (an endangered fish);

    - Murray cod (*Maccullochella peelii*) (a vulnerable fish);

    - trout cod (*Maccullochella macquariensis*) (an endangered fish); and

    - Booroolong frog (*Litoria Booroolongensis*) (an endangered amphibian).

Golden sun moth (*Synemon plana*) (critically endangered) also occurs within the route that the Ginninderra Drive extension is proposed to take, and also in land adjacent to the Project Area.

EPBC Act listed ecological community 'Natural temperate grassland of the south eastern highlands' (natural temperate grassland) (critically endangered) occurs in small patches in Jarramlee and Macgregor offset areas. Near to the route the Ginninderra Drive extension is proposed to take. It is also expected to occur within the WBCC, generally coinciding with native grasslands associated with pink-tailed worm-lizard habitat (see 'Impacts to MNES' section below).

The riparian corridors also play an important role for regional connectivity. The Murrumbidgee River is an important branch of the Murray – Darling Basin and connects to all key aquatic systems in the region. The lowland woodland and forest habitat that occurs within the riparian corridors links with montane and sub-alpine forests of southern ACT.

Impacts to MNES

Pink-Tailed Worm-Lizard

In total, 16.4 hectares (10.2 hectares of high and 6.2 hectares of low quality) of pink-tailed worm-lizard habitat will be directly impacted by the Program. The remaining 146.4 hectares (141.9 hectares of high and 4.5 hectares of low quality) will be protected within the WBCC. There will be no direct impact to pink-tailed worm-lizard habitat as result of the sewer tunnel construction. The provision of infrastructure and recreational facilities within the WBCC will result in no net loss of pink-tailed worm-lizard habitat within the WBCC. The WBCC RMP will include measures to avoid and mitigate these impacts as more detailed design is undertaken and construction and operation phases begin.

Golden Sun Moth

Impact to Golden sun moth habitat has been minimised to the greatest extent practicable by alignment selection for the Ginninderra Drive extension. The construction of the proposed road will impact upon 1.8 hectares of golden sun moth habitat and fragment the remaining habitat within Jarramlee and Macgregor West Environmental Offset Areas.

Box Gum Woodland

An estimated 3.8 hectares of poor quality box gum woodland within the Drake Brockman Drive upgrade area will be directly impacted by the Program. All other examples of the community (68.2 hectares) will be protected in accordance with the Molonglo Strategic Assessment and the Program within the WBCC and will be further enhanced by the Program.

Natural Temperate Grassland

Due to the recent change in the listing of natural temperate grassland under the EPBC Act, it has now been identified that the community occurs within the Project Area. The community is generally co-located with pink-tailed worm-lizard habitat, however, the exact extent and quality within the Urban Development Area is not known. Any potential impacts to natural temperate grassland would be surveyed, assessed and offset (if required) using the defined Process Strategy (see 'Key Outcomes' section below).

Other MNES

Impacts to other MNES have been assessed as unlikely to be significant subject to implementing commitments of the Program. Direct impacts are almost completely avoided (excluding the loss of a maximum of 28 trees within the WBCC) by the Program. Indirect and cumulative impacts may affect MNES that are protected within the WBCC as discussed below.

Indirect, Cumulative, and Facilitated Impacts

MNES protected within the WBCC will still be at risk of indirect, cumulative, and facilitated impacts resulting from the proximity of the urban development and ongoing recreational use of the corridor. The mechanisms for managing this risk are discussed under 'Key Outcomes' below.

Impacts to Existing Offset Areas

Implementation of the Program will result in an extension to Ginninderra Drive being constructed through small portions of the existing Jarramlee and Macgregor offset areas. The assessment identifies that an appropriate response under the EPBC Act offset policy to impacts of the Program can be achieved by ensuring the outcome is one that:

- replaces the change in extent of offsets committed to in earlier Part 9 EPBC Act approvals (1.8 hectares);
- offsets the impact to MNES caused by the Program by protecting and enhancing 11.9 hectares of golden sun moth habitat; and
- compensates for the loss of strategic value of the co-located offsets by protecting and enhancing 19.4 hectares of currently unoccupied habitat that will be managed to improve connectivity and area of distribution for the species.

As such, the Program commits to protecting 11.9 hectares of golden sun moth habitat, and enhancing surrounding areas to increase the habitat to 33.1 hectares.

Key Outcomes – Avoidance, Mitigation and Offset

A majority of the potential impacts to MNES have been avoided by considering them throughout the design phase of the Program. Through this, impacts to pink-tailed worm-lizard, box gum woodland, golden sun moth, and connectivity values within the riparian corridors have either been avoided completely or minimised. The design of the Program has also minimised indirect impacts to the WBCC through the implementation of Water Sensitive Urban Design (WSUD) principles, integrating the open space network with the WBCC, and providing development buffers.

Remaining indirect, cumulative, and facilitated impacts to MNES will be avoided or mitigated through the implementation of Construction Environment Management Plans (CEMPs) and the WBCC RMP.

Residual and unavoidable impacts to golden sun moth, pink-tailed worm-lizard, and box gum woodland will be offset via a suite of actions that consider compensation for the impacts to MNES and their habitats, and for impacts to established offset areas. The management of the offset areas will be incorporated into the responsibilities of the EMT, including the existing obligations and commitments for Jarramlee and Macgregor West Environmental Offset Areas. The offset package and associated measures are an appropriate response to the anticipated impacts of the Program and are considered to adequately compensate for them.

Key Outcomes – Defined Process Strategy

The Program also establishes a Defined Process Strategy. The process has been developed to apply in either of two potential scenarios; being: 1) a proposal to develop any areas dominated by native grasses and also containing pink-tailed worm lizard habitat i.e. areas that may meet the listing criteria of natural temperate grassland; or 2) additional servicing or infrastructure requirements within the WBCC that impact MNES beyond what is already described by the Program.

This process will allow the survey, assessment and offset (if required) of MNES, in a rigorous and transparent manner consistent with the processes established by this Strategic Assessment, while ensuring the continued flexibility and adaptability of the Program.

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Appendices

Abbreviations

ACT	Australian Capital Territory
Action Plan 27	Action Plan No. 27 Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy
Action Plan 28	Action Plan No. 28 A Vision Splendid of the Grassy Plains Extended: ACT Lowland Grassland Conservation Strategy
Action Plan 29	Action Plan No. 29 Ribbons of Life: ACT Aquatic Species and Riparian Zone Conservation Strategy
AHIMS	Aboriginal Heritage Information Management System (NSW)
APZ	Asset Protection Zone (in relation to bushfire management)
ARI	Average Recurrence Interval
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals
CAMBA	China – Australia Migratory Bird Agreement
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environment Management Plan
COG	Canberra Ornithologists Group
CSP	Canberra Spatial Plan (ACT)
Cwth	Australian Commonwealth
DoEE	Department of the Environment and Energy (Cwth)
EEC	Endangered Ecological Community
EMT	Environmental Management Trust
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
EPBC Act Offset Policy	*Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (Cwth)
EPBC Act Offset Guide	'How to use the Offsets Assessment Guide' accompanying the EPBC Act Offset Policy
ESD	Ecologically Sustainable Development
FM Act	*Fisheries Management Act 1994* (NSW)
Green Community Rating	a building sustainability rating system under the Green Building Council of Australia's Green Start Community Pilot Rating Program
IUCN	International Union for Conservation of Nature
JAMBA	Japan – Australia Migratory Bird Agreement
LGA	Local Government Area
Master Plan	West Belconnen Master Plan
MNES	Matters of National Environmental Significance

NC Act	*Nature Conservation Act 2014* (ACT)
NCP	National Capital Plan (NCP)
NSW	New South Wales
PD Act	*Planning and Development Act 2007* (ACT)
PMST	Protected Matters Search Tool [http://www.environment.gov.au/epbc/protected-matters-search-tool]
Regional Plan	Draft South East and Tablelands Regional Plan (NSW)
RMP	Reserve Management Plan
RNE	Register of the National Estate
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SEWPaC	Former acronym of the Department of the Environment and Energy (DoEE)
Territory Plan	*Territory Plan 2008* (Current Version R173) (ACT)
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
WBCC	West Belconnen Conservation Corridor
WSUD	Water Sensitive Urban Design
YLEP	*Yass Valley Local Environment Plan 2013* (NSW)

1.0 Introduction

1.1 Objectives of this Report

This document forms the Strategic Assessment Report of the West Belconnen Project Strategic Assessment (the Strategic Assessment). The objective of this Strategic Assessment Report is to assess the impacts to and outcomes for matters of national environmental significance (MNES) (see **Section 1.2.1**) from the 'Urban Development at west Belconnen' (the Program) in relation to the requirements of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

It should be read in conjunction with the Program Report (AT Adams Consulting 2016[1]) which sets out the proposed development and commitments, associated works and actions, and management and funding arrangements that are included in the Program to achieve appropriate outcomes for matters protected under the EPBC Act.

1.2 What is a Strategic Assessment

1.2.1 The *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act is the Commonwealth Government's key piece of environmental legislation. It provides the legal framework for the protection and management of nationally and internationally important flora, fauna, ecological communities, and heritage places. These are defined under the EPBC Act as matters of national environmental significance (MNES).

The nine MNES are:

- world heritage properties;
- national heritage places;
- wetlands of national importance (i.e. Ramsar wetlands);
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining); and
- a water resource, in relation to coal seam gas development and large coal mining development.

Actions taken by Commonwealth agencies or on Commonwealth land are also covered under the EPBC Act.

[1] AT Adams Consulting (2016) *Urban Development at West Belconnen Program Report*, prepared for The Riverview Group, Canberra (January, 2015).

The EPBC Act also establishes the principles of ecologically sustainable development (ESD) that all development must follow so that it does not occur to the greater detriment of social, environmental, or economic values (i.e. a triple bottom line approach to sustainability). These are discussed in relation to the Program in **Section 7.2**.

1.2.2 Strategic Assessments

Strategic Assessments (Part 10 of the EPBC Act) provide an opportunity to assess proposed actions at a large scale and over a longer timeframe than traditional site-by-site assessments.

As an overview, the Strategic Assessment process occurs in two steps:

1. Assessment and endorsement of a 'policy, plan or program' (in this case, referred to as 'the Program').

2. Approval of actions, or classes of actions, associated with the Program. This potentially allows development to proceed across a large area without the need for EPBC Act approval at each individual site.

This process is detailed in **Figure 1-1**. The Commonwealth Department of the Environment and Energy (DoEE) administers the strategic assessment provisions of the EPBC Act and provides advice to the Commonwealth Minister for the Environment and Energy (the Minister) throughout this process (Australian Gov't 2013a[2]). In addition, the Minister may also choose to apply conditions to the approval (if granted) such as to protect MNES, repair or mitigate damage to MNES, or ensure compliance with relevant State or Territory assessments and / or approvals.

[2] Australian Government (2013a) *A Guide to Undertaking Strategic Assessments*, *Environment Protection and Biodiversity Conservation Act 1999*, Department of Sustainability, Environment, Water, Populations and Communities, Canberra.

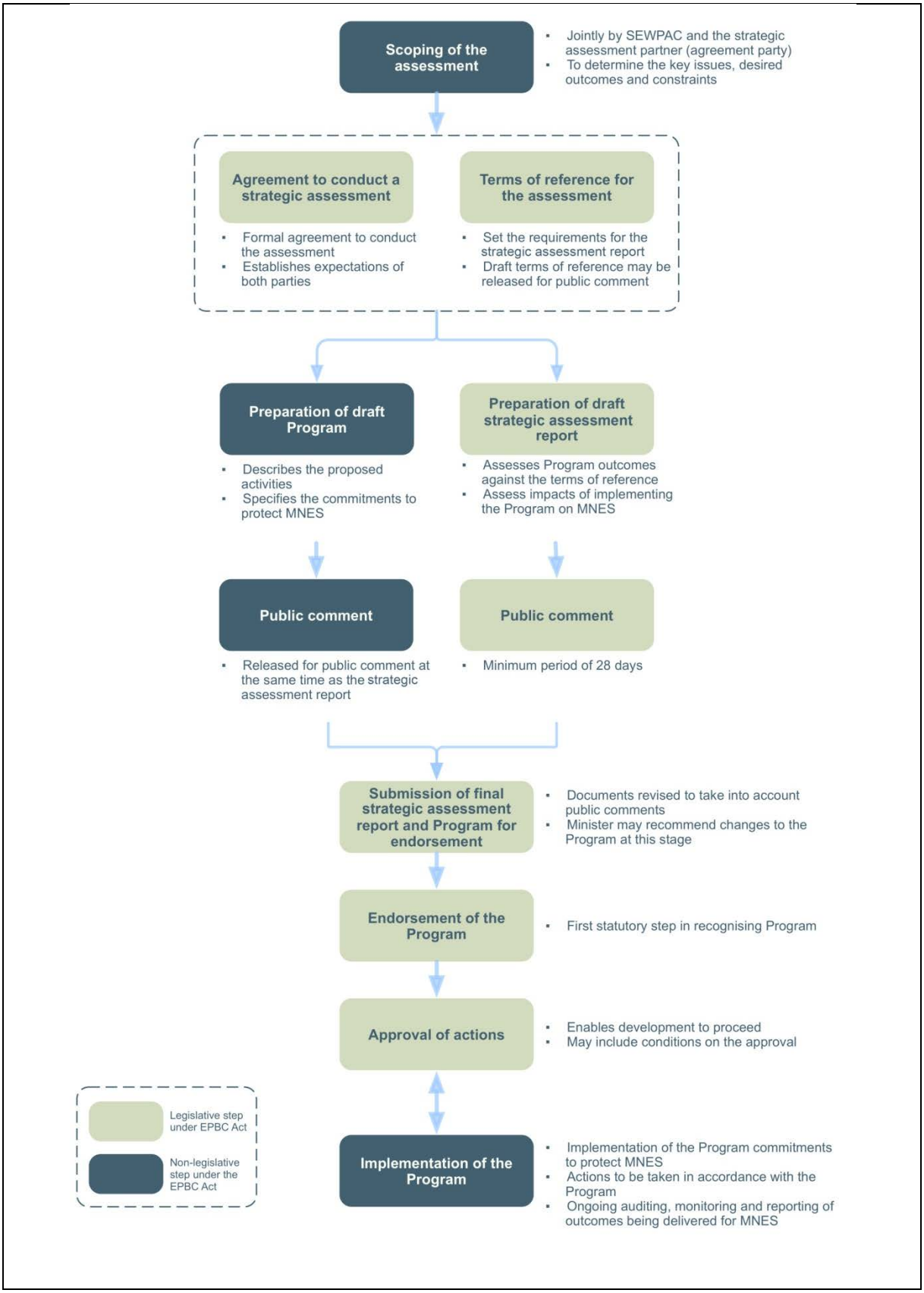

Figure 1-1

Strategic Assessment Process (reproduced from Figure 3 in Australian Gov't 2013a)

1.2.3 Strategic Design Principles

Strategic Assessment is by its nature an assessment of environmental values at a broad scale. Consequently, interpretation of measurements requires an appreciation that detailed planning has not occurred and accordingly minor variations in the distances, areas, and locations of features discussed is to be expected when further design and planning at a finer scale is undertaken at latter stages of development. The implication is that boundaries used in the Program Report and as assessed in the Strategic Assessment Report (this document) are accurate only at the strategic scale and when translated into boundaries for detailed planning and design need to allow for a degree of latitude in order to arrive at an optimal outcome that considers environmental, planning, and engineering factors.

To this effect, this Strategic Assessment Report assumes that all areas, distances, and locations may vary up to two percent (2%) from those stated in the Program Report once translated into the detailed design stages. Any variation beyond this would be considered a potentially significant variation from the intent of the Program and may require further consideration with regards to commitments and outcomes under the EPBC Act.

Principles under which this would occur are:

1. **Give and Take**: the principle of 'give and take' would mean that in developing the detailed design, adjustments to the development area boundary are likely to be required, but in making such changes the overall area of conserved land would not vary by more than two percent than what has been assessed in the Strategic Assessment Report. By applying this principle, a boundary that is moved five metres (for example) is complemented by a corresponding adjustment elsewhere to compensate.

   Outcome: total conserved area does not vary by more than two percent.

2. **Ecological Balance**: the principle of 'ecological balance' would require that areas of ecological value affected by the 'take' aspect of design variation are balanced in the 'give' response. The consequence would be that if design variations result in a further loss of MNES habitat, the principle of 'give and take' would apply in directing the complementary design adjustment to result in reduced impacts to MNES habitat elsewhere across the Project.

   Outcome: total impacts to MNES do not vary by more than two percent.

3. **Ecological Equivalence**: the principle of 'ecological equivalence' requires that complementary areas in meeting the 'give and take' and 'ecological balance' principles are provided for on a like for like basis, or as near as possible. Accordingly, in balancing the minor design variations, good quality habitat for one MNES would not be complemented by habitat for a different MNES or of a different quality.

   Outcome: conserved habitat and quality for each MNES does not vary by more than two percent.

The strategic intent is that the quantitative outcomes prescribed by The Program Report are met to within two percent of what is committed to. When applied in accordance with the strategic design principles, this provides for flexibility in implementing the Program without compromising the outcome.

2.0 Description of the Program

The Program proposes to rezone land at west Belconnen to allow urban development and biodiversity conservation. It is fully described in the Program Report (AT Adams Consulting 2016) and key elements are summarised below.

2.1 Description of the Project Area

The Project Area covers 1,583.3 hectares of land that straddles the Australian Capital Territory (ACT) and New South Wales (NSW) border, west of the Canberra suburbs of Higgins, Holt, and Macgregor. It is bounded by the Murrumbidgee River to the west, Ginninderra Creek to the north, Macgregor to the east, and Stockdill Drive to the south. It also includes land that will be impacted by the proposed Ginninderra Drive extension, which links the current Ginninderra Drive terminus to the proposed development area; and road improvement works along existing portions of Southern Cross Drive, Ginninderra Drive, and Drake Brockman Drive (**Figure 2-1**). It is also likely that other minor road works will be required within existing suburban areas along feeder roads where intersection upgrades will be necessary to maintain road safety standards. Areas subject to minor works have not been identified for the purpose of this assessment given the absence of any matter of national or Territory significance.

An indicative width of the works along Drake Brockman Drive has been considered for the purpose of the assessment and notionally includes all land adjoining the existing road corridor to a distance of up to 20 metres south of the existing cadastral boundary. This provides the basis for estimated impacts to environmental values within the road corridor. Owing to the preliminary nature of road and servicing designs, the Drake Brockman Drive area has been over-estimated in order to consider a worst-case scenario for the project in terms of footprint.

The Strathnairn Arts Association land is not included in the Project Area (**Figure 2-1**).

The Project Area also includes approximately 279 hectares of land referred to in the Molonglo Strategic Assessment (ACT Gov't 2011[3]) as 'west Molonglo'. A further 38 hectares that was described as part of west Molonglo is not within the Project Area and comprises the electricity substation to the west of the Belconnen golf course. A commitment of the Molonglo Strategic Assessment included the avoidance of impacts on MNES within west Molonglo. This commitment is respected by the west Belconnen project and accordingly all commitments made by the Molonglo Strategic Assessment relevant to the Project Area are considered.

The elevation within the Project Area ranges from approximately 425 to 625 metres above sea level (RobertsDay 2014[4]). The topography includes undulating terrain, generally sloping down from the south eastern corner westwards towards the Murrumbidgee River, and northwards towards the ACT / NSW border. There are four creek lines that generally flow from east to west across the Project Area and empty into the Murrumbidgee River, the most significant of these is Ginninderra Creek (David Hogg Pty Ltd 2013[5]).

[3] ACT Government (2011) *Molonglo Valley Plan for the Protection of Matters of National Environmental Significance; NES Plan*, ACT Planning and Land Authority, Canberra.

[4] RobertsDay (2014) *West Belconnen Master Plan Report*, prepared for The Riverview Group and the Land Development Agency, Canberra.

[5] David Hogg Pty Ltd (2013) *West Belconnen Woodland Areas: Confirmatory Ecological Assessment*, prepared by Nash, K. and Hogg, D.McC. for The Riverview Group, Canberra.

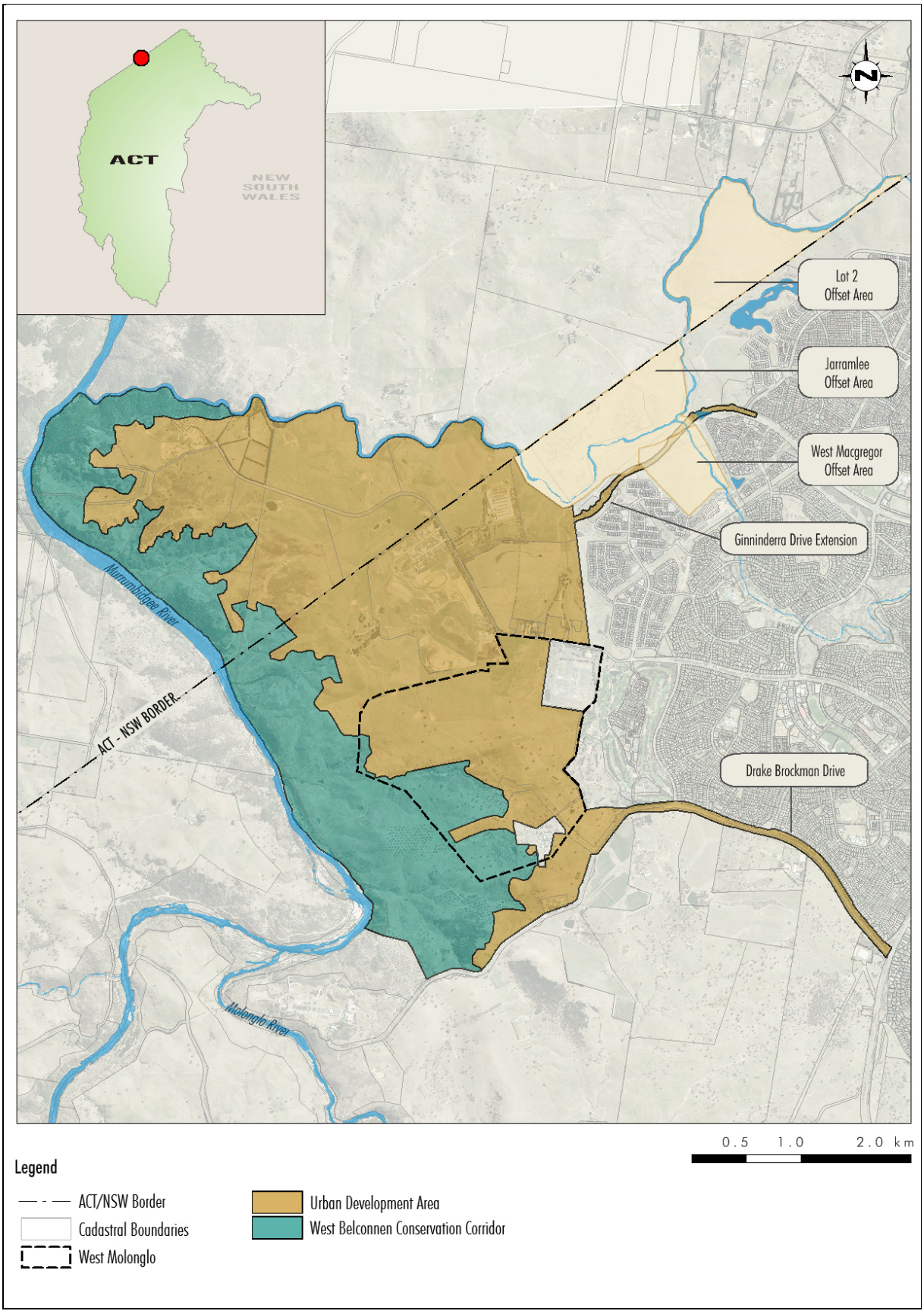

Figure 2-1

west Belconnen Project Area

2.2 Current Protected Lands

Currently, land within the Murrumbidgee River Corridor is protected in the ACT under the *Territory Plan 2008* (Territory Plan) and in NSW under the *Yass Valley Local Environmental Plan 2013* (YLEP) (**Figure 2-2**).

There are no National Parks within the Project Area. Woodstock Nature Reserve lies within the ACT Murrumbidgee River Corridor in the southwest of the Project Area and extends across to the west bank of the Murrumbidgee River. It is contiguous with land protected as 'River Corridor' along both the Murrumbidgee and Molonglo Rivers to the west and south of the Project Area. The area directly east from Woodstock Nature Reserve in the ACT has a 'special purpose reserve' overlay. This recognises the recreational, scenic, and amenity values of the area without formally recognising it as a nature reserve. Dunlop Grassland Nature Reserve lies to the east of the Project Area, within the ACT (**Figure 2-2**).

The established environmental offset areas known as the Macgregor west environmental offset area[6] and the Jarramlee environmental offset area[7] are situated between Macgregor, Dunlop, and the ACT / NSW border. These two areas form the eastern most portion of the Project Area within the ACT (**Figure 2-2**) and will be impacted upon by the Program.

The Macgregor offset was established following Commonwealth approval under Part 9 of the EPBC Act for development at Macgregor West (EPBC 2010/5520). The area was selected because it contains one of the largest golden sun moth (*Synemon plana*) populations in the ACT (Braby 2005[8]).

The Jarramlee offset was established as a result of Commonwealth approval under Part 9 of the EPBC Act for development at Lawson South (EPBC 2010/5549). It was selected for its 'natural temperate grassland of the South Eastern Highlands' (natural temperate grassland) (EPBC listed ecological community) and golden sun moth habitat values and for being contiguous with the Macgregor offset (ACT Gov't 2013a[9]).

Territory Plan Variation 351 commenced on 22 July 2016, amending the Territory Plan to facilitate the Program. Changes to protected lands as a result of Variation 351 include gazetting the Jarramlee and Macgregor offsets as Nature Reserves and introducing a Nature Reserve overlay to the West Belconnen Conservation Corridor (WBCC).

[6] referred to hereafter as the 'Macgregor offset'

[7] referred to hereafter as the 'Jarramlee offset'

[8] Braby, M.F. (2005) *Distribution and Provisional Management Plan of the Golden Sun Moth Synemon plana (Lepidoptera : Castniidae), in Remnant Grasslands of Macgregor West, ACT,* prepared for the Australian Capital Territory Planning and Land Authority, Canberra.

[9] ACT Government (2013a) *Jarramlee Offset Management Plan*, Territory and Municipal Services Directorate, Canberra.

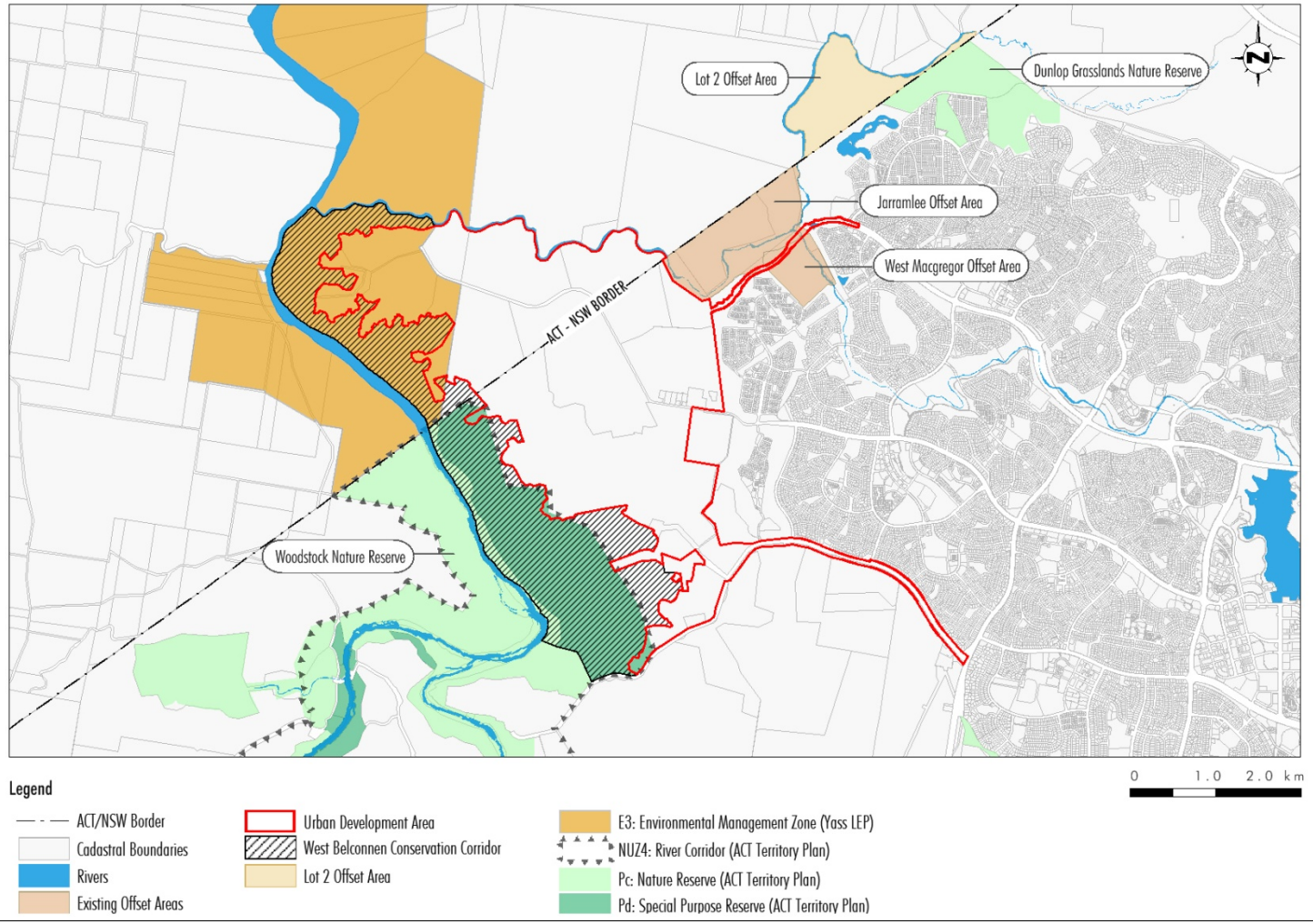

Figure 2-2

Current protected lands within and nearby to the Project Area

2.3 Land Use

A majority of the proposed Urban Development Area within the ACT is leased to one operator, Corkhill Bros, and has been used for rural land use purposes (namely grazing and horse agistment) (KMA 2014[10]). Land within the NSW portion of the Project Area covers four rural properties which are all within the Yass Valley Council Local Government Area (LGA) (KMA 2009a[11]).

The land has been used for farming activities for over 150 years. A majority of it is divided into large paddocks, most of which have poor ecological values as a result of pasture improvement, grazing, altered fire regimes, and other activities that are associated with such uses (e.g. fencing, dam building) (KMA 2009b[12]). Current land uses within the ACT portion of the Project Area include:

- agriculture – poultry (Parkwood Eggs), grazing, and horse agistment
- ACT heritage listed Belconnen Farm Precinct and Parkwood Homestead and Chapel
- services – ACTEW vent
- recreation – Bicentennial National Trail and pony club
- community and education services – Billabong Aboriginal Development Corp
- river corridor, part of which is incorporated into Woodstock Nature Reserve which lies predominantly on the opposite side of the river to the Project Areabusinesses – landscape supply, plant nursery, kennels, and veterinary surgery; and
- the old Belconnen landfill – includes Parkwood recycling estate (secondary industrial area), green waste recycling, asbestos disposal, hydrocarbon affected soil treatment area, and an emergency landfill site.

Current land uses within the NSW portion of the Project Area include:

- agriculture – predominantly grazing
- rural residential – both unoccupied and single residence
- gravel quarry; and
- commercial accommodation and function centre – Ginninderry Homestead.

Land uses adjacent to the Project Area include:

- services – the Lower Molonglo Valley Water Quality Control Centre and Belconnen substation
- community and education services – Magpies Belconnen Golf Course and Strathnairn Arts Association

[10] Kevin Mills and Associates (KMA) (2014) *Ecological Studies West Belconnen Australian Capital Territory*, prepared for The Riverview Group, Canberra.

[11] Kevin Mills and Associates (KMA) (2009a) *Further Flora and Fauna Studies: Land at West Molonglo and Ginninderra Creek New South Wales Australian Capital Territory*, prepared for The Riverview Group, Canberra.

[12] Kevin Mills and Associates (KMA) (2009b) *West Belconnen Project ACT and NSW Land Flora and Fauna Studies*, prepared for The Riverview Group, Canberra.

- residential development
- agricultural land, especially in NSW
- Macgregor and Jarramlee offsets; and
- protected river corridor areas.

Land within the existing riparian corridors has previously been open to the public for recreational activities including bush walking, fishing, boating, and swimming; for which paths and fences were constructed. In particular, the Ginninderra Falls area, which was open to the public between 1979 and 2004 (Watson 2013[13]) was the primary location for these activities. The scenic and recreation values of this area are still strongly held within the community. Trespassers are often sighted at and near Ginninderra Falls (Osborne and Gilbert 2015[14]) despite it not currently being open to the public.

2.4 Planning Framework and Context

Based on ACT Government projections, the ACT's population is expected to grow to approximately 457,300 by 2030 and to over 550,000 by 2059. The populations of neighbouring LGAs in NSW are also projected to increase during this time. This population growth presents the challenge to both the ACT and NSW Governments to provide affordable housing, infrastructure, and services whilst conserving the natural values of the region. These projections indicate that 55,000 new dwellings are required in the region to meet housing demands; 45,000 of which should be in the ACT (ACT Gov't 2012a[15]).

As a cross-border development, the planning context must consider both ACT and NSW planning legislation and policies. Due to the ACT's location in the south-east of NSW, maintaining and enhancing cross border collaborations between the governments (state, territory, and relevant local) of the two jurisdictions has been a priority for at least two decades. This notion has been formalised numerous times over the years through Memoranda of Understanding, agreements, forums, and more recently the establishment of the South East Regional Organisation of Councils, which have led to the consideration of both jurisdictions in each of the planning strategies for the ACT and NSW. These planning strategies are outlined in greater detail below, but according to the latest Memorandum of Understanding between the ACT Government and NSW Government (2011[16]), must promote targeted service delivery, sustainable regional growth, and future economic prospects of the region as a whole. The Program has been developed to reflect the strategic planning intentions for the growth and development of Canberra and the surrounding region, as outlined in the following sections.

2.4.1 ACT Planning

Part of the ACT portion of the Project Area was identified for future residential development in the 'Canberra Spatial Plan' (CSP) (ACT Gov't 2004a[17]); a document required under the ACT's *Planning and*

[13] Watson, C. (2013) *Submission to the ACT Legislative Assembly Select Committee on Regional Development*, Ginninderra Falls Association, Canberra, received 11 April 2013.

[14] Osborne, T. and Gilbert, E. (2015) 'Ginninderra Falls land owners struggling to keep carloads of trespassers out, as plans to reopen area to public progress' *ABC News*, (online) Available: http://www.abc.net.au/news/2015-12-28/ginninderra-falls-owners-struggle-to-keep-trespassers-out-safe/7056638 (Accessed 05/09/2016), 28 December 2015.

[15] ACT Government (2012a) *ACT Planning Strategy: Planning for a Sustainable City*, Environment and Sustainable Development Directorate, Canberra.

[16] ACT Government and NSW Government (2011) *Australian Capital Territory and New South Wales Memorandum of Understanding for Regional Collaboration*, signed on 2 December 2011.

[17] ACT Government (2004a) *The Canberra Spatial Plan*, Australian Capital Territory Planning and Land Authority, Canberra.

Development Act 2007 (PD Act) to provide a strategy for urban settlement in Canberra that aligns with ESD principles. In it, localised town centres such as Belconnen, will be developed to improve community accessibility to services and cultural activity, reduce the resident's dependency on cars, and constrain urban growth to within 15 kilometres of Civic. This changed previous strategies that focussed on expanding greenfield development to link Canberra with the region (e.g. the 1969 'Y' Plan).

Belconnen as a whole is also identified in the CSP as part of an east – west corridor of activity nodes that include major education institutions, health and sporting facilities, and key employment locations. It is also a key transport trunk within the ACT, in particular for its links to Civic and possible future links to Molonglo.

These plans were confirmed in the 'ACT Planning Strategy' (ACT Gov't 2012a), which replaced the CSP as the long-term planning policy for the ACT under the PD Act. In it, a portion of the Project Area was identified as a 'future urban investigation area' (**Figure 2-3**).

Furthermore, the ACT Planning Strategy sets out five outcomes that are aimed to be achieved by 2030 through the implementation of nine strategies. Of relevance to the Program, outcome A of the ACT Planning Strategy has the following indicator of success:

'The proportion of new housing delivered through urban intensification is 50% or more' (p. 67, ACT Gov't 2012a).

This indicator is the basis for the ACT Government's 50:50 policy, whereby 50 percent of new development (including residential) is to be accommodated in infill areas and 50 percent in greenfield areas. This policy recognises the need for diversity and affordability in housing choice to improve liveability whilst reducing the ACT's environmental impact. In addition to reducing the amount of greenfield land being released for development, the ACT Planning Strategy outlines the importance of location when releasing greenfield areas and for considering environmental impacts during design phases (ACT Government 2012a).

The 'National Capital Plan' (NCP) (Australian Gov't 2014a[18]) is the pre-eminent land use control mechanism in the ACT. Its aim is to ensure that the region is developed in accordance with its national significance and place within Australia's future. One of the key ways it achieves this is through its influence on the provisions of the Territory Plan.

The Territory Plan is the key statutory planning document for the ACT. Its aim is to manage land use change and development in the area and ensure that it occurs in a manner that follows the strategic directions outlined in the planning strategy (currently the 'ACT Planning Strategy' (ACT Gov't 2012a)) and is not inconsistent with the NCP.

Under the NCP the land within the Project Area along the ACT / NSW border is zoned as 'Hills, Ridges and Buffers'; the area extending down the Murrumbidgee River is zoned as 'River Corridor'; and the remainder as 'Broadacre'. Not inconsistent with this, the Territory Plan zones each respective area as: 'NUZ3 – Hills, Ridges and Buffers'; 'NUZ4 – River Corridor'; and 'NUZ1 – Broadacre'.

The Program will require a number of amendments to the NCP and the Territory Plan. The following amendments apply to the NCP:

- extend the 'Urban Areas' land use policy over the Urban Development Area
- expand the 'River Corridor' boundary as described in **Section 2.6.2**

[18] Australian Government (2014a) *Consolidated National Capital Plan Incorporating Amendments*, National Capital Authority, Canberra.

- remove two areas currently zoned as 'Hills, Ridges and Buffers'
- remove one 'Broadacre' area; and
- create one new 'Broadacre' area.

Similar amendments to land use zonings under the Territory Plan will need to be approved by the ACT Minister for Planning. The variation to the Territory Plan will also bring into effect two key instruments that will control the use and development of the site in the long-term future. These are:

- the 'Structure Plan' which is a written statement that sets out principles and policies for the development of the site; and
- the 'Concept Plan' which applies the principles and policies set out above and specifies the key spatial requirements for the site.

The 'Structure Plan' and 'Concept Plan' were approved on 23 October 2015 by the ACT Minister for Planning (Notifiable Instrument NI2015-610) and formed Territory Plan Variation 351 (DV351). It has yet to be commenced.

The Program has also been included in the 'ACT Indicative Land Release Program 2016 – 17 to 2019 – 20' (ACT Gov't 2016[19]). This document outlines the land release program for the ACT over a four year period and is updated annually. The residential component of the land release program is guided by the need to control supply to assist with housing affordability whilst adhering to the overall objectives of meeting the demands of a growing population and the community's desire for a more compact city. The 2016-17 land release program sets the target of releasing 17,780 residential dwellings over the four years until 30 June 2020. Of these, it is expected that development at west Belconnen will contribute 1,200 dwellings (less than 10 percent of the four year target for the ACT) at a rate of 300 per year.

In 'People, Place, Prosperity: The ACT's Sustainability Policy', the ACT Government (2009a[20]) committed to incorporating sustainability principles into all decision making processes. In particular, a triple bottom line approach to all planning and reporting was outlined; the aim of which allows for only socially responsible, environmentally sound, and economically viable development to proceed. The Program aims to incorporate ESD Principles into its design and implementation so that west Belconnen will become an area renowned for its sustainability legacy (RobertsDay 2014). This is discussed further in **Sections 2.5** and **7.2**.

[19] ACT Government (2016) *Indicative Land Release Program 2016 – 17 to 2019 – 20*, Economic Development Directorate, Canberra.

[20] ACT Government (2009a) *People, Place, Prosperity – The ACT's Sustainability Policy*, Chief Minister, Treasury and Economic Development Directorate, Canberra accessed online (March 2015): http://www.cmd.act.gov.au/__data/assets/pdf_file/0003/119730/people_place_prosperity.pdf.

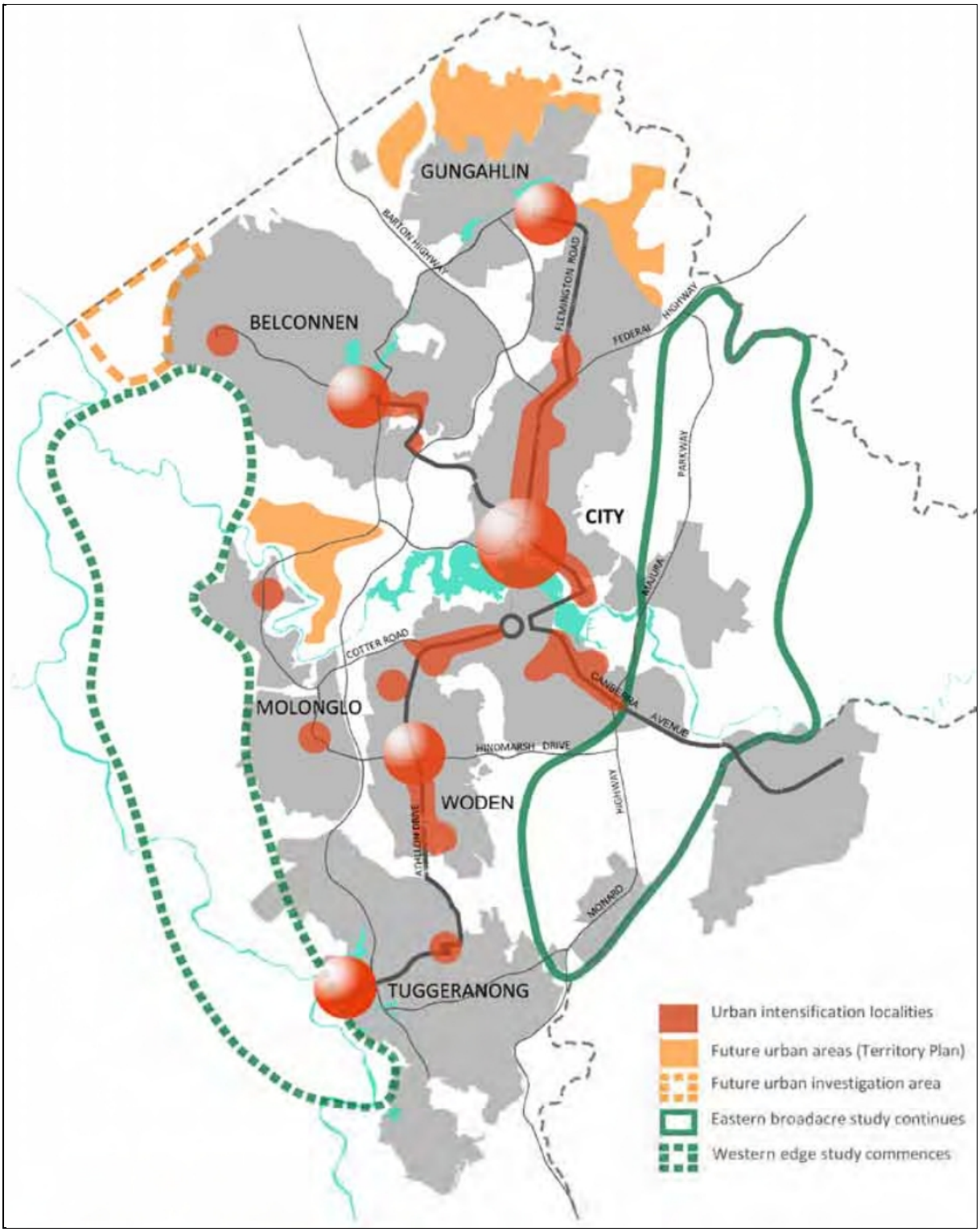

Figure 2-3

Future Urban Areas and Investigation Areas in Canberra (Figure reproduced from ACT Gov't 2012a)

2.4.2 NSW Planning

The land use planning controls in NSW are governed by the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). In accordance with the EP&A Act, the YLEP is the principal environmental plan for the entire Yass Valley LGA. Under the YLEP, the land along Parkwood Road, bounded by the Murrumbidgee River and Ginninderra Creek is zoned as either 'RU1 Primary Production' or 'E3 Environmental Management' (**Figure 2.2** shows all 'E3 Environmental Management' areas within the Project Area).

'RU1 Primary Production' zones aim to maintain the rural character of the Yass Valley by enhancing the natural resource base and limiting its fragmentation, and diversifying primary industry and encouraging its presence in the area. The aim of 'E3 Environmental Management' zones is to *'protect, manage, and restore areas with ecological, scientific, cultural or aesthetic values'* (YLEP, Part 2.3).

Development of the Project Area within NSW is contingent upon an amendment to the YLEP, as the current zoning does not provide for the proposed urban development, nor does the 'E3 Environmental Management' zone accurately map the extent of the land with conservation value (discussed further in **Section 2.6.2**).

A 'Planning Proposal' has been lodged in accordance with the EP&A Act and supporting guidelines with the aim to amend the YLEP and rezone the proposed Urban Development Area to 'R1 General Residential' and redefine the boundary of the current 'E3 Environmental Management' zoning to reflect the conservation values of the area .

The NSW Department of Planning and Environment is in the process of developing numerous regional plans to prepare for future populations' needs for housing, jobs, infrastructure, and a healthy environment across the state. Of relevance to the Program is the 'Draft South East and Tablelands Regional Plan' (Regional Plan) (NSW Gov't 2016a[21]), which includes the Yass Valley LGA in the Greater Capital Regional Landscape, along with Queanbeyan - Palerang Regional Council[22]. This Regional Plan supersedes the 'Sydney – Canberra Corridor Regional Strategy 2006-31' (NSW Gov't 2008[23]) which included the NSW portion of the Project Area.

The vision set out in the Regional Plan is to build resilient and sustainable communities by balancing growth opportunities with protecting the region's diverse natural environment and lifestyles. It identifies four goals, underpinned by various directions and actions, in order to achieve this.

The Program aligns with the Regional Plan in numerous ways. Similarly to the ACT Planning Strategy (ACT Gov't 2012a) the Regional Plan recognises the increased demand for housing as a result of a growing and changing population. It is expected that the population of the Greater Capital Regional Landscape will require an additional 14,750 new dwellings. At this stage, this demand will be met by existing release areas at Googong, South Jerrabomberra, Yass, Murrumbateman, and west Belconnen[24] (NSW Gov't 2016a).

Furthermore, the Regional Plan recognises that new residential developments must protect natural environmental values. Recommendations include focussing growth in existing urban growth areas; using field-verified ecological mapping to assist with planning and design; utilising the avoid,

[21] NSW Government (2016a) *Draft South East and Tablelands Regional Plan*, NSW Department of Planning and the Environment, Wollongong, May 2016.

[22] The May 2016 draft of the Regional Study was written prior to the recent NSW council amalgamations, as such it refers to the Palerang Regional Council and Queanbeyan City Council as separate entities, rather than the Queanbeyan-Palerang Regional Council.

[23] NSW Government (2008) *Sydney – Canberra Corridor Regional Strategy: 2006 – 31*, Department of Planning, Sydney.

[24] The Program is referred to as '*cross-border development at Parkwood*' in the Regional Study.

mitigate, and offset hierarchy when considering impacts to the environment; considering connectivity at a landscape and / or regional scale; and being especially mindful of sensitive habitats, such as aquatic environments. The impacts of development are further reduced by incorporating active transport, water sensitive urban design, and water and energy efficiency measures into designs. There is also an opportunity to restore the natural assets of the region and allow communities to reconnect to the natural environment, which will aid environmental protection by increasing public awareness and management opportunities.

Goal four of the Regional Plan focuses on ensuring the social values of communities are maintained, in particular through 'place based planning' that develops 'neighbourhoods' of social cohesion and community wellbeing by integrating housing with the landscape, open space, community facilities and meeting places, and active transport options. In addition to the environmental benefits of building in urban growth areas, this option is also identified as being more sustainable as it takes advantage of existing job markets, commercial and retail opportunities, and especially in the case of the Greater Capital Regional Landscape – services.

2.4.3 Existing Commonwealth EPBC Approvals

2.4.3.1 Molonglo Strategic Assessment

The Molonglo Strategic Assessment (ACT Gov't 2011) was published by the ACT Government in September 2011, and endorsed by the Commonwealth Minister for the Environment on 7 October 2011. The plan focused on urban development in the area known as east Molonglo (south of the Project Area, adjacent to Western Creek, ACT), but also included west Molonglo (see **Figure 2-1**). As west Molonglo is included within the Project Area all relevant approval commitments within the Molonglo Strategic Assessment must be incorporated into the Program.

The relevant commitments, conservation outcomes, and associated actions are:

- A commitment to avoid impacts to MNES within west Molonglo.
- A conservation outcome to maintain and enhance the EPBC listed 'white box – yellow box – Blakely's red gum grassy woodland and derived native grassland' (box gum woodland) ecological community within west Molonglo.
- Two proposed actions to achieve the above conservation outcome:
    - Action 21, manage the box gum woodland that occurs in west Molonglo in accordance with the terms of a Land Management Agreement and associated Land Action Plan which dates from the period prior to the preparation of the Molonglo Strategic Assessment. It was intended that these agreements and plans were to be reviewed and updated so that they provide for the conservation management of box gum woodland.
    - Action 22, in the event that west Molonglo is developed (as is proposed in the Program), subject to confirmatory ecological assessment, the area of box gum woodland will be set aside as Nature Reserve prior to construction commencing.

Ecological assessment of box gum woodland to confirm its quality and extent within west Molonglo and throughout the remainder of the Project Area was conducted by David Hogg Pty Ltd (2013). Consequently, the box gum woodland that occurs within the 'west Molonglo' portion of the Project Area has been incorporated into the West Belconnen Conservation Corridor (WBCC, a non-urban component described further in **Section 2.6.2**) and will not be impacted by the Program. The Land Management Agreement and associated Land Action Plan will be replaced by the WBCC Reserve

Management Plan (WBCC RMP), which will include measures to avoid future impacts to box gum woodland within the WBCC and improve its quality. This is discussed further in **Sections 4** and **5**.

The Program will impact low quality pink-tailed worm-lizard (*Aprasia parapulchella*) habitat within the west Molonglo area. As this does not comply with the Molonglo Strategic Assessment commitment to avoid impacts to MNES in this area it is appropriate to consider the action under the EPBC Act in the context of not only the Program but also the Molonglo project. This is discussed further in **Sections 4.5.5** and **5.2.2**.

2.4.3.2 Macgregor and Jarramlee Offsets

The Macgregor and Jarramlee offsets were established following Commonwealth approval under Part 9 of the EPBC Act for development at Macgregor West (EPBC 2010/5520) and Lawson South (EPBC 2010/5549) respectively. As the Program will impact upon both of these areas, the commitments established under the current Offset Management Plans for these offsets will be incorporated into the Program. The current Offset Management Plans will be incorporated into a combined Offset Management Plan that will form part of the overall WBCC RMP. This will include measures to address the commitments on existing offsets in addition to commitments of the Program with respect to the new offsets.

2.5 Design Process

The draft 'West Belconnen Master Plan' (Master Plan) (RobertsDay 2014) was prepared for the Project Area between 2007 and 2014. This is a non-statutory document that provides a readily understandable illustration of the likely development outcomes of the Program. It determines the site design, numbers and sizes of blocks, provisions for schools and other community facilities, and public open space. The current indicative Master Plan is shown in **Figure 2-4**.The development of the Master Plan for the Program has been subject to a comprehensive stakeholder engagement process. This process has been driven by the Great Places framework, which is aimed to facilitate innovation whilst being focused on practical outcomes. The Great Places framework uses six stages to understand, discover, envision, design, convert, and finally to deliver the Program (RobertsDay 2014).

This process began in 2007, with feedback sought from key community groups regarding an initial proposal for a cross border residential development at west Belconnen. This early stage engagement was focussed on understanding the requirements and possibilities of the Program. Key feedback from this consultation indicated support for the following concepts:

- a diversity of housing types, including affordable options
- sustainable energy use at both the household and community scale
- good public transport options
- increased recreational opportunities for both the existing and new Belconnen residents; and
- a development that is integrated with and a natural extension of existing residential areas in Belconnen (RobertsDay 2014).

The development of the Master Plan began in earnest in 2009, following a Sustainability Workshop. This workshop developed the 'sustainability vision', 'project objectives', and 'guiding principles' (outlined in detail in RobertsDay 2014); all of which ensured that ESD principles under the EPBC Act were incorporated into the design by utilising a triple bottom line approach. At this time it was

agreed that the Program would be designed around the existing values in the Project Area, and a number of studies were begun at this time to provide this information.

The Riverview Group is aiming to create a sustainable community in the nation's capital that will be recognised with a 'six star – a world leader in sustainability' rating (Green Community Rating) under the Green Building Council of Australia's Green Star Community Pilot Rating Program. The criteria for a Green Community Rating were also explored at this point of the design process. This is a pilot program aimed at enabling the long-term sustainability of urban development by assessing criteria for the planning, design, and construction phases. This final score is based on measures which include liveability, economic prosperity, environmentally responsible community design, and governance (RobertsDay 2014).

The first draft Master Plan was developed at a Planning and Design Forum in November 2013. It was developed in real time at the forum, as designers responded to discussions between the decision makers, technical experts, and community representatives to review challenges and design options.

Following the Planning and Design Forum, the draft Master Plan was further refined. This refinement took into account (in greater detail than previously) the information from the various technical studies that had occurred on subjects such as access (including transport), health (especially the roles of physical activity and fresh food), land use, neighbourhood creation and a community sense of place, stormwater systems and Water Sensitive Urban Design principles (WSUD, see **Section 4.3.3**), and conservation of ecological values (RobertsDay 2014). The refined (and current) Master Plan for the Program is shown in **Figure 2-4**.

As it was developed following extensive and detailed technical studies and stakeholder engagement, and there has been no new scientifically sound evidence emerge since the completion of the Strategic Assessment reports in early 2016, there has been no need to change the Master Plan to date. Any changes following the review of recent information received, particularly in relation to the protection of ecological values in the NSW portion of the Project Area, will be incorporated into a resubmission of the NSW planning proposal. Note that this process will not result in any reduction of the current conservation area; consequently there will be no impact to EPBC commitments or outcomes as outlined in this Strategic Assessment. Notwithstanding this, legislative change over the design period has introduced a different and broader definition of the natural temperate grassland community under the EPBC Act; this has resulted in an acknowledgement of potential future deviation from the master plan as a result of implementing a defined process assessment method for areas supporting the endangered community (discussed further in **Section 2.6**).

By undertaking the planning of the Program in this manner, it has been able to consider and incorporate measures and recommendations from both the ACT and NSW planning context, stakeholder consultation, and technical, field-based studies. The development process for the Master Plan has also provided a mechanism for evaluating options, opportunities, and constraints presented in the Program. This has been used to confirm the practicality and veracity of the 'Structure Plan', which has been developed and approved (Plan Variation 351, as per Notifiable Instrument NI2015-610). Following the proposed zoning amendments to the NCP, Territory Plan, and YLEP, more detailed design for each stage of development will be undertaken.

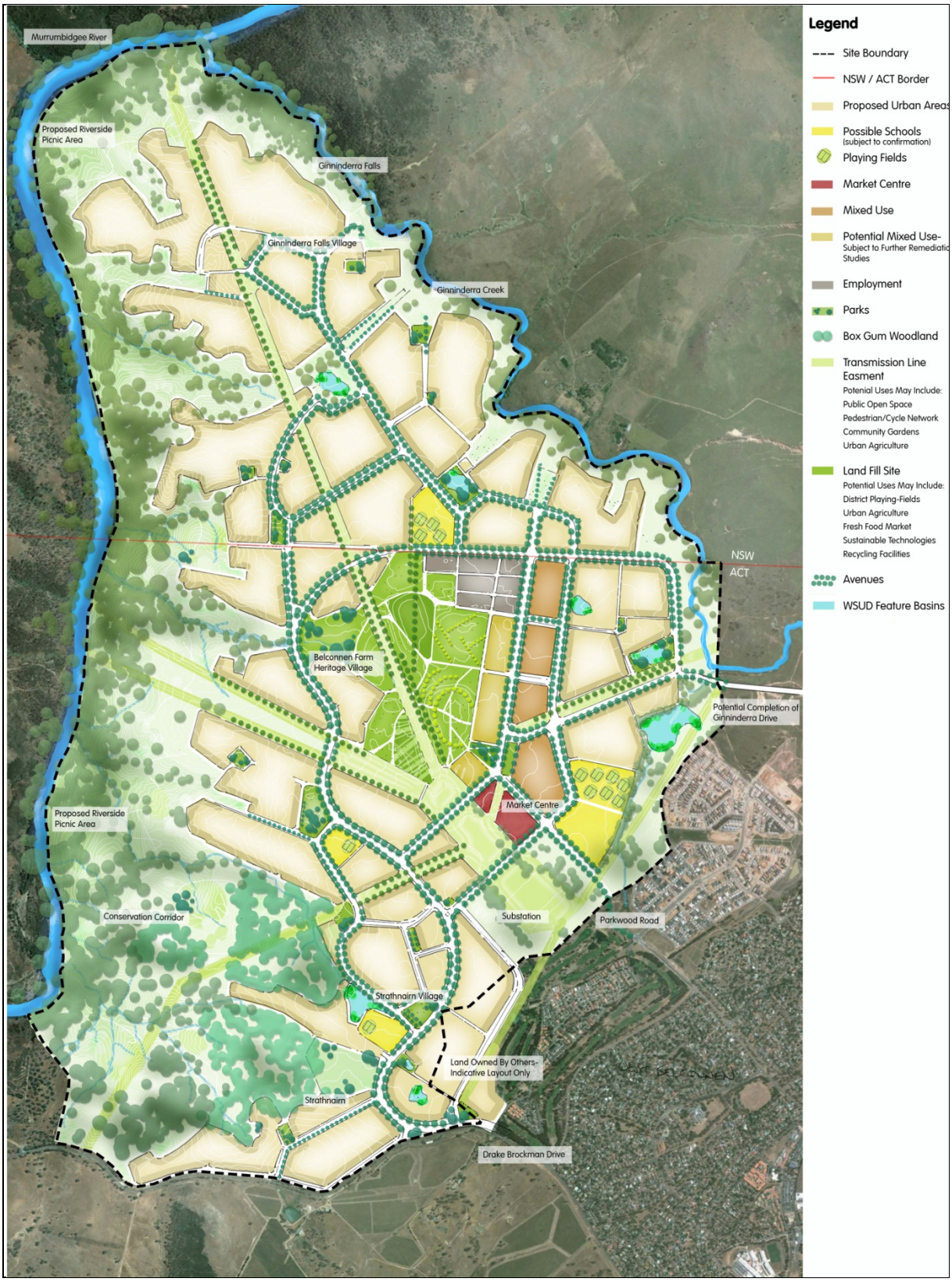

Figure 2-4

Indicative Master Plan (Figure reproduced from RobertsDay 2014)

2.6 Key Components

The Program aims to provide a third urban development front within the ACT (in addition to Gungahlin and Molonglo), which extends into bordering NSW. This is proposed to occur by extending the existing urban area of Belconnen west and north. It is anticipated that a total of 11,500 dwellings over a 30 to 40 year period (approximately 300 dwellings per year) will be provided to house approximately 30,000 people (RobertsDay 2014).The Program may be discussed in terms of three major components. The first includes the development of urban areas and the associated provision of services and infrastructure. In particular, this includes an extension of Ginninderra Drive (explained further in **Section 2.7.3**); upgrade works along Drake Brockman Drive / Stockdill Drive, Southern Cross Drive / Parkwood Road, and existing portions of Ginninderra Drive (discussed further in **Section 2.6.1**); and the installation of a sewer pipeline (discussed further in **Section 2.7.4**). The area proposed for development (Urban Development Area, **Figure 2-1**) is situated west of Holt in the ACT, and includes land generally east of Parkwood Road and north through NSW, up to Ginninderra Creek; and Macgregor and Jarramlee offsets.

The second component of the Program predominantly involves the creation of the West Belconnen Conservation Corridor (WBCC) along the riparian areas of the Murrumbidgee River and Ginninderra Creek (**Figure 2-1**). This component will provide biodiversity protection and enhancement, recreational facilities, and contribute to urban amenity for the community of west Belconnen (RobertsDay 2014).

The third component is the Defined Process Strategy**.** The Defined Process Strategy will provide assurance that impacts to MNES from actions outside of those specified in the Program will be consistently assessed and managed. It will be particularly applied to the development of infrastructure within the WBCC and the assessment of impacts to listed matters and associated offsets (see **Section 3.3.1.1** and **4.7**). These components are discussed in greater detail in the following sections.

2.6.1 Description of the Urban Development Component

The Program proposes to develop greenfield land west of the Canberra suburbs of Holt, Higgins, and Macgregor (Urban Development Area, **Figure 2-1**). The design of the Urban Development Area is to be based on Walter Burley Griffin's legacy of Canberra and incorporate best practice sustainability planning and design to provide a community that is diverse and inclusive, and provides places to live, work, and play (RobertsDay 2014).

Whilst greenfield expansion is not considered more sustainable than infill development options, the environmental and economic impacts of the Program will be reduced by the provision of the WBCC and associated management outcomes, and implementation of urban design principles that utilise existing infrastructure, public and active transport methods, and a range of affordable housing types (RobertsDay 2014), in accordance with current planning frameworks for NSW and the ACT.

The urban development component also includes the extension of Ginninderra Drive. Currently, at the point from where it will be extended from, Ginninderra Drive is a single carriageway pavement road that has been completed to the western extremity of Dunlop. To service the proposed Urban Development Area, it will need to be extended westward. There are a number of alignment options under consideration for this extension; these are discussed in relation to the Program in **Section 2.7.3.**

In addition, upgrades to existing road segments along Drake Brockman Drive / Stockdill Drive, Southern Cross Drive / Parkwood Road, and Ginninderra Drive will occur to ensure that the roads are able to service the increased usage as a result of implementation of the Program. The road

improvement works will be staged to reflect the changing usage of the roads as the Program progresses (Aecom 2014a[25]). The section of Ginninderra Drive between Florey and Tillyard Drives would require duplication around the same time as the Ginninderra Drive extension also occurs.

Development of Parkwood Road would not be expected to occur until post 2020, at which time the bend west of Macfarlane Burnet Avenue will be realigned and off-road pedestrian and cycle facilities will be constructed. Development further along on Southern Cross Drive would not be required until post 2031. This work would include minor intersection works such as signalisation and bus queue jump facilities. By 2041, two service roads may be required between Spofforth Street and Beaurepaire Crescent, and west of Starke Street (Aecom 2014a). Illustrated in **Figure 2-5** is a map of the existing road network proximate to the Project Area.

Development of Stockdill Drive and Drake Brockman Drive will occur in stages. Stage 1 will include construction of the access road into the Urban Development Area approximately one kilometre west of Britten-Jones Drive, the provision of an off-road concrete path and on-road cycle lane from the access road to Spofforth Street, and minor intersection works at Spofforth Street and Britten-Jones Drive. By the late 2030s duplication of Stockdill Drive that includes changes to the road reserve in one area, and major intersection upgrades at the access road to the urban development area, Spofforth Street, and Britten-Jones Drive will be required. Similar work will also be required along Drake Brockman Drive (Aecom 2014a).

The Program also proposes the provision of sewer pipes to service the Urban Development Area. This will involve the placing of pipes along a north / south alignment through the Project Area, generally following the WBCC boundary. It should be noted that whilst this is considered as part of the Urban Development component of the Program, it is partially located within the WBCC and will impact this area. There are a number of methods proposed for achieving this and these are discussed in more detail in **Section 2.7.4**.

[25] Aecom (2014a) *West Belconnen Technical Traffic Report*, unpublished report prepared for Riverview Projects Pty Limited, Canberra.

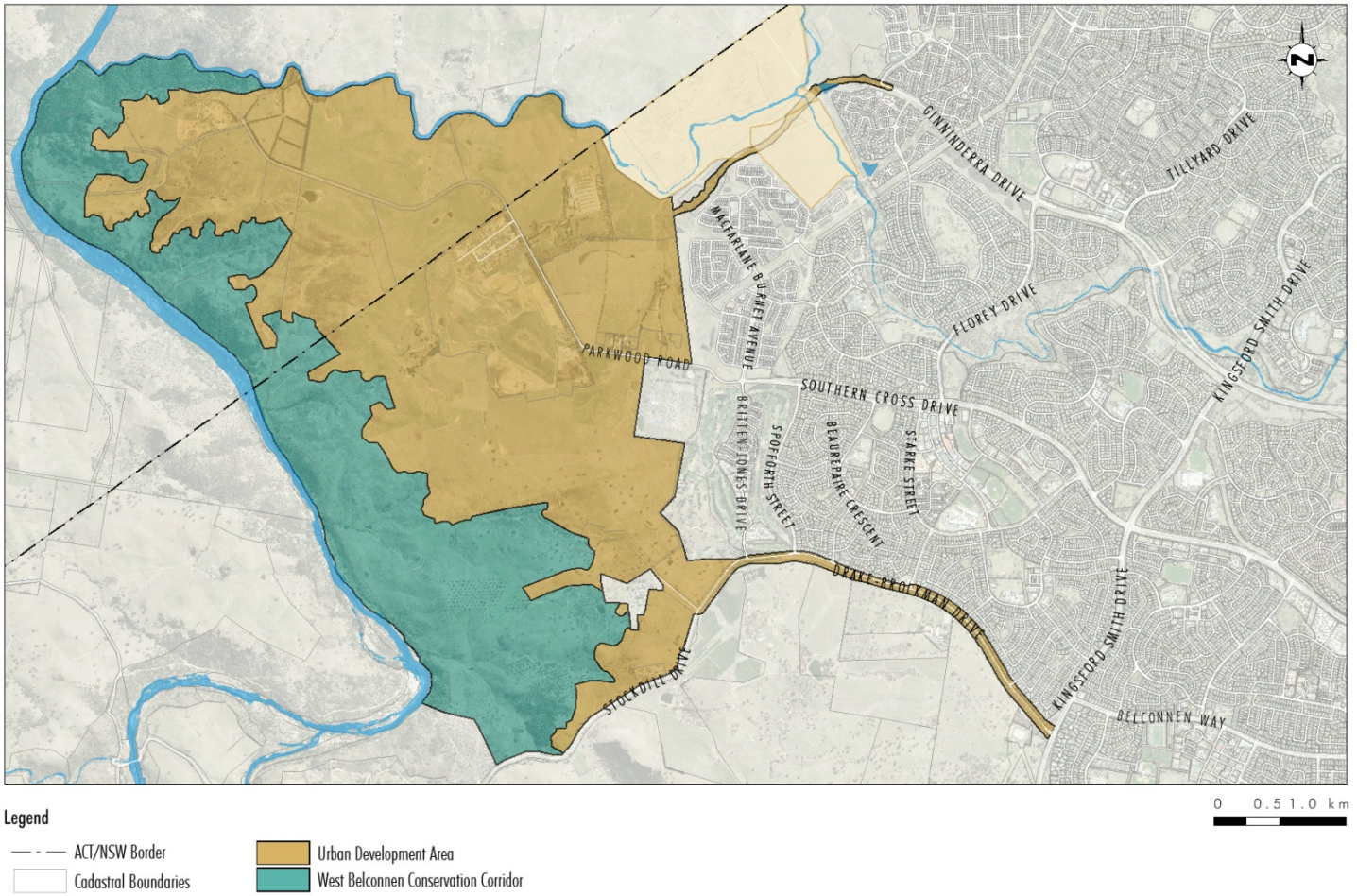

Figure 2-5

Existing road network peripheral to the Project Area

2.6.2 Description of the Non-Urban Component

The current Murrumbidgee River Corridor, as identified in the Territory Plan and YLEP, arbitrarily covers the river valley (**Figure 2-2**). In the ACT this generally covers the immediate river gorge whilst in NSW it is more broadly covered by the areas of E3 'Environmental Management' zoning – neither of which accurately represents the environmental values on the ground. Due to the scale of the YLEP, zoning is most often applied to an entire Lot in order to avoid split-zoned parcels. Whilst this makes sense from a broad-scale land-use planning perspective, it would be an over-simplification to assume that this zoning reflects the location of environmental values on the ground, particularly when discussing much smaller scales. Furthermore, the Regional Plan (NSW Gov't 2016a) highlights the lack of local scale, field validated mapping across many areas of NSW (including the Project Area) as an issue. Prior to any development, the Regional Plan recommends that field survey occurs to determine the actual distribution of environmental values present in the area, and as discussed above, this is the approach used by the Program.

KMA (2013a[26]) identified a number of conservation priorities within and adjacent to the Project Area based on flora and fauna studies that had occurred over the preceding four years. These include:

- the Murrumbidgee River and Ginninderra Creek Corridors (the watercourses and adjacent riparian vegetation)
- woodland within the gorge
- rocky habitat above the Murrumbidgee River; and
- hollow bearing trees.

These areas were identified based on the presence of habitat for threatened fauna and flora species, a threatened ecological community (including within west Molonglo), sensitive riparian habitats, and regional connectivity values, especially for riparian and woodland habitats. Most of these values are found within or adjacent to riparian habitat along the Murrumbidgee River and Ginninderra Creek (discussed further in **Section 3**). The boundary of the WBCC has been developed to avoid the majority of these conservation priorities, using field verified, site-based information. The Program also increases the protection of these lands by adding a 'nature reserve' overlay to the updated zoning. In addition to protecting key ecological values, the WBCC also includes the greater of the 100-year average recurrence interval (ARI) (flood line) or required 40 metre riparian zone for Ginninderra Creek, is designed to be contiguous with the Murrumbidgee River Corridor to the north and south of the Project Area, and uses the topography as a natural aid for delineation.

The WBCC also protects places of Indigenous heritage values that are associated with the Murrumbidgee River Corridor and Ginninderra Gorge. Heritage assessments have been completed for the Project Area (see **Section 3.3.3**), and work continues with the Indigenous community to identify values in the area to ensure they are appropriately incorporated into the WBCC and managed into the future.

The Program's non-urban component proposes to extend the existing Murrumbidgee River Corridor to create the WBCC so that these values may be protected in perpetuity (**Figure 2-2**). In total, 549.9 hectares of land is proposed to be reserved within the WBCC.

Habitat avoided by the Program through its inclusion in the WBCC comprises all structured native vegetation, including mosaics of open grassland and woodland that currently occur outside of the

[26] Kevin Mills and Associates (KMA) (2013a) *West Belconnen Project NSW Land Flora and Fauna Studies*, prepared for The Riverview Group, Canberra.

Murrumbidgee River Corridor. Ongoing management of the WBCC will seek to enhance overall natural values (i.e. diversity of habitats and associated features, and connectivity); ensuring that species other than those formally protected under legislation will also be protected within the WBCC. This includes species that occupy ecotonal habitats such as grazing marsupials, which require vegetation diversity and connectivity of habitats.

These values will be further protected by a buffer between the WBCC boundary and the edge of the main urban development. This buffer will be wholly included within the Urban Development Area and will include all bushfire Inner Asset Protection Zones (APZs) required by the 'ACT Strategic Bushfire Management Plan 2014- 2019' (ACT Gov't 2014[27]), 'Planning for Bush Fire Protection' (NSW Gov't 2006[28]), and associated legislation; water sensitive urban design (WSUD) measures and infrastructure; and the required boundary 'ring-road' surrounding the urban development. As such, the boundary presented on the maps as the WBCC is the minimum required to meet the Program's triple bottom line approach and protect the identified MNES habitat and the river corridors; it does not represent the exact boundary of the urban development.

Bushfire management measures to protect ecological values will occur within the WBCC. These measures do not include the establishment of APZs to protect the urban development, which as stated above will occur outside of the WBCC boundary. Rather, they are actions that focus on managing fuel loads to reduce the impact of fire on the species and communities present in the WBCC. The extent to which these measures will be applied will be minimised through design of the urban area and houses as required.

The values of the WBCC will be protected and managed as an International Union for Conservation of Nature (IUCN) Category IV reserve (Stolton, Shadie, and Dudley 2013[29]) that employs a best-practice approach to:

- Protect and restore biodiversity and ecosystem functions and ecological connectivity across the regional landscape to the Murrumbidgee River Corridor and other reserves.
- Manage the urban edge to protect both the values of the reserve and the amenity, health, and safety of the urban community.
- Provide quality recreation experiences for the enjoyment of visitors and local residents.
- Encourage active learning and engagement in management by the community, organisations, the local Aboriginal community, and research and educational institutions.
- Provide an adaptive management framework through monitoring, research, and periodic review of the management plan enabling evidence-based adjustments as needed.

This approach will be overseen by the WBCC Management Trust and implemented through the WBCC RMP (see **Section 4.3** for greater detail on how these two entities operate within the Program).

In addition to the ecological values of the Project Area, the Program also recognises the important scenic and amenity values the Murrumbidgee River Corridor and Ginninderra Gorge have to the community. The WBCC will protect the scenic values of the river corridor and gorge by blocking the

[27] ACT Government (2014) *ACT Strategic Bushfire Management Plan 2014 – 2019*, ACT Emergency Services Agency, Canberra.

[28] NSW Government (2006) *Planning for Bush Fire Protection – A guide for Councils, Planners, Fire Authorities and Developers*, NSW Rural Fire Service and Department of Planning,

[29] Stolton, S. Shadie, P. and Dudley, N. (eds) (2013) *Guidelines for Applying Protected Area Management Categories*, Best Practice Protected Area Guidelines Series No. 21, IUCN, Gland.

view of urban development from most of the reserve. Furthermore, in order to open these values up to the public, in particular Ginninderra Falls, the Program proposes to allow infrastructure and tourism development in certain parts of the WBCC for recreational and tourism purposes.

2.6.2.1 Other Development within the West Belconnen Conservation Corridor

As noted above, the Program includes development within the WBCC to provide for recreational, bushfire management, and maintenance activities. The Program Report discusses the current draft plan for development in the WBCC, though in summary it includes:

- recreation and tourist facilities such as buildings, picnic areas, car parks, two access roads, and numerous unsealed walking and cycling tracks
- bushfire management activities such as vegetation control by way of slashing, controlled burns, and livestock grazing; and
- unsealed bushfire and maintenance management tracks.

The detailed design for this development is yet to occur as it is likely to change over the life of the WBCC. The details of these works will be specified progressively as development applications for works are lodged and approved over the course of the construction and operational phases of the Program. These development applications will be compliant with Commonwealth legislation and, therefore, the commitments set out in the Program.

In the event that the designs for this infrastructure substantially changes, the Defined Process Strategy (**Section 2.6.3**) will be implemented to assess additional impacts to MNES within the WBCC. Discussed in detail in the Program Report, in summary the Defined Process will apply the same assessment criteria as set out in this report for current proposed impacts of the Program.

As discussed further in **Section 4.3.1**, the WBCC RMP will guide all planning and development actions that will occur within the WBCC such that the conservation priorities of the WBCC (particularly regarding MNES) are maintained throughout the development process. Section 4.3.1 of the Program Report outlines the principles that must be adhered to with respect to the implementation of infrastructure within the WBCC. In particular the WBCC RMP will ensure there is no net reduction in total areas of MNES habitat as a result of these development activities.

2.6.3 Defined Process Strategy

This component of the Program seeks to define a process that will apply to future development within the Project Area; which will be implemented when either of the following occurs:

- Proposal to develop any area dominated by native grasses that is part of a larger patch of native grassland which includes high or moderate quality pink-tailed worm-lizard habitat as mapped by Osborne and Wong (2013).
- Additional servicing or infrastructure requirements within the WBCC that impact MNES beyond what is already described by the Program.

In these instances, the Defined Process will provide the Commonwealth with the confidence that impacts to MNES from actions outside of those specified in the Program will be consistently and appropriately assessed and managed. In achieving this outcome the relevant conservation advice, recovery plans, significant impact assessment guidelines and offset policy under the EPBC Act will be

applied in order to ensure a consistent outcome for MNES across the implementation of the Program.

In summary, the Defined Process relating to MNES within the Project Area is as follows:

1. Where development within the Project Area triggers the need to implement the Defined Process Strategy, assess the impact of the proposed development using data collected from site-based, field verified surveys that are consistent with EPBC Guidelines.

2. Implement avoidance and mitigation measures to the greatest extent practicable through design.

3. Determine offset requirements for any residual impacts using the criteria outlined above and applied in assessment of the Program.

4. Identify an appropriate offset and establish according to the relevant State or Territory jurisdiction.

5. Prepare and implement an offset management plan either for incorporation into the WBCC management plan or as a stand-alone plan in the instance that the offset cannot be co-located in or adjoining the WBCC. Any management plan will include all aspects that apply to other MNES such as adaptive management and ensuring delivery of the offset and environmental values in perpetuity.

Any actions undertaken and offsets established using the Defined Process will be included in the Program's annual report. Any amendments to the Defined Process or offset assessment criteria will be managed through the adaptive management process and also reported annually.

As no impacts are currently known, the Defined Process Strategy is not subject to detailed assessment in this report. In lieu of this, two scenarios are described in **Section 4.7** to demonstrate the application of the Defined Process.

2.7 Alternatives

This section outlines the various alternatives associated with the Program and describes the basis for design and approvals solutions proposed by the Program.

2.7.1 Alternatives to the Approval Process

There are two options for approval processes under the EPBC Act, these are:

1. To undertake a conventional development assessment whereby different stages and State / Territory jurisdictions are assessed, approved, and constructed separately. With respect to the EPBC Act process, this would mean approval through Part 9.

2. To undertake assessment under Part 10 of the EPBC Act to consider all aspects of the Program concurrently and commit to defined outcomes over the life of the Program. This approach would still require the relevant approvals at a State / Territory level, however, would ensure that the planning and subsequent development benefits from a wider consideration of factors than would be included under a Part 9 process.

Whilst both of the above options would potentially achieve the same development goals, the first option, to undertake site-by-site EPBC Act Referrals whether by stage or through State / Territory jurisdiction, would come at a greater financial cost due to the administrative burden of preparing

multiple referrals and establishing and managing the mitigation activities and offset sites associated with them. Site-by-site referrals also make it difficult to identify and address the cumulative effects of development at the landscape level (Australian Gov't 2013a). The assessment of a complex area such as west Belconnen using site-by-site referrals is unlikely to yield as positive outcomes for the environment or development as a Strategic Assessment (option 2 above); therefore, site-by-site referrals are not considered viable.

The second and preferred option, for the assessment of impacts to MNES and approval of the Program under Part 10 of the EPBC Act, also influences the approach to planning for all subsequent local jurisdiction approvals. A Strategic Assessment is able to consider long-term and regional factors across all components of the Program from the outset, results in greater efficiencies and improved outcomes for the environment and development objectives. By taking a longer term look at the staging, implementation and nature of development, the strategic assessment approach is able to avoid the 'tyranny of small decisions' that characterise cumulative impacts and a progressive loss of opportunities, particularly with environmental factors. Accordingly, this process is the preferred option to address environmental approval requirements.

In addition the Strategic Assessment process allows for assessment of impacts prior to the detailed design phase by taking a 'whole of program' approach. This process describes the commitments to environmental performance of the project which will need to be met through the detailed design and construction process.

The Program identifies all land required for urban development in the Project Area for the next 30 – 40 years. Should any additional areas for urban development or actions not covered by the Program, be identified for development, these will require assessment and approval through the EPBC Act referral process under Part 9 of the EPBC Act.

2.7.2 Alternatives to the Program

To do nothing would be to leave current land use zoning and leases in place. This is considered not to be a suitable alternative as both the ACT and NSW Governments have highlighted that the region's population is projected to grow over the next 30 – 50 years. To accommodate this population growth, it is estimated that 55,000 new dwellings will be required in the region by 2059 (NSW Gov't 2016a; ACT Gov't 2012a).

As discussed in **Section 2.4.1**, the CSP and the ACT Planning Strategy replaced the 1960s 'Y' Plan with a strategy to balance greenfield and infill development (i.e. 50:50 ratio). Furthermore, the ACT Planning Strategy has identified the key areas in which these types of development shall occur over the next 15 (and up to 45) years (**Figure 2-3**). In this, the Project Area is identified as a 'Future Urban Area' utilising greenfield land.

Despite infill development generally being considered more sustainable as it reduces infrastructure requirements and travel times, and impacts areas that may already be experiencing stress due to the surrounding land uses; according to the ACT Government (2012a) it alone cannot provide enough housing (including affordable housing options) to meet the estimated future demand. In contrast, the Program will:

- reduce the impact of greenfield development by using the criteria of the Green Community Rating to design and plan the development
- avoid and protect ecological values where possible
- utilise existing major transport routes

- build on the current Canberra wide east – west business / education / community corridor that Belconnen forms a part of
- keep the 'market centre' to 15 kilometres from the Canberra City
- prioritise social networks and community based planning mechanisms to ensure social sustainability; and
- provide a range of housing types and business opportunities to meet the economic principles of ecologically sustainable development.

As a consequence, the need for the Program is demonstrated through a necessity to provide housing and recreational facilities to a growing population. Accordingly, the 'do-nothing' option is not acceptable to the ACT or NSW governments.

Consideration of alternate locations for the development that is necessary to meet population growth and the need for services in the ACT and surrounding region is limited by a range of factors including considerations of access, feasibility, environmental impact, and sustainability of the communities once constructed. Forward planning for Canberra had identified the Project Area as being part of the urban growth plan given it has the advantage of access to the existing infrastructure and services in the broader west Belconnen area and is largely unconstrained by environmental factors (**Figure 2-3**) (ACT Gov't 2012a). Attributes of the area also add to the potential social benefits of the Program. Other potential locations are presently not considered as financially viable in comparison to the Project Area.

Within the Program itself there are also alternatives for the placement of two of the major infrastructure components. These are the alignment of the Ginninderra Drive extension and the construction options for the sewer alignment. These are discussed below.

2.7.3 Ginninderra Drive Extension Alternatives

The Program will extend Ginninderra Drive to provide a third arterial road access to the Project Area and service the final stages of the development. The road will be a two lane carriageway (single lane in each direction) with a posted speed limit of 60 kilometres per hour and would be in addition to the two other arterial road connections at Drake Brockman / Stockdill Drive and Parkwood Road / Southern Cross Drive (Brown Consulting 2014a[30]).

With respect to the Ginninderra Drive extension, a range of options have been considered with the first alternative being not to proceed and exclude this aspect from the Program. This would result in the development having to depend on the existing connections at Drake Brockman / Stockdill Drive and Parkwood Road / Southern Cross Drive. Under this option there would be no impacts to the established environmental offset areas and associated MNES.

Although technically feasible, traffic modelling has indicated that not constructing the Ginninderra Drive extension will lead to longer travel times and distances (leading to significantly increased greenhouse gas emissions), increased social impacts such as noise pollution and suburb amenity, and reduced efficiency of public transport networks (Brown Consulting 2014a; Aecom 2014a). Given these factors, the option to not construct the Ginninderra Drive extension is undesirable as it will lead to significant, adverse social and environmental impacts that would otherwise be avoidable and by limiting access to the Project Area to two arterial connections, sustainability of the Program is not optimised.

[30] Brown Consulting (2014a) *West Belconnen Structure Plan: Ginninderra Drive extension Alignment Options Study*¸ prepared for The Riverview Group, Canberra.

The current alignment of Ginninderra Drive has been designed and built to service the increased usage levels that will be associated with the Program. Extending Ginninderra Drive is not only consistent with the original design intent, but also realises the value of the original investment in constructing Ginninderra Drive to its existing standard. It is, therefore, a more sustainable alternative as construction costs will be limited and existing infrastructure will be used more efficiently (Brown Consulting 2014a; Aecom 2014a).

In planning for the extension of Ginninderra Drive, a total of eleven alignment options have been considered. The route options are illustrated in **Figure 2-6** and the characteristics of these options are discussed further below.

As illustrated in **Figure 2-6**, all options that extend Ginninderra Drive from its current termination pass through environmental offset areas except option 3. The corresponding impacts on MNES of each of these options vary and include golden sun moth and natural temperate grassland values.

A number of other alignment options (3, 6A, and 6B) follow a route that originates from the intersection of Ginninderra Drive and an existing high voltage power easement which traverses the suburb of Dunlop. These alignment options include alternatives for entirely avoiding impacts to the environmental offset areas or options that result in impacts confined only to the Macgregor offset. Despite this, these routes were considered unfeasible due to the need to access the powerlines for ongoing maintenance and associated noise and traffic impacts to the residents of Dunlop.

Following stakeholder consultation, the options were narrowed down to three preferred: 4, 4A, and 5. This decision was based on considerations including engineering feasibility (e.g. number of bridges), costs (e.g. length), impacts to Aboriginal heritage values, impacts to existing infrastructure (including maintenance access and safety concerns), and impacts to golden sun moth and natural temperate grassland (Brown Consulting 2014a).

Further discussions during workshops held to address this issue led to option 5 being the most preferred due to it having comparatively less environmental impacts than options 4 and 4A. These environmental impacts include the loss of planted trees and the primary impact of fragmentation and removal of known golden sun moth habitat (Brown Consulting 2014a). The assessment of impacts to MNES, including golden sun moth, as a result of the Program (including the proposed Ginninderra Drive extension) are considered with respect to the 'Matters of National Environmental Significance Significant Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999*' (Significant Impact Guidelines 1.1) (Australian Gov't 2013b[31]) in **Section 4**.

Table 2.1 summarises option descriptions and the positive and negative environmental factors that were considered for each (Brown Consulting 2014a).

[31] Australian Government (2013b) *Matters of National Environmental Significance: Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*, Department of the Environment, accessed online (April, 2015): http://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf.

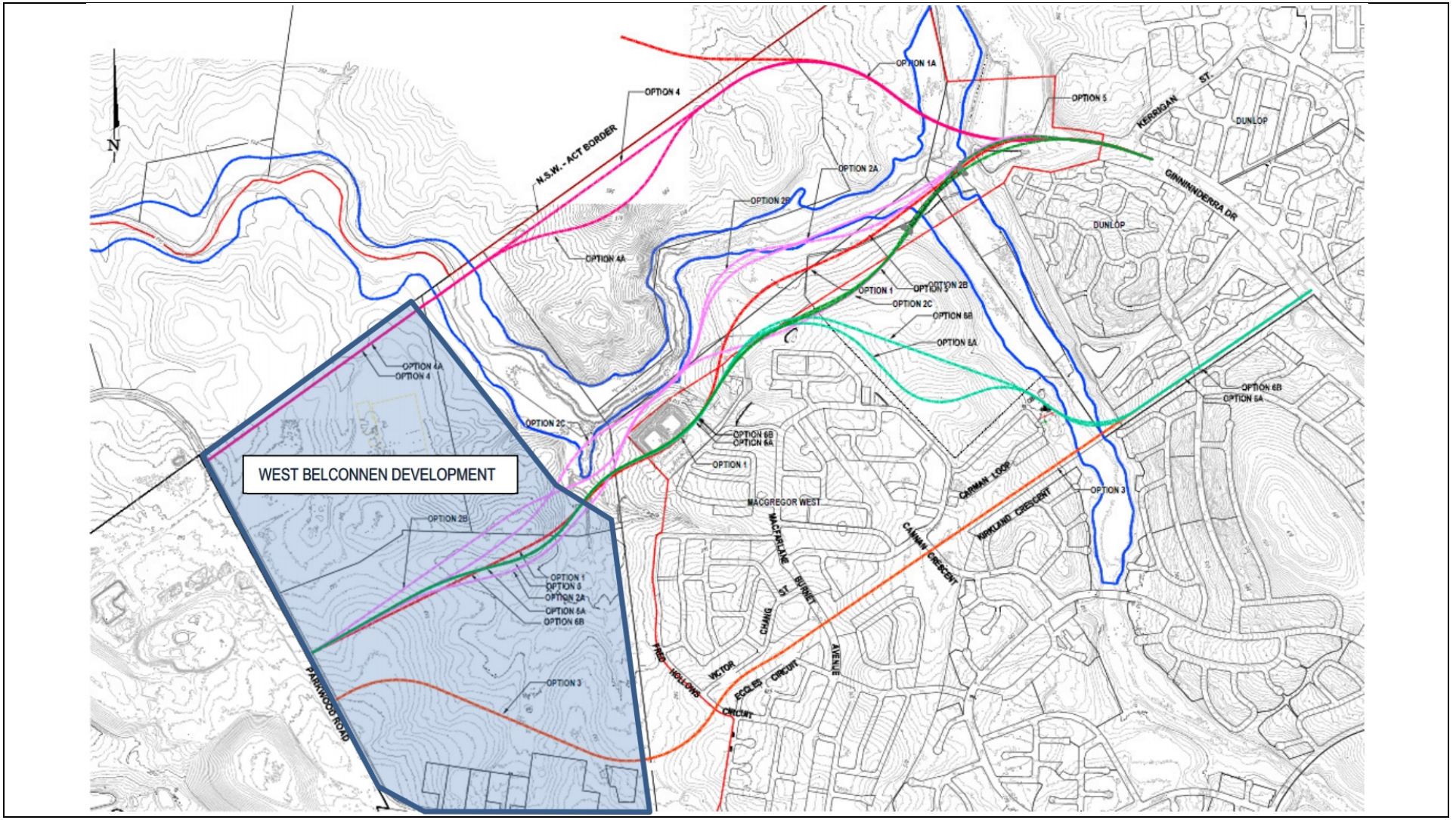

Figure 2-6

Ginninderra Drive extension Route Options (reproduced from Figure 18 in Brown Consulting 2014a)

Table 2.1 Route Option Summary

Option	Option Description	Positive Factors	Negative Factors
1	Runs through the centre of the environmental offset areas using disturbed land south of Ginninderra Creek, avoiding existing services and the creek. It is 2.2 kilometres long with one creek crossing.	• Avoids existing infrastructure. • Bridge location spans area of highest golden sun moth density, thereby limiting impacts in this section. • Uses existing Jarramlee homestead (NSW) access road alignment.	• Lies within 100 metres of residents in Macgregor West. • Requires the reconstruction of the water quality control pond in Dunlop. • Breaks connectivity between the Jarramlee and Macgregor offsets. • Impacts to known golden sun moth habitat.
1A	Northern route that utilises the existing Jarramlee Road and traverses private land in NSW west to connect to the Project Area. It is 1.3 kilometres long within the ACT (the final alignment through NSW would need to be negotiated with landholders) and will require two creek crossings.	• Minimal impact on golden sun moth habitat. • Preserves connectivity between the Jarramlee and Macgregor offsets. • Avoids the water quality control pond in Dunlop.	• Road uses private property in NSW. • Breaks connectivity of low – medium quality golden sun moth habitat at Gooromon Ponds Creek crossing. • Breaks connectivity to Dunlop Grassland Nature Reserve.

Option	Option Description	Positive Factors	Negative Factors
2A	Generally runs east to west and is located in the north of the non-habitat zone, closest to Ginninderra Creek. It is 2.2 kilometres long and will require one creek crossing.	• Avoids existing infrastructure. • Minimal impact on golden sun moth.	• Breaks connectivity between the Jarramlee and Macgregor offsets. • Portions of the road lie within the 100 year ARI of Ginninderra Creek. • Requires the reconstruction of the water quality control pond in Dunlop. • Potential safety issues where it passes high voltage power poles. • Requires the relocation of the Bicentennial National Trail.
2B	Generally runs east to west and is located in the south of the non-habitat zone furthest from Ginninderra Creek. It is 2.25 kilometres long and will require one creek crossing.	• Avoids existing infrastructure. • Minimises impact on golden sun moth habitat areas.	• Requires the reconstruction of the water quality control pond in Dunlop. • Portions of the road lie within the 100 year ARI of Ginninderra Creek. • Potential safety issues where it passes high voltage power poles. • Requires the relocation of the Bicentennial National Trail.

Option	Option Description	Positive Factors	Negative Factors
2C	Generally runs east to west crossing the tree plantings in the Macgregor offset. It is 2.15 kilometres long and requires one creek crossing.	• Avoids existing infrastructure. • Minimal impact on Bicentennial National Trail. • Predominantly within low quality habitat areas. • Minimises disturbance within environmental offset areas.	• Portions of the road lie within the 100 year ARI of Ginninderra Creek. • Loss of planted trees. • Breaks connectivity between the Jarramlee and Macgregor offsets. • Impacts to known golden sun moth habitat. • Requires the reconstruction of the water quality control pond in Dunlop.
3	Located along high voltage power line easement south of Dunlop and passes through Macgregor. It is 2.15 kilometres long and requires one short creek crossing.	• Minimum golden sun moth habitat impact. • Does not impact on existing ponds.	• Requires a major intersection connection at Ginninderra Drive, and other intersections within Macgregor and Dunlop. These will increase traffic congestion and create inefficiencies in traffic movement within these areas. • Noise impacts to Macgregor West and Dunlop. • Runs between high voltage power poles.

Option	Option Description	Positive Factors	Negative Factors
4	Northern most route within the ACT, variation to option 1. It is 2.4 kilometres long and requires two short creek crossings.	• Utilises existing Jarramlee Road. • Low loss of golden sun moth habitat. • Maintains connectivity between the Jarramlee and Macgregor offsets. • Maximises distance from existing residential developments. • Does not impact on Dunlop water quality control pond.	• Longest route within an environmental offset area. • Requires an approximately 16 metre deep cut which extends into NSW, to achieve minimum safety standards. • Breaks connectivity to Dunlop Grassland Nature Reserve. • Separates the Jarramlee offset from adjacent NSW land that contains unknown golden sun moth values. • Long lengths of straight east to west road providing numerous safety hazards.
4A	Northern most route within the ACT, variation to option 1. It is 2.5 kilometres long and requires two short creek crossings.	• Utilises existing Jarramlee Road. • Low loss of golden sun moth habitat. • Maintains most of the connectivity between the Jarramlee and Macgregor offsets. • Maximises distance from existing residential developments. • Does not impact on Dunlop water quality control pond.	• Longest route within an environmental offset area. • Requires an approximately 8 metre deep cut to achieve minimum safety standards. • Breaks connectivity to Dunlop Grassland Nature Reserve. • Breaks connectivity at Gooromon Ponds Creek, isolating some patches within the Jarramlee offset. • Separates the Jarramlee offset from adjacent NSW land that contains unknown golden sun moth values. • Long lengths of straight east to west road providing numerous safety hazards.

Option	Option Description	Positive Factors	Negative Factors
5	Combination of options 1 and 2C, following the planted trees. It is 2.15 kilometres long and requires one creek crossing.	• Follows low quality habitat. • Avoids existing infrastructure. • Avoids Bicentennial National Trail. • Shortest route across environmental offset areas and golden sun moth habitat. • Maintains connectivity between the Jarramlee offset and Dunlop Grassland Nature Reserve. • Connectivity between the Jarramlee and Macgregor offsets may be mitigated by bridge length.	• Loss of planted trees. • Requires the reconstruction of the Dunlop water quality control pond. • Comes within 100 metres of residents at Macgregor West. • Breaks connectivity between the Jarramlee and Macgregor offsets. • Impacts known golden sun moth habitat.
6A	Combination of options 3 and 5. It is 2.6 kilometres long and will require one creek crossing.	• Minimal impact on areas of high golden sun moth density. • Maintains most of the connectivity between the Jarramlee and Macgregor offsets, and all of the connectivity between the Jarramlee offset and Dunlop Grassland Nature Reserve.	• Requires a major intersection connection at Ginninderra Drive and another intersection at Dunlop. These will increase traffic congestion and create inefficiencies in traffic movement within these areas. • Comes within 100 metres of residents at Macgregor West. • Increased traffic noise for residents at Dunlop and Macgregor West. • Longest route within the Macgregor offset. • Isolates a patch within the Macgregor offset.

Option	Option Description	Positive Factors	Negative Factors
6B	Combination of options 3 and 5 using a different route through the Macgregor offset. It is 2.65 kilometres long and will require one creek crossing.	• Minimum impact on areas with high densities of golden sun moth. • Maintains most of the connectivity between the Jarramlee and Macgregor offsets, and all of the connectivity between the Jarramlee offset and Dunlop Grassland Nature Reserve.	• Requires a major intersection at Ginninderra Drive, and another in Dunlop. These will increase traffic congestion and create inefficiencies in traffic movement within these areas. • Comes within 100 metres of Macgregor West residents. • Isolates a patch within the Macgregor offset.

2.7.4 Sewer Alignment Alternatives

An important component of the Program that must be considered is the provision of infrastructure for services and utilities such as sewerage, potable water, electricity, gas, and communications. Of these, the sewer alignment requires further discussion due to the potential for impacts to MNES as a result of its development. The following section outlines the alignment alternatives proposed for both the eastern (Murrumbidgee River) and western (Ginninderra Creek) catchments in the Project Area.

Existing sewer services within west Belconnen converge upon the Ginninderra sewer tunnel, which runs generally north – south through the ACT portion of the Project Area, and empties at the Lower Molonglo Valley Water Quality Control Centre (located approximately one kilometre to the southwest of the Project Area). The Ginninderra sewer tunnel includes an overflow structure and sewer vent, three mechanised odour / scrubbing control units, and an adjoining gravity sewer that runs through Macgregor West (**Figure 2-6**). Low reticulation mains also have been installed within Macgregor West and service the Magpies Belconnen Golf Club. There is no existing sewer infrastructure within the NSW portion of the Project Area (Brown Consulting 2014b[32]).

As a result of natural topography, the Project Area is divided into two catchments for the purpose of gravity drainage. These are defined by the ridge line that runs approximately northeast to southwest through the Project Area (shown in blue in **Figure 2-7**). Consequently, the Project Area will be serviced by two different trunk sewers: the Ginninderra Creek Trunk Sewer and the Murrumbidgee River Trunk Sewer (Brown Consulting 2014b).

The existing Ginninderra sewer tunnel has sufficient capacity to service the urban development proposed under the Program, therefore, both trunk sewers will empty into it. There are a number of construction methods that may be used for these connections, which in turn influence their final alignment. The range of alignment options are discussed below and form part of the analysis of alternatives for the Program.

The two key methods of construction for the sewer are trenching and micro-tunnelling. In general, trenching is limited to following the natural contours of the land in order to take advantage of gravity for flow and is generally the cheapest construction method. It can be augmented with pump stations at locations where gravity cannot be relied upon; or through the installation of above ground pipes to cross watercourses or other features whilst maintaining a gravity-fed flow. These additional elements are engineering solutions that add additional cost and ongoing maintenance liabilities. This includes the requirement of the provision and maintenance of an access road along the alignment in order to maintain the serviceability of the sewer over its operational life. In areas of steep country, this can lead to extensive cut and fill requirements to facilitate stable and safe access.

Alternatively, micro-tunnelling results in minimal surface impacts. It is typically used to install pipes under areas that are constrained by natural values or other high value or critical infrastructure (e.g. railways, roads, rivers, or environmentally sensitive areas). Surface impacts are limited to an approximately 20 metre by 20 metre area per vertical shaft, from which the vertical shafts are excavated. These shafts are used to lower the tunnelling equipment which bore tunnels to the next shaft, and are then used to fit and grout the pipes into place. The shafts are retained after construction is complete as manhole access points (Brown Consulting 2014b). While this construction method is more expensive in terms of capital outlay, it has negligible surface impacts, allows for the entire system to be gravity-fed, and avoids many ongoing liabilities.

[32] Brown Consulting (2014b) *West Belconnen Sewer and Water Concept Plan Report*, prepared for The Riverview Group, Canberra.

A summary of the positive and negative impacts for each alternative is discussed below in **Table 2.2**. Due to the topography and environmental values present along the western edge of the Murrumbidgee catchment, the analysis of options for this component of the proposed sewer alignment has a greater bearing on the potential environmental impacts of the Program. The alternatives considered for the Murrumbidgee River catchment are shown in **Figure 2-8**. For all options, minor impacts to the environment are likely during construction, however, these can be managed to avoid all impacts to MNES and other ACT listed matters. Maintenance and servicing access will also be required; however, the design has been able to accommodate these requirements on existing farm tracks in most instances. The options where provision for access would have substantial environmental effects are also undesirable from a construction or maintenance cost perspective.

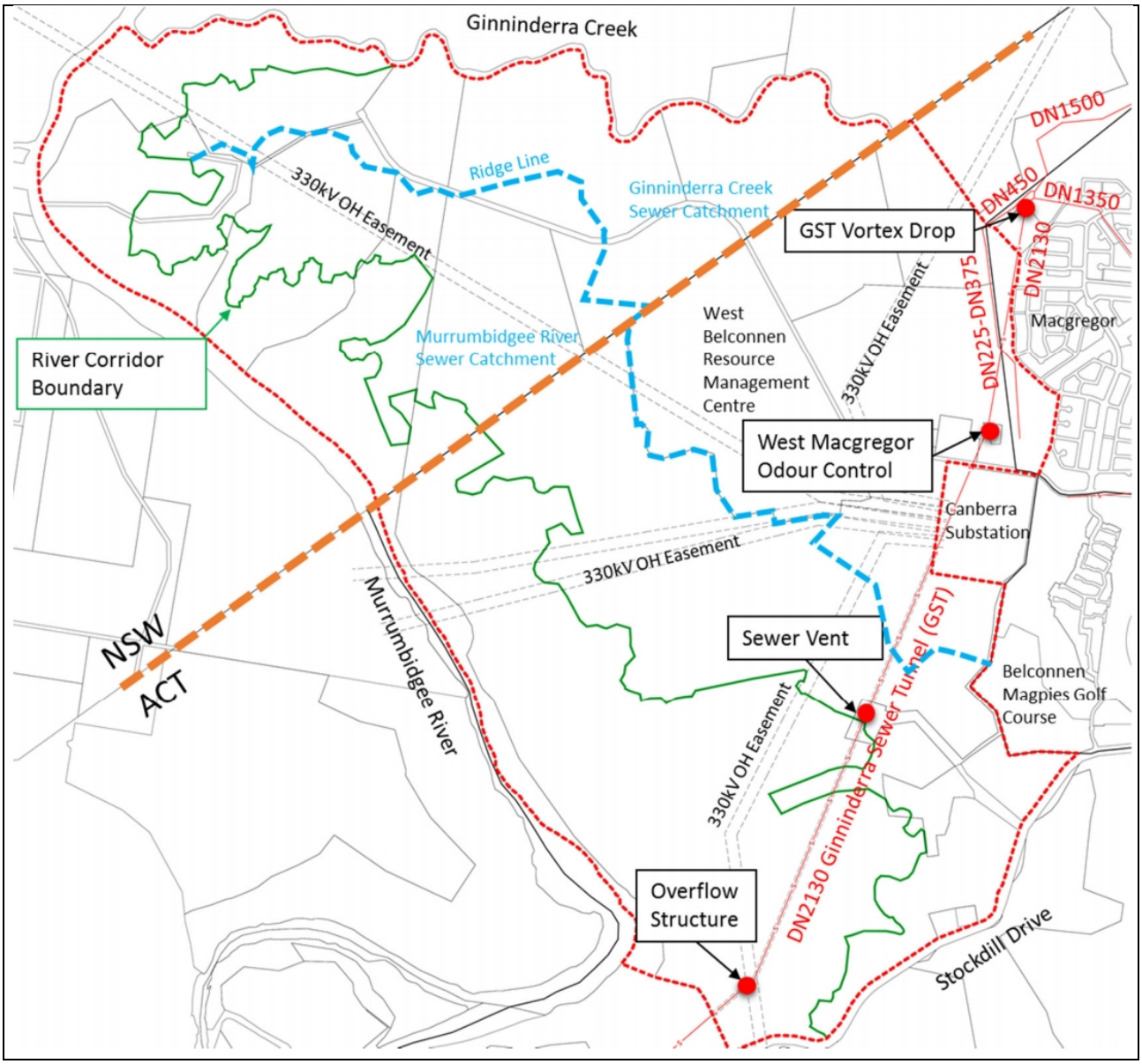

Figure 2-7

Two Catchments and Existing Sewer Services within the Project Area (Figure reproduced from Figure 4 in Brown Consulting 2014b)

Table 2.2 Sewer Alignment Options

Option	Positive Factors	Negative Factors
Ginninderra Catchment		
G1 – Microtunnel Gravity Sewer	• Avoids impacts to MNES including golden sun moth, pink-tailed worm-lizard, and box gum woodland[#].	• 48 percent more expensive in capital costs and 16 percent more expensive in net present value than G2. • 12 trees removed, 9 of high quality (impacts to the high quality trees may be reduced or eliminated at the detailed design phase). • Unknown impact to Aboriginal heritage sites.
G2 – Pump Station and Gravity Sewer	• No trees are removed. • Avoids impacts to golden sun moth, pink-tailed worm-lizard, and box gum woodland[#].	• Requires two pump stations as the gravity sewer alone cannot service the catchment.
Murrumbidgee Catchment		
M1 – Trench Gravity Sewer	• Cheapest in regards to capital costs and net present value. • No impact to Aboriginal heritage values.	• Impacts approximately 5.3 hectares or four percent of pink-tailed worm-lizard habitat within the WBCC. • 16 trees of medium (three), poor (12), or dead (one) quality will be removed. • Impacts upon more developable area than M2. • There are requirements for noise and odour buffers around the pump stations.

Option	Positive Factors	Negative Factors
M2 – Microtunnel Gravity Sewer	• Reduced trunk sewer length, therefore, less impacts to developable area than M1. • No impacts to pink-tailed worm-lizard and box gum woodland[#]. • No impact to Aboriginal heritage values.	• Most expensive. • 16 trees of poor (eight), medium (seven), or dead (one) quality will be removed. • Impact 0.05 hectares of box gum woodland (may be reduced at the detailed design phase). • There are requirements for noise and odour buffers around the pump stations.
M3 – Gravity Sewer and Large Pump Station	• No impact to pink-tailed worm-lizard or box gum woodland.	• 16 trees will be removed. • There are requirements for noise and odour buffers around the pump stations.
M4 – Gravity Sewer and Large Pump Station	• No impact to pink-tailed worm-lizard habitat. • No impact to Aboriginal heritage sites.	• Impacts approximately 1.4 hectares of box gum woodland. • 16 trees of poor (eight), medium (seven), or dead (one) quality will be removed. • There are requirements for noise and odour buffers around the pump stations.
M5 – Gravity Sewer and Large Pump Station. Pumps to the Ginninderra Creek catchment to avoid the WBCC.	• Cheapest pump station option at 1.4 times the capital cost of M1. • Equivalent to M2 over a 50 year costing*. • No construction through the river corridor.	• 16 trees will be removed. • There are requirements for noise and odour buffers around the pump stations.

[#]box gum woodland is the EPBC Act critically endangered ecological community 'white box – yellow box – Blakely's red gum grassy woodland and derived native grassland'
*assuming there is no increase in energy costs, after which M5 will become more expensive

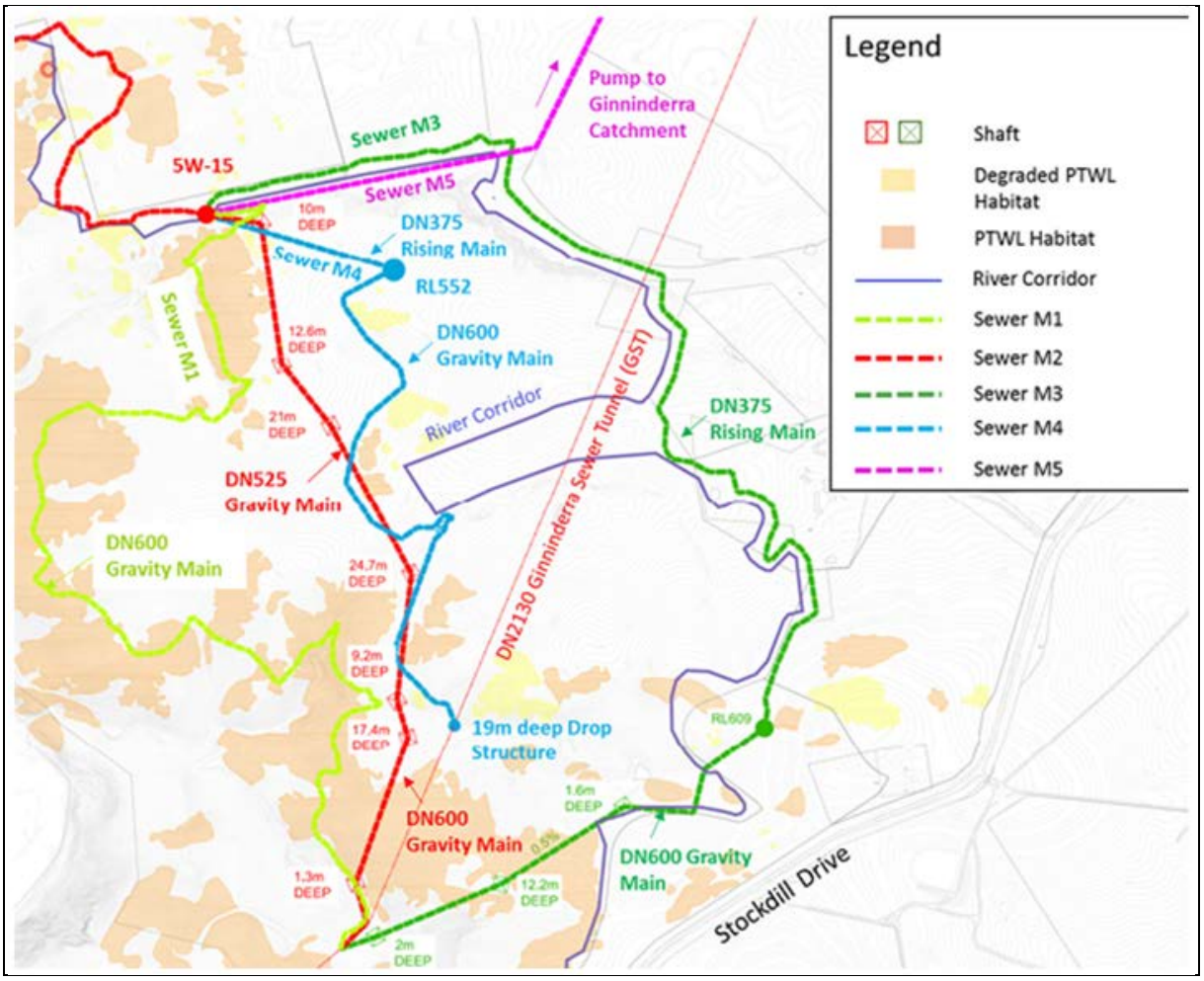

Figure 2-8

Sewer Alignment Options for the Murrumbidgee River Catchment South of 5W-15 (Figure Reproduced from Figure 9 in Brown Consulting 2014b)

Microtunneling options (G1 and M2) are considered the most preferable as they:

- decrease the environmental impacts within the Murrumbidgee River catchment
- maximise the size of the catchment serviced by gravity sewers
- have lower ongoing operational costs; and
- have no requirements for noise or odour buffers compared with pump station options.

The high upfront costs of microtunneling may be mitigated by implementing staged construction that would delay these costs over an agreed period of time (Brown Consulting 2014b).

These options will require seven vertical shafts, and, therefore, 0.28 hectares of surface will be impacted. The location of the shafts has been chosen such that there are no impacts to pink-tailed worm-lizard or box gum woodland. This aspect of the Program is discussed in greater detail with regard to MNES impacts in **Section 4**.

3.0 Existing Environment

This section provides a detailed description of the existing environment in the broader west Belconnen area that is likely to be impacted (both directly and indirectly) by the Program. It describes:

- the broad environmental and heritage values of the area
- important ecological processes in the environment, including components of biodiversity and landscape connectivity
- an introduction to the threatened species and communities relevant to the EPBC Act, occurring in the region
- Commonwealth land that lies within the broader west Belconnen area; and
- wetlands of international significance that occur within the same catchment as the Project Area.

The MNES that may be affected by the Program are introduced and discussed briefly in this section. As required, the significance of these impacts is discussed in more detail in **Section 4.**

For the purposes of this discussion, the Murrumbidgee River and Ginninderra Creek have been included within the Project Area as many actions undertaken as part of the Program have the potential to result in indirect or facilitated impacts to these riparian areas. The discussion also assumes the entirety of the Jarramlee and Macgregor offset areas also form part of the Project Area despite the proposed Ginninderra Drive extension affecting a relatively minor component of both.

Species that are listed at a State / Territory level that are relevant to the Program are also discussed briefly in this section. In NSW threatened terrestrial species are protected under the *Threatened Species Conservation Act 1995* (TSC Act), whilst aquatic species and marine vegetation are protected under the *Fisheries Management Act 1994* (FM Act). In the ACT all threatened species are listed under the *Nature Conservation Act 2014* (NC Act). These species will also be assessed in detail during State / Territory approval processes and are discussed in greater detail in **Section 6**.

3.1 Regional Context

The ACT and adjoining NSW land is located within the South Eastern Highlands and the Australian Alps bioregions. The Australian Alps bioregion consists of the higher elevation areas of the ACT and NSW (Australian Gov't 2000[33]) and is not of relevance to the assessment of potential impacts of the Program.

The Project Area lies entirely within the South Eastern Highlands bioregion, which is described by the Australian Government (2000) as being typified by the following characteristics:

> *Steep dissected and rugged ranges extending across southern and eastern Victoria and southern NSW. Geology predominantly Palaeozoic rocks and Mesozoic rocks. Vegetation predominantly wet and dry sclerophyll forests, woodland, minor cool temperate rainforest and minor grassland and herbaceous communities. Large areas, particularly in the Box-Ironbark Forests, were felled for fuel and timber for the mines during the gold rushes in Victoria. Large areas have also been cleared in NSW for grazing or plantations.*

[33] Australian Government (2000) *Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and Development of Version 5.1: Summary Report*, Environment Australia, Canberra.

The South Eastern Highlands were traditionally occupied by nomadic Aboriginal groups, who would travel according to the availability of food sources. The Canberra area is Ngunnawal country. The Ngunnawal are the Indigenous people of the region and its first inhabitants. Neighbouring Indigenous people include the Gundungurra to the north, the Ngarigo to the south, the Yuin on the coast, and the Wiradjuri inland (NCA undated[34]).

European settlement of the region began in the 1820s, with agricultural and urban development underway by the 1830s (ACT Gov't 2005a[35]).

Past and present land-use pressures have had a major consequence on the biodiversity of the South Eastern Highlands. Natural temperate grasslands[36] have declined by 99.5 percent in the Murrumbateman subregion (wherein lies the Project Area) since European settlement. Similarly, the woodlands of the South Eastern Highlands are under threat, with the once wide spread box gum grassy woodland community[37] reduced by approximately 92 percent from a total pre-European extent of 295,000 hectares to 25,200 hectares today. The remaining vegetation is highly fragmented and this has resulted in the loss of connectivity within the community across the landscape (Australian Gov't 2009a[38]). The high levels of clearing and fragmentation have led to many of the vegetation communities in the South Eastern Highlands being listed under threatened species legislation.

The Project Area supports a wide range of flora and fauna and contains areas of important biodiversity and regional connectivity value. These areas provide important habitat for threatened species listed under the EPBC Act, as well as at the State / Territory level. These are discussed in further detail in **Sections 3.2** and **3.3** below.

The broader west Belconnen area, including the Project Area, also contains numerous Aboriginal, European, and natural heritage values. These are discussed further in **Section 3.3.3**.

3.2 Natural Environmental Values

This section discusses the broad environmental values that occur within the Project Area under the headings of vegetation communities, flora, fauna, aquatic and riparian ecosystems, and landscape function and connectivity.

3.2.1 Vegetation Communities

Prior to European settlement, south eastern Australia was predominantly covered in temperate eucalypt woodlands dominated by yellow box *(Eucalyptus melliodora*), Blakely's red gum (*E. blakelyi*), and white box (*E. albens*). While in the ACT, white box is absent, this ecological community formed a

[34] National Capital Authority (NCA) (undated) *Ngunnawal Country*, factsheet prepared by National Capital Authority, accessed online (May, 2015): https://www.nationalcapital.gov.au/index.php/fact-sheets#1.

[35] ACT Government (2005a) *Action Plan No. 28: A Vision Splendid of the Grassy Plains Extended, ACT Lowland Native Grassland Conservation Strategy*, Environment ACT, Canberra.

[36] natural temperate grassland here includes the EPBC Act endangered ecological community 'natural temperate grassland of the south eastern highlands'.

[37] box gum grassy woodland community includes the EPBC Act critically endangered ecological community 'white box –yellow box – Blakely's red gum grassy woodlands and derived native grasslands'.

[38] Australian Government (2009a) *Australia's Strategy for the National Reserve System 2009 – 2030*, prepared by the National Reserve System Task Group convened under the Natural Resource Policies and Program Committee, endorsed by The Natural Resource Management Ministerial Council, Canberra.

mosaic across the landscape as it merged with grasslands at lower elevations, and with dry sclerophyll forests along higher slopes and ridges (ACT Gov't 2004b[39]).

Within the ACT, three Action Plans have been developed to target the conservation of specific vegetation types. These are:

- 'Action Plan No. 27 Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy' (Action Plan 27) (ACT Gov't 2004b) discussing woodland in the low lying areas of ACT

- 'Action Plan No. 28 A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy' (Action Plan 28) (ACT Gov't 2005a) concerning grasslands within the ACT; and

- 'Action Plan No. 29 Ribbons of Life: ACT Aquatic Species and Riparian Zone Conservation Strategy' (Action Plan 29) (ACT Gov't 2007[40]) which details the conservation of riparian communities within the ACT.

These Action Plans define vegetation types in the ACT based on altitude, aspect, topography, and underlying geology. Using these definitions and information provided in technical surveys of the Project Area (KMA 2009a and 2009b; David Hogg Pty Ltd 2013), vegetation types likely to have been present in the Project Area prior to European settlement include:

- **Woodland on Low Hills and Plains:** within this woodland type Action Plan 27 describes the ecological community 'tablelands and slopes yellow box – red gum grassy woodland' as dominated by yellow box, Blakely's red gum, and apple box (*Eucalyptus bridgesiana*). This community is listed as 'yellow box – Blakely's red gum grassy woodland' an endangered ecological community (EEC) under the NC Act which is a part of the broader 'white box yellow box Blakely's red gum woodland' an EEC under the TSC Act and the EPBC Act listed critically endangered ecological community (CEEC) 'white box – yellow box – Blakely's red gum grassy woodland and derived native grassland'. All of these communities will hereafter be referred to as 'box gum woodland'. This woodland type typically occurs in lower slope positions and would have been found across most of the Project Area; refer to labels 'D' and 'E' in **Figure 3-1** for a schematic representation of this community's occurrence in the landscape.

- **Woodland on Low Hills and Plains:** within this woodland type Action Plan 27 describes the ecological community 'tablelands valley snow gum grassy woodland' as being dominated by snow gum (*E. pauciflora*) and candlebark (*E. rubida*). This community is found at lower elevations to box gum woodland, where it integrates with natural temperate grassland, and is often associated with depressions and frost hollows. Within the Project Area it would have occurred along the minor ephemeral creek lines. Refer to label 'B' in **Figure 3-1** for a schematic representation of this community's occurrence in the landscape.

- **Woodland on Dry Hill Slopes and Mountain Foothills:** within this woodland type Action Plan 27 describes the ecological community 'tablelands dry shrubby box woodland' as dominated by bundy (*E. goniocalyx*), mealy bundy (*E. nortonii*), red box (*E. polyanthemos*), apple box, and broad-leaved peppermint (*E. dives*). This woodland type can occur on lower exposed slopes where it intergrades with box gum woodland and has a similar structure and understorey floristic composition. In the Project Area it would have been found on south facing slopes. Refer to label 'F' in **Figure 3-1** for a schematic representation for this community's occurrence in the landscape.

[39] ACT Government (2004b) *Action Plan No. 27: Woodlands for Wildlife, ACT Lowland Woodland Conservation Strategy*, Environment ACT, Canberra.

[40] ACT Government (2007) *Action Plan No. 29: Ribbons of Life, ACT Aquatic Species and Riparian Zone Conservation Strategy*, Department of Territory and Municipal Services, Canberra.

- **Woodland on Dry Hill Slope and Mountain Foothills:** within this woodland type and present in the Project Area, Action Plan 27 describes the ecological community 'tablelands brittle gum dry forest' as dominated by red stringybark (*E. macrorhyncha*), scribbly gum (*E. rossii*), and brittle gum (*E. mannifera*). This community would have had a limited distribution within the Project Area occurring on exposed, dry, rocky sites on hill tops. Refer to label 'G' in **Figure 3-1** for a schematic representation of this community's occurrence in the landscape.

- **Natural Temperate Grassland:** Action Plan 28 describes natural temperate grassland as being dominated by native perennial tussock grass species with a high (up to 70 percent of species present) diversity of forbs. It is naturally treeless or has less than ten percent tree foliage cover. This ecological community is listed as an EEC under the EPBC Act as 'natural temperate grassland of the South Eastern Highlands' and as 'natural temperate grassland' under the NC Act. Both listed communities will hereafter be referred to as 'natural temperate grassland'. This grassland type is found in lower elevation areas, where it often intergrades with box gum woodland. It would not have been common within the Project Area, occurring only within the eastern portions where the elevation is lower. Refer to label 'A' in **Figure 3-1** for a schematic representation of this community's occurrence in the landscape.

- ***Casuarina cunninghamiana* Tableland Riparian Woodland:** Action Plan 29 describes '*Casuarina cunninghamiana* Tableland Riparian Woodland' as being characterised by river oak (*Casuarina cunninghamiana)*, black wattle (*Acacia mearnsii*), silver wattle (*A. dealbata*), river bottlebrush (*Callistemon sieberi*), white tea-tree (*Kunzea ericoides*), and weeping grass (*Microlaena stipoides*). It is typically located on river fringes between normal water levels and maximum flood levels. The ecological community is relatively short lived (approximately 100 years) and will give way to ribbon gum (*E. viminalis*) or apple box in the absence of disturbance. The cycle will begin again following flood or changes in the river course. Within the Project Area it would have occurred within the Murrumbidgee River Corridor and Ginninderra Creek Corridor. Refer to label 'C' in **Figure 3-1** for a schematic representation of this community's occurrence in the landscape.

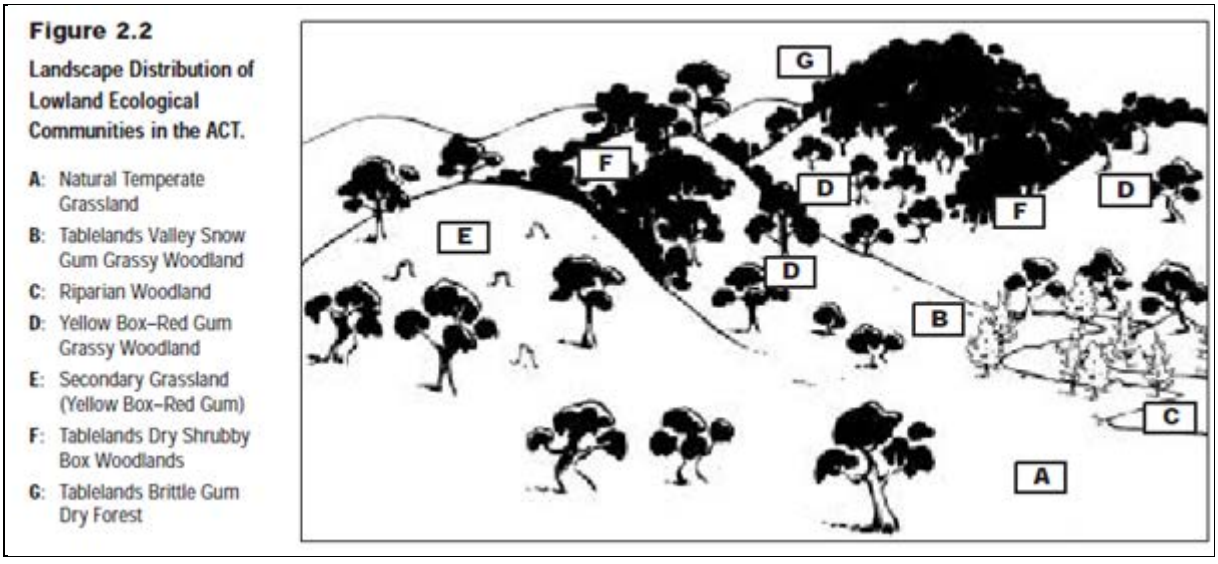

Figure 3-1

Distribution of Lowland Ecological Communities in the ACT (Figure 2.2 in ACT Gov't 2004b)

All of these communities still occur within the Project Area, though have much reduced distributions than historically. This is particularly true for 'woodland on low hills and plains' and 'natural temperate grassland', both of which contain EPBC listed ecological communities.

Since European settlement, most of the original lowland vegetation (particularly box gum woodland) has been modified through tree removal, cattle grazing, and pasture improvement (introduction of pasture species, ploughing and fertiliser use). These practices have resulted in habitat simplification, a reduction of species' diversity, and the widespread establishment of introduced grass species and weeds (KMA 2014).

At lower elevations, only relatively small stands of trees now remain. Box gum woodland occurs in scattered patches in the ACT portion of the Project Area, with 'tablelands valley snow gum grassy woodland' located in frost hollows (KMA 2009b). Overall, the box gum woodland of the Project Area is generally considered to be of moderate quality although there is some variability in floristics and structure (David Hogg Pty Ltd 2013).

The other two lowland woodland types both occur at higher elevations and steeper land within the Project Area (KMA 2009b). *'Casuarina cunninghamiana* Tablelands riparian woodland' occurs along the Murrumbidgee River and Ginninderra Creek, and is associated with a mostly exotic understorey (KMA 2009a and 2009b).

The majority of the grassland within the Project Area is classified as exotic grassland (KMA 2009b). The only recorded natural temperate grassland (as per the definition above) within the Project Area occurs in small patches (4.8 hectares) in the Jarramlee offset and one small patch in the Macgregor offset (**Figure 3-4**) (ACT Gov't 2013a). There are also some patches of native pasture located throughout the Project Area. The most diverse of these are in the south adjacent to box gum woodland remnants, and are, therefore, considered to be 'severely modified lowland woodland – paddock trees' as classified under Action Plan 27 (KMA 2009b). It should be noted that this description of native pasture differs to the definition in Action Plan 28 as the historic states are different (i.e. Action Plan 28 describes native pasture as a degraded form of natural temperate grassland rather than box gum woodland); descriptions of its current form are relatively similar.

3.2.2 Flora

Despite there being a range of woodland communities present within the Project Area, these appear to support few threatened flora species. Explorative vegetation surveys were undertaken in 2008, 2009, and 2013 throughout the Project Area to classify, describe, and map the vegetation; and record as many flora species as possible. Surveys particularly targeted the lower topography, within the most likely potential development areas (KMA 2009b; 2013a; 2013b[41]). In addition, targeted surveys were conducted for the EPBC Act listed pale pomaderris (*Pomaderris pallida*) and Ginninderra peppercress (*Lepidium ginninderrense*) following discussion with NSW Department of the Environment and Climate Change (now known as NSW Department of Planning and the Environment) and Environment ACT (ACT Environment, Planning and Sustainable Development Directorate) staff, interrogation of the NSW Wildlife Atlas, the Environment ACT website and previous habitat assessments within the study area (KMA 2009b). Targeted surveys for other species were not undertaken on the basis of a lack of potential occurrence based on the research, consultations and site inspections undertaken.

No listed threatened plant species were found in the study area, however, based on the habitat requirements for these species, if any individuals do occur within the Project Area, they will be protected by the WBCC.

Targeted flora surveys were also conducted for the TSC Act listed silky Swainson-pea (*Swainsona sericea*) (vulnerable). While not being recorded within the Project Area, if present it would likely occur within the WBCC (KMA 2013a) and as such would not be affected by the Program. The ACT

[41] Kevin Mills and Associates (KMA) (2013b) *West Belconnen ACT Parkwood Land Flora and Fauna Assessment*, prepared for Riverview Group, Canberra.

listed Murrumbidgee bossiaea (*Bossiaea grayi*) also has the potential to occur and has not been identified within the Project Area, despite being a conspicuous plant. Potential impacts to these species are discussed further in **Section 6.3.8**.

ACT Government has identified a number of non-threatened yet significant flora species that will be the focus of future conservation management actions across the Territory. A number of these, particularly small crowea (*Crowea exalata* subs. e*xalata*), currawong (*Acacia doratoxylon*), and varnish wattle (*Acacia verniciflua*) are present within the WBCC (A Lane 2016, pers. comm. 12 August). This is discussed further in **Section 6.3.8**.

Despite a lack of records of EPBC Act threatened flora species within the Project Area, it is still considered possible that some species may occur. This is based on results presented in the Protected Matters Search Tool (PMST) (refer to **Appendix 1**) and are discussed in greater detail in relation to the impacts of the Program in **Section 3.3.1.8**.

3.2.3 Fauna

A number of threatened fauna species have been recorded within the Project Area with further species predicted to occur on the basis of the PMST report (refer to **Appendix 1**). All species known or modelled as being potentially present have been considered in the assessment. Despite this, only those species with potential to be present on the basis of consultation and review of available reports were targeted in field surveys.

Rocky habitat occurs along the exposed slopes and ridges of the riparian corridors. This forms a relatively unbroken belt of occupied habitat for the EPBC Act vulnerable pink-tailed worm-lizard, which runs from Stockdill Drive to approximately one kilometre north of the ACT / NSW border. North of this, scattered patches occur up to Ginninderra Creek, potentially providing stepping-stone connectivity for the species beyond the Project Area. The population of pink-tailed worm-lizard within the Project Area is of national significance due to its size, regional connectivity, and overall abundance (Osborne and Wong 2013[42]).

Golden sun moth habitat present within the Project Area occurs within the Jarramlee and Macgregor offsets. Impacts to this species will arise from the Ginninderra Drive extension as described in **Section 2.7.3**, and are assessed in the context of the EPBC Act in **Section 4.5.4**.

The woodland habitats found along the upper slopes of the Project Area are variable in terms of structural and floristic complexity (KMA 2009b). Areas that have a high level of complexity, especially in the form of tree hollows, fallen timber, trees of different ages, a mid-level shrub layer, and a grassy understorey are of higher value for threatened bird species that use the habitat for nesting sites, shelter, and food resources. The woodland throughout the gentler topography contains 246 hollow-bearing trees that have an average of approximately four hollows per tree. During surveys conducted in 2012, 69 observations of 13 animal species utilising these hollows were made (KMA 2013c[43]).

Bird surveys were conducted in the Project Area between 2008 and 2013 (KMA 2009b and 2013c) as part of broader ecological investigations. The 2008 surveys aimed to detect as many of the species present as possible, particularly targeting threatened species within woodland areas (**Table 3.1**). The targeted species were chosen following discussion with NSW Department of the Environment and

[42] Osborne, W. and Wong, D. (2013) *The Extent of Habitat for the Vulnerable Pink-Tailed Worm-lizard (Aprasia parapulchella) in the West Belconnen – Ginninderra Creek Investigation Area – Confirmatory Distribution Surveys and Mapping*, prepared for The Riverview Group, Canberra.

[43] Kevin Mills and Associates (2013c) *West Belconnen Project ACT and NSW Land Targeted Bird Surveys*, prepared for The Riverview Group, Canberra.

Climate Change and Environment ACT staff, interrogation of the NSW Wildlife Atlas, the Environment ACT website, and previous habitat assessments within the study area (KMA 2009b).

Table 3.1 Bird Species Targeted in Woodland Bird Surveys (KMA 2009b)

Bird Species	NC Act	TSC Act	EPBC Act
brown treecreeper (*Climacteris picumnus victoriae*)	V	V	-
diamond firetail (*Stagonopleura guttata*)	-	V	-
hooded robin (*Melanodryas cucullata cucullata*)	V	V	-
painted honeyeater (*Grantiella picta*)	V	V	V
speckled warbler (*Chthonicola sagittata*)	-	V	-
superb parrot (*Polytelis swainsonii*)	V	V	V
varied sittella (*Daphoenositta chrysoptera*)	V	V	-
white-winged triller (*Lalage sueurii*)	V	-	-

NOTE: V = vulnerable; E = endangered; - = not listed

The 2013 surveys built on the 2008 surveys, targeting superb parrot (*Polytelis swainsonii*), birds of prey such as little eagle (*Hieraaetus morphnoides*), and other significant species (particularly those that are listed under the NC Act and TSC Act), in addition to updating the bird species list as required (KMA 2013c). Swift parrot (*Lathamus discolor*) was also assessed by KMA (2013c) though not specifically targeted during the survey effort due to the sporadic nature of the species and the inconsistent and unpredictable nature of their presence at sites across the ACT. Similarly, regent honeyeater (*Anthochaera phrygia*) was also noted as having the potential to occasionally occur within the Project Area (KMA 2009b), though was not specifically targeted due to the unpredictability of its presence in the ACT.

These surveys recorded superb parrots using mature trees to travel through the south of the Project Area, with no evidence of breeding recorded. The EPBC Act migratory species rufous fantail (*Rhipidura rufifrons*) was recorded within the central portion of the Project Area (KMA 2009b and 2013c). In addition, previously listed EPBC migratory species rainbow bee-eater (*Merops ornatus*) was also recorded in this area. Australian painted snipe (*Rostratula australis*) (endangered under the EPBC Act) was recorded by Canberra Ornithologists Group (COG) in the Project Area during the 2012 – 2013 survey year (COG 2014[44]). Despite swift parrots not being recorded during targeted surveys, previous records show that it is likely to utilise the area when mature eucalypts are flowering (KMA 2013c). Regent honeyeater may also occur occasionally within the Project Area (KMA 2009b).

Flame robin (*Petroica phoenicea*), scarlet robin (*Petroica boodang*), spotted harrier (*Circus assimilis*), gang-gang cockatoo (*Callocephalon fimbriatum*) and speckled warbler (*Chthonicola sagittata*) (all vulnerable under the TSC Act, scarlet robin also vulnerable under the NC Act) were recorded within lowland treed areas in the Project Area, including the exotic tees that surround Belconnen Farm (KMA 2009b and 2013c). Scarlet robin was also recorded along Ginninderra Creek (Geoff Butler and Associates 2000[45]). White-bellied sea eagle (*Haliaetus leucogaster*) (vulnerable under the TSC Act)

[44] Canberra Ornithologists Group (COG) (2014) *Annual Bird Report: 1 July 2012 to 30 June 2013*, Canberra Bird Notes 39(1):1-112, Canberra Ornithologists Group, Canberra.

[45] Geoff Butler and Associates (2000) *The Revegetation of Ginninderra Creek Between Barton Highway and Macgregor, ACT*, prepared for Canberra Urban Parks and Places, Canberra.

was recorded flying over the Project Area. White-winged triller (*Lalage sueurii*) (vulnerable under the NC Act) was recorded in woodland within the ACT portion of the Project Area (KMA 2013c). Other ACT and NSW listed bird species have the potential to occur, these are discussed further in **Section 6.1.2**.

Additionally and subsequent to the surveys discussed above, a pair of little eagles was recorded nesting in a pine tree at the Strathnairn Arts Association property (KMA 2014). Little eagles are listed as vulnerable in the ACT and NSW, although are not uncommon elsewhere in Australia. The nest site is adjacent to the WBCC and the urban development component of the Program includes a 200 metre buffer to protect the site from development impacts. The buffer to urban development was determined on the basis of agreement with ACT Government wildlife research personnel. A research program including scat analysis and radio tracking to determine foraging area and diet has also been initiated. An assessment of potential impacts to this species is included in **Section 6.1.2**.

Most bird species were recorded within woodland areas in the ACT portion of the Project Area or riparian habitats. These are proposed for protection within the WBCC, and direct impacts to these species will be predominantly avoided. Additional connectivity will also be provided through the retention and addition of significant trees within the urban development area. As discussed in **Table 2.2**, the preferred sewer alignment will remove up to 16 trees, assessed as being of poor (eight) and medium (seven) quality and one stag. This number may be reduced during the final detailed design stage for the sewer alignment. The assessment of impacts to bird species that occurs in **Section 4.5.1**, assumes the full 16 trees will be removed.

The NSW listed eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) is vulnerable under the TSC Act) was also recorded at three sites within the Project Area. This species is listed as vulnerable due to threats affecting nursery caves (KMA 2009b). Impacts to this species as well as other mammal species with the potential to occur are discussed in **Section 6.1.6**.

KMA (2013a) noted a record for Rosenberg's goanna (*Varanus rosenbergi*) (vulnerable under the TSC Act) from approximately 15 years ago in the Ginninderra Falls area. Their presence has recently been confirmed via wildlife cameras by the ACT Government (A Lane 2016, pers. comm. 12 August). Potential impacts to this species are discussed in **Section 6.1.7**.

3.2.4 Aquatic and Riparian Systems

The Project Area lies within the Murray – Darling Basin and is bordered by the Murrumbidgee River to the west and Ginninderra Creek to the north, with their confluence marking the northwest corner. Both of these riparian ecosystems play a key role in providing habitat for flora and fauna species within the broader west Belconnen area.

In particular, the Murrumbidgee River is of regional and national importance as it is one of the main tributaries of the Murray River. ACT Government mapping (ACT Gov't 2015a[46]) and Action Plan 29 show that Macquarie perch (*Macquaria australasica*), Murray cod (*Maccullochella peelii*), and trout cod (*Maccullochella macquariensis*) all occur or are likely to occur within the reach of the Murrumbidgee River that runs alongside the Project Area, with Murray cod having also been introduced to Ginninderra Creek.

Two other aquatic species (Murray River crayfish (*Euastacus armatus*) and eel-tailed catfish (*Tandanus tandanus*)) listed under State / Territory legislation also have the potential to occur within the Project Area. These are discussed further in **Section 6.1.3**.

[46] ACT Government (2015a) *ACTmapi: ACT Government Online Interactive Maps* 'Significant Plants and Animals Map', Environment and Planning Directorate, Canberra, accessed online (March, 2015): http://www.actmapi.act.gov.au.

The vegetation within these riparian ecosystems also provides important habitat corridors, particularly for woodland bird species and pink-tailed worm-lizard. This is discussed further in terms of general regional landscape connectivity in **Section 3.2.5**.

Catchments of both the Murrumbidgee River and Ginninderra Creek, particularly upstream of Ginninderra Falls, have been heavily modified post European Settlement. In the Ginninderra Creek Catchment grazing, clearing and urbanisation has led to an increase in run-off and erosion, and rural land uses have resulted in invasive species introduction (both pasture and woody weeds). Presently very few native understorey species remain and only some well-established copses of native trees (namely river oak) occur within the creek corridor (Geoff Butler and Associates 2000). The Ginninderra Creek gorge (downstream of Ginninderra Falls) includes an area of woodland that, due to the steep terrain, is relatively undisturbed.

Threats to the Murrumbidgee River include:

- clearing of riparian woodland and forest vegetation
- erosion, a decrease in streambank stability, weed invasion, and destruction of habitat as a result of trampling by stock
- changes to species composition and a loss of floral and structural diversity from plant introductions; and
- removal of biomass, trampling, eutrophication, weed invasion, destruction of faunal habitat, soil erosion, loss of soil moisture, and prevention of seedling recruitment within grassy ecosystems that have been grazed (ACT Gov't 2007).

Urbanisation in northern Canberra has also led to an increase in sedimentation and peak run-off in the Murrumbidgee River (ACT Gov't 2007). In the Project Area, recreational activities at Ginninderra Falls have required the installation of fences and paths (Watson 2013), which have potentially also had an impact on riparian ecosystems.

3.2.5 Landscape Function and Connectivity

Two important conservation outcomes of the Program relate to maintaining landscape scale function and connectivity between environmental values. This will primarily be achieved through the creation of the WBCC.

The WBCC will protect woodland and forest habitat within and adjoining the riparian corridors. This habitat provides regional links to Mulligan's Flat Nature Reserve in Gungahlin, and links to forest and woodland habitat further along the Murrumbidgee River and its tributaries into Namadgi National Park (KMA 2014) (**Figure 3-2**). Furthermore, the woodland habitat will not only be protected, but also enhanced via the management activities of the WBCC RMP (RobertsDay 2014).

Existing high quality trees will also be retained within the open space network of the urban development component of the Program, providing stepping stone habitat for woodland bird species that complements the use of the riparian habitat corridors. Additionally, the planting of significant trees will be incorporated into the landscape design phase to build on the values provided by the existing trees in the long-term (RobertsDay 2014).

The WBCC will also protect rocky habitat that supports a nationally significant population of pink-tailed worm-lizard. This will link with stepping stone habitat patches that occur to the north and south of the Project Area, creating a habitat corridor for the species.

In addition to the targeted approaches for box gum woodland and pink-tailed worm-lizard values, the conservation strategies within WBCC RMP will take a landscape scale approach. This will help to ensure that overall connectivity and ecological values of the WBCC are maintained and enhanced over time.

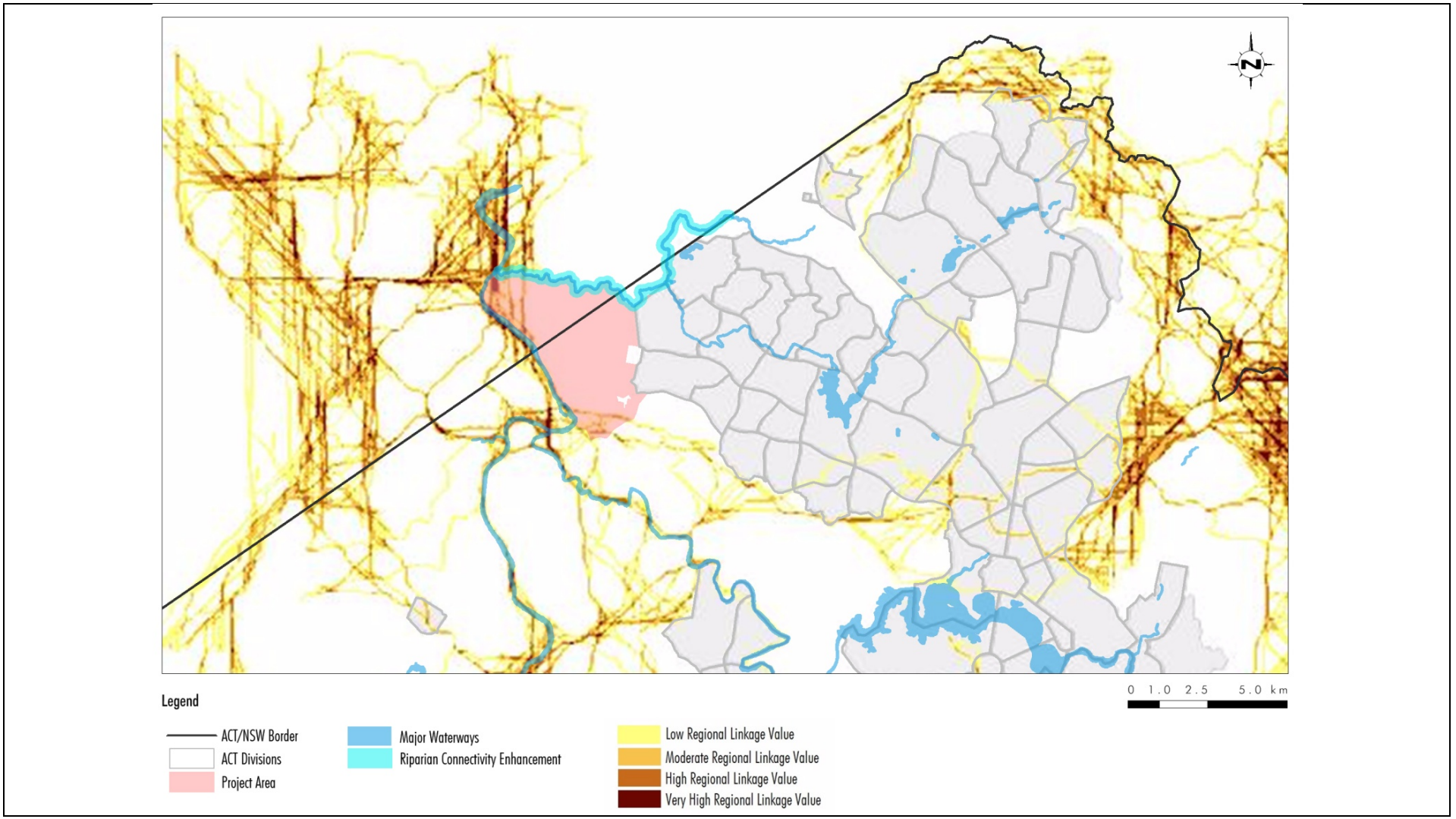

Figure 3-2

Forest and Woodland Habitat and Riparian Linkage Values in Northern ACT and Surrounding NSW (base map from ACT Gov't 2015a)

3.3 Matters of National Environmental Significance

As stated in **Section 1.2.1**, the EPBC Act is the Commonwealth Government's key piece of environmental legislation. It provides the legal framework for the protection and management of MNES, and governs actions that are undertaken by Commonwealth agencies or on Commonwealth land. There are a number of these matters that may be impacted by the Program, as identified by the Australian Government's Protected Matters Search Tool (PMST). The PMST report (refer to **Appendix 1**) is based on known species and ecological community distributions or habitat requirements (Australian Gov't 2015a[47]), and is discussed in the following sections. For convenience the discussion has been broken into the following categories: EPBC Act threatened ecological communities and species, migratory species, heritage, wetlands of international importance and Commonwealth land.

The following MNES are not addressed in this report as they are not applicable to this Program:

- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mines); and
- a water resource, in relation to coal seam gas development and large coal mining development.

3.3.1 EPBC Act Threatened Ecological Communities and Species

In order to identify all EPBC Act listed threatened ecological communities and species that have the potential to occur within the Project Area, a ten kilometre buffer was used in generating the PMST report (refer to **Appendix 1**). The list of threatened ecological communities and species was then refined based on an assessment of their likelihood of occurrence using a review of relevant literature. The following tables identify the results of the PMST report and subsequent literature review.

Threatened ecological communities and species with a reported presence of 'known', 'likely', or 'potential' are discussed in detail, as all others are unlikely to be significantly impacted by the Program. Communities and species with the potential to be impacted by the Program are then subject to a complete analysis in **Section 4** of this report.

Table 3.2 and **Table 3.3** outline the definitions and abbreviations used in this section of the report.

[47] Australian Government (2015a) *Protected Matters Search Tool*, Department of the Environment, Canberra, (last updated: January 2014): accessed online (December, 2015): http://www.environment.gov.au/epbc/pmst/index.html.

Table 3.2 Definitions of Presence

Presence	Definition
known	Recent and reliable records of this matter exist within the Project Area.
likely	Despite a lack of records, it is probable that the matter occurs in the Project Area.
potential / potential habitat	Characteristics of the broader west Belconnen area are not inconsistent with requirements of the threatened ecological community or species, however, use of this area would be infrequent and episodic, potentially associated with unusual or extreme climatic events e.g. prolonged drought.
unlikely	There are no records for this species or community, habitat requirements are not met or normal distribution range does not coincide with the broader west Belconnen area. Despite this, the species or community may be present in rare circumstances.
no	There is no potential for the species to occur in the broader west Belconnen Area.

Table 3.3 Key to Threatened Communities and Species Status

Abbreviation	Status
Ecological Communities	
CEEC	critically endangered ecological community
EEC	endangered ecological community
Species	
V	vulnerable
E	endangered
CE	critically endangered
X	extinct
M	EPBC Act listed migratory species

3.3.1.1 Ecological Communities

Three threatened ecological communities were identified in the PMST report as having the potential to occur within the Project Area (**Table 3.4**).

Table 3.4 Threatened Ecological Communities in the Project Area

Generic Description	Statute	Listed Name	Status	Presence
alpine sphagnum bogs and fens	NC Act	-	-	-
	TSC Act	-	-	-
	EPBC Act	alpine S*phagnum* bogs and associated fens	EEC	no
box gum woodland	NC Act	yellow box / red gum grassy woodland	EEC	known
	TSC Act	white box yellow box Blakely's red gum woodland	EEC	no*
	EPBC Act	white box – yellow box – Blakely's red gum grassy woodland and derived native grassland	CEEC	known
natural temperate grassland	NC Act	natural temperate grassland	EEC	known
	TSC Act	-	-	-
	EPBC Act	natural temperate grassland of the South Eastern Highlands	CEEC	known

*There is no TSC Act listed box gum woodland within the NSW portion of the Project Area. As such this EEC is not discussed in detail in this report. However, part of the box gum woodland within the ACT portion of the Project Area would meet the TSC Act criteria for box gum woodland.

'Alpine sphagnum bogs and associated fens' endangered ecological community is defined by the presence of *Sphagnum* spp. on a peat substrate and occurs in small pockets of alpine, subalpine, and some montane areas (TSSC 2008a[48]). No areas with these characteristics occur within the Project Area.

Box Gum Woodland

'Yellow box / red gum grassy woodland' is declared an EEC under the ACT's NC Act. This is a part of the broader TSC Act listed EEC 'white box yellow box Blakely's red gum woodland' and the EPBC Act listed CEEC 'white box – yellow box – Blakely's red gum grassy woodland and derived native grassland'.

Box gum woodland occurs either in a woodland form or as derived / secondary grassland. The community in either context is typified by a ground layer of native tussock grasses and herbs, and a sparse, scattered shrub layer. The broader EPBC Act and TSC Act descriptions of the community

[48] Threatened Species Scientific Committee (TSSC) (2008a) *Commonwealth Conservation Advice for the Alpine Sphagnum Bogs and Associated Fens Ecological Community*, accessed online (November, 2016): http://www.environment.gov.au/biodiversity/threatened/communities/pubs/29-conservation-advice.pdf.

includes white box along with the locally occurring yellow box and Blakely's red gum as dominant trees where a canopy still occurs, or were once present in the case of grassland sites (TSSC 2006[49]).

The distribution of box gum woodlands and derived grasslands comprises of the western slopes and tablelands of the Great Dividing Range, from southern Queensland through NSW to central Victoria. It is suggested that over 92 percent of box gum woodlands have been cleared, with those remaining representing isolated remnants (TSSC 2006). The largest remaining good condition box gum woodland remnants are within the ACT, due to the significantly lower grazing levels that have occurred there post European settlement (ACT Gov't 2004b).

The presence of box gum woodland was described within the ACT portion of the Project Area (excluding the road upgrade areas) by KMA (2009b), separately as part of the Molonglo Strategic Assessment by ELA (2010), and then in more detail by David Hogg Pty Ltd (2013) and KMA (2014) and is shown in **Figure 3-3**. Currently, a portion (approximately 15 hectares) is protected within the Murrumbidgee River Corridor, with the remainder occurring on adjacent land within the Project Area and on the Strathnairn Arts Association Land (outside of the Project Area). It also adjoins pink-tailed worm-lizard (*Aprasia parapulchella*) habitat, particularly to the west towards the Murrumbidgee River. The community is described by David Hogg Pty Ltd (2013) as ranging in quality from low to high, with a majority of it considered to be of a moderate quality. This reflects the degradation that has occurred as a result of previous clearing and agricultural use of the land (David Hogg Pty Ltd 2013).

Box gum woodland also occurs in several small patches within the Drake Brockman Drive upgrade area (**Figure 3-3**), from the intersection with William Hovell Drive through to the Urban Development Area boundary. These areas are low quality remnants that occur along the roadside and generally only meet the definition of the listed community as a result of being contiguous with larger occurrences of the community that extend into the adjoining private properties. The quality of vegetation along the road alignment meeting the box gum woodland definition is generally poor and is typified by low native grass diversity and few native non-grass species.

The Program will protect all areas of box gum woodland (as defined by David Hogg Pty Ltd (2013)) within the west Molonglo Area by placing it inside the WBCC (**Figure 3-3**), in accordance with the commitments under the Molonglo Strategic Assessment. Any additional areas of this community that occur in the broader west Belconnen area, but not within the footprint of the area subject to the Program (for example Strathnairn) are beyond the scope of this assessment and would be subject to consideration by the ACT Government in its implementation of the Molonglo Strategic Assessment. The box gum woodland that occurs within the Drake Brockman Drive upgrade area will be impacted by the Program as a result of the upgrades to that road (see **Section 2.4.1**). The likely significance of this impact and any other potential impacts associated with the Program is discussed along with the avoidance strategy in **Section 4.4.** This discussion also includes consideration of potential indirect impacts to box gum woodland within Strathnairn Arts Association land.

[49] Threatened Species Scientific Committee (TSSC) (2006) *Commonwealth Listing and Conservation Advice Amendment on White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands*, accessed online (March, 2015): http://www.environment.gov.au/system/files/pages/dcad3aa6-2230-44cb-9a2f-5e1dca33db6b/files/box-gum.pdf.

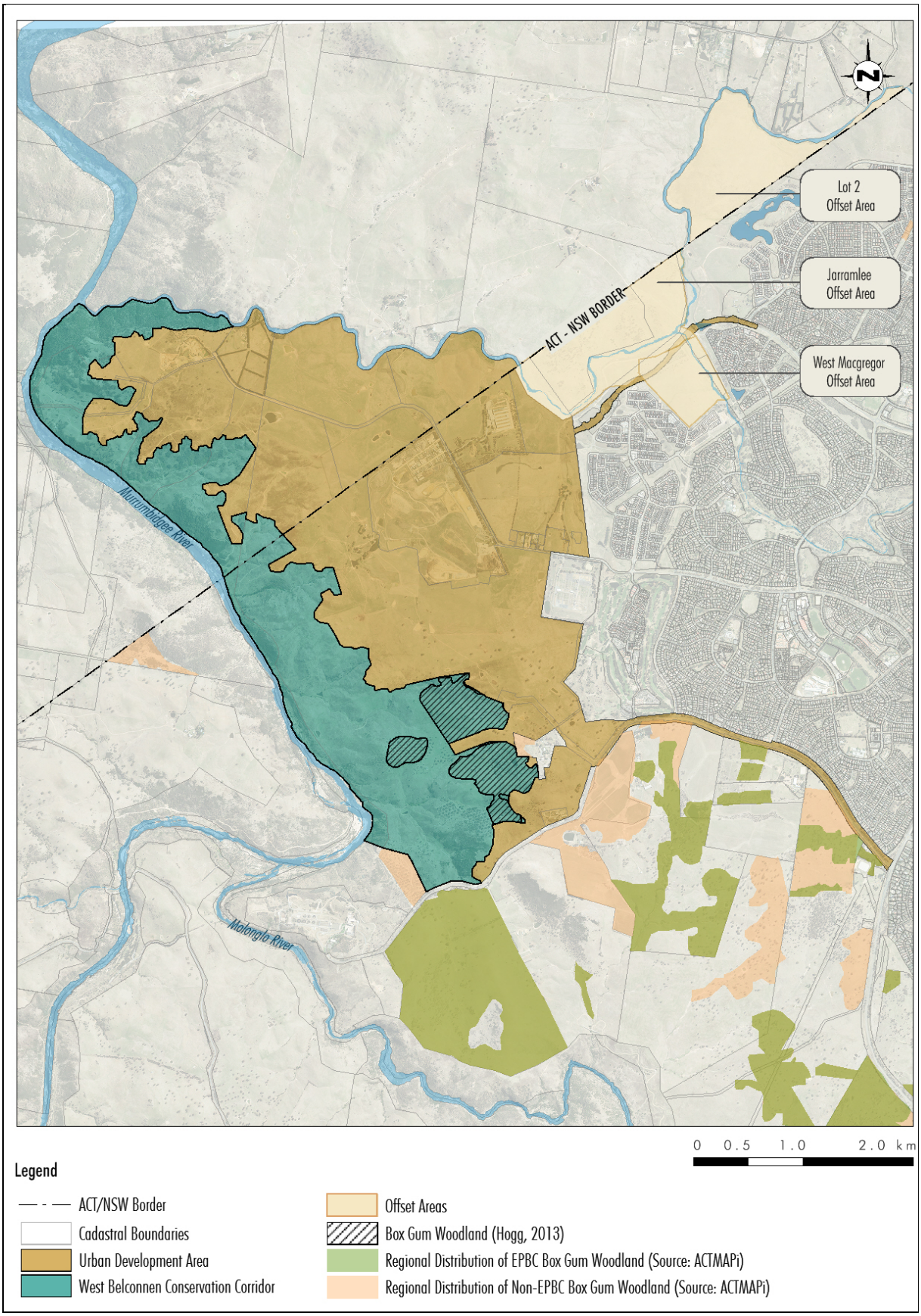

Figure 3-3

Box Gum Woodland within the Project Area and Broader West Belconnen Area

Natural Temperate Grassland

'Natural temperate grassland of the Southern Eastern Highlands' is listed as a CEEC under the EPBC Act and as EEC 'natural temperate grassland' under the NC Act. This ecological community replaces the previously listed EEC 'natural temperate grasslands of the southern tablelands of NSW and the Australian Capital Territory'.

The approved conservation advice (TSSC 2016[50]) describes the biophysical characteristics of the community and references the regional vegetation classification of Armstrong *et al.* (2013[51]) for recognised associations that meet the definition of the community. Similar to the conservation / listing advice for box gum woodland, the advice for natural temperate grassland includes identification guidelines including procedures for assessing presence, condition, and patch extent.

In summary, natural temperate grassland is a grassy vegetation community typically dominated by moderately tall to tall (25 – 100 centimetres) tussock grasses such as kangaroo grass (*Themeda triandra*), snowgrass (*Poa sieberiana*), river tussock grass (*Poa labillardierei*), kneed speargrass (*Austrostipa bigeniculata*), slender speargrass (*Austrostipa scabra*), red leg grass (*Bothriochloa macra*), wallaby grass (*Rytidosperma* spp.), and blowngrass (*Lachnagrostis* spp.). The community must also contain a minimum of at least eight native non-grass species, or two indicator species (as defined in the Conservation Advice (TSSC 2016)), or have a floristic value score of at least five.

It typically occurs in valleys influenced by cold air drainage and in broad plains within the South Eastern Highlands of NSW, the ACT, and Victoria. These areas occur at altitudes between 250 metres in central and northern parts of its distribution and 1,200 metres in the south. The community is not a derived or secondary grassland; as such the context of the location is critical for accurately identifying it (TSSC 2016).

The new description of natural temperate grassland is broader than the previous as it captures grassy areas not previously included. Of relevance to the Program, the revised listing brought all areas of pink-tailed worm-lizard habitat, which are characterised by kangaroo grass and rocky outcrops, into consideration. Whilst these areas have not been adequately assessed to date, it is likely that all areas of pink-tailed worm-lizard habitat meet the criteria for natural temperate grassland.

In addition, areas of native grassland adjacent to pink-tailed worm-lizard habitat are likely to meet the definition of a 'patch' of natural temperate grassland and thus be included in any future assessment of the community. The Conservation Advice (TSSC 2016) describes a 'patch' as follows:

A patch is defined as a discrete and continuous or semi-continuous area of the ecological community. Patches can be spatially variable and are often characterised by one or more areas within a patch that meet the condition threshold criteria that are surrounded by areas of lower quality. Therefore, a patch may include small-scale disturbances, such as tracks or breaks (including exposed soil, leaf and other plant litter, cryptogams) or small-scale variations in vegetation that do not significantly alter its overall functionality. In this case, areas of a patch that are exotic dominated, or otherwise do not meet the minimum condition thresholds, are included within the patch as a whole, but should not be included in sampling plots (e.g. this may apply to drainage lines that often contain more weeds than surrounding areas of a patch).

Aside from the above likely areas of natural temperate grass, small patches are known to occur within the Jarramlee and Macgregor offset areas (blue and orange areas in **Figure 3-4**) (ACT Gov't 2013a; Braby 2005). These patches are small and isolated, dominated by either wallaby grass or

[50] Threatened Species Scientific Committee (TSSC) (2016) *Approved Conservation Advice (including Listing Advice) for Natural Temperate Grassland of the South East Highlands*, prepared for the Minister for the Environment, Canberra.

[51] Armstrong RC, Turner KD, McDougall KL, Rehwinkel R & Crooks JI (2013) 'Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory' *Cunninghamia* 13(1): 125-265

kangaroo grass (as noted in **Figure 3-4**) (ACT Gov't 2013a). The following **Table 3.5** summarises the approximate patch size and designation of natural temperate grassland in the existing offset areas and also indicates the number of patches per association and area.

Table 3.5 Natural temperate grassland patches in the existing offset areas

Mapped Name	Area (Ha)		
	Jarramlee (#)	Macgregor (#)	Total (#)
Dry Themeda Association	*1.44 (2)*	*0 (0)*	**1.44 (2)**
Wallaby Grass Association	*3.43 (7)*	*0.15 (1)*	**3.58 (8)**
Total	**4.87 (9)**	**0.15 (1)**	**5.02 (10)**

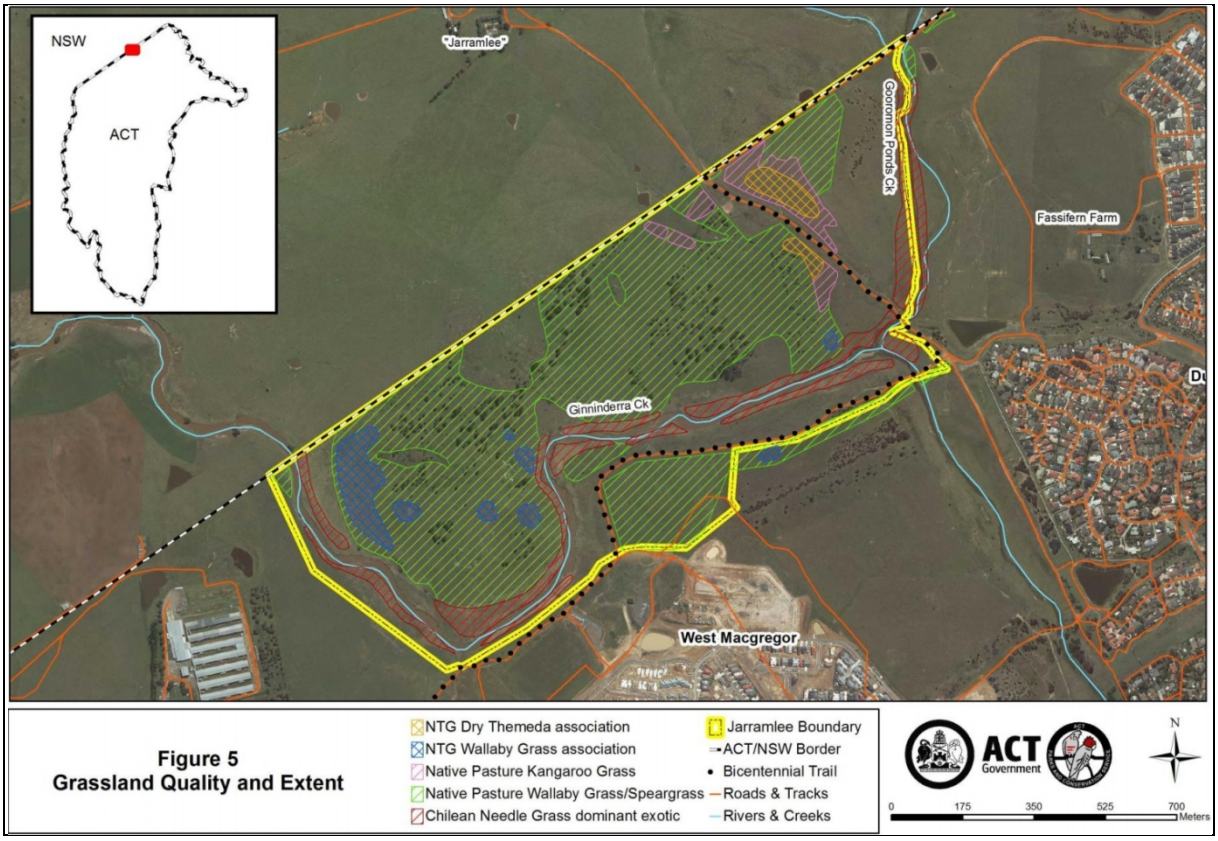

Figure 3-4

Extent and Quality of Jarramlee Grassland (Figure 5 from ACT Gov't 2013a)

Areas of likely natural temperate grassland that are associated with pink-tailed worm-lizard habitat will be assessed under the Defined Process Strategy (**Section 4.7**) as there is insufficient information regarding the extent and quality of the community in these areas at present.

Areas of known natural temperate grassland within the Jarramlee and Macgregor West offset areas were taken into consideration when alignment options for the Ginninderra Drive extension were discussed (see **Section 2.7.3** for further details). As a result, no natural temperate grassland in these areas will be directly impacted by the Program. Indirect impacts will be managed via the

implementation of a Construction Environment Management Plan (CEMP) that will control run-off, waste disposal, and weed management (discussed further in **Section 4.3.2**). It is, therefore, considered that no further assessment of impacts is necessary for this ecological community.

Notwithstanding the absence of natural temperate grassland, areas of the Project Area that support grassy communities of various forms, in some instances still provide important habitat for threatened fauna, in particular golden sun moth. Impacts to these grasslands are discussed in **Section 4.5.4** in relation to golden sun moth and its habitat requirements.

3.3.1.2 Birds

Seven birds listed under the EPBC Act were identified by the PMST report as having the potential to occur within the Project Area (**Table 3.6**). Species considered likely to occur (i.e. presence defined as potential or higher) are discussed below and impacts as a result of the Program are discussed **Section 4.5.1.**

Table 3.6 Threatened Bird Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	TSC Act	
Rostratula australis	Australian painted snipe	E	-	E	known
Polytelis swainsonii	superb parrot	V	V	V	known
Anthochaera phrygia	regent honeyeater	CE	E	CE	potential
Lathamus discolor	swift parrot	CE	V	E	potential
Grantiella picta	painted honeyeater	V	V	V	potential
Calidris ferruginea	curlew sandpiper	CE	-	E	no
Numenius madagascariensis	eastern curlew	CE	-	-	no

Both curlew sandpiper (*Calidris ferruginea*) and eastern curlew (*Numenius madagascariensis*) have primarily coastal distributions. When recorded inland, both species prefer large lakes with mudflats for foraging. These are not found within the Project Area, with the nearest being at Lake George and Lake Bathurst to the north-east (Australian Gov't 2015b). As no habitat for these species exists within the Project Area, they will not be considered further in this report.

Australian Painted Snipe

Australian painted snipe is listed as endangered under the EPBC Act and TSC Act. It is a stocky wading bird around 220 – 250 millimetres long. It has a pale stripe that extends from each shoulder down its

back, creating a 'V' shape. Generally they are sighted either singularly or in pairs, though small groups can appear around the breeding season (Australian Gov't 2015b[52]).

Habitat preferred by Australian painted snipe is predominantly shallow terrestrial freshwater wetlands; though they will use waterlogged grassland or saltmarsh, dams, rice crops, sewage farms, and bore drains. It requires some level of medium to dense grass or shrub cover, as well as areas of open mud. Nests generally lie on or near small islands and breeding occurs at all times of the year, seeming to depend upon habitat condition rather than time. Due to a decrease in wetland habitat since European settlement, it is believed that the numbers of Australian painted snipe are decreasing, though records are unreliable (TSSC 2013a[53]).

Records of this species are predominantly from eastern Australia, though they have been seen in wetlands across all states. It was not observed during bird surveys of the Project Area (KMA 2013c), though COG (2014) recorded the species in singles and pairs at the West Macgregor Pony Club and Parkwood Horse Paddocks (both of which are within the Project Area) during their 2012 – 2013 survey season. The same survey also recorded the species nearby at the west Belconnen pond (Dunlop) and Kama Nature Reserve.

The range of avoidance and mitigation strategies implemented by the Program is discussed in **Section 4.5.1** in relation to all threatened bird species that may be affected by the Program.

Superb Parrot

Superb parrots are a medium sized parrot with bright green plumage which is listed as vulnerable under the EPBC Act, the NC Act, and the TSC Act.

Superb parrots inhabit forests and woodlands in the Riverina, western slopes and plains, and the southern tablelands. In the Canberra region box gum woodlands provide the key habitat for the species (ACT Gov't 2005b[54]). Critical habitat features include large living and dead trees, predominantly Blakely's red gum and scribbly gum in the ACT region, which are used for nesting sites (ACT Gov't 2004b).

Superb parrots arrive in the ACT region in early spring to breed and are generally sighted between Canberra, Yass, Sutton, and Gundaroo. They generally feed on flowering eucalypts, grasses, and grains; foraging up to 15 kilometres from nesting sites (ACT Gov't 2004b). The species departs the area in January, travelling north to their NSW overwinter areas (ACT Gov't 2005b).

Superb parrots are vulnerable to the effects of habitat fragmentation. Connectivity between breeding and foraging sites is particularly important as they appear reluctant to cross large areas of open ground, typically following wooded links such as those along the Murrumbidgee River or Ginninderra Creek. Historically other key threats have been the poisoning and illegal trapping of the species (ACT Gov't 2004b).

Targeted surveys between 2008 and 2013 recorded superb parrots in small numbers (12 birds over five separate days) in the wooded areas to the south of the Project Area. The trees near Stockdill Drive and the golf course are seemingly particularly important as a movement corridor for the species. In addition, a survey of tree hollows was also undertaken in spring 2012, during which any use by animals was recorded. There was no observation of breeding of superb parrot, which typically

[52] Australian Government (2015b) *Species Profile and Threat (SPRAT) Database,* Department of the Environment, Canberra, accessed online (December 2015): http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

[53] Threatened Species Scientific Committee (TSSC) (2013a) *Commonwealth Listing Advice Amendment Rostratula australis,* accessed online (April 2015): http://www.environment.gov.au/biodiversity/threatened/species/pubs/77037-listing-advice.pdf.

[54] ACT Government (2005b) *Threatened Species and Communities of the ACT Information Sheet: Superb Parrot (Polytelis swainsonii) A vulnerable species*, Environment ACT, Canberra.

occurs at Throsby Ridge (Gungahlin) and in the central Molonglo Valley (KMA 2013c). Observations of the species in the Project Area are most likely indicative of its use of the area for movements between the central Molonglo breeding area and other foraging habitat, or wider seasonal movement corridors. COG (2015a[55]) notes a similar movement of superb parrots into Belconnen Farm that has occurred since the 2005 – 2006 survey year as well as numerous records from nearby Belconnen suburbs.

Areas of woodland with high value connectivity and quality will be protected under the Program. This avoidance strategy is discussed in relation to threatened birds that may be affected by the Program in **Section 4.5.1**.

Regent Honeyeater

Regent honeyeaters are recognisable by the yellow scalloping on their wings and back, which are predominantly black. The species is listed as critically endangered under the EPBC Act and the TSC Act, and as endangered under the NC Act. Regent honeyeaters have been described by COG as a rare, breeding visitor to the ACT (COG 2012[56]).

Regent honeyeaters are known to regularly occur in woodlands with an abundance of mature trees, high canopy cover, and a large number of mistletoe species; where it feeds on nectar from flowering yellow box, Blakely's red gum, and associated mistletoe. It is a partially migratory bird which moves north in autumn and winter, and returns south for breeding in the spring. The species' movements are thought to be governed largely by the availability of flowering eucalypts. Breeding is recorded with some regularity in the ACT, but this has tended to involve individual pairs (Australian Gov't 2015b).

Loss of habitat and food through inappropriate fire regimes, uncontrolled grazing, tree clearing, and tree dieback are considered to be key threats to the species in the ACT (ACT Gov't 2004b).

The species was not observed during targeted bird surveys within the Project Area (KMA 2013c) but all native woodland patches provide potential habitat and it is considered likely that the species is present occasionally, when suitable conditions and other circumstances prevail. A description of the avoidance and mitigation measures implemented as part of the Program relevant to threatened birds is discussed further in **Section 4.5.1.**

Swift Parrot

Swift parrots are a small green parrot with a red spiked tail and red forehead and throat. The species is listed as critically endangered under the EPBC Act, endangered under the TSC Act, and as vulnerable under the NC Act.

Swift parrots are a migratory species that use Tasmanian blue gums (*Eucalyptus globulus*) in southeast Tasmania for breeding in September to December. In winter they are semi-nomadic, foraging in dry woodlands mainly in Victoria and NSW. Smaller but significant numbers have been recorded regularly in south-eastern Queensland and occasionally in the ACT and south-eastern South Australia (Saunders and Tzaros 2011[57]).

[55] Canberra Ornithologists Group (COG) (2015a) *Annual Bird Report: 1 July 2013 to 30June 2014*, Canberra Bird Notes 40(1):1-118, Canberra Ornithologists Group, Canberra.

[56] Canberra Ornithologists Group (COG) (2012) *Annual Bird Report: 1 July 2010 to 30 June 2011*, Canberra Bird Notes 37(1): 1-92, Canberra Ornithologists Group, Canberra.

[57] Saunders and Tzaros (2011) *National Recovery Plan for the Swift Parrot Lathamus discolor,* Birds Australia, Melbourne.

Within the ACT, swift parrots may occur in dry sclerophyll eucalypt forests and box gum woodland; however, most records appear to be of birds passing through the region, rarely spending much time at a given site (Taws and Saunders 2005[58]).

The species was not observed in the Project Area during targeted bird surveys, although may occur in woodland when mature eucalypts are flowering (KMA 2013c). It is classified as having the potential to occur within the Project Area; however, it would only occur when specific habitat conditions around the flowering of certain eucalypts are met as the species is regarded as having a high degree of site fidelity (Taws and Saunders 2005).

Areas of woodland with high value connectivity and quality will be protected under the Program. This avoidance strategy is discussed in relation to threatened birds that may be affected by the Program in **Section 4.5.1**.

Painted Honeyeater

Painted honeyeaters (*Grantiella picta*) have black wings with yellow flight and tail feathers, a white belly with black spots on its flanks, and a pink bill. It is listed as vulnerable under the EPBC Act, the NC Act, and the TSC Act.

Painted honeyeaters inhabit mistletoes in eucalypt forests and woodlands, riparian woodlands, *Casuarina* spp., cypress pine (*Callitris* spp.), and farms and gardens. They display a preference for woodlands with a high number of mature trees and are more common in wider blocks than in narrow strips (TSSC 2015a[59]).

They are often sighted singularly or in pairs, though will occasionally be recorded in small flocks. They are sparsely distributed between south eastern Australia and north western Queensland and eastern Northern Territory; predominantly along the western slopes of the Great Dividing Range. The species follows a north to south seasonal movement pattern that is governed by the fruiting of mistletoe during breeding seasons, after which they move north and west to more arid regions (TSSC 2015a).

Habitat loss is the key threat for the species across most of their distribution. Furthermore, remaining remnants of painted honeyeater habitat is being degraded by overgrazing reducing the recruitment rate of the woodland habitats. Other threats to the species include: competition with noisy miner (*Manorina melanocephala*), predation by invasive species (e.g. black rat *Rattus rattus*), deliberate destruction of mistletoe in production forests, exacerbation of tree decline through pasture improvement activities, vehicle collision, and nest predation from other bird species (TSSC 2015a).

Painted honeyeaters have the potential to occur along the Murrumbidgee River in river oak vegetation where mistletoe is also present (KMA 2009b); although it is unclear to what extent the patch of potentially suitable habitat would be utilised by painted honeyeaters should they occur. Closest COG records in 2013-2014 are from Stony Creek and the Molonglo River, south of the Project Area (COG 2015a).

Vegetation within the existing Murrumbidgee River Corridor will be protected from impacts of the Program by the WBCC. This avoidance strategy is discussed in relation to threatened birds in **Section 4.5.1**.

[58] Taws, N. and Saunders, D. (2005) *Swift Parrot Invasions*, Canberra Bird Notes 30(2): 76-78, Canberra Ornithologists Group, Canberra.

[59] Threatened Species Scientific Committee (TSSC) (2015a) *Approved Conservation Advice Grantiella picta painted honeyeater,* prepared for the Department of the Environment, Canberra.

3.3.1.3 Fish

Three fish species listed under the EPBC Act were identified by the PMST report as having the potential to occur within the Project Area (**Table 3.7**). In addition, silver perch (*Bidyanus bidyanus*) is described below. This species was not identified by the PMST report; however, it has been raised as a concern by stakeholders and so is discussed within this report.

It is not anticipated that there will be any direct impacts to any of these fish species by the Program. Furthermore, potential indirect impacts will be managed through design and management of urban runoff systems and the retention, protection, and enhancement of the WBCC; eliminating or minimising a majority of the threats to aquatic environments. These avoidance and mitigation measures are discussed in greater detail in **Section 4.5** as part of the assessment for significance of residual impacts.

Table 3.7 Threatened Fish Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	FM Act	
Macquaria australasica	Macquarie perch	E	E	E	known
Maccullochella peelii	Murray cod	V	-	-	known
Maccullochella macquariensis	trout cod	E	E	E	likely
Bidyanus bidyanus	silver perch	CE	E	V	unlikely

Silver perch has historically been recorded in the reach of the Murrumbidgee River that runs alongside the Project Area (ACT Gov't 2007). Since this time, the species has suffered a continued decline and is considered extinct in the ACT (ACT Gov't 2015c). This is despite stocking of impoundments throughout the Murray Darling Basin (including Lake Burrinjuck) for recreational purposes. In most cases (with the exception of Cataract Dam near Sydney), stocking does not appear to have established self-sustaining populations in the wild (NSW Gov't 2016b[60]). In the event that individuals stocked at Lake Burrinjuck have been able to migrate upstream (approximately 85 kilometres) into the Project Area, there is no evidence to show that they are able to sustain a viable population from year to year. For this reason, it is considered unlikely that the species occurs in this reach of the Murrumbidgee River and is not considered any further in this assessment.

Macquarie Perch

Macquarie perch is listed as endangered under the EPBC Act, the NC Act, and the FM Act. It is a moderately sized, deep-bodied, laterally compressed fish with large white eyes, a humped back, and a rounded tail. It is grey to black in colour with a whitish ventral surface and an obvious lateral line (ACT Gov't 2007).

[60] NSW Government (2016b) *Silver Perch Bidyanus bidyanus NSW Recovery Plan*, Department of Primary Industries, Nelson Bay.

The species' preferred habitat is cool, shaded, upland streams with deep rocky pools and substantial cover. It is generally confined to the upper reaches of catchments that are more natural (ACT Gov't 2007).

Action Plan 29 notes many important threats to Macquarie perch in the ACT. These include damage to riparian vegetation, sedimentation, barriers to fish passage, flow regime alteration, recreational angling, predation, diseases / parasites, and the impacts of the ACT bushfires in 2003.

Macquarie Perch are restricted to four rivers in the ACT: the Murrumbidgee, Molonglo, Paddys, and Cotter Rivers (ACT Gov't 1999[61]). ACT Government mapping (ACT Gov't 2015a) and Action Plan 29 show habitat for the species along the reach of the Murrumbidgee River that lies within the Project Area.

Murray Cod

Murray cod is listed as vulnerable under the EPBC Act. The species is the largest native freshwater fish in Australia and occurs extensively throughout the Murray-Darling Basin in south-eastern Australia. It is predominantly light olive to dark green in colour with mottled patterning and white to cream coloured undersides, and has rounded fins (Australian Gov't 2015b).

Its preferred habitat ranges from small, clear, rocky streams to large, slow flowing rivers with shelter such as deep holes, rocks, fallen timber, stumps, clay banks, or overhanging vegetation (Australian Gov't 2015b).

Action Plan 29 notes sedimentation as the most important threat to Murray cod within the ACT. Other important threats include damage to riparian vegetation, barriers to fish passage, flow regime alteration, reduced water quality, illegal harvesting, competition for food and habitat, diseases and parasites, and impacts from the ACT 2003 bushfires.

The 'National Recovery Plan for the Murray Cod *Maccullochella peelii peelii*' (Victorian Gov't 2010a[62]) identifies a population within the ACT portion of the Murrumbidgee River. This population is considered important due to its scale, size, integrity, and proximity to the Murray Darling Basin upland limit. In addition, the species is regularly stocked in Canberra lakes including Lake Ginninderra, Gungahlin Pond, and Yerrabi Pond. ACT Government mapping (ACT Gov't 2015a) shows the species within the reach of the Murrumbidgee River that occurs within the Project Area as well as within Ginninderra Creek upstream of the Project Area.

Trout Cod

Trout cod is listed as endangered under the EPBC Act, the NC Act, and the FM Act. It is similar in appearance to the Murray cod and was only recognised as a distinct species in the 1970s. It is a large, elongate, and deep-bodied fish that is generally blue – grey, with a light grey – white ventral surface, and with small dark grey to black spots or dashes extending to the lower sides.

Trout cod were once widespread in the south-eastern region of the Murray Darling Basin. Now there are only two self-sufficient populations remaining, both in Victoria. Adults are essentially pool dwelling, cover-seeking fish that are associated with snags and wood debris, or are found in areas of relatively fast flowing currents (ACT Gov't 2007).

[61] ACT Government (1999) *Action Plan No. 13: Macquarie Perch (Macquaria australasica) An endangered species*, Environment ACT, Canberra.

[62] Victorian Government (2010a) *National Recovery Plan for the Murray Cod Maccullochella peelii peelii*, Department of Sustainability and Environment, Melbourne.

Action Plan 29 notes many threats to trout cod in the ACT. Most importantly these include damage to riparian vegetation, sedimentation, recreational angling, and predation from introduced species.

There are two sites within the ACT that have been stocked with the species. The first is in Bendora Dam (1989 – 1990) and the other is at Angle Crossing (1996 – 1998). It is not known how far this species extends along the Murrumbidgee River currently, though Action Plan 29 notes that it is likely to be present in Reach 5 of the Murrumbidgee River which lies within the Project Area. Aside from these stocked populations, the species is considered locally extinct in the ACT (ACT Gov't, 2015c).

3.3.1.4 Frogs

Four threatened frog species listed under the EPBC Act have the potential to occur within the Project Area as identified by the PMST (**Table 3.8**).

Table 3.8 Threatened Frog Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	TSC Act	
Litoria Booroolongensis	Booroolong frog	E	-	E	potential
Pseudophryne pengilleyi	northern corroboree frog	CE	E	CE	no
Litoria castanea	yellow-spotted tree frog	E	-	CE	no
Litoria aurea	green and golden bell frog	V	-	V	no

Northern corroboree frogs (*Pseudophryne pengilleyi*) and yellow-spotted tree frogs (*Litoria castanea*) both occur at elevations higher than that which occur within the Project Area (Australian Gov't 2015b). Due to the absence of suitable conditions or habitat, these species are not likely to be present and are considered no further.

Despite previously occurring in the region green and golden bell frog (*Litoria aurea*) has only been confirmed from one inland site at Captain's Flat (east from Canberra) since 1990 (Australian Gov't 2015b; NSW Gov't 2015b). Given the distance to known populations the species is not likely to be present and is considered no further.

Booroolong Frog

Booroolong frogs (*Litoria Booroolongensis*) are listed as endangered under the EPBC Act and the TSC Act. They are a small (approximately five centimetres in length) riparian frog that is a green brown – black in colour, with pink or beige flecks (Australian Gov't 2015b).

Historically the species was known to occur in generally western flowing river catchments in the Northern, Central, and Southern Tablelands, and some eastern flowing catchments north of Sydney. Since 1990 the species has suffered a serious decline in its range and a majority of the extant

population occurs along tributaries of the Tumut and upper Murray Rivers in the Southern Tablelands (TSSC 2007[63]).

This contraction in distribution is believed to be caused by drought (Booroolong frogs require a permanent water source), habitat disturbance, the disease *chytridiomycosis*, and predation of tadpoles by introduced fish (TSSC 2007).

Habitat for Booroolong frogs includes permanent slow-flowing large rivers with extensive rock bank structures that contain crevices in slow to medium flowing sections of the stream and some fringing vegetation such as ferns, sedges, or grasses (TSSC 2007).

Despite the species not being recorded within the Project Area, habitat suitable for Booroolong frogs may exist along the Murrumbidgee River within the Project Area. The distance between the Project Area and the nearest known populations reduces the likelihood that the species is present. Regardless, if Booroolong frogs are present within the Project Area, direct impacts to the species will be avoided as a result of establishing the WBCC. Mitigation measures for potential indirect impacts to Booroolong frogs are discussed in **Section 4.5.3** as part of the assessment for significance.

3.3.1.5 Invertebrates

One threatened invertebrate species listed under the EPBC Act is known to occur within the Project Area (**Table 3.9**).

Table 3.9 Threatened Invertebrate Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	TSC Act	
Synemon plana	golden sun moth	CE	E	E	known

Golden Sun Moth

Golden sun moths are a medium-sized, day-flying moth that is listed as critically endangered under the EPBC Act, and endangered under the NC Act and TSC Act.

Historically, golden sun moth occurred across approximately two million hectares of natural temperate grasslands in NSW, ACT, Victoria, and South Australia. Less than one percent of these temperate grasslands remain and populations of golden sun moth are highly reduced and fragmented as a result (NSW Gov't 2007a[64]).

Presently, the species occurs in natural temperate grasslands and open grassy woodlands. Once considered to be restricted to only natural temperate grasslands dominated by more than 40 percent coverage of wallaby grass, the species is now found to have a broader tolerance for other species compositions and has been recorded in exotic grasslands dominated by Chilean needle-grass (*Nassella neesiana*) (Australian Gov't 2015b).

[63] Threatened Species Scientific Committee (TSSC) (2007) *Commonwealth Listing Advice on Litoria Booroolongensis*, prepared for the Department of Environment, Heritage, and the Arts, Canberra, accessed online (April, 2015): http://www.environment.gov.au/biodiversity/threatened/species/pubs/1844-listing-advice.pdf.

[64] NSW Government (2007a) *Draft NSW and National Recovery Plan for the Golden Sun Moth –Synemon plana*, Department of Environment and Conservation, Queanbeyan.

Conservation of golden sun moth in the ACT was addressed first through 'Action Plan No. 7 Golden Sun Moth *Synemon plana*' (ACT Gov't 1998[65]), then in a more integrated context through Action Plan 28. Since those Action Plans were prepared, the number of sites where golden sun moth has been recorded in the ACT has increased substantially to over 70 sites (Mulvaney 2012[66]).

Within the Project Area populations of golden sun moth occur in the Jarramlee (Biosis 2015[67]; Rowell 2015[68]; ACT Gov't 2013a) and Macgregor (Braby 2005; Rowell 2015) offsets, and have previously been recorded in the ACT land parcel block immediately to the west of Jarramlee (Block 1621, Belconnen) and adjacent NSW land (Rowell 2013[69]).

Targeted surveys for golden sun moth and basic habitat assessment were undertaken by Rowell (2015) as part of the baseline studies for the west Belconnen project. These surveys considered the Jarramlee and Macgregor offsets in addition to the following three other parcels along the ACT-NSW border, all along Wallaroo Road to the north of the Project Area:

- Lot 1 DP 1144979 Yass, NSW;
- Lot 2 DP 1144979 Yass, NSW; and
- Block 48 Hall, ACT.

Surveys identified a patchy but widespread distribution of golden sun moth based on the presence of flying males. Findings for the Jarramlee and Macgregor offsets were consistent with previous work (Braby 2005; ACT Gov't 2013a) and contemporary surveys undertaken concurrently by others (Biosis 2015). In addition to providing a high degree of confidence in the results, the surveys by Rowell (2015) also allowed for the first time a more complete understanding of the relative abundance of golden sun moth on the Macgregor offset site. This has allowed for assessment from a consistent basis across all sites but importantly also on the Jarramlee offset site which had previously been based on an assessment of habitat as opposed to the presence of flying males.

The Ginninderra Drive extension will impact upon golden sun moth in both the Jarramlee and Macgregor offsets. Assessment of this impact and management strategies associated with it are discussed in **Section 4.5.4**.

3.3.1.6 Mammals

Six threatened mammal species were identified by the PMST report as having the potential to occur within the Project Area (**Table 3.10**).

[65] ACT Government (1998) *Action Plan No. 7: Golden Sun Moth Synemon plana*, Environment ACT, Canberra.

[66] Mulvaney, M. (2012) *The Extent and Significance of Gungahlin's Biodiversity Values*, Technical Report 24, prepared for Environment and Sustainable Development Directorate, Canberra.

[67] Biosis (2015) *Golden Sun Moth Monitoring Report – Jarramlee Nature Reserve*, prepared for Territory and Municipal Services, Canberra.

[68] Rowell A (2015) *Riverview Project: Ginninderra Drive extension Golden Sun Moth Surveys*, prepared for Umwelt Pty Ltd (February 2015), Canberra.

[69] Rowell, A. (2013) *West Belconnen Golden Sun Moth Surveys, October to December 2012*, prepared for The Riverview Group, Canberra.

Table 3.10 Threatened Mammal Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	TSC Act	
Dasyurus maculatus maculatus	spotted-tail quoll	E	V	V	likely
Pteropus poliocephalus	grey-headed flying fox	V	-	V	potential
Phascolarctos cinereus	koala	V	-	V	unlikely
Petauroides volans	greater glider	V	-	E*	no
Pseudomys fumeas	konoom, smoky mouse	E	E	CE	no
Mastacomys fuscus mordicus	tooarrana, broad-toothed rat	V	-	V	no

*In NSW two endangered populations are recognised, rather than the species as a whole.

Of these species, koala (*Phascolarctos cinereus*), konoom (*Pseudomys fumeas*), tooarrana (*Mastacomys fuscus mordicus*), and greater glider (*Petauroides volans*) are unlikely to be present and will not be considered further in this assessment. The basis for this conclusion is as follows:

- Koalas are unlikely to occur within the Project Area as their preferred habitat in the region occurs predominantly within the Brindabella Ranges or in forests on the eastern side of the ACT. There have been occasional sightings of the species in suburban areas of Canberra, though these are rare and only occur in extreme circumstances (Australian Gov't 2015b).

- In the region, konoom, tooarrana, and greater glider are only known in the Brindabella Ranges and, therefore, are not considered to occur within the Project Area (Australian Gov't 2015b).

Spotted-Tail Quoll

Spotted-tail quoll (*Dasyurus maculatus maculatus*) is listed as endangered under the EPBC Act, and vulnerable under both the NC Act and the TSC Act. It is a nocturnal, carnivorous marsupial that has red – brown fur with distinctive white spots on its back and tail. On average males weigh approximately 4.5 kilograms and females weigh two kilograms (Australian Gov't 2015b).

Previously spotted-tail quoll was found throughout southeast Queensland, eastern NSW, Victoria, southeast South Australia, and Tasmania. Currently it is found in declining numbers in fragmented subpopulations throughout most of this region. The species occupies large home ranges and is highly mobile within them. It has an elusive nature, which when combined with low densities make spotted-tail quolls difficult to detect (Victorian Gov't 2016[70]).

Spotted-tail quoll have a preference for mature, wet forests that contain sufficient structural diversity to supply den sites and plentiful prey. Dens are fashioned from a range of landscape

[70] Victorian Government (2016) *National Recovery Plan for the Spotted-tail Quoll Dasyurus maculatus*, Department of Environment, Land, Water and Planning, Melbourne.

features such as rock crevices, hollow logs, tree hollows, caves, dense vegetation, or in the right substrate be dug into the soil (Victorian Gov't 2016). Prey varies throughout the species' distribution, however, in the ACT region generally consists of brush-tailed possum (*Trichosurus vulpecula*), ring-tailed possum (*Pseudocheirus peregrinus*), greater glider (*Petauroides volans*), and rabbit (*Oryctolagus cuniculus*) (D Fletcher 2016, pers. comm. 28 September).

Despite their preference for wet forest, spotted-tail quolls have been recorded throughout numerous forest, woodland, heathland, grassland, rocky outcrops, and urban areas; particularly where these habitats occur adjacent to forest (Victorian Gov't 2016). This is understood to reflect the high mobility and large home ranges of the species, rather than as evidence of a resident population (D Fletcher 2016, pers. comm. 28 September).

Records in the ACT region most regularly occur within the Brindabella Ranges with others occurring throughout the urban area. There are no records within the Project Area; however, the species has been historically sighted within the nearby suburbs of Holt and Charnwood (Canberra Nature Map 2016[71]).

It is unlikely that there is a resident population of spotted-tail quolls within the Project Area given the size of potential habitat. It is, however, considered likely that vagrants from breeding populations in the Brindabella Mountains utilise forest and woodland habitats within the river and creek corridors as a dispersal corridor, though the extent to which this may occur is unknown.

As the connectivity function of the river corridor will be maintained, and the availability of den and prey items is unlikely to be adversely affected by the Program, it is considered unlikely that the Program will impact upon spotted-tail quoll.

Grey-Headed Flying Fox

Grey-headed flying fox (*Pteropus poliocephalus*) is listed as vulnerable under the EPBC Act and the TSC Act. It is Australia's largest flying fox species with a head and body length up to 29 centimetres and a wingspan up to one metre. Fur on the body is dark grey, with light grey fur on the head, and red around the neck (Australian Gov't 2015b).

Grey-headed flying fox are found along eastern Australia between the coast and the western slopes from Bundaberg, Queensland to Melbourne, Victoria, with some records from South Australia. The species is migratory, following the flowering patterns of food species (NSW Gov't 2009[72]). The ACT region lies to the west of the species' usual distribution; though in recent years a population has established a diurnal roost in Commonwealth Park, ACT.

Grey-headed flying fox have been known to travel more than 50 kilometres between roosting camps and foraging sites. As such, the Project Area is situated within the foraging range of the population at Commonwealth Park. However, given the lack of suitable foraging habitat, observations of this species in the vicinity of the Project Area are most likely associated with foraging in fruiting or flowering trees in existing residential areas or dispersal to the vineyards further north between Canberra and Yass. Accordingly, the Program is unlikely to adversely affect the species' foraging or roosting habitat and no further assessment of impacts is considered necessary.

[71] Canberra Nature Map (2016) *Distribution Map*, accessed online (October 2016): http://canberranaturemap.org/Community/Map?Species=15506.

[72] NSW Government (2009) *Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus*, prepared by Eby, P. Department of Environment, Climate Change and Water, Sydney.

3.3.1.7 Reptiles

Three reptile species listed under the EPBC Act were identified by the PMST as having the potential to occur within the Project Area (**Table 3.11**).

Table 3.11 Threatened Reptile Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	TSC Act	
Aprasia parapulchella	pink-tailed worm-lizard	V	V	V	known
Delma impar	striped legless lizard	V	V	V	unlikely
Tympanocryptis pinguicolla	grassland earless dragon	E	E	E	unlikely

It is considered unlikely that striped legless lizard (*Delma impar*) occurs within the Project Area due to a lack of appropriate cover by tussock grass species and lack of previous records.

Whilst it appears that appropriate habitat for grassland earless dragon (*Tympanocryptis pinguicolla)* occurs in areas of natural temperate grassland in the Jarramlee offset; the only known populations occur in the Majura and Jerrabomberra Valleys in the ACT and in Queanbeyan and the Monaro Basalt Plains in NSW. It is not considered likely to occur within the Project Area and will not be considered further in this report.

Pink-Tailed Worm-Lizard

Pink-tailed worm-lizard is listed as vulnerable under the EPBC Act, the NC Act, and the TSC Act. It is a cryptic, fossorial pygopod (legless lizard) species that grows to up 14 centimetres long and is recognised by the characteristic pink colouring on its tail.

The species has a patchy distribution along the foothills of the western slopes of the Great Dividing Range (TSSC 2015b[73]). In the ACT, the species is known to occur primarily along the Molonglo River between Belconnen and the Molonglo Valley; and Mount Taylor and Farrer Ridges in Tuggeranong (ACT Gov't 2007). In NSW the species is concentrated in the Southern Tablelands Region surrounding the ACT; however, it is also found further west and northwest in areas such as Bathurst, West Wyalong, and Griffith. Albury marks the southern tip of the known distribution within NSW (NSW Gov't 2015a[74]). New populations have also recently been found in Bendigo, Victoria (Osborne and Wong 2013).

Habitat preferences of pink-tailed worm-lizards are discussed by Wong (2013[75]) in relation to the national distribution of the species and the range of habitats it occupies. Pink-tailed worm-lizards generally occur in open grassland habitat that is dominated by native grasses such as kangaroo,

[73] Threatened Species Scientific Committee (TSSC) (2015b) *Conservation Advice Aprasia parapulchella Pink-tailed worm-lizard*, approved by the Minister for the Environment's Delegate on 01/10/2015, Canberra.

[74] NSW Government (2015a) *Threatened Species Profile Search*, Office of Environment and Heritage, Sydney, accessed online (March, 2015): http://www.environment.nsw.gov.au/threatenedspeciesapp/default.aspx?keywords=.

[75] Wong D.T.Y. (2013) *Environmental factors affecting the occurrence and abundance of the Pink-tailed Worm-lizard (Aprasia parapulchella) in the Australian Capital Territory*, A thesis submitted for the degree of Doctor of Philosophy at the University of Canberra (May 2013)

spear, and wallaby grass; although may sometimes be found in highly modified grasslands dominated by exotic species. The species is most commonly found sheltering under small, shallowly embedded rocks which are used for thermoregulation and the species may remain under the same rock for long periods. Preference is shown for sunny aspects and avoidance of south facing slopes. Ant burrows (particularly *Iridomyrmex* spp.) are often used to retreat into deeper ground to avoid hot, dry weather (TSSC 2015b). Within the ACT the occurrence of the species is positively correlated to species rich native tussock grasslands on areas of Silurian acid volcanic geology with shallowly embedded surface rocks (Wong 2013).

Within the Project Area the species has been recorded in rocky habitat along the Murrumbidgee River and its confluence with Ginninderra Creek, with a majority of it occurring between Stockdill Drive and approximately one kilometre north of the ACT / NSW border (**Figure 3-5**). The habitat condition is moderate to high, with some small patches of low quality occurring on the outer edges, which are believed to be unoccupied (Osborne and Wong 2013).

The population within the Project Area is considered to be an important population (see **Section 4.1** for definition) of pink-tailed worm-lizard. In addition to the extensive area that it covers, it also provides a dispersal corridor that links populations north of Ginninderra Falls to populations in the Molonglo River Corridor (Osborne and Wong 2013).

The Program has applied the impact mitigation hierarchy with regard to pink-tailed worm-lizard. Survey for the species in the Project Area was undertaken by herpetologist experts David Wong and Will Osborne (2013) prior to the design of the Master Plan. This allowed the urban edge to be defined such that it would avoid the greatest extent of habitat practicable. As a result of this, 146.4 ha (90%) will be protected from direct impacts within the WBCC. Mitigation measures applicable to the species, as well as direct impacts to small areas of occupied habitat outside of the WBCC as a result of the Program are discussed in **Section 4.5.5**.

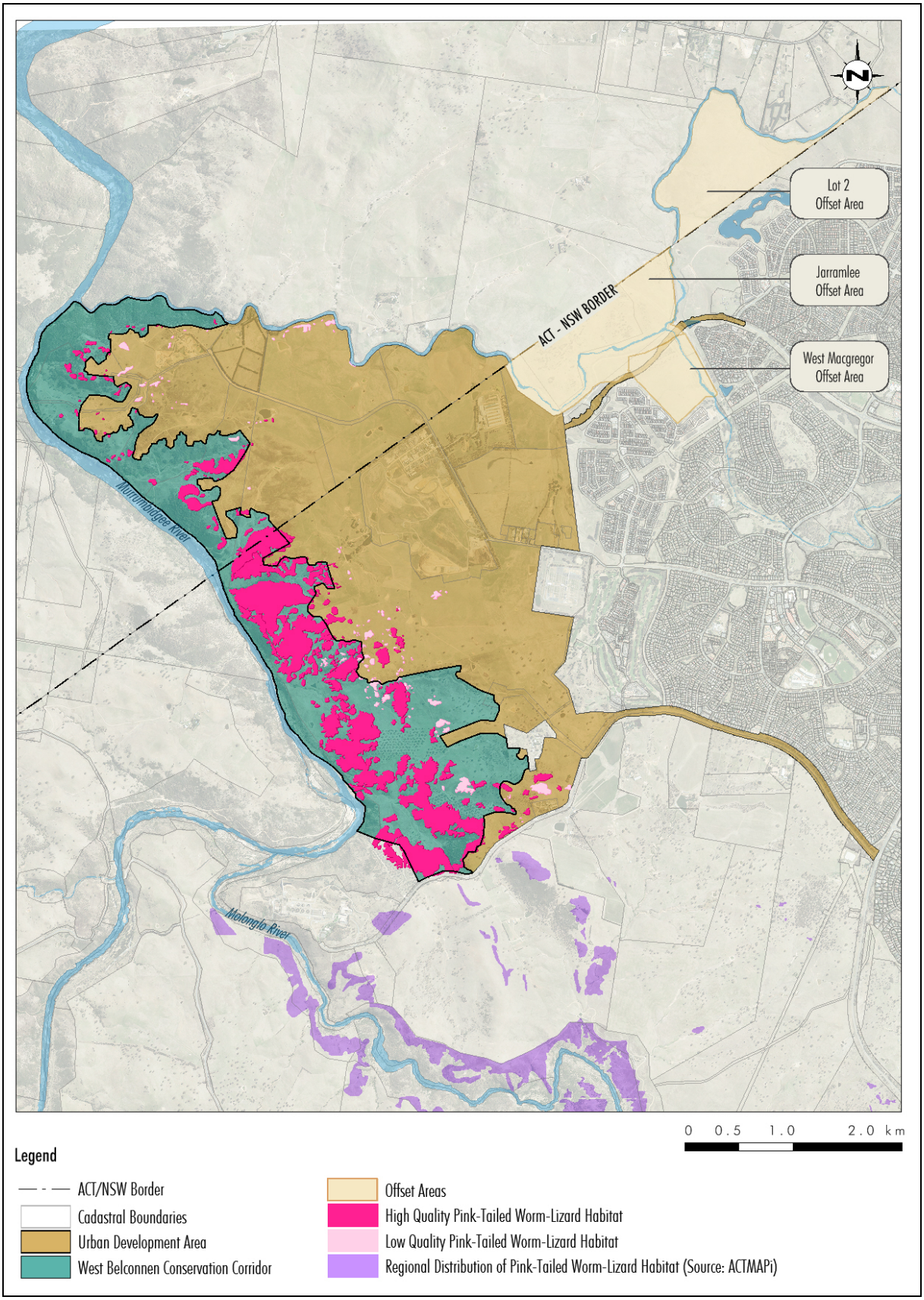

Figure 3-5

Moderate to High and Low Quality Pink-Tailed Worm-Lizard Habitat within the Project Area

3.3.1.8 Flora

Ten flora species listed under the EPBC Act were identified by the PMST report as having the potential to occur within the Assessment Area (**Table 3.12**).

Table 3.12 Threatened Flora Species in the Project Area

Scientific Name	Common Name	Status			Presence
		EPBC Act	NC Act	TSC Act	
Swainsona recta	small purple pea	E	E	E	likely
Pomaderris pallida	pale pomaderris	V	-	V	likely
Thesium australe	Austral toadflax	V	-	V	likely
*Prasophyllum petilum**	Tarengo leek orchid	E	E	E	potential
Leucochrysum albicans var. *tricolor*	hoary sunray	E	-	-	potential
Lepidium hyssopifolium	basalt peppercress	E	-	E	unlikely
Lepidium ginninderrense	Ginninderra peppercress	V	E	-	unlikely
Eucalyptus aggregata	black gum	V	-	V	unlikely
Pterostylis oreophila	blue-tongued orchid	CE	-	CE	no
Pelargonium sp. *striatellum*	Omeo stork's-bill	E	-	E	no

**Prasophyllum petilum* is synonymous with *P.* sp. Wybong (C. Phelps ORG 5269) which is listed separately on the PMST report.

Five of the species identified by the PMST report are unlikely to occur within the Project Area or it is considered to be out of their normal distribution, they are addressed briefly below:

- Basalt peppercress (*Lepidium hyssopifolium*) is considered unlikely to occur within the Project Area due to its low dispersal capabilities. The nearest known population is located at Bungendore, NSW and natural introduction of seed to new sites seems unlikely (Victorian Gov't 2010b[76]).

- Ginninderra peppercress is considered unlikely to occur within the Project Area as it is found in natural temperate grasslands along the Ginninderra floodplain. Whilst some of this habitat

[76] Victorian Government (2010b) *National Recovery Plan for the Basalt Peppercress Lepidium hyssopifolium*, prepared by Tumino, M. for the Department of Sustainability and Environment, Melbourne.

occurs within the Jarramlee offset, it has not been recorded despite numerous recent surveys (ACT Gov't 2013a).

- Black gum (*Eucalyptus aggregata*) occurs to a very minor extent in the ACT. The only know wild mature trees are located along the Kings Highway in the Kowen region, which is near the eastern edge of the Territory. This population is considered to be the western extent of the population at this latitude and it is considered unlikely to occur within the Project Area (TSSC 2015c[77]).

- Blue-tongued orchid (*Pterostylis oreophila*) is not considered likely to occur within the Project Area as its habitat occurs beside montane and subalpine streams under tall, dense thickets of mountain tea tree (*Leptospermum grandiflorum*), which does not occur within the Project Area (TSSC 2011a[78]).

- Omeo stork's-bill (*Pelargonium* sp. *striatellum*) occurs between 680 and 1030 metres above sea level, therefore, is not expected to occur within the Project Area (TSSC 2011b[79]).

The remaining flora species are described in more detail below and also have corresponding assessments presented in **Section 4.6**.

Small Purple Pea

Small purple pea (*Swainsona recta*) is listed as endangered under the EPBC Act, the NC Act, and the TSC Act. It is a perennial forb that produces 20 to 30 centimetre long stems from a tap root with purple – blue flowers (Australian Gov't 2015b).

Historically small purple pea was distributed throughout the western slopes of NSW and north east Victoria. In recent times this distribution has been reduced to two population clusters, one in central eastern NSW and the second in the Canberra / Williamsdale district (ACT Gov't 2004b).

The species' preferred habitat includes native grasslands and woodland. These woodlands may be dominated by Blakely's red gum, yellow box, apple box, red box, white box, rough-barked apple (*Angophora floribunda*), or black cypress pine (*Callitris endlicheri*) with a grassy native understorey, which includes a wide range of native forbs (NSW Gov't 2012[80]). Within the ACT district it is known only from grassy woodlands (ACT Gov't 2004b). The black cypress pine that is present within the 'tablelands dry shrubby box woodland' on the upper slopes of the Project Area is not considered to be habitat for the species given the shrubby mid-layer vegetation that is present (KMA 2009b).

Agricultural practices are believed to be predominantly responsible for the decline in small purple pea numbers. Now populations are so small they are at risk of becoming locally extinct from a single event (ACT Gov't 2004b; NSW Gov't 2012). Within the Project Area habitat for small purple pea is considered to be box gum woodland patches (excluding those that occur along Drake Brockman Drive); all of which will be protected within the WBCC. The box gum woodland that occurs within the Drake Brockman Drive upgrade area is not considered to be of sufficient quality with regard to native forbs to constitute habitat for the species.

[77] Threatened Species Scientific Committee (TSSC) (2015c) *Conservation Advice Eucalyptus aggregata black gum*, approved by the Minister for the Environment on 17/11/2015.

[78] Threatened Species Scientific Committee (TSSC) (2011a) *Commonwealth Listing Advice on Pterostylis oreophila,* prepared for the Department for Sustainability, Environment, Water, Population and Communities, Canberra.

[79] Threatened Species Scientific Committee (TSSC) (2011b) *Commonwealth Listing Advice on Pelargonium sp. Striatellum,* prepared for the Department for Sustainability, Environment, Water, Population and Communities, Canberra.

[80] NSW Government (2012) *National Recovery Plan for Small Purple-pea (Swainsona recta)*, Office of Environment and Heritage, Hurstville.

Pale Pomaderris

Pale pomaderris is a perennial shrub that is listed as vulnerable under the EPBC Act and the TSC Act. It grows to 1.5 metres tall, has dark green and grey to white elliptical leaves, with cream or pale yellow flowers (TSSC 2008[81]).

It is currently distributed along river corridors in the ACT, southern NSW, and eastern Victoria. In the ACT it is scattered along the eastern banks of the Cotter, Paddys, and Murrumbidgee Rivers, and in the Molonglo Gorge (TSSC 2008). NSW distribution of pale pomaderris generally occurs to the west of the ACT (TSSC 2008), though there are also records from the Murrumbidgee River north-west of the ACT (NSW Gov't 2015a).

Habitat for pale pomaderris includes the eastern banks of rivers, with steep upper slopes and cliffs between 480 and 600 metres above sea level. The stands in which it grows are nearly monospecific and occur on the edge of eucalypt or cypress pine woodland (Australian Gov't 2015b). The key threats to this species are rural development, competition from weeds, feral goat grazing, inappropriate fire regimes, fragmentation, and loss of remnants (TSSC 2008).

KMA (2013a) noted that the species is known within the broader west Belconnen area and conducted targeted surveys. Pale pomaderris was not found within the Project Area and is unlikely to occur within the flat and heavily disturbed land proposed for urban development.

Potential habitat for pale pomaderris within the Project Area occurs along the Murrumbidgee River, which will be protected as part of the WBCC.

Austral Toadflax

Austral toadflax (*Thesium australe*) is listed as vulnerable under the EPBC Act and TSC Act. It is a perennial herb that is semi-parasitic on roots of grass species (in particular kangaroo grass). It grows to approximately 40 centimetres tall and produces small white flowers (TSSC 2013b[82]).

The species occurs across a wide range of altitudes in damp sites within shrubland, grassland, or woodland (Australian Gov't 2015b). Its current distribution extends from south east Queensland to north east Victoria and into the tablelands of NSW. It is an inconspicuous plant that is often overlooked, leading to the belief that the austral toadflax may be more widespread than currently thought. Key threats to austral toadflax include inappropriate fire regimes, intensive grazing, encroaching development, and weed invasion (TSSC 2013b).

In the ACT region it is known from a site at Kambah Pool. Whilst the species has not been recorded within the Project Area, potential habitat occurs within box gum woodland that will be incorporated into the WBCC. The box gum woodland that occurs within the Drake Brockman Drive upgrade area is not considered to be of sufficient quality to constitute habitat for the species.

Tarengo Leek Orchid

Tarengo leek orchid (*Prasophyllum petilum*) is listed as endangered under the EPBC Act, the NC Act, and the TSC Act. It is a slender herb with a single cylindrical leaf that grows to 30 centimetres.

[81] Threatened Species Scientific Committee (TSSC) (2008) *Approved Conservation Advice for Pomaderris pallida*, accessed online (April, 2015): http://www.environment.gov.au/biodiversity/threatened/species/pubs/13684-conservation-advice.pdf.

[82] Threatened Species Scientific Committee (TSSC) (2013b) *Approved Conservation Advice for Thesium australe (austral toadflax)*, accessed online (January 2016): http://www.environment.gov.au/biodiversity/threatened/species/pubs/15202-conservation-advice.pdf.

In October to November, between five and 18 green to mauve flowers are produced on a spike (NSW Gov't 2010a[83]).

Tarengo leek orchid is found only in high quality native grassland and grassy woodland that are not subject to continuous grazing. Its past distribution is not known due to the species only being identified in 1991. Primary threats to Tarengo leek orchid include weed invasion, native species encroachment, grazing pressure (particularly during flowering and fruiting time), mechanical injury from cemetery management, air pollutants, and small population size (ACT Gov't 2004b; NSW Gov't 2010a).

The nearest population is at Hall Cemetery, to the north east of the Project Area. Here the species is found among Blakely's red gum and yellow box with a grassy understorey of kangaroo and wallaby grass (NSW Gov't 2010a). In the Project Area potential habitat for Tarengo leek orchid occurs in the high quality patch of box gum woodland in the south. Potential direct impacts to the species will be avoided by inclusion of this habitat in the WBCC.

Hoary Sunray

Hoary sunray (*Leucochrysum albicans* var. *tricolor*) is listed as endangered under the EPBC Act. It is a perennial paper daisy that grows to 15 centimetres tall and flowers in spring and summer. It has silver foliage which produces a white everlasting flower head with a yellow centre (Victorian Gov't 2011a[84]).

Historically the species was widespread throughout Australia; though presently it occurs in an area roughly bounded by Goulbourn, Albury, and Bega within the south east of NSW and the ACT, as well as in Victoria and Tasmania. Its habitat is highly varied across its national range, though in the ACT and NSW includes grassland, grassy woodland, and dry open forest that contains an overstorey of yellow box, Blakely's red gum, red box, brittle gum, or snow gum; a native shrubby midstorey; and an understorey dominated by kangaroo and wallaby grass. Bare ground is required for germination, allowing it to be somewhat tolerant of grazing and be present on roadside verges (Victorian Gov't 2011a).

Threats to hoary sunray include habitat destruction particularly through soil disturbance, weed invasion, poor reservation status, lack of appropriate biomass reduction (i.e. open space for germination), small population sizes, and inappropriate fire and grazing regimes (Victorian Gov't 2011a).

Woodland that is likely to provide habitat for hoary sunray within the Project Area occurs in box gum woodland (excluding that along Drake Brockman Drive) and 'tablelands valley snow gum grassy woodland'. Notwithstanding that the species is readily identifiable and has not been recorded, all of its potential habitat within the Project Area will be protected within the WBCC.

3.3.2 Migratory Species

Ten EPBC Act migratory species were identified by the PMST as having the potential to occur within the Project Area (**Table 3.13**). The EPBC Act lists migratory species protected under a number of international agreements including the Japan – Australia Migratory Bird Agreement (JAMBA), China – Australia Migratory Bird Agreement (CAMBA), the Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild

[83] NSW Government (2010a) *National Recovery Plan for Prasophyllum petilum*, Department of Environment and Climate Change and Water, Hurstville.

[84] Victorian Gov't (2011a) *National Recovery Plan for the Hoary Sunray Leucochrysum albicans var. tricolor*, prepared by Sinclair ,SJ. for Department of Sustainability and Environment, Melbourne.

Animals (Bonn Convention). Many of these species are listed due to their potential to fly over the site during migration or occasionally use it as a foraging resource. Note that since the first versions of this report were released for public comment, changes have been made to JAMBA. As such, rainbow bee-eater (*Merops ornatus*), eastern great egret (*Ardea modesta*), and cattle egret (*Ardea ibis*) have been removed from the list of EPBC migratory species.

Table 3.13 Migratory Bird Species in the Project Area

Scientific Name[85]	Common Name	EPBC Act Status	Presence
Rhipidura rufifrons	rufous fantail	M	known
Apus pacificus	fork-tailed swift	M	likely
Hirundapus caudacutus	white-throated needletail	M	likely
Gallinago hardwickii	Latham's snipe/ Japanese snipe	M	likely
Myiagra cyanoleuca	satin flycatcher	M	potential
Monarcha melanopsis	black-faced monarch	M	unlikely
Pandion haliaetus	osprey	M	unlikely
Motacilla flava	yellow wagtail	M	unlikely
Calidris ferruginea	curlew sandpiper	M	no
Numenius madagascariensis	eastern curlew/ far eastern curlew	M	no

Black-faced monarch (*Monarcha melanopsis*) is considered unlikely to occur within the Project Area as its preferred habitat is rainforest. Whilst it has been known to be recorded within marginal habitat that includes dry woodlands in the ACT, the closest record is from Lake Ginninderra (COG 2015b[86]).

Osprey (*Pandion haliaetus*) is generally found in coastal areas, particularly in the north of Australia, though will occasionally travel inland following major rivers. However, as they require extensive areas of open water for foraging, they are not considered likely to occur within the Project Area (Australian Gov't 2015b). The last record from COG of the species within the ACT region is from Googong Dam in 2013 (COG 2015a).

Yellow wagtail (*Motacilla flava*) is considered to be an extremely uncommon migrant to Australia, being noted as a vagrant in southern NSW. Whilst a majority of the continent is mapped as habitat for the species, the nearest sightings to the Project Area are from the Sydney and Melbourne regions

[85] Some of the species in this table are listed under different scientific names on their respective migratory agreements, the scientific names indicated correspond with the EPBC Act listings and the currently accepted Australian taxonomy.

[86] Canberra Ornithologists Group (COG) (2015b) *Bird Info: All Canberra's Birds – Photos, Calls, Local Status, and Population Data*, accessed online (March, 2015): http://canberrabirds.org.au/birds/.

(Australian Gov't 2015c[87]). COG does not have any records of yellow wagtail within the ACT (COG 2015b). It is, therefore, considered unlikely to occur within the Project Area.

Both curlew sandpiper (*Calidris ferruginea*) and eastern curlew (*Numenius madagascariensis*) are also listed as critically endangered species. Potential impacts of the Program in the context of threatened bird species are discussed in **Section 4.5.1.3**. Both species have primarily coastal distributions; though when recorded inland prefer large lakes with mudflats for foraging. These are not found within the Project Area, with the nearest being at Lake George and Lake Bathurst to the north-east (Australian Gov't 2015b). As no habitat for these species exists within the Project Area, they will not be considered further in this report.

3.3.2.1 Rufous Fantail

Status: Bonn Convention; migratory species (EPBC Act)

Rufous fantail is listed as a migratory, marine species under the EPBC Act. It is a medium sized bird that transitions from olive to reddish – brown to blackish – brown in colour down its back. It has a fan-shaped tail and a white arc underneath its eyes.

The species occurs in coastal and near coastal districts of northern and eastern Australia. Breeding occurs from the South Australia / Victoria border, to south and central Victoria, and along the east coast of Australia to northern Queensland. The species overwinters in the Cape York Peninsula, Torres Strait Islands, and Papua New Guinea (Australian Gov't 2015b).

Habitat preferred by the species includes rainforests, wet forests, swamp woodlands, and mangroves. Rufous fantail is considered an uncommon breeding, summer migrant to the ACT and is usually recorded in the tall, wet forests of the Brindabella Range, with occasional fly-over records from the suburbs (COG 2014). It was recorded in the ACT woodland within the Project Area (KMA 2009b and 2013c) and in nearby suburbs (COG 2014).

It is considered unlikely that the Program will have a significant impact on rufous fantail due to the important habitat for the species occurring in the Brindabella Range, the fly-over nature of records in the Project Area, and most of its habitat being conserved within the WBCC. There will be no further assessment of impacts to rufous fantail in this report.

3.3.2.2 Fork-Tailed Swift

Status: JAMBA, CAMBA, ROKAMBA; migratory species (EPBC Act)

Fork-tailed swift (*Apus pacificus*) is listed as a migratory, marine species under the EPBC Act. It is a medium sized swift that is characterised by a long and deeply forked tail.

The species is found in south Siberia, north Mongolia, north China, and Japan; and migrates to south-east Asia and Australia. It is considered native to most of these countries, including Australia, where it is a non-breeding visitor to most regions (Australian Gov't 2015b).

The global population is unknown, however, populations are considered stable across all of its range except Pakistan. Abundance in Australia is also unknown, although large flocks of tens of thousands of birds have been recorded in NSW and Victoria (Australian Gov't 2015b).

[87] Australian Government (2015c) *Referral Guideline for 14 Birds Listed as Migratory Species under the EPBC Act,* Draft, Department of the Environment, Canberra.

Fork-tailed swift is almost exclusively aerial, flying from one metre to above 300 metres in height, often observed over cliffs and beaches and sometimes well out to sea. The species commonly occurs over a range of habitat types including urban, dry, or open areas, riparian woodland, swamps, heathland, grasslands, sandplains, saltmarsh, rainforests, wet sclerophyll forest, or planted pine (*Pinus* spp.) (Australian Gov't 2015b).

Fork-tailed swifts arrive in Australia around October, entering via the Northern Territory and remain highly mobile for the duration of their stay. The species is common in the ACT between December and March, with several flocks passing through within this period (Australian Gov't 2015b).

The species has been recorded within the broader west Belconnen area. Most recently in Mount Painter Nature Reserve and West Belconnen Ponds in Dunlop during the 2012 – 2013 survey year (COG 2014). Whilst it is likely that the species flies over the Project Area, potential impacts to the species as a result of the Program are considered unlikely due to its aerial nature and wide distribution. There will be no further assessment for this species as a part of this report.

3.3.2.3 White-Throated Needletail

Status: JAMBA, CAMBA, ROKAMBA; migratory species (EPBC Act)

White-throated needletail (*Hirundapus caudacutus*) is listed as a migratory, marine species under the EPBC Act. It is a large swift, with a dark olive head and neck, a paler mantle, and black to green tips on the wings and tail.

Globally white-throated needletails occur across Asia and Australasia. Breeding sites are located in central and southeast Siberia, Mongolia, Russia, northern Japan, and China. In Australia the species arrives in winter and has been recorded in coastal regions of Queensland and NSW, inland to the western slopes of the Great Dividing Range (Australian Gov't 2015b).

White-throated needletails are almost exclusively aerial, occurring over a variety of habitats including open forest, rainforest, open heathland, swamps, and grasslands. Threats to the species are limited in Australia to collision with overhead wires and lighthouses (Australian Gov't 2015b).

White-throated needletails are not very common in the ACT, though are associated with the arrival of weather fronts in the region. They have previously been recorded over the Project Area and in nearby suburbs (COG 2014 and 2015a).

Whilst it is likely that the species flies over the Project Area, due to its aerial nature and wide distribution, potential impact to the species as a result of the Program are considered unlikely and there will be no further assessment for this species as a part of this report.

3.3.2.4 Latham's Snipe

Status: Bon convention; JAMBA, ROKAMBA; migratory species (EPBC Act)

Latham's snipe (*Gallinago hardwickii*) is listed as a migratory, marine species under the EPBC Act. It is a medium sized wader and is the largest snipe in Australia. The plumage is intricately marked in buff, black, and brown colours, with black to brown stripes across the crown and cream stripes along the back, and a white belly, head, and tail tip.

The species is a seasonal migrant, leaving their breeding grounds in Japan to overwinter in Australia. The species arrives in the ACT region in mid-August and departs in late February or March (Australian Gov't 2015b).

In the region surrounding the Project Area, the preferred habitat of Latham's snipe is shallow, freshwater marshes and bogs that include suitable feeding habitat and roosting sites. It forages in firm mud on beetles (*Coleoptera* spp.) and fly larvae (*Diptera* spp.) (Australian Gov't 2015b).

Latham's snipe is more commonly recorded further east of the Project Area, in and around Lake Burley Griffin, Lake Ginninderra, and Mulligan's Flat Nature Reserve. The nearest records are from West Belconnen Pond, Dunlop (COG 2015a). Geoff Butler and Associates (2000) noted a previous record along the Ginninderra Creek, however, did not provide any detail on when or where this record was taken.

As all major water bodies will be conserved as a part of the Program, it is considered unlikely that the Program will have any impact upon Latham's snipe. No further assessment of this species is required as part of this report.

3.3.2.5 Satin Flycatcher

Status: Bonn convention; migratory species (EPBC Act)

Satin flycatcher (*Myiagra cyanoleuca*) is listed as a migratory, marine species under the EPBC Act. The species is characterised by an upright posture, short erect crest, and its habit of quivering its tail when perched. Their backs, chest, and head are blue to black; with white underneath. Females also have an orange to red chin.

The species is widespread in eastern Australia and mainly inhabits heavily vegetated gullies in eucalypt forests, taller woodlands, coastal forests, mangroves, and open forest; often near wetlands or watercourses (Australian Gov't 2015b).

Satin flycatchers breed in the ACT during summer, departing in late autumn (Mulvaney 2012). Most records are from the tall, wet forests of the Brindabella Range, though there are a few records of the species in the broader west Belconnen area (COG 2015a).

As these records are uncommon occurrences and are separate from the main habitat type, it is not considered likely that the Program will impact upon this species. As such no further assessment will be required as a part of this report.

3.3.3 Heritage

World heritage properties, national heritage places, and Commonwealth heritage places are protected under the EPBC Act. The likelihood of impact on properties that occur within the broader west Belconnen area has been assessed in the following section.

In addition to EPBC Act listed heritage matters, objects and places that are listed on the Register of the National Estate (RNE), ACT Heritage Register, or under the NSW *Heritage Act 1977*; as well as Aboriginal heritage matters, are discussed below as they relate to the Program. As none of these heritage matters are protected under the EPBC Act they will not be assessed in detail, however, where relevant, impacts, and avoidance and mitigation strategies are discussed below.

Table 3.14 below summarises the heritage values that occur within the broader west Belconnen area. EPBC Act matters were identified through the PMST report (refer to **Appendix 1**). Places on the RNE were identified through an older PMST report (created on the 18/03/2015). Sources of heritage information included the following:

- ACT Heritage Register (ACT Gov't 2015b[88]);
- NSW Heritage Register (NSW Gov't 2015b[89]); and
- Aboriginal cultural heritage assessments (Biosis 2014a[90] and 2014b[91]).

Table 3.14 Heritage Values in the Broader west Belconnen Area

Heritage List	Protected as a MNES	Number of Places / Items in broader west Belconnen area
World Heritage List	Yes	0
National Heritage Place	Yes	1
Commonwealth Heritage List	No – but protected more broadly under the EPBC Act	4
Register of the National Estate	No	36*
ACT Heritage Register	No	1
NSW Heritage Act	No	0
Aboriginal Heritage	No unless otherwise specified	Numerous

*Of the 36 places identified within the broader west Belconnen area, only three occur within or adjacent to the Project Area. These are discussed in **Section 3.3.3.4**.

3.3.3.1 World Heritage List

There are no World Heritage properties that occur within the vicinity of the Project Area.

3.3.3.2 National Heritage List

The PMST report identified one place listed on the National Heritage List that lies within ten kilometres of the Project Area as shown in **Table 3.15**.

Table 3.15 National Heritage Places in the Broader west Belconnen Area

Name	Location	Potential for Impact
Australian Alps National Parks and Reserves	Australian Alps – southern NSW, southern ACT, and northern Victoria	unlikely

[88] ACT Government (2015b) *ACT Heritage Register*, Environment and Planning Directorate, Canberra, accessed online (April, 2015): http://www.environment.act.gov.au/heritage/heritage_register.

[89] NSW Government (2015b) *Search for NSW Heritage*, Office of Environment and Heritage, Sydney, accessed online (April, 2015): http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx.

[90] Biosis (2014a) *Aboriginal Cultural Heritage Assessment Report West Belconnen Development Project, Yass NSW*, prepared for The Riverview Group, Canberra.

[91] Biosis (2014b) *West Belconnen Development Project: ACT Land Cultural Heritage Assessment*, prepared for The Riverview Group, Canberra.

As no part of the 'Australian Alps National Parks and Reserves' lies within the Project Area, there will not be any direct or foreseeable indirect impact to it as a result of the Program. There is minimal habitat connectivity to the Australian Alps through the Murrumbidgee River Corridor, however, impacts to the Murrumbidgee River will be avoided or mitigated under the Program and are not considered likely to extend this far, or in an upstream direction.

3.3.3.3 Commonwealth Heritage List

The PMST report identified four places listed on the Commonwealth Heritage List in proximity to the Project Area (**Table 3.16**).

Table 3.16 Commonwealth Heritage List Places in the Broader west Belconnen Area

Name	Locations	Potential for Impact
Synemon plana moth habitat	Lawson (Royal Australian Naval Transmitting Station)	none
Cameron Offices (wings 3, 4, and 5, and bridge)	Belconnen	none
Mount Stromlo Observatory Precinct	Mount Stromlo	none
Royal Australian Naval Transmitting Station	Lawson	none

As none of these places lie within or directly adjacent to the Project Area, it is not expected that the Program will impact upon them.

3.3.3.4 Register of the National Estate

Due to significant levels of overlap between heritage lists at the national, state, territory, and local government levels, the RNE was closed in 2007 and is no longer a statutory list. It is now an archive of more than 13,000 places, including many places of local or state significance.

The listing of a place on the RNE does not in itself create a requirement for Commonwealth protection; however, it may provide relevant information for decision makers regarding locally or regionally important heritage places that may be protected. There are three listed or indicative places on the RNE that occur within or directly adjacent to the Project Area. These are:

- Ginninderra Falls Area on Parkwood Road, Wallaroo
- Murrumbidgee River Corridor as defined in Appendix F of the NCP; and
- Parkwood Homestead and Chapel.

As these matters are only protected under the EPBC Act if they are also a National or World Heritage Place, or are leased by the Commonwealth they are not considered further here. Potential impacts to these places will be considered through relevant State or Territory approvals processes as appropriate.

3.3.3.5 ACT Heritage Places

One place in addition to numerous Aboriginal heritage places (which are discussed in **Section 3.3.3.7**) was identified from a search of the ACT Heritage Register (ACT Gov't 2015b) (**Table 3.17**).

Table 3.17 ACT Heritage Places in the Project Area (excluding Aboriginal Heritage Places)

Name	Location	Presence in/adjacent to Project Area
Belconnen Farm	Block 1605, Belconnen	yes

Belconnen Farm lies within the Project Area and is adjacent to the Old Belconnen Landfill. The precinct and view corridor have been integrated into the Master Plan so that heritage values of the Belconnen Farm may contribute to a sense of place within the community. It will be adapted to provide accommodation, function, and community facilities in line with the Conservation Management Plan and ACT Heritage Council specifications. These changes will not impact upon the heritage values of the precinct, rather protecting them in the long-term, and will be designed so that Belconnen Farm and an understanding of its heritage values may be more accessible to the community.

3.3.3.6 NSW Heritage Places

A search of the NSW Heritage Register (NSW Gov't 2015b) identified ten listed places within the Yass Valley LGA listed under the NSW *Heritage Act 1977*. These are summarised in **Table 3.18**.

Due to their distance from the Project Area, these NSW Heritage Places will not be impacted by the Program.

Table 3.18 NSW Heritage Places within Yass Valley Local Government Area

Name	Location	Presence in/adjacent to Project Area
Bowning Railway Station Group	Bowning	no
Burrinjuck Dam	Burrinjuck	no
Burrinjuck Dam Site – Barren Jack Creek Water Supply Dam	Burrinjuck	no
Burrinjuck Dam Site (Greater)	Burrinjuck	no
Cooma Cottage	Yass	no
Wee Jasper Bridge over Goodradigbee River	Wee Jasper	no
Yass Junction Railway Station Group	Yass Junction	no
Yass Post Office	Yass	no
Yass Town Rail Bridge over Yass River	Yass	no
Yass Town Railway Station and Yard Group	Yass	no

3.3.3.7 Aboriginal Cultural Heritage

Biosis (2014a and 2014b) undertook Aboriginal heritage assessments across the NSW and ACT portions of the Project Area respectively.

These studies utilised data from the ACT Heritage Register and the NSW Aboriginal Heritage Information Management System (AHIMS), which was then corroborated through field work and consultation with Representative Aboriginal Organisations and Registered Aboriginal Parties.

Within the ACT portion of the Project Area, the ACT Heritage Register identified 43 recorded Aboriginal cultural heritage sites (32 within the urban development area, seven within WBCC, and six adjacent) (Biosis 2014b). AHIMS recorded five sites within the NSW portion of the Project Area, with 16 other previously recorded sites identified in addition to these (Biosis 2014a).

Field survey identified a further 49 previously unidentified sites within the ACT portion of the Project Area, 11 within the urban development area and 38 within the WBCC (Biosis 2014b); and 29 new sites within the NSW portion of the Project Area, 18 within the urban development area and 9 within the WBCC (Biosis 2014a).

A majority of sites consisted of low density artefact scatters or isolated finds and were considered to be of low heritage significance. Larger artefact scatters and scarred trees were considered to hold moderate heritage significance and have the potential to provide further information of occupation in the area. The Aboriginal rock shelter and a large surface artefact scatter with sub-surface deposits were assessed as having high heritage significance (Biosis 2014a and 2014b). Some previously recorded sites have been salvaged as part of previous management actions and no longer hold heritage constraints (Biosis 2014b).

Despite a majority of the sites individually considered to hold low heritage significance, the high density of sites along the Murrumbidgee River and Ginninderra Creek are of high importance collectively as they provide information regarding the camping sites, use of the region, and the importance of riparian areas to past generations (Biosis 2014a and 2014b).

Smaller sites, though important for demonstrating the past occupation of the area do not provide any additional information as to how the past generations used the Murrumbidgee River and region and, therefore, are not considered to be important for heritage values (Biosis 2014a).

Direct impacts to the sites within the WBCC will be avoided under the Program and considered during future management actions.

For 16 of the 18 sites within the NSW urban development area an Aboriginal Heritage Impact Permit (AHIP) has been applied for. These sites have low potential for sub-surface artefacts and are considered to be appropriate for relocation (Biosis 2014a).

For all other sites which may be impacted by the Program mitigation actions will include:

- sub-surface testing of PAD WB1 (NSW) and the Ginninderra Creek area to ascertain the full site areas;
- a cultural heritage induction for all construction workers;
- ongoing liaison with Registered Aboriginal Parties and Representative Aboriginal Organisations in regards to site management and future development plans within the WBCC; and
- developing an unanticipated discovery plan.

Subsequent to these surveys, further Aboriginal values associated particularly with Ginninderra Falls were identified. These values are currently being investigated, including with consultation with the relevant Aboriginal parties. If the outcomes of this investigation lead to the identification of areas of cultural significance that warrant protection, any such requirements will be incorporated into the revised NSW planning submission and will not be considered further in this report.

3.3.4 Wetlands of International Importance

Ramsar wetlands are recognised as MNES under the EPBC Act. They are defined as representative, rare, or unique wetlands or as being important for conserving biological diversity. The PMST report identified four Ramsar wetlands that could potentially be impacted by the Program. These are:

- Hattah-Kulkyne Lakes
- Banrock Station Wetland Complex
- The Coorong and Lakes Alexandrina and Albert Wetland; and
- Riverland.

Hattah-Kulkyne Lakes is located in Victoria, approximately 80 kilometres south-east of Mildura Victoria, on the Murray River floodplain; and the other sites are all located in the lower reaches of the Murray River in South Australia. They have been identified due to their presence within the same catchment as the Project Area (the Murrumbidgee River is a major tributary of the Murray River). Given the nature of the Program and the proposed water quality control measures, the Ramsar wetlands are all considered to be sufficiently far from the Project Area not to be impacted by the Program.

3.3.5 Commonwealth Land

Within ten kilometres of the Project Area, the PMST identified four areas of Commonwealth land. These areas are summarised in **Table 3.19**.

Table 3.19 Commonwealth Land within the Broader west Belconnen Area

Name	Location	Presence in/adjacent to Project Area
Australian Telecommunications Commission	Black Mountain	none
Commonwealth Scientific and Industrial Research Organisation	Nicholls	none
Defence – Belconnen Radio Station, Belconnen Communications Station	Lawson	none
Defence – Hewlett Packard Building, Fernhill Park	Bruce	none

None of these sites are located within or adjacent to the Project Area and given their distance will not be impacted by the Program.

4.0 Assessment of Impacts to MNES

This section provides a detailed analysis of the impacts to MNES as identified in **Section 3** as potentially being affected by the Program and assessment of the adequacy of the Program's conservation commitments to protect the matters.

The beginning of this section provides a definition of terms used in the following assessment (**Section 4.1**). This is followed by a description of the avoidance and mitigation strategies that are used for a number of threatened ecological communities and species under the Program. These are the West Belconnen Conservation Corridor (WBCC), Ginninderra alignment options, WBCC Reserve Management Plan (RMP), Construction Environment Management Plans (CEMPs), and Water Sensitive Urban Design (WSUD) principles (**Sections 4.2** and **4.3**).

For the purposes of this discussion, the Murrumbidgee River and Ginninderra Creek have been included within the Project Area as many actions undertaken by the Program are relevant to environmental values in these waterways. It should be noted, however, that management measures will not occur within the aquatic areas themselves. Rather they will extend to the south bank of Ginninderra Creek and the east bank of the Murrumbidgee River, and will occur with the cooperation of the ACT and NSW Governments who have management responsibility for the aquatic areas.

If impacts have not been avoided or mitigated (with consideration of the Significant Impact Guidelines 1.1), they are proposed to be offset as part of the Program. The offset commitments of the Program are discussed and assessed against the EPBC Act Environmental Offsets Policy (EPBC Act Offset Policy) (Australian Gov't 2012a[92]) in **Section 5**.

4.1 Definition of Terms

For the purposes of this assessment the definitions outlined in the Significant Impact Guidelines 1.1 are used, these are:

- **Population of a critically endangered, endangered, or vulnerable species:** an occurrence of the species within a particular area.
- **Important population of vulnerable species**: is necessary for a species' long-term survival and recovery as it is:
    - identified in the species' recovery plan
    - a key source population for either breeding or dispersal
    - necessary for maintaining genetic diversity; and/or
    - near the limit of the species' range.
- **Invasive species**: an introduced species (including a translocated native species), which out-competes native species for space and resources, is a predator of native species, or modifies native species' habitat.

[92] Australian Government (2012a) *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

- **Habitat critical to the survival of a species or ecological community:** are areas that are necessary:
    - for foraging, breeding, roosting, or dispersal activities
    - for the long-term maintenance of the species or ecological community (including other species that are essential to the survival of the species or ecological community)
    - to maintain genetic diversity and long-term evolutionary development; or
    - for the reintroduction of populations or recovery of the species or ecological community.

4.2 Avoidance Strategies

This section outlines the overarching avoidance strategies that have been incorporated into the Program: the creation of the WBCC and the Ginninderra Drive Extension alignment options. These strategies are discussed in general below and in greater detail as they apply to specific MNES in **Section 4.4** (ecological communities), **Section 4.5** (fauna), and **Section 4.6** (flora).

4.2.1 West Belconnen Conservation Corridor

As discussed in the preceding chapters, many of the ecological values present within the Project Area occur alongside the Murrumbidgee River. In particular this includes pink-tailed worm-lizard and threatened woodland bird habitat, and box gum woodland. The Murrumbidgee River Corridor contains steep, rocky slopes with stands of river oak and exotic vegetation along the river edge, with the upper slopes and plateau containing woodland of variable type and quality.

In accordance with the impact mitigation hierarchy outlined in the EPBC Act Offsets Policy, impacts to these MNES habitat areas are avoided under the Program by the creation of the WBCC. As described in **Section 2.5** the boundary of the WBCC was delineated after the completion of field verified, site-based survey of ecological values, technical assessment of infrastructure requirements, consideration of management criteria, and consultation with government agencies, technical experts, and the public. As a result of this process, the WBCC includes river side habitats, steep valley sides, a majority of pink-tailed worm-lizard and woodland bird habitat, and box gum woodland.

Overall, the WBCC serves to expand the existing Murrumbidgee River Corridor (**Figure 4-1**) within the ACT and results in a better correlation between the extent of protected area and the extent of ecological values on the ground, especially within NSW. The consequence is a conservation corridor that is contiguous with existing river corridors to the north and south of the Project Area and more appropriately represents the extent of ecological values.

Specifically, creation of the WBCC allows the Program to avoid all direct impacts to box gum woodland within the west Molonglo area (as required by the Molonglo Strategic Assessment), Australian painted snipe, superb parrot, regent honeyeater, swift parrot, painted honeyeater, Booroolong frog, small purple pea, pale pomaderris, austral toadflax, Tarengo leek orchid, and hoary sunray. In addition a total of 146.4 hectares (90 percent) of pink-tailed worm-lizard habitat, and a number of Aboriginal and historic heritage sites will be avoided by the WBCC.

In addition to protecting these MNES, creation of the WBCC will also protect riparian and woodland habitat as part of the broader regional riparian corridor system and link it to the urban open space system within the development footprint, which will include the preservation of select mature paddock trees and significant tree planting over time. In this way, the WBCC does not only avoid

impacts to MNES, but also improves habitat connectivity values across the landscape for all mobile woodland and riparian species.

The values protected within the WBCC will be further protected by a buffer between the WBCC boundary and the urban development edge. This buffer is yet to be fully detailed, but will incorporate all WSUD infrastructure, inner APZs for urban bushfire management, and required development buffers. As such, the WBCC boundary presented in figures in this report is the minimum avoidance area and the actual boundary will be larger and more regular to aid management and further protect MNES within.

Under the Program, within the ACT component, the WBCC will be rezoned under the Territory Plan to 'NUZ3 – Hills Ridges and Buffers' with a 'Pc – nature reserve' overlay. The NSW component of the WBCC will be zoned 'E3 – Environmental Protection' under the YLEP. This will enhance statutory protection and facilitate achievement of environmental conservation outcomes through implementation of the WBCC RMP.

The Program describes the WBCC as being managed as an IUCN Category IV reserve. The primary objective of a reserve managed in accordance with this standard is '*to maintain, conserve and restore species and habitats*' (IUCN 2015[93]). The IUCN description of the characteristics of such a reserve note that they are:

- not strictly protected from human use
- aim conservation efforts towards particular species or habitats in a targeted manner
- generally associated with landscapes where human pressure is comparatively greater; and
- rely on regular management intervention.

Given the intent of an IUCN Category IV reserve is on focussed conservation outcomes whilst not precluding human use, implementation of the WBCC RMP will be used to ensure that wherever practicable, that the avoidance of MNES will be maintained throughout the life of the Program. Where avoidance is not entirely possible such as for walking trail construction or access roads, measures to minimise and mitigate impacts will be implemented such that no net loss of habitat occurs within WBCC. These indirect impacts will be managed through the WBCC RMP (see **Section 4.3.1**).

4.2.2 Ginninderra Drive Extension Route Alignment

As discussed in **Section 2.7.3** the proposed route option for the Ginninderra Drive Extension considered impacts to MNES and avoided these where possible. This avoidance strategy allowed for no direct impact to natural temperate grassland, and minimal direct impacts to golden sun moth. As the alternative routes were discussed in detail in **Section 2.7.3** they are not discussed in detail here.

[93]International Union for Conservation of Nature (IUCN) (2015) *Protected Areas Category IV*, accessed online (August 2015): http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/gpap_category4/ , last updated January 2014.

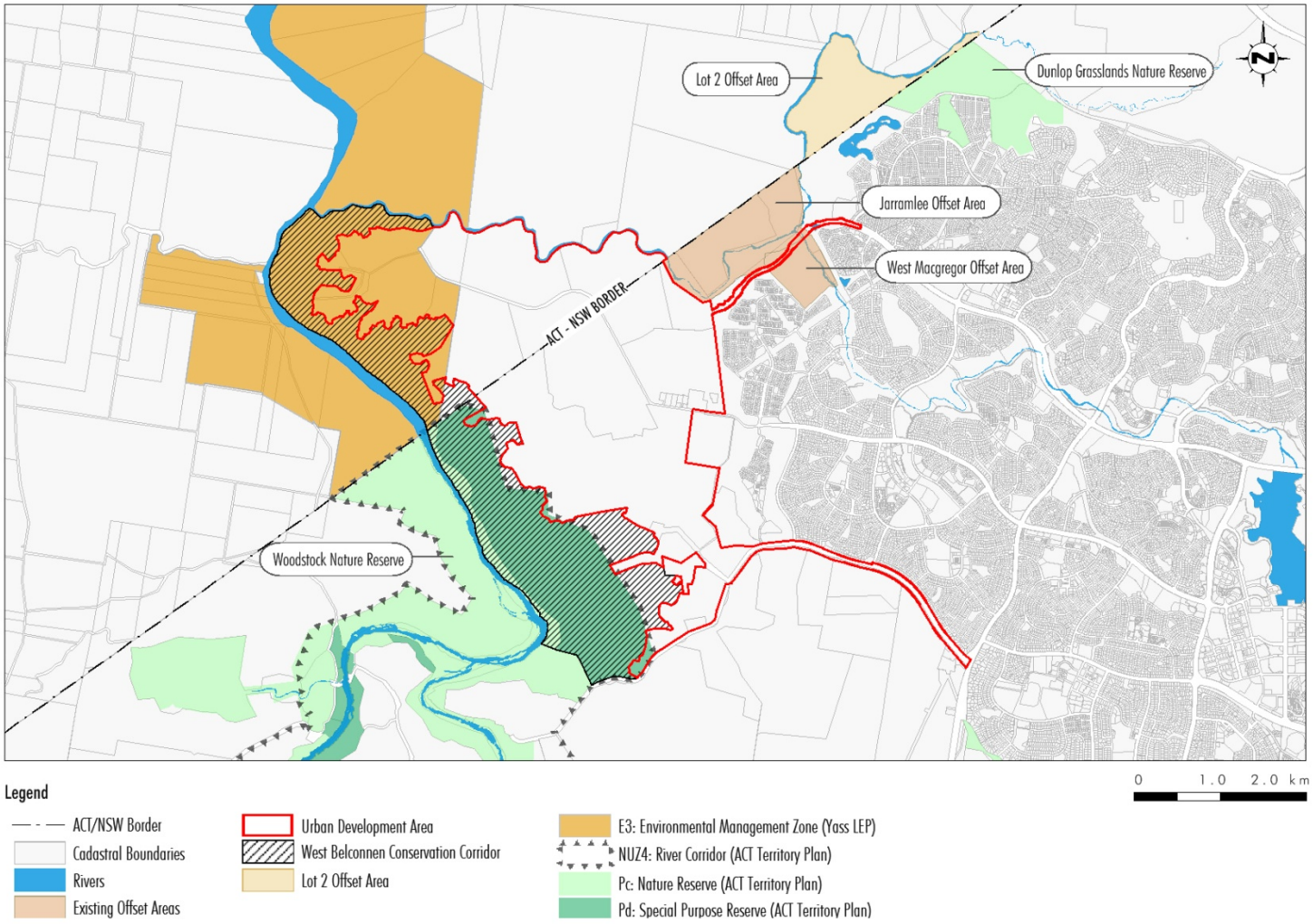

Figure 4-1

West Belconnen Conservation Corridor and Existing Land Zoning

4.3 Mitigation Strategies

4.3.1 WBCC Reserve Management Plan

As noted above, the primary purpose of the WBCC is to protect MNES values present within the Project Area; however, it will also be used to help achieve the development goals of the Program. That is, to produce a sustainable, integrated, and collaborative community (RobertsDay 2014). In general, this requires protection of the broader natural values (e.g. habitat and species diversity, connectivity, and ecosystem function) whilst permitting certain recreational activities (e.g. walking, cycling, fishing, swimming, boating). To achieve this, the WBCC RMP (TRC Tourism 2015a[94]) will consider the numerous environmental, cultural, recreational, and amenity values present within the WBCC. Cultural integration, active learning, and community awareness initiatives will also be promoted and will link with other community spaces within the development (TRC Tourism 2015a and 2015b[95]).

The WBCC will be governed by the environmental management trust (EMT), which will be a skills based company with strong community representation and public and government accountability. The EMT will be responsible for the development, effective implementation, and the ongoing review of the WBCC RMP. Details of this management plan, the EMT structure, and funding for the WBCC are outlined in the Program Report (refer to Section 5). The EMT and WBCC RMT will cover all natural areas associated with the Program. These include the:

- entire WBCC inclusive of the corridors associated with the Murrumbidgee River and Ginninderra Creek
- the Macgregor and Jarramlee offset areas; and
- proposed additional offset site to compensate for impacts to Jarramlee, West Macgregor, and MNES at Lot 2 Wallaroo Road (refer to **Section 5**).

This will ensure that a holistic management approach is implemented with regards to dealing with conservation matters at landscape scale.

In addition to the above, the WBCC RMP must also meet Commonwealth, ACT, and NSW legislative requirements in a cross-border and cohesive framework. Of particular importance will be the development of a bushfire management strategy and public health and safety standards for recreational activities (TRC Tourism 2015a and 2015b). Commonwealth requirements are guided by the Strategic Assessment and will include strategies for the implementation of management measures under an adaptive management framework that target the achievement of biodiversity outcomes as committed to under the Program. Requirements to be met for other jurisdictions will not be inconsistent and will be confirmed through the Development Application processes to be followed under State / Territory legislation.

As noted previously, the Program will allow for recreational, tourism, and maintenance development to occur within the WBCC. The detailed design of the infrastructure required to allow for this is yet to occur and will likely change over the duration of the Program. As such, the WBCC RMP will operate by utilising adaptive management principles to guide the final planning and design stages of this development. Not only does this process provide the required flexibility for planning and providing

[94] TRC Tourism (2015a) *Operational Plan West Belconnen Conservation Reserve Stage 1 Report*, draft version 2, prepared for The Riverview Group, Canberra.

[95] TRC Tourism (2015b) *West Belconnen Conservation Area Strategic Direction Discussion Paper*, draft, prepared for The Riverview Group, Canberra.

such infrastructure, it also allows the commitments of the Program to be incorporated into detailed design. This will better ensure effective management of the urban edge interface for the protection of MNES, in particular with regards to mitigating indirect impacts.

All areas of box gum woodland within the west Molonglo component of the WBCC will be avoided and not impacted by this development. All other MNES will be avoided to the greatest extent practicable in accordance with the Program commitments for managing MNES. Where MNES habitat cannot be avoided the WBCC RMP will implement measures to ensure that there will be no net loss of habitat within the WBCC. Measures to address this will include targeted rehabilitation of areas within the WBCC (including those that seek to improve connectivity between small patches) and enhancement of quality and restoration of environmental values subject to an assessment of best return on investment by the EMT. If necessary, any such unforeseen future impact will be assessed using the same methodology as is used in **Section 5** of this report as is relevant to the impacted MNES.

The WBCC RMP will also act as an avoidance and mitigation strategy for unforeseen ongoing and potential future impacts that are not addressed here. This will be achieved by incorporating adaptive management principles into it.

Following Section 5.3.1 of the Program Report, management strategies and principles that will be included in the WBCC RMP include:

- Identification of management zones so that impacts to MNES and their habitats are avoided as far as possible. This includes locating of visitor hubs and access routes in locations where impacts such as habitat fragmentation, isolation, and removal can be avoided.

- Ensure that there is no net reduction in total MNES habitat areas. This includes ensuring picnic and other facilities will avoid known habitat areas.

- Ensure increased use of the WBCC does not impact upon threatened fish species. This includes implementing:

    - Controls on recreational fishing such as bag limits, prohibitions on taking certain species, and licensing requirements in line with those that already exist within the ACT and NSW.

    - Controls to public access and use of the riparian areas post construction.

- Recognise the importance of enhancing connectivity between MNES habitat areas. In particular, where complete avoidance of habitat for pink-tailed worm-lizard is not possible, roads and tracks will be targeted to poorer quality areas and incorporate raised grating (or similar) to enhance connectivity between habitat patches that they otherwise bisect. The design of such roads and tracks will provide for sufficient height and width considerations to permit adequate vegetation growth beneath the grating to establish suitable conditions so as to enhance connectivity. This will also be incorporated into roads and tracks to be upgraded which presently traverse pink-tailed worm-lizard habitat resulting in improved connectivity of habitat beyond the current situation.

- Informed infrastructure design based on advice from relevant scientific experts, particularly with regard to protecting and avoiding impacts to MNES and their habitat areas as part of an adaptive approach to the management of ecological values.

- Utilisation of existing infrastructure and resources, including the knowledge and experience of existing conservation and land managers. In particular, roads and tracks will follow existing alignments where practicable.

- Vehicle track widths will be a maximum of six metres, other tracks and trails a maximum of 2.5 metres wide with further design considerations that can further reduce the width of roads, for example, passing bays. Unused existing tracks will be rehabilitated to enhance connectivity between habitat areas where they fragment existing habitat paths.

- Mechanisms that allow for integrated consideration of all values as facilitated through holistic management of the WBCC and associated offsets through the EMT with a clear priority for MNES where appropriate.

- Consultation and collaboration with community, government, and expert stakeholders.

- Compliance with legislative requirements.

- An adaptive management process based on a monitoring regime that will address cumulative impacts and changing knowledge frameworks in future planning and management actions.

- Prohibition of 'off-leash' dog areas within the WBCC.

Measures required for specific MNES are discussed in **Section 4.4** (ecological communities), **Section 4.5** (fauna), and **Section 4.6** (flora) in context to the impacts of the Program.

The WBCC RMP will also include bushfire mitigation activities that will occur within the WBCC. The aim of these activities would be to control biomass to protect the ecological values present from severe fires. Methods will include (but are not limited to) grazing and slashing and will consider the relevant thresholds of ecological values. These are separate to the APZ (urban asset protection zones), which occur outside of the WBCC and are more extreme in their required measures.

The EMT will also be responsible for managing education initiatives regarding the risk posed by domestic animals to the flora and fauna of the WBCC. These will work in conjunction with prohibition of dog 'off-leash' areas within the WBCC and the cat containment policy that applies to all residences of the Program to minimise the risk of potential impacts from domestic dogs, cats and other exotic species.

Implementation of the WBCC RMP will be staged to coincide with the urban development. It will be operational prior to the first residents moving in so that strategies may form a part of the community from the outset, and protect values from early visitor access (TRC Tourism 2015b).

4.3.2 Construction Environment Management Plans

CEMPs are implemented to avoid and mitigate impacts that may occur throughout the construction phase of the Program. They will specify regulations for practices such as erosion and sediment control, clearing procedures, boundary identification, rehabilitation activities, and monitoring and reporting requirements.

Specific requirements relevant to each MNES are discussed in detail below. Those specific requirements would apply to any construction occurring adjacent to retained habitat areas (including retained trees in urban open space) or the WBCC. In addition to the specific requirements set out in the following sections for impacted MNES, CEMPs implemented under the Program must ensure that the following are implemented:

- waste management procedures

- worker and public health and safety policies

- traffic and access controls
- monitoring and compliance strategies
- appropriate surface remediation post-construction; and
- buffer zones around sensitive values.

The CEMPs will be prepared in accordance with ACT Government guidelines in addition to any specific requirements of the WBCC RMP for mitigation of indirect impacts from adjacent development. CEMPs will be prepared prior to construction commencing and be maintained until after construction and remediation activities have been finalised.

CEMPs will also be prepared to guide pre-construction activities such as geotechnical sampling and ensuring direct and indirect impacts to sensitive areas are avoided. The primary risks during these activities are from uncontrolled vehicle access and discharge of sediment laden water from the drilling process or as runoff from excavated soil. Best practice measures to manage the potential effects from these activities will be incorporated in to the CEMPs.

4.3.3 Water Sensitive Urban Design

Section 5.3.3 of the Program Report addresses WSUD and notes that the change in surface run-off that will occur as a result of the Program will need to be managed so that unacceptable changes to the hydrology within surrounding riparian corridors are avoided. This is necessary not only for environmental health in general but also in order to avoid potential impacts to threatened fish and amphibian species that occur in the Murrumbidgee River and lower reaches of Ginninderra Creek below the falls.

In the ACT, stormwater management is subject to two separate codes:

- the 'Water Use and Catchment General Code' (ACT Gov't 2009b[96]); and
- the 'Waterways Water Sensitive Urban Design General Code' (ACT Gov't 2009c[97]).

The purpose of the 'Water Use and Catchment Code' is to identify the environmental values and permitted water uses of ACT waterways, and note criteria for water quality and streamflow that will protect these uses and values.

The purpose of the 'Waterways Water Sensitive Urban Design General Code' is to implement the principles of WSUD, so that the water cycle may be integrated into the urban development process.

A number of water-sensitive urban design guides are available through NSW Government agencies and where appropriate these will be applied to land development in the Yass Valley Shire.

WSUD within the Program includes a broad range of measures that aim to:

- reduce reliance on the town water supply system
- optimise the opportunities for the use of stormwater and reuse of wastewater

[96] ACT Government (2009b) *Water Use and Catchment General Code*, ACT Planning and Land Authority, Canberra.

[97] ACT Government (2009c) *Waterways: Water Sensitive Urban Design Code*, ACT Planning and Land Authority, Canberra.

- maintain the export of stormwater run-off and associated pollutants to pre-development levels or better
- work within existing natural ephemeral drainage lines
- avoid MNES habitat and significant trees
- minimise the take of developable land, development costs, and affects to existing infrastructure
- consolidate the number of ponds and infrastructure required
- consider maintenance requirements; and
- fit within the urban open space system of the Master Plan (Aecom 2014b[98]).

These measures will be implemented with the aim of benefitting the environment in general in addition to aquatic species in the Murrumbidgee River and Ginninderra Creek. Implementation of WSUD by the Program will also mitigate potential cumulative impacts further downstream in relation to other aquatic species and Ramsar wetlands.

Combinations of these measures, integrated into a system that will meet and exceed the regulatory requirements and which will contribute to the Green Star Rating for the Program are under investigation and will be subject to a triple bottom line evaluation to be conducted by specialist consultants Aither (Aecom 2014b).

These measures are considered to be both adequate and appropriate in avoiding and mitigating potential impacts of urban development to MNES and the broader environment.

4.4 Threatened Ecological Communities

The Project Area was once typified by a range of natural habitats including grasslands, woodlands, open forest, and riparian corridors. Most of the communities that were present at lower elevations (namely box gum woodland and small areas of natural temperate grassland) have been severely modified by agricultural and urban land uses post 1750. Ecological communities that occur at higher elevations and within the Murrumbidgee River Corridor have been less severely modified, and provide important habitat connectivity for threatened fauna species.

Two threatened ecological communities that are listed under the EPBC Act occur within the Project Area. These are:

- white box – yellow box – Blakely's red gum grassy woodland and derived native grasslands (box gum woodland); and
- natural temperate grasslands of the South Eastern Highlands (natural temperate grassland).

As discussed in **Section 3.3.1.1** natural temperate grassland only occurs as a number of small patches (4.8 hectares total) in the Jarramlee offset area and one small patch (0.15 hectares) within the Macgregor offset area (ACT Gov't 2013a). The potential for inadvertent impacts to natural temperate grassland and other areas of golden sun moth habitat not within the development footprint will be managed through the implementation of site specific CEMPs.

[98] Aecom (2014b) *West Belconnen A Water Sensitive Community: Water Sensitive Urban Design Report*, prepared for The Riverview Group, Canberra.

4.4.1 Box Gum Woodland

White box – yellow box – Blakely's red gum grassy woodland and derived native grasslands (box gum woodland) is listed under the EPBC Act as a CEEC, and under the NC Act and the TSC Act as an EEC.

Box gum woodland occurs either in a woodland form or as derived / secondary grassland (former grassy woodland from which trees have been removed). The community in either context is typified by a ground layer of native tussock grasses and herbs and a sparse, scattered shrub layer.

The EPBC Act policy statement for 'White Box – Yellow Box – Blakely's Red Gum Grassy woodlands and derived native grasslands' (Australian Gov't 2006[99]) provides identification guidelines to determine if an area of vegetation meets the definition of box gum woodland under the EPBC Act. The guidelines need to be interpreted with reference to the Commonwealth Listing Advice (TSSC 2006), however, in general include the following criteria:

- The overstorey must be, or have previously been, dominated by white box, yellow box, or Blakely's red gum.
- It must have a predominantly native understorey, where at least 50 percent of the perennial ground layer vegetation cover is made up of native species.
- It must be 0.1 hectares or greater in size.
- It must contain an understorey with at least 12 native understorey species other than grasses, as well as at least one listed important species. The requirements for diversity in the understorey to meet the definition of the community are met provided the requisite understorey species can be located from anywhere across the total extent of the 'patch'.

In addition, a potential 'patch' of box gum woodland may still meet the listed community criteria despite not supporting 12 or more non-grass native understorey species, if it is two hectares or greater in size, has an average of 20 or more mature trees per hectare, and displays evidence of natural mature tree regeneration. The concept of what comprises a 'patch' of the listed community extends at the lowest level of quality to the extent of the area that was previously occupied by the community provided it retains a predominantly native understorey and is contiguous with an area meeting the community's definition.

4.4.1.1 Methodology for Assessment

Box gum woodland has been extensively mapped and assessed within the ACT. It is considered that the distribution of the community within the ACT is generally well understood, however, the knowledge of woodland quality is considered to represent a gap.

Differences between listing definitions under the EPBC Act, NC Act, and TSC Act have also resulted in inconsistencies in the identification of box gum woodland patches across these areas.

These limitations, as well as the more general limitations described below (**Section 4.8**) were considered when undertaking this assessment.

Information utilised for the assessment of box gum woodland has included the following data sources:

[99] Australian Government (2006) *EPBC White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands Policy Statement*, Department of Environment and Heritage, Canberra.

- Targeted Surveys:
    - KMA (2014) Ecological Studies West Belconnen Australian Capital Territory; and
    - David Hogg Pty Ltd (2013) West Belconnen Woodland Areas: Confirmatory Ecological Assessment
    - KMA (2009b) West Belconnen Project ACT and NSW Land Flora and Fauna Studies.
- Government Resources:
    - ACT Government (2015a) ACTmapi: ACT Government Online Interactive Maps
    - ACT Government (2004b) Action Plan No. 27 Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy
    - Australian Government (2006) White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands EPBC Act Policy Statement 3.5
    - Threatened Species Scientific Committee (2006) Commonwealth Listing and Conservation Advice on White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands
    - NSW Government (2010b[100]) National Recovery Plan for Box Gum Woodland and Derived Native Grassland; and
    - Australian Government (2015b) Species Profile and Threats Database.

Information in the KMA (2014) assessment was prioritised as it is the most recent, was conducted at the Project Area scale, built on previous Project Area scale assessments (i.e. David Hogg Pty Ltd 2013), and utilised the EPBC Act definition of box gum woodland to identify patches. David Hogg Pty Ltd (2013) determined the quality of patches within the west Molonglo area based on an assessment of:

- native groundcover
- proportion of annual and perennial species
- species richness
- native species diversity and floristic value; and
- eucalypt regeneration and tree density.

Subsequent to the detailed analysis by David Hogg Pty Ltd (2013), KMA (2014) undertook further targeted validation of vegetation boundaries in collaboration with a range of ACT Government specialists; and Umwelt investigated the box gum woodland patches present within the Drake Brockman Drive upgrade area to verify mapping published by the ACT Government on ACTmapi. This resulted in slight amendments to the extent of the woodland community as previously mapped such that a total of 72 hectares is considered to be present within the Project Area (**Figure 3-3**). This figure includes approximately 3.8 hectares of vegetation assumed to be box gum woodland on a precautionary basis within the Drake Brockman Drive corridor and the remaining 68.2 hectares

[100] NSW Government (2010b) *National Recovery Plan for White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, Department of Environment, Climate Change and Water NSW, Sydney.

associated with the west Molonglo component of the Project Area; and excludes the box gum woodland that is present within the Strathnairn property.

The box gum woodland present within the road upgrade area is of low quality due to a general absence of non-grass native species diversity, important species, and grass diversity overall. It is comprised of approximately 0.7 hectares of vegetation in a woodland form and the remaining 3.1 hectares as derived native grassland. The apparent connectivity of predominantly native grass areas to other patches as identified by ACTmapi as box gum woodland principally provided the basis for classification of box gum woodland within the Drake Brockman Drive corridor.

4.4.1.2 Current Condition and Threats

Box gum woodland and associated derived grasslands occur along the western slopes and tablelands of the Great Dividing Range, from southern Queensland through NSW to central Victoria. It is suggested that over 95 percent of box gum woodland has been cleared, with remaining patches being highly modified, degraded, and fragmented; occurring in small remnants that are typically less than ten hectares (Mulvaney 2012).

Modelling by Fallding (2002[101]) shows that prior to European settlement approximately 665 hectares of box gum woodland would have occurred within the Project Area. It is believed to have covered a majority of the lower slopes that are now dominated by exotic grassland or native pasture (KMA 2009b). There is currently 68.2 hectares of box gum woodland located in the southern portion representing an estimated ten percent of its former distribution over the Project Area.

The Commonwealth Conservation Advice (TSSC 2006) outlines various ongoing threats to box gum woodland across its range, these include:

- clearing
- grazing
- weed invasion
- salinity
- nutrient enrichment
- altered fire regimes; and
- fragmentation effects.

In addition, Action Plan 27 notes the following threats relevant to the ACT:

- habitat degradation as a result of adjoining urban development such as predation from domestic cats and dogs, removal of bush rock and fallen timber, and dumping of garden waste; and
- loss of mature trees from dieback and firewood and timber cutting.

In the Project Area these threats have arisen from a history of agricultural land use and urban development of areas north of Drake Brockman Drive, and have resulted in a reduced area of occupancy for the community and degradation of the remaining patches. The woodland ranges in

[101] Fallding, M (2002) *Planning Framework for Natural Ecosystems of the ACT and NSW Southern Tablelands*, Natural Heritage Trust, NSW National Parks and Wildlife Service and Land & Environment Planning.

quality from moderate / low to high and includes a 7.89 hectare patch with a planted overstorey (David Hogg Pty Ltd 2013). Also at the far eastern end of the Drake Brockman Drive area adjacent to the William hovel Drive intersection is another example of box gum woodland with a planted tree component.

4.4.1.3 Direct, Indirect and Cumulative Impacts

There will be no direct impacts to the box gum woodland that occurs within the west Molonglo area, as per the commitment set out in the Molonglo Strategic Assessment.

The road upgrade works to Drake Brockman Drive will impact approximately 3.8 hectares of box gum woodland that occurs along the existing road reserve and within adjacent private properties (Drake Brockman Drive upgrade area).

Indirect impacts that may affect retained box gum woodland within the Project Area include edge effects, weed invasion, and changes in hydrological conditions that could affect species composition.

Cumulative impacts to retained box gum woodland may arise from increased public access to the WBCC and the introduction of associated services and infrastructure. These may lead to damage to the understorey and regrowth success, invasive species introduction, and eutrophication and other pollution. The provision of visitor infrastructure may also facilitate further impacts in the foreseeable future as it promotes the use of the WBCC for recreational purposes and makes it more accessible to the public; however, these are generally included in the range of activities proposed within the river corridor.

4.4.1.4 Measures to Avoid and Mitigate

Impacts to box gum woodland within the west Molonglo area will be avoided by inclusion of all existing patches as mapped by KMA (2014) within the WBCC. The WBCC will connect the remnant box gum woodland to forest and woodland patches along the Murrumbidgee River and Ginninderra Creek. Approximately 3.8 hectares of box gum woodland will be directly impacted within the Drake Brockman upgrade area.

Impacts (indirect and cumulative) affecting the WBCC as a result of recreational activities, increased public access, and service delivery (e.g. sewerage pipes) will be avoided during the design and planning phase, and mitigated through CEMPs and the WBCC RMP.

Indirect impacts to retained box gum woodland from the urban development component of the Program (including the Drake Brockman Drive upgrade) will be mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP (for impacts within the WBCC). These processes are outlined in more detail in **Section 4.3** of this report and in the Program Report. Actions specific to box gum woodland protection will include:

- WSUD principles:
    - Stormwater flow retardation based on geotechnical, surface water, and groundwater assessments to reduce impacts to hydrological systems.
- CEMPs that:
    - Define clearing procedures and boundaries, including the retention of selected significant trees, clearing outside of threatened bird breeding seasons, and fauna rescue procedures.
    - Implement weed management during construction.

- Enforce sediment and erosion controls to prevent site run-off during construction.

- WBCC RMP (applicable to the WBCC patches only):
  - ongoing habitat improvement;
  - ongoing quality monitoring; and
  - avoidance of box gum woodland patches.

These plans will be prepared prior to construction commencing in accordance with relevant guidelines.

Facilitated impacts within the WBCC will be avoided or mitigated by the WBCC RMP within an adaptive management framework.

4.4.1.5 Impact Assessment

As the Program will affect up to 3.8 hectares of box gum woodland within the Drake Brockman Drive upgrade area, the Significant Impact Guidelines 1.1 were used to assess the likely significance of these impacts (**Table 4.1**).

Table 4.1 Significant Impact Criteria for Critically Endangered and Endangered Ecological Communities

Significant Impact Criteria	Assessment of Box Gum Woodland
Reduce the extent of an ecological community.	The extent of box gum woodland within the Project Area would be reduced by 3.8 hectares. This is comprised of approximately 0.7 hectares in the woodland form and the remaining 3.1 hectares as derived native grassland. All of this directly impacted area occurs within the Drake Brockman Drive upgrade area.
Fragment or increase fragmentation of an ecological community.	The upgrades to Drake Brockman Drive will not lead to further fragmentation of box gum woodland within and near to the Project Area as the box gum woodland within the Drake Brockman Drive upgrade area is currently isolated from other patches to the north, and connectivity will be maintained to the south.
Adversely affect habitat critical to the survival of an ecological community.	All areas of box gum woodland that meet the EPBC Act definition of the ecological community (see **Section 4.4.1**) are considered critical to the survival of it (NSW Gov't 2010b). Therefore, the Program will impact 3.8 hectares of habitat critical to the survival of an ecological community.

Significant Impact Criteria	Assessment of Box Gum Woodland
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	The abiotic factors necessary for an ecological community's survival will be protected from modification or destruction through the implementation of CEMPs and WSUD principles throughout the Program's lifetime.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species.	The WBCC RMP will contain measures to manage the retained areas of box gum woodland. This includes maintaining their quality and ensuring substantial change in the species composition of box gum woodland does not occur.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including but not limited to: • assisting invasive species that are harmful to the listed ecological community, to become established; or • causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	CEMPs and the WBCC RMP will both contain weed management measures to prevent the establishment or spread of weeds within the retained areas of box gum woodland. In addition the CEMPs and WSUD principles will contain measures (e.g. water quality measures, sediment and erosion controls) that will prevent the regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which kill or inhibit the growth of species in box gum woodland into the ecological community. The WBCC RMP will also include other measures that will protect the quality and integrity of the box gum woodland from other pressures such as public and maintenance access and bushfire mitigation actions. The Program is not expected to cause a substantial reduction in the quality or integrity of an occurrence of box gum woodland.

Significant Impact Criteria	Assessment of Box Gum Woodland
Interfere with the recovery of an ecological community.	The National Recovery Plan for box gum woodland states an objective to achieve '*no net loss in extent and condition of the ecological community throughout its geographic distribution*' (NSW Gov't 2010b pp. 44). The Program affects approximately 3.8 hectares of box gum woodland comprised principally of secondary grassland that lacks a floristically diverse ground layer. Given the relatively low quality and context of the area affected, it is unlikely that the Program would interfere with the national recovery of box gum woodland.

The Program will reduce the extent, impact critical habitat, and may interfere with the recovery of a critically endangered ecological community through the removal of 3.8 hectares of box gum woodland. While superficially this indicates a potentially significant impact, it does not include an understanding of the context for the impact. As noted previously, the areas determined to be box gum woodland within the Drake Brockman Drive corridor were defined as being part of larger patches that are mapped by ACTmapi as occurring to the south of Drake Brockman Drive within private land. Notwithstanding a single tussock of kangaroo grass (*Themeda triandra*) which is regarded by the box gum conservation advice as an 'important species', every occurrence of the community as mapped in **Figure 3-3** Is characterised by the following:

- low native grass diversity;
- either an absence or very low species richness of non-grass native species;
- a general absence of 'important species' (with the exception of one kangaroo grass tussock along the fence line east of the entrance to 'Pegasus').

Owing to the definition of the box gum woodland community as including secondary grasslands that lack a floristically diverse ground layer (i.e. native grasses only), where they are connected to areas which do meet the floristic requirements for the community, many areas that support little biodiversity are included in the overall definition of a 'patch'. Effectively, a patch contains the community but is not necessarily comprised entirely of vegetation that meets the full floristic definition of the community. This is the case along Drake-Brockman Drive where none of the occurrences of the 'community' would meet the definition of the community but are included as part of a patch owing to the dominance of native grasses in an area that was or still is dominated by Blakely's red gum or yellow box trees. Accordingly, it is only through being contiguous with areas already mapped by the ACT Government do areas identified as box gum woodland along Drake Brockman Drive meet the definition of the community through being considered part of a patch.

The context, therefore, is that the Program would result in the removal of areas containing native grasses and some remnant trees from the existing Drake Brockman Drive road reserve and some vegetation of a similar quality in adjoining private land to the south. The road reserve component is regularly mown and has been landscaped with drainage swales and non-native deciduous trees. On this basis the impact to box gum woodland is not considered to be significant.

Despite this conclusion, as the strategic assessment process has the ability to consider broader effects and account to a greater extent for cumulative impacts, a component of the offset package has been prepared to address the small scale impact to box gum woodland the Program represents.

Section 5 presents a discussion of the offsets relating to this and the context within which the offsets are proposed.

4.4.2 Natural Temperate Grassland

Natural temperate grassland of the south-eastern highlands is a CEEC under the EPBC Act. The description of this community has recently changed (TSSC 2016) and is now broader in that it now captures grassy areas not previously included within the community.

Natural temperate grassland occurs in valleys influenced by cold air drainage and in broad plains within the South Eastern Highlands of NSW, the ACT, and Victoria. It is found at altitudes between 250 metres in central and northern parts of its distribution and 1,200 metres in the south. Whilst it may contain up to ten percent tree or shrub cover, it cannot occur as derived or secondary grasslands (TSSC 2016).

It is a grassy vegetation community typically dominated by moderately tall to tall (25 – 100 centimetres) tussock grasses such as kangaroo grass (*Themeda triandra*), snowgrass (*Poa sieberiana*), river tussock grass (*Poa labillardierei*), kneed speargrass (*Austrostipa bigeniculata*), slender speargrass (*Austrostipa scabra*), red leg grass (*Bothriochloa macra*), wallaby grass (*Rytidosperma* spp.), and blowngrass (*Lachnagrostis* spp.). A range of native non-grass species (i.e. forbs and sedges) will also be present. The Conservation Advice identifies eight vegetation associations based on the regional vegetation classification of Armstrong *et al.* (2013)[102].

Natural temperate grassland within Jarramlee and Macgregor West offset areas have previously been identified under the previous description of the community. All examples as previously mapped (**Section 3.3.1.1**) remain within the definition of the community.

In addition to the above, the new definition affects other areas of the Project Area. Of note to the Program is Association 8: 'Kangaroo Grass – Purple Wire-grass – Wattle Mat-rush dry tussock grassland in the Southern Tablelands region of the South Eastern Highlands Bioregion'. This association often co-occurs with pink-tailed worm-lizard habitat, which is dominated by tussock grassland and rocky outcrops. Natural temperate grassland, therefore, also occurs within these areas.

Due to the recent change in description, it is known that natural temperate grassland occurs in locations where pink-tailed worm-lizard habitat exists, however, it is unknown whether these areas also represent the full extent of the 'patch' which needs to be considered when identifying the community in accordance with the conservation advice.

Similar to the Listing Advice for box gum woodland, the advice for natural temperate grassland includes identification guidelines including procedures for assessing presence, condition, and patch extent. The conservation advice describes a 'patch' as follows:

A patch is defined as a discrete and continuous or semi-continuous area of the ecological community. Patches can be spatially variable and are often characterised by one or more areas within a patch that meet the condition threshold criteria that are surrounded by areas of lower quality. Therefore, a patch may include small-scale disturbances, such as tracks or breaks (including exposed soil, leaf and other plant litter, cryptogams) or small-scale variations in vegetation that do not significantly alter its overall functionality. In this case, areas of a patch that are exotic dominated, or otherwise do not meet the minimum condition thresholds, are included within the patch as a whole, but should not be included in sampling plots (e.g. this may apply to drainage lines that often contain more weeds than surrounding areas of a patch).

[102] Armstrong RC, Turner KD, McDougall KL, Rehwinkel R & Crooks JI (2013) 'Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory' *Cunninghamia* 13(1): 125-265

In summary, to meet the condition criteria of natural temperate grassland, the following must be satisfied:

- A patch must be at least 0.1 hectares in size.
- The patch must contain any of the following:
    - 50 percent foliage cover of kangaroo grass
    - 50 percent foliage cover of river tussock grass
    - 50 percent foliage cover of plains sedge (*Carex bichenoviana*); or
    - dominated by native vascular plants (annual and perennial species) and contains the following:
        - at least eight native non-grass species
        - at least two indicator species; or
        - a floristic value score of five or more.

The conservation advice also recommends a 30 metre buffer for the management of edge effects to patches of the community. It is noted that the buffer is not to be considered as part of the community that is protected under the EPBC Act as a MNES, however, should be considered in order to minimise the risk of any significant adverse impacts extending into patches of the community from adjacent development.

4.4.2.1 Methodology for Assessment

As previously noted, while it is known that natural temperate grassland is present, the extent and quality of this community within the Urban Development Area is not known. Accordingly, an assessment of significance under the Significant Impact Guidelines 1.1 has not been prepared for the purpose of this report.

Despite this, given the community is listed as critically endangered and the Program will remove in the order of 16.4 hectares of pink-tailed worm-lizard habitat (refer to **Section 4.5.5**), it is clear that this would also constitute a significant impact to the grassland community.

In order to ensure impacts to this community are appropriately considered, the Program proposes an approach to assessment of impacts following further more detailed studies that are able to define the extent and condition of natural temperate grassland patches. As the conservation advice provides detailed guidance as to the field surveys and analysis methods, the Program does not include an alternative approach.

The assessment of impacts to natural temperate grassland as a result of the Program will be undertaken using the Defined Process Strategy (**Section 2.6.3**). To demonstrate the application of the process a Scenario is described in **Section 4.7** using natural temperate grassland impacts as a case study.

This Strategic Assessment considers this to be an appropriate response.

4.5 Threatened Fauna

This section provides a detailed assessment of the potential impacts of development on the threatened fauna species considered likely to be affected by the Program as identified in **Section 3.3.1**.

4.5.1 Birds

Five bird species listed as threatened under the EPBC Act were identified as having the potential to be affected by the Program. These were Australian painted snipe, regent honeyeater, swift parrot, superb parrot, and painted honeyeater. Impacts to these species are assessed together in the following section as the impacts and avoidance, mitigation, and offset measures are consistent for each species.

4.5.1.1 Methodology for Assessment

Information utilised for the assessment of threatened bird species has included the following data sources:

- Targeted Surveys:
    - KMA (2013c) West Belconnen Woodland Project ACT and NSW Land Targeted Bird Surveys
    - KMA (2014) Ecological Studies West Belconnen Australian Capital Territory
    - KMA (2013a) West Belconnen Project NSW Land Flora and Fauna Studies
    - KMA (2009b) West Belconnen Project ACT and NSW Land Flora and Fauna Studies; and
    - Geoff Butler and Associates (2000) The Revegetation of Ginninderra Creek Between Barton Highway and Macgregor, ACT.
- Government Resources:
    - National Recovery Plans for superb parrot (*Polytelis swainsonii*) (Victorian Gov't 2011b[103]), and swift parrot (*Lathamus discolor*) (Saunders and Tzaros 2011)
    - Commonwealth Conservation Advice for *Grantiella picta* Painted Honeyeater (TSSC 2015a) and *Anthochaera phrygia* Regent Honeyeater (TSSC 2015d[104])
    - Commonwealth Listing Advice for Australian Painted Snipe *Rostratula australis* (TSSC 2013a)
    - Australian Government (2015b) Species Profile and Threats Database
    - ACT Government (2004b) Action Plan No. 27 Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy; and
    - ACT Government (2005b) Superb Parrot *Polytelis swainsonii* Information Sheet.

[103] Victorian Government (2011b) *National Recovery Plan for the Superb Parrot Polytelis swainsonii,* prepared by Baker-Gabb, D. for the Department of Sustainability and Environment, Melbourne.

[104] Threatened Species Scientific Committee (TSSC) (2015d) *Approved Conservation Advice Anthochaera phrygia Regent Honeyeater,* prepared for the Department of the Environment, Canberra, accessed online (December 2015): http://www.environment.gov.au/biodiversity/threatened/species/pubs/82338-conservation-advice.pdf.

- ACT Government (2015a) ACTmapi ACT Government Online Interactive Maps

- Other Resources:
  - Canberra Ornithologists Group (2015b) Bird Info: All Canberra's Birds – Photos, Calls, Local Status, and Population Data
  - Canberra Ornithologists Group (2011; 2012; 2014; 2015a) Annual Bird Reports; and
  - Taws and Saunders (2005) Swift Parrot Invasions.

Information in the KMA (2013a) assessment is the most recent and targeted assessment of avian diversity within the Project Area and also targeted the threatened species of interest to this assessment. Records noted by other survey reports were also considered as part of the assessment as supporting information. The broader records accumulated by the ACT Government (2004b), Australian Government (2015b), and COG (2011, 2012, 2014, and 2015a) were used to provide a regional context and assess the likelihood of occurrence for avian species in general in addition to other threatened species for which no recent records in the Project Area or surrounds exist. It is noted, however, that these other data sources indicate presence only and cannot be used to determine the abundance of these species in the broader west Belconnen area. It also cannot be used to determine the absence of any species with any reliability. Records from COG may be particularly patchy given that much of the data centres on areas that are easily accessible and more heavily populated, however, it does provide a valuable source of information across numerous years.

Due to the variety of sources within the larger scale datasets, the accuracy and precision of some records may be questioned. This is not considered to be a significant limitation for this assessment as a precautionary and scaled approach is used to determine the likelihood of occurrence, and a landscape approach will be taken for the conservation of habitat values for these species (as opposed to measures targeting specific bird species).

4.5.1.2 Current Condition and Threats

Australian painted snipe (EPBC listed endangered) and superb parrot (EPBC vulnerable) are both known to occur within the Project Area. Based on habitat requirements and regional records, regent honeyeater (EPBC critically endangered), swift parrot (EPBC critically endangered), and painted honeyeater (EPBC vulnerable) have the potential to occur during suitable conditions.

Australian painted snipe is endemic to Australia and records of the species exist in all states and territories, most commonly along the east coast of the mainland (Australian Gov't 2015b). Estimates of population size are difficult to determine given the cryptic nature and wide distribution of the species, and frequent fluctuations in population size due to changes in habitat condition. As such the decline in numbers is evidenced primarily by reporting rates and anecdotal evidence. Loss and degradation of its habitat caused by hydrological changes, and its vulnerability to climate change, are the key threats to this species (TSSC 2013a). Parts of the Project Area with greatest habitat potential for this species occur along the Murrumbidgee River corridor in vegetation closely associated with the watercourse.

Superb parrots occur in a range of forest and woodland types throughout the Riverina, western slopes and plains, and the southern tablelands of NSW and ACT. The species still occurs throughout most of its historic range, through its numbers have declined and there has been a contraction in its breeding range. The most drastic declines have been attributed to attempts at poisoning other pest species during the early twentieth century, after which numbers struggled to recover due to a decrease in extent and the fragmentation of suitable habitat (Victorian Gov't 2011b). The species is particularly vulnerable to the effects of habitat fragmentation as it is reported to be reluctant to

cross open ground when travelling between breeding and foraging sites (ACT Gov't 2004b). Within the Project Area, superb parrot has been recorded in grassy woodland areas in the south.

Regent honeyeaters occur in woodlands with an abundance of mature trees, high canopy cover, and a large number of mistletoe. They occur in a patchy distribution along the western slopes from southeast Queensland to central Victoria, as they follow food sources between their breeding areas in the south and over-winter areas in the north (Australian Gov't 2015b). The population is decreasing as a result of the loss and degradation of habitat and food from inappropriate fire regimes, uncontrolled grazing, tree clearing, tree dieback, and weed invasion (TSSC 2015d). Other factors include competition with other honeyeaters, increased predation, and loss of genetic diversity (ACT Gov't 2004b). Although regent honeyeaters have a varied diet and may occur in any of the woodland or forest communities, it is the grassy woodlands that generally represent the highest quality foraging habitat, however, the riparian forests, particularly where mistletoe is present would also represent potential habitat. Although uncommon, regent honeyeaters have also previously been recorded breeding in the ACT. From the perspective of the assessment, it is assumed that any native wooded area within the Project Area has the potential to support regent honeyeaters given suitable conditions.

Swift parrots exist as a single population that migrates between Tasmania and the south eastern part of the Australian mainland, principally NSW but also with records occurring as far as southeast Queensland and South Australia (Saunders and Tzaros 2011). As they pass through the ACT region, the species utilises dry sclerophyll eucalypt forest and box gum woodland (Taws and Saunders 2005). Key threats include habitat loss, degradation, and fragmentation, climate change, tree dieback, predation from native wildlife and feral cats, competition from feral honeybees, and beak and feather disease (Saunders and Tzaros 2011). Similarly to regent honeyeaters, swift parrots may forage over a wide range of habitat types, particularly where flowering of canopy species coincides with their winter migration though they do demonstrate a degree of site fidelity. Within the Project Area, areas of potential habitat are primarily the grassy woodland areas.

Painted honeyeaters are sparsely distributed throughout south eastern Australia to north-west Queensland and east Northern Territory; with the greatest concentrations at latitude of 26 degrees and south on the western slopes of the Great Dividing Range. Due to the species' movement patterns all individuals are considered to be part of the same, single population. It is a highly specialised species, particularly concerning its diet of fruiting mistletoes, with low nesting success due to predation. The key threats to the species include habitat loss resulting from clearing, grazing, and direct removal of mistletoes from mature trees. In addition, other threats such as competition, predation, pasture improvement, and vehicle collision are also listed. Painted honeyeaters are expected to continue to decline on the edges of its distribution even if habitat loss is halted due to the low population numbers in these areas (TSSC 2015a). Within the Project Area, the species has the potential to occur along the Murrumbidgee River in river oak vegetation where mistletoe is also present, though the extent to which this habitat would be utilised should they occur, is unclear.

4.5.1.3 Direct, Indirect and Cumulative Impacts

The drilling of seven vertical shafts for the sewer alignment within the WBCC will directly impact upon 0.28 hectares of forest and woodland (not box gum woodland) that is potential swift parrot and regent honeyeater habitat; including the loss of a maximum of 28 trees (nine high and three moderate quality trees, one stag, and the remainder of poor or unknown quality) (Brown Consulting 2014b). The estimated 3.8 hectares of box gum woodland within the Drake Brockman Drive upgrade area that will be removed under the Program, is also considered as being habitat for superb parrot, regent honeyeater, and swift parrot, albeit marginal. While box gum woodland in general is considered to be an indicator of potential habitat for superb parrots, regent honeyeaters, and swift parrots; areas that lack a tree component and occur as derived native grassland and are subject to

ongoing effects from adjacent urbanisation are unlikely to be of conservation significance. While there is an estimated 3.8 hectares of 'box gum woodland' within the Drake Brockman Drive upgrade area, only 0.7 hectares of this would represent potential habitat for these species.

All potential painted honeyeater habitat occurs within the Murrumbidgee River Corridor, and will not be directly impacted by the Program.

The COG records of Australian painted snipe are noted as being from the West Macgregor Pony Club and Parkwood Horse Paddocks. It is likely that these records are associated with long grass areas associated with the farm dams which occur throughout the lowland section of the Project Area in addition to other grassy sections along the banks of the Murrumbidgee River.

Increased public access, recreational activities, and service provision (including maintenance) has the potential to adversely affect natural areas protected by the WBCC. This may result in localised damage to habitat, pollution, increased disturbance due to human presence and activities, and invasive species introduction. Allowing recreational activities to occur within the WBCC may facilitate greater use of the area (though these are generally currently accounted for in the Program), or more intensive activities in the future. In addition, it may create the opportunity for indirect impacts such as trampling and predation from unrestrained domestic animals to occur.

Other indirect impacts that may arise from the urban development component of the Program and affect threatened bird species within the Project Area include edge effects, weed invasion, and changes in hydrological conditions.

4.5.1.4 Measures to Avoid and Mitigate

The primary avoidance strategy with regards to habitat for threatened bird species is the establishment of the WBCC, which expands the area already protected within the Murrumbidgee River Corridor and increases the level of protection provided to this area by rezoning with a 'nature reserve' overlay. Detailed planning of the urban open spaces will also result in the retention of a range of mature trees, and as part of a mitigation plan, will enhance the value of retained trees with an open space tree management and enhancement strategy that includes the planting of additional trees as appropriate.

Potential impacts to habitat values in the WBCC as a result of increased public access, recreational activities, and service delivery (e.g. sewerage pipes) will be avoided where possible during the design and planning phase, and mitigated through the implementation of CEMPs and the WBCC RMP. In particular, any future development within the WBCC (i.e. related to recreational activities) will be subject to the commitments of the Program, and the strategies and principles set out in the WBCC RMP (**Section 4.2.1**) such that they do not significantly impact upon MNES, including threatened bird species. In this way the WBCC RMP will act to avoid facilitated impacts within the WBCC as required and ensure due consideration is given to MNES values throughout the lifetime of the Program.

Indirect impacts from the urban development component of the Program will be mitigated through implementation of CEMPs, WSUD principles, and the WBCC RMP. This process is outlined in more detail in **Section 4.3** of this report and in the Program Report. Specific actions targeting impacts to birds including threatened species involve:

- WSUD principles based on geotechnical, surface water, and groundwater assessments that:
    - Retard stormwater flows and the increased run-off from the urban development area before they enter the WBCC. This will minimise the impact of altered hydrological regimes on vegetation upon which avifauna will rely.

- Provide suitable wetland habitat for water birds (e.g. Australian painted snipe) where appropriate.

- Mitigation actions during the construction phase implemented through CEMPs prepared prior to construction commencing in accordance with relevant guidelines:
  - Definition of clearing procedures and boundaries that include the retention of trees; avoid with appropriate buffers threatened bird species' nesting trees; clear outside of threatened bird species' breeding seasons, and outline faunal rescue procedures.
  - Recovery and beneficial use for the purpose of fauna habitat enhancement of fallen timber, including logs and tree sections containing hollows.
  - Invasive species management.
  - Sediment and erosion controls to prevent site run-off.
- Operation phase management including:
  - Domestic pet containment policies within the proposed residential development, prohibition of 'off-leash' areas for dogs within the WBCC, and education initiatives targeting the west Belconnen community regarding the impact of unrestrained domestic animals.
  - Ongoing management actions as outlined in the WBCC RMP.

4.5.1.5 Impact Assessment

The Significant Impact Guidelines 1.1 were used to inform the assessment of impacts on critically endangered and endangered birds from implementing the Program (Australian painted snipe, regent honeyeater, and swift parrot) and the vulnerable superb parrot and painted honeyeater. The assessment of critically endangered and endangered species is presented in **Table 4.2** while the assessment of vulnerable species is presented in **Table 4.3**. Refer to **Section 4.1** for the definitions of 'population' and 'habitat critical to the survival...' as applied in the following tables.

Table 4.2 Significant Impact Criteria for Endangered and Critically Endangered Bird Species

Significant Impact Criteria	Assessment of Australian painted snipe, regent honeyeater, and swift parrot
Lead to a long-term decrease in the size of a population.	The Program will not lead to a long-term decrease in the size of a population for any of the critically endangered or endangered bird species. The removal of 0.28 hectares (a maximum of 28 trees) of forest and woodland habitat (excluding box gum woodland) and estimated 0.7 hectares of suitable box gum woodland of marginal quality will not lead to a long-term decrease in the size of a population due to the areas of highest quality and greatest regional connectivity significance for the highly mobile swift parrot and regent honeyeater being protected in the WBCC as part of the Program. Riparian habitat areas along the banks of the Murrumbidgee River will be protected by inclusion within the WBCC. Residual impacts to each of these species will be further mitigated through the implementation of other measures to be included in CEMPs and the Master Plan. These include the prevention of clearing during the breeding season of these species, where practicable protecting existing mature trees within the urban development area to maintain connectivity as appropriate (the Program has embarked on a program of study into the management of remnant trees within an urban environment, with a report having been commissioned from the ANU Fenner School of Environment and Society: "West Belconnen Tree simulation modelling: Stage 1 Precinct Plan, Le Roux, Gibbons, Ikin & Rayner, 2015[105]; further work is proposed), and create wetland habitat areas.
Reduce the area of occupancy of the species.	As the species have been recorded in, or potentially occur within the Project Area but do not regularly occupy the habitat that will be cleared for development; implementation of the Program will not result in a reduction in the area of occupancy for any of the endangered or critically endangered bird species considered in this assessment.

[105] Le Roux, D. Gibbons, P. Ikin, K. and Rayner, L. (2015) *West Belconnen Tree Simulation Modelling: Stage 1 Precinct Plan*, Fenner School of Environment and Society, Australian National University.

Significant Impact Criteria	Assessment of Australian painted snipe, regent honeyeater, and swift parrot
Fragment an existing population into two or more populations.	As a result of the highly disturbed nature of the Project Area, direct impacts of the Program will not result in habitat removal that causes any populations to be fragmented. Despite this, increased intensity of human occupation and the associated infrastructure of an urban development may represent a barrier to the thoroughfare of some species. To mitigate against this potential impact, the retention and enhancement of trees within the proposed urban open spaces will ensure connectivity is maintained. Research into ways of achieving this within an urban development context is underway (refer above). As none of the endangered or critically endangered species that may occur within the Project Area are resident, and the riparian corridor will be avoided and protected, it is unlikely the proposed action will fragment an existing population of any of the critically endangered or endangered bird species into two or more populations.
Adversely affect habitat critical to the survival of a species.	Habitat critical to the survival of Australian painted snipe is defined as the Riverina of Victoria and NSW, Queensland Channel Country, Fitzroy Basin (central Queensland), and south eastern South Australia and adjacent Victoria (TSSC 2013a). Habitat critical to the survival of regent honeyeater is considered to be mugga ironbark (*Eucalyptus sideroxylon*) forest (Victoria), NSW riparian forest (such as river oak forest), and swamp mahogany (*E. robusta*) forest in coastal NSW as refuge sites (Victorian Gov't 1999[106]). Habitat critical to the survival of swift parrots includes Tasmanian blue gum and swamp gum (*E. ovata*) forests where they breed, the box ironbark region of Victoria, and woodlands and forests of the coastal and western slopes of NSW (TSSC 2012[107]). The river oak forests that occur within the riparian corridors of the Project Area are considered critical for regent honeyeater and will not be adversely affected by the Program. Any impacts to this habitat as a result of recreation activities and infrastructure will be avoided or mitigated by the WBCC RMP. No other habitat within the Project Area is considered critical to the survival of endangered or critically endangered bird species likely to occur.

[106] Victorian Government (1999) *Regent Honeyeater Recovery Plan 1999-2003*, Department of Natural Resources and Environment, Melbourne.

[107] Threatened Species Scientific Committee (TSSC) (2012) *Commonwealth Listing Advice for Lathamus discolor*, prepared for the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Significant Impact Criteria	Assessment of Australian painted snipe, regent honeyeater, and swift parrot
Disrupt the breeding cycle of a population.	Of the critically endangered and endangered bird species that may potentially occur, swift parrots do not breed on the mainland of Australia and neither Australian painted snipe or regent honeyeater have been recorded breeding in the vicinity of the Project Area. Australian painted snipe breed in wetlands that contain continuous reed beds and avoid areas of low cover (TSSC 2013a). The farm dam habitat present within the Project Area is unlikely to meet these requirements and breeding is considered unlikely to occur. The Project Area lies outside of the three main regions of regent honeyeater breeding; however, should breeding occur it is likely to be in the spring and summer months and focussed on the woodland and forest communities which will largely be protected as a consequence of implementing the Program. Further mitigation measures that apply to the construction phase of implementation will limit the potential for disturbance to breeding birds through implementation of CEMPs that include measures to avoid clearing during threatened bird species' breeding times. As noted above, these CEMPS will be tailored to each location where works are adjacent to either retained habitat in the WBCC or retained trees in urban open space. As a result it is unlikely that implementation of the Program will lead to disruption of breeding cycles of any of the critically endangered and endangered bird species considered.

Significant Impact Criteria	Assessment of Australian painted snipe, regent honeyeater, and swift parrot
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The majority of habitat for critically endangered and endangered bird species will be avoided and protected within the WBCC, including all painted honeyeater habitat. Whilst the sewer alignment will remove 0.28 hectares (including up to 28 trees) of forest and woodland, and the Drake Brockman Drive upgrade will remove an estimated 0.7 hectares of suitable box gum woodland, which is although being of marginal quality may represent potential swift parrot and regent honeyeater habitat. The very low quality of this habitat suggests it is not likely to be of importance to any of the listed species. The Program will affect farm dams which provide potential Australian painted snipe habitat, however, this habitat will be replaced by the provision of constructed wetlands where possible. Any impacts to wetland habitat within the WBCC will be avoided under the WBCC RMP. Any habitat along the Murrumbidgee River will be maintained to ensure no net loss as a result of the Program. Any further loss of woodland or forest habitat within the WBCC will be guided by the commitments, strategies, and principles of the WBCC RMP and will not affect MNES. It is, therefore, considered that the limited vegetation removal that will occur under the Program is insignificant and unlikely to lead to a decline in any of the critically endangered or endangered bird species considered.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	Implementation of the Program will not lead to the introduction of any invasive species that is likely to adversely affect habitat for any of the critically endangered and endangered bird species considered. A cat containment policy will be implemented for the entire development area and the WBCC RMP will include specific invasive species management actions (such as fox control).
Introduce disease that may cause the species to decline.	The Program is considered very unlikely to introduce disease that may cause any critically endangered and endangered bird species to decline, as urbanisation is not linked to any specific disease.

Significant Impact Criteria	Assessment of Australian painted snipe, regent honeyeater, and swift parrot
Interfere with the recovery of the species.	The Program will not interfere with the recovery of any critically endangered or endangered bird species (Saunders and Tzaros 2011; Victorian Gov't 1999; ACT Gov't 2004b).The recovery plans all have the general aims to protect the highest quality habitat using the most appropriate means (e.g. a comprehensive, adequate, and representative reserve system); undertake varying types of research to better understand the threats, behaviour, and distribution of threatened species; incorporate the consideration of ecological values into development planning; and reduce threats and where possible regenerate habitat. As the Program will protect and enhance the areas of highest quality habitat by establishing it as a nature reserve, it will not interfere with these recovery objectives.

On the basis of the assessment of critically endangered and endangered bird species in consideration of the scale and intensity of the proposed action in addition to the avoidance and mitigation measures, it is highly unlikely there will be a potentially significant impact to swift parrot, regent honeyeater, or Australian painted snipe.

The following assessment (**Table 4.3**) considers the vulnerable superb parrot and painted honeyeater with respect to assessment criteria in the Significant Impact Guidelines 1.1.

Table 4.3 Significant Impact Criteria for Vulnerable Superb Parrot and Painted Honeyeater

Significant Impact Criteria	Assessment of superb parrot and painted honeyeater
Lead to a long-term decrease in the size of an important population.	All superb parrots occurring in the ACT are at or near the south eastern limit of their distribution and in accordance with the definition provided above, these birds will be part of an important population that breeds across the northern parts of the ACT. Box gum woodland in the southern parts of the Project Area represents habitat that may be of some importance to the superb parrot population by providing connectivity to breeding areas in the Molonglo valley. Accordingly, the maintenance of functionality in this connectivity is important in ensuring there are to be no adverse impacts to superb parrots. Given that most of the box gum woodland habitat will be protected within the WBCC and further mitigation measures are included to maintain and enhance connectivity through the proposed urban open space network, it is unlikely connectivity for superb parrots will be adversely affected. As per the discussion on fragmentation **Table 4.1** the removal of an estimated 0.7 hectares of suitable but marginal box gum woodland within the Drake Brockman Drive upgrade area is not considered to increase fragmentation of this habitat type. In addition, indirect impacts from the Program will be managed through the implementation of CEMPs and WSUD principles. Painted honeyeater is considered to occur as a single population, which, therefore, meets the definition of an important population. The Program is not considered likely to lead to a long-term decrease in the size of the population given that the only potential painted honeyeater habitat within the Project Area will be avoided and incorporated into the WBCC. The mitigation measures outlined in the CEMP, WSUD, and WBCC RMP will further reduce the risk of the Program impacting the painted honeyeater population. Accordingly, it is unlikely that implementation of the Program will lead to a long term decrease in the important population of superb parrots or painted honeyeaters in the ACT.

Significant Impact Criteria	Assessment of superb parrot and painted honeyeater
Reduce the area of occupancy of an important population.	All of the painted honeyeater habitat (river oak forest) within the Project Area will be avoided and protected under the Program. Superb parrots are highly mobile through the Project Area, using it as a thoroughfare between nesting and foraging habitat. The removal of an estimated 0.7 hectares of suitable but marginal box gum woodland (which does not increase fragmentation) is, therefore, not considered to reduce the area of occupancy of superb parrots. In addition, connectivity throughout the development area will be maintained through the strategic retention and addition of significant trees as appropriate throughout the urban open space system. This will be particularly important for maintaining the existing movement corridor for superb parrots through the south of the Project Area. As such, the Program will not reduce the area of occupancy of an important population of superb parrot or painted honeyeater.
Fragment an existing important population into two or more populations.	As connectivity through and around the Project Area will be maintained, the Program will not lead to fragmentation of the ACT superb parrot population, nor the national painted honeyeater population.
Adversely affect habitat critical to the survival of a species.	Habitat critical to the survival of superb parrots in the ACT is comprised primarily of breeding sites given the seasonal influx of this species during the warmer months of the breading season. Particular attributes of these sites include hollow bearing trees, proximate foraging areas and pathways for dispersal that maintain connectivity. Within the Project Area, habitat connectivity is the only attribute that is critical to superb parrots in the ACT and particularly for those birds that may be traversing the site between breeding and foraging sites. As the Program will not disrupt this habitat connectivity, it is unlikely that the proposed action will adversely affect habitat critical to the survival of superb parrots in the ACT. Painted honeyeater migration and breeding is governed by the fruiting of mistletoe (TSSC 2015a) as such it is the protection of this habitat characteristic, rather than a geographical area that determines habitat critical to the survival of the species. As all painted honeyeater habitat present within the Project Area will be protected by its inclusion within the WBCC and indirect impacts will be mitigated via CEMPs, WSUD, and WBCC RMP; the Program will not adversely affect habitat critical to the survival of the species.

Significant Impact Criteria	Assessment of superb parrot and painted honeyeater
Disrupt the breeding cycle of an important population.	The breeding cycle of a population of superb parrot will not be disrupted by the Program as there are no known breeding sites for species within the Project Area and connectivity between foraging areas and the known breeding areas in the Molonglo Valley will be maintained. There are no known breeding records of painted honeyeater from within the Project Area and any potential breeding will be governed by the fruiting of mistletoes and the availability of suitable habitat. As the Program will be protecting such habitat it will not disrupt the breeding of painted honeyeater.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	All potential painted honeyeater habitat will be avoided by the Program and will not be modified, destroyed, removed, isolated, or made less accessible; its quality will also be managed through the WBCC RMP. As superb parrot habitat within the Project Area is transitional, the removal of an estimated 0.7 hectares of suitable but marginal box gum woodland is not considered to result in the decline of the species. This is particularly true as the broader habitat connectivity values will be maintained throughout the Project Area.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.	The Program will not result in the introduction of any invasive species that are likely to adversely affect habitat for superb parrots or painted honeyeater within the Project Area. A cat containment policy will be implemented for the entire development area and the WBCC RMP will include specific invasive species management actions (such as fox control).
Introduce disease that may cause the species to decline.	The Program is considered very unlikely to introduce disease that may cause vulnerable bird species to decline, as urbanisation is not linked to any specific disease.

Significant Impact Criteria	Assessment of superb parrot and painted honeyeater
Interfere with the recovery of the species.	The National Recovery Plan for superb parrot (Victorian Gov't 2011b) has the following objectives: • determine the population trends of the species; • increase knowledge of the ecological requirements of the species; • develop and implement threat abatement strategies; and • increase community involvement in and awareness of the recovery program. Currently there is no national recovery plan for painted honeyeater; however, both NSW and the ACT have State / Territory recovery plans in place. Broadly, these plans target the protection of mistletoe habitat using various appropriate tools (e.g. agreements, awareness raising, and inclusion in nature reserves) and targeting refuge sites, habitat rehabilitation through the planting of species that host the required mistletoe species and improving habitat connectivity, and weed removal; monitor the abundance and impact of noisy miners; and promote targeted research to identify practical methods of habitat restoration (NSW Gov't 2015c[108]; ACT Gov't 2004b). The Program will not interfere with the recovery of superb parrot or painted honeyeater as it will protect the habitat areas for both species.

Based on the significant impact criteria, it is considered that the avoidance and mitigation measures presented in the Program will prevent the Program from having a significant impact on any of the threatened bird species. Key elements to this finding are the avoidance and protection of woodland and forest communities within the WBCC, in addition to mitigation measures that will seek to further enhance vegetation through the urban open space network; and the inclusion of constructed wetlands as part of the WSUD plan for the Program.

4.5.2 Fish

Three EPBC Act threatened fish species were identified as having the potential to be impacted by the Program. Macquarie perch and trout cod are listed as endangered, and Murray cod is listed as vulnerable under the EPBC Act. In the following sections, these species will be assessed together as the impacts and the avoidance, mitigation, and offset measures are generally consistent for each species.

4.5.2.1 Methodology for Assessment

There has been no detailed assessment of the presence of fish species within the Project Area (inclusive of the relevant reaches of the Murrumbidgee River and Ginninderra Creek). As such ACT

[108] NSW Government (2015c) *Painted Honeyeater Grantiella picta Species Action Statement*, Office of Environment and Heritage ,accessed online (December 2015): http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10357.

and Australian Government landscape and regional scale mapping and survey databases were utilised for this assessment as outlined below:

- ACT Government (2015a) ACTmapi ACT Government Online Interactive Maps
- ACT Government (2007) Action Plan No. 29 Ribbons of Life: ACT Aquatic Species and Riparian Zone Conservation Strategy; and
- Australian Government (2015b) Species Profile and Threats Database.

Records within these data sets only indicate presence, not absence. Where no records of a species within the Project Area were identified, details of habitat preference and location of the nearest known populations were used to determine the likelihood of occurrence.

Specific population, habitat, and threat information was determined using the following Commonwealth sources:

- National Recovery Plans for Murray cod (Victorian Gov't 2010a) and trout cod (Victorian Gov't 2008a[109]
- Referral guidelines for Macquarie perch *Macquaria australasica* (Australian Gov't 2011a[110]); and
- Conservation Advice for Macquarie Perch *Macquaria australasica* (TSSC 2013c[111]).

Due to the variety of sources within these datasets, the accuracy and precision of some records may be questioned. The impact of this on the assessment has been mitigated by the precautionary approach built into the assessment of likelihood of occurrence, allowing for a scale of choices rather than a dichotomous present / absent score for each species.

These limitations are further mitigated by the landscape scale approach to conservation within the Program. Meaning that riparian values as a whole shall be managed and protected, not simply those that relate to threatened species (e.g. water quality).

4.5.2.2 Current Condition and Threats

Each of these species is found within the Murray Darling Basin, of which the Murrumbidgee River is a tributary.

Nationally, Macquarie perch are generally confined to the upper reaches and more natural catchments within the Murray Darling Basin. Within the ACT, Macquarie perch is restricted to the Murrumbidgee, Molonglo, Paddys, and Cotter Rivers (ACT Gov't 1999). Threats to this species include damage to riparian vegetation, sedimentation, barriers to fish passage, flow regime alteration, recreational angling, predation and competition with alien fish species, diseases and parasites, and the impacts of the 2003 ACT bushfires (ACT Gov't 2007; TSSC 2013c).

[109] Victorian Government (2008a) *National Recovery Plan for the Trout Cod Maccullochella macquariensis*, Department of Sustainability and Environment, Melbourne.

[110] Australian Government (2011a) *Environment Protection and Biodiversity Conservation Act 1999 Draft referral guidelines for the endangered Macquarie perch, Macquaria australasica*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

[111] Threatened Species Scientific Committee (TSSC) (2013c) *Approved Commonwealth Conservation Advice for Macquaria australasica (Macquarie perch),* accessed online (December 2015): http://www.environment.gov.au/biodiversity/threatened/species/pubs/66632-conservation-advice.pdf.

Murray cod are widespread throughout the Murray Darling Basin, though it is regularly re-stocked in Canberra lakes nearby to the Project Area (Lake Ginninderra, Gungahlin Pond, and Yerrabi Pond). The Murrumbidgee River population is considered important due to its size, integrity, and proximity to the Murray Darling Basin upland limit (Victorian Gov't 2010a). Sedimentation is listed as the most important threat to the species in the region (ACT Gov't 2007). Other threats include damage to riparian vegetation, barriers to fish passage, flow regime alteration (including dam release regulation and cold water release), reduced water quality, illegal harvesting, competition for food and habitat, diseases and parasites and impacts from the 2003 ACT bushfires (ACT Gov't 2007; Victorian Gov't 2010a).

There are only two populations of trout cod (both in Victoria) that are believed to be naturally viable, despite the species previously being widespread in the southeast of the Murray Darling Basin. Two sites within the ACT (Bendora Dam and Angle Crossing) have been stocked with trout cod and it is not known how far it currently extends up the Murrumbidgee River. Threats include damage to riparian vegetation, de-snagging (the removal of large woody debris), sedimentation, recreational angling, predation from introduced species, changes to water quality (including temperature) and flows, and barriers to fish movement (ACT Gov't 2007; Victorian Gov't 2008a).

4.5.2.3 Direct, Indirect and Cumulative Impacts

Direct impacts to threatened fish species as a result of works within the Murrumbidgee River or associated creeks or damage to riparian vegetation are avoided by the Program.

Indirect impacts may occur from increased public access (and its associated infrastructure) into the Murrumbidgee River and Ginninderra Creek for recreational purposes, including an increased incidence of recreational angling; and the proposed urban development upstream in accordance with the concept master plan. These impacts include changes to hydrology (increases in run-off and associated changes to flow regimes), increased erosion and stream incision, sedimentation, pollution, and habitat disturbance.

Facilitated impacts that may be foreseeable include increased public access into and use of the WBCC; however, these are generally included in the range of activities proposed within the river corridor. These will result from the introduction of infrastructure that increase ease of access and encourage recreational use of the riparian areas within or adjacent to the WBCC.

4.5.2.4 Measures to Avoid and Mitigate

Direct impacts to threatened fish species will be avoided by the Program as no works within the Murrumbidgee River or associated creeks is proposed. In addition, the WBCC RMP will guide planning and construction of recreational infrastructure such that impacts to fringing aquatic vegetation important to these species will be avoided.

Indirect and cumulative impacts to threatened fish species will be managed through the implementation of a number of mechanisms:

- the WBCC RMP, which will be implemented prior to allowing public access and will include:
    - controls to public access and use of the riparian areas post construction phase; and

- site-scale survey prior or concurrent to the design stage for recreational development in the WBCC to determine the location of threatened fish species and their habitat within the proposed development footprint and avoid as necessary.
- (State / Territory based controls on recreational fishing (e.g. bag limits) will not be implemented by the WBCC RMP as they are currently law and enforced as such.)

- Incorporation of WSUD principles into the Master Plan that aim to:
  - maintain stormwater run-off to acceptable levels as defined ; and
  - treat urban runoff to reduce urban pollutants to acceptable levels before discharge to the Murrumbidgee River or Ginninderra Creek.
- Implementation of CEMPs to be prepared prior to construction commencing and targeting among other environmental values:
  - erosion and sediment controls
  - water treatment standards before release in the Murrumbidgee River or Ginninderra Creek;
  - flow controls
  - pollution and waste management; and
  - avoidance of riparian habitat areas.

Facilitated impacts have been anticipated by the Program, and will be avoided or managed through the WBCC RMP.

4.5.2.5 Impact Assessment

The Significant Impact Guidelines 1.1 were used to determine if any actions under the Program are likely to have a significant impact on threatened fish species. See **Table 4.4** for endangered species (Macquarie perch and trout cod), and **Table 4.5** for the vulnerable Murray cod.

Table 4.4 Significant Impact Criteria for Endangered Fish Species

Significant Impact Criteria	Assessment of Macquarie perch and trout cod
Lead to a long term decrease in the size of a population.	The Program will not lead to a long-term decrease in the size of a population of endangered fish species as there are to be no direct impacts to the species or their riverine habitat under the Program. Further measures such as CEMPs, WSUD principles, and the WBCC RMP will be used to mitigate indirect and cumulative impacts.
Reduce the area of occupancy of the species.	The Program will not reduce the area of occupancy of any endangered fish species as there will be no direct impacts to these species or their riverine habitat; and indirect and cumulative impacts will be mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP.

Significant Impact Criteria	Assessment of Macquarie perch and trout cod
Fragment an existing population into two or more populations.	No fragmentation of existing populations will occur as there will be no barriers placed in aquatic habitats.
Adversely affect habitat critical to the survival of a species.	There is no identified critical habitat for Macquarie perch (TSSC 2013c), therefore, the Program will not adversely affect habitat critical to the survival of Macquarie perch. The National Recovery Plan for trout cod (Victorian Gov't 2008a) identifies critical habitat for the species as containing a high quantity of large woody debris, is close to deeper water and high surface velocity, and further from the river bank. Habitat in the upper Murrumbidgee River (including the Project Area) generally has little woody debris (Victorian Gov't 2008a), so does not meet this definition. As such, no habitat critical to the survival of these species will be adversely affected by the Program.
Disrupt the breeding cycle of a population.	There is limited evidence that the reintroduced population of trout cod in the Murrumbidgee River is breeding (Victorian Gov't 2008a; ACT Gov't 2015c[112]). In addition, trout cod breeding appears to be governed primarily by water temperature and the presence of a hard substrate on which to lay, neither of which will be impacted by the Program (Victorian Gov't 2008b[113]). It is therefore, unlikely that the Program will disrupt the breeding cycle of a population of trout cod. Macquarie perch spawn in shallow water at the foot of pools, where eggs sink and lodge into cracks in the substrate (made of boulders, cobbles, or gravel). These areas are between 20 and 90 centimetres in depth and have a water velocity of 0.3 to 0.6 metres per second (Australian Gov't 2011a). As the Program does not include any works within the Murrumbidgee River and or associated creeks, these habitat characteristics will not be impacted by the Program, and the Program will not disrupt the breeding cycle of a population of Macquarie perch.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No threatened fish habitat will be directly impacted as a result of the Program (see discussion above). Indirect impacts to habitat will be avoided or mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP. The Program will not affect habitat for endangered fish species to the extent that species will decline.

[112] ACT Government (2015c) *Fish Stock Plan for the Australian Capital Territory 2015-2020*, Environment and Planning Directorate, Canberra, accessed online (December 2015): http://www.environment.act.gov.au/cpr/fish/fisheries_management/fish-stock-plan-for-the-australian-capital-territory-2015-2020.

[113] Victorian Government (2008b) *Background and Implementation Information for the Trout Cod Maccullochella macquariensis National Recovery Plan*, Department of Sustainability and Environment, Melbourne.

Significant Impact Criteria	Assessment of Macquarie perch and trout cod
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat.	The Program will not facilitate the introduction of invasive species into habitat for endangered fish species, which are harmful to those species.
Introduce disease that may cause the species to decline.	The Program is considered very unlikely to introduce disease that may cause these species to decline.
Interfere with the recovery of the species.	The trout cod National Recovery Plan (Victorian Gov't 2008a) primarily targets actions towards increased and continuing research into trout cod biology and ecology especially relating to recruitment and breeding. This is applied to understanding habitat requirements and limitations, investigating threatening processes, and continuing to re-introduce the species across its range and monitor the success of such programs. The Program will not interfere with any of these actions and will not interfere with the recovery of the species. There is currently no National Recovery Plan for Macquarie Perch. Both NSW and ACT Governments have state (NSW Gov't 2005[114])/ Territory (ACT Gov't 2007) based Action Plans that detail recovery actions to be implemented at these scales. Neither of these action plans will be interfered with by the Program as sedimentation and impacts to water quality will be avoided, a corridor approach will be applied to the management of the WBCC including the protection of corridor values such as connectivity, the impacts of the urban development have been considered and reduced throughout the planning process, recreational activities (including the placement of associated infrastructure) will be actively managed throughout the life of the Program, and the conservation priorities of the WBCC will be communicated to the west Belconnen community and public visiting the WBCC.

Table 4.5 Significant Impact Criteria for Vulnerable Murray Cod

Significant Impact Criteria	Assessment of Murray Cod
Lead to a long term decrease in the size of an important population.	The Program will not lead to a long-term decrease in the size of an important population as there will be no direct impacts to Murray cod. Indirect and cumulative impacts will be avoided or mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP as discussed above.

[114] NSW Government (2005) *Threatened Species in NSW Macquarie perch Macquaria australasica*, Primefact 9, NSW Department of Primary Industries, Sydney.

Significant Impact Criteria	Assessment of Murray Cod
Reduce the area of occupancy of an important population.	The Program will not reduce the area of occupancy of an important population of Murray cod as there will be no direct impacts to this species or its habitat. Indirect and cumulative impacts will be avoided and mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP as discussed above.
Fragment an existing important population into two or more populations.	No fragmentation of existing populations will occur as no barriers to Murray cod migration will be created under the Program.
Adversely affect habitat critical to the survival of a species.	There is no identified critical habitat for Murray cod (Victorian Gov't 2010a), therefore, the program will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population.	The Program will not disrupt the breeding cycle of the Murrumbidgee River important population of Murray cod as it will not impact water temperatures or flood patterns, nor will it impact hard substrates required for spawning (Victorian Gov't 2010a).
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	There will be no direct impacts to Murray cod or its habitat as a result of the Program. Indirect and cumulative impacts will be avoided or mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP (as discussed in **Section 4.3**). The Program will not affect habitat of Murray cod to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.	The Program will not facilitate the introduction of invasive species which are harmful to Murray cod into its habitat.
Introduce disease that may cause the species to decline.	The Program is considered very unlikely to introduce disease that may cause the decline of Murray cod.
Interfere with the recovery of the species.	The National Recovery Plan for Murray cod (Victorian Gov't 2010a) focuses on actions that will provide greater information on the distribution (including population dynamics), habitat requirements, and risk of threats to the species. It also includes actions to manage river flows and increase community ownership of Murray cod. The Program will not interfere with any of these actions; therefore, will not interfere with the recovery of the species.

Based on the significant impact criteria above, it is believed that the avoidance and mitigation measures presented in the Program will prevent the Program from having a significant impact on any of the threatened fish species likely to occur within or adjacent to the Project Area.

4.5.3 Amphibians

One EPBC Act listed amphibian – Booroolong frog (endangered) may be affected by the Program. In the following section, impacts to this species will be assessed with consideration of the relevant avoidance, mitigation, and offset measures implemented by the Program.

4.5.3.1 Methodology for Assessment

There has been no detailed assessment of the presence of amphibian species within the Project Area (inclusive of the relevant reaches of the Murrumbidgee River and Ginninderra Creek), though KMA (2009b) did include a preliminary frog survey as part of the broader ecological surveys they conducted. Results from KMA (2009b) were used to identify presence (i.e. not absence) of amphibian species in the first instance, as it is a recent Project Area scale survey, however, there was no record of Booroolong frog made. As such Australian Government landscape and regional scale mapping and survey databases were utilised for this assessment as outlined below:

- Threatened Species Scientific Committee (2007) Commonwealth Listing Advice Booroolong Frog *Litoria booroolongensis*
- NSW Government (2011b[115]) National Recovery Plan for Booroolong Frog; and
- Australian Government (2015b) Species Profile and Threats Database.

Records within these data sets only indicate presence, not absence. Where no records of a species within the Project Area were identified, details of habitat preference and location of the nearest known populations were used to determine the likelihood of occurrence.

These limitations are mitigated by the landscape scale approach to conservation within the Program. Meaning that riparian values as a whole shall be managed and protected, not simply those that relate to threatened species (e.g. water quality).

4.5.3.2 Current Condition and Threats

Historically Booroolong frogs were known to generally occur in western flowing river catchments in the Northern Tablelands, Central Tablelands, and Southern Tablelands, and some eastern flowing catchments north of Sydney. Since 1990, the species has suffered a serious decline in its range and now it is believed to be extinct in the Northern Tablelands and rare in the Central Tablelands. Sites along tributaries of the Tumut and upper Murray Rivers in the Southern Tablelands now contain a majority of the extant population. This contraction in distribution is believed to be caused by drought (Booroolong frogs require a permanent water source), habitat disturbance, the disease *chytridiomycosis*, and predation of tadpoles by introduced fish (TSSC 2007). In particular, the National Recovery Plan notes that actions that reduce the permanency of streams or reduce the number of rock crevices would likely threaten the persistence of the species in an area. Adult Booroolong frogs generally occur on or near cobbled banks or bedrock structures that occur next to or within permanent, shallow, slow – medium flowing water. Crevices within the rocks are used by the species for protection and shelter at all times of year (NSW Gov't 2011b).

[115] NSW Government (2011b) *National Recovery Plan for Booroolong Frog (Litoria Booroolongensis)*, Office of Environment and Heritage (NSW), Hurstville.

4.5.3.3 Direct, Indirect and Cumulative Impacts

The Program will not directly impact Booroolong frog as it will not reduce stream permanency or the availability of rock crevices, nor will it increase the predation of tadpoles by introduced fish.

The Program may result in indirect and cumulative impacts to Booroolong frog habitat which include changes to hydrology (increases in run-off and associated changes to flow regimes), increased erosion and stream incision, sedimentation, pollution, habitat disturbance, and may also include the inadvertent introduction of chytrid fungus from increased human presence.

Facilitated impacts that may be foreseeable include increased public access into and use of the WBCC; however, these are generally included in the range of activities proposed within the river corridor. These will result from the introduction of infrastructure that increase ease of access and encourage recreational use of the riparian areas within or adjacent to the WBCC.

4.5.3.4 Measures to Avoid and Mitigate

Direct impacts to threatened amphibian species will be avoided by the Program.

Indirect and cumulative impacts to threatened amphibian species will be managed through the implementation of a number of mechanisms:

- WBCC RMP to be implemented prior to allowing public access, which will include controls to public access and use of the riparian areas post construction. This will particularly include consideration of activities that occur on the river / creek banks that provide habitat for Booroolong frog and avoidance of impacts to rock structures in the riparian zone.
- Incorporation of WSUD principles into the Master Plan that aim to:
    - maintain stormwater run-off to acceptable levels; and
    - treat urban runoff to reduce urban pollutants to acceptable levels before discharge to the Murrumbidgee River or Ginninderra Creek.
- Implementation of CEMPs to be prepared prior to construction commencing, targeting among other environmental values:
    - erosion and sediment controls
    - water treatment standards before release in the Murrumbidgee River or Ginninderra Creek
    - flow controls
    - pollution and waste management; and
    - avoidance of riparian habitat areas.

Facilitated impacts have been anticipated by the Program, and will be avoided or managed through the WBCC RMP.

4.5.3.5 Impact Assessment

The Significant Impact Guidelines 1.1 was used to determine if the Program is likely to have a significant impact on Booroolong frog (**Table 4.6**).

Table 4.6 Significant Impact Criteria for Endangered Amphibians

Significant Impact Criteria	Assessment of Booroolong frog
Lead to a long-term decrease in the size of a population.	The Program will not lead to a long-term decrease in the size of a population of Booroolong frog as there are to be no direct impacts to the species. Further measures such as CEMPs, WSUD principles, and the WBCC RMP will be used to mitigate indirect and cumulative impacts.
Reduce the area of occupancy of the species.	The Program will not reduce the area of occupancy of Booroolong frog as there will be no direct impacts to this species, and indirect and cumulative impacts will be mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP.
Fragment an existing population into two or more populations.	No fragmentation of existing populations will occur as there will be no barriers placed in aquatic habitats.
Adversely affect habitat critical to the survival of a species.	Habitat critical to the survival of Booroolong frog is considered to be rocky habitat that occurs alongside permanent streams that is occupied by the species (NSW Gov't 2011b). As such, the Project Area may contain critical habitat, only if the species is determined to be present. At this time, there is not considered to be any critical habitat within the Project Area, therefore, the Program will not adversely affect it.
Disrupt the breeding cycle of a population.	Rock crevices are central to the breeding of Booroolong frog as it is where males call from, and females lay the eggs (NSW Gov't 2011b). These crevices will not be impacted by the Program. Impacts to water quality and flows will also be mitigated through the implementation of WSUD principles and CEMPs, therefore, reducing impacts to tadpoles during their development. Therefore, the Program will not disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	There will be no direct impact to Booroolong frog as a result of the Program. In particular, the Program will not reduce the permanency of the water nor reduce the number of crevices in the rocks – both actions are identified as being likely to result in the decline of the species. Indirect impacts to habitat will be avoided or mitigated through the implementation of CEMPs, WSUD principles, and the WBCC RMP. The Program will not affect habitat for Booroolong frog to the extent that species will decline.

Significant Impact Criteria	Assessment of Booroolong frog
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat.	The Program will not facilitate the introduction of invasive species into habitat for Booroolong frog that are harmful to the species. This includes the introduction of exotic fish which prey on tadpoles.
Introduce disease that may cause the species to decline.	The Program notes that inadvertent introduction of pathogens such as chytrid fungus as a result of increased human presence. However, as there are no known populations of Booroolong frog and that the WBCC RMP would include measures to monitor frogs and manages the risk of introduction of chytrid, the Program is considered unlikely to introduce disease that may cause this species to decline.
Interfere with the recovery of the species.	The National Recovery Plan for Booroolong frog (NSW Gov't 2011b) includes actions that focus on understanding the impact of threats on extant populations, appropriate re-introduction methods, taxonomy discrepancies, and increase of community awareness (particularly of land holders whose land contains populations of Booroolong frog (NSW Gov't 2011b). The Program will not interfere with any of these recovery actions for Booroolong frog.

Based on the significant impact criteria above, it is believed that the avoidance and mitigation measures presented in the Program will prevent the Program from having a significant impact on the threatened amphibian species likely to occur within or adjacent to the Project Area.

4.5.4 Golden Sun Moth

Golden sun moth is an EPBC Act critically endangered species that historically occurs in natural temperate grasslands and open grassy woodlands. Flying season generally runs from late spring into early summer, though exact timing varies depending upon weather conditions. During this time adults live for up to four days after they emerge, and males fly over the grassland in search of females. Its habitat requirements are very specific as its larvae feed only on the roots of C3 grasses (namely wallaby grasses, spear grasses, and the exotic Chilean needle-grass), and females require bare ground between tussocks from which they display (Rowell 2013).

4.5.4.1 Methodology for Assessment

Targeted surveys for golden sun moth and its required habitat have been conducted throughout the Project Area (Rowell 2013), the Jarramlee offset (Biosis 2015; Rowell 2015; ACT Gov't 2013a), the Macgregor offset (Braby 2005; Rowell 2015), and the Lot 2 proposed additional offset (Rowell 2015). These surveys were all conducted in conditions that met the Commonwealth survey guidelines for

the species (Australian Gov't 2009b[116]). Biosis (2015) only conducted three survey efforts due to the short length of the 2014 survey season, however, when this data is combined with that from Rowell (2015), the appropriate number of survey efforts for Jarramlee is met. Information from these surveys was prioritised for use in the assessment of impacts to golden sun moth as it is recent and specific to the Project Area.

Other information utilised for the assessment of impacts to golden sun moth has included the following data sources:

- Government Resources:
    - ACT Government (2015a) ACTmapi ACT Government Online Interactive Maps
    - ACT Government (2005a) Action Plan No. 28: A Vision Splendid of the Grassy Plains Extended, ACT Lowland Grassland Conservation Strategy
    - Australian Government (2015b) Species Profile and Threats Database
    - Australian Government (2009b) Significant Impact Guidelines for Golden Sun Moth; and
    - Threatened Species Scientific Committee Commonwealth Conservation Advice (2013d[117]) and Listing Advice (2002[118]).

Additional sources listed above were used to provide a national and regional context for the condition of the species and to provide information on habitat and threats.

It should be noted that golden sun moth populations are most often described in terms of presence and activity levels. Due to the ecological and biological traits of the species, population abundance is difficult to determine. Where population size and / or density are described this is referring to the number of flying male moths, a trait which is used as an alternative to abundance scores. Whilst this is standard practice, it is a limitation as the correlation between the number of flying male moths and population size is not fully understood (TSSC 2013d).

It is also important to note that basing assessment of an area of occupation on observations of flying males may over-estimate the area that is actually occupied. It is understood that male moths will fly or disperse up to 200 metres over areas that may or may not be occupied by breeding females. Given the poor flying ability of females, the presence of males alone needs to be acknowledged as a potentially limited method of determining distribution.

The most reliable methods for determining the extent of a breeding population's distribution would be through larval counts, counting of pupal cases, and / or counting adult female moths. In the case of larval counts, this is a destructive method and not preferred as a result of the adverse impact. The alternate methods of determining distribution through pupal case counts or counting females is labour intensive and not an efficient means to survey large areas.

Accordingly while golden sun moth distribution is estimated on the basis of flying males and correlated to the presence of suitable habitat, some males counted during surveys may have

[116]Australian Government (2009b) *Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (Synemon plana)*, Nationally Threatened Species and Ecological Communities EPBC Act Policy Statement 3.12, Department of the Environment, Water, Heritage and the Arts, Canberra.

[117] Threatened Species Scientific Committee (TSSC) (2013d) *Approved Conservation Advice for Synemon plana (golden sun moth)*, accessed online (April, 2015): http://www.environment.gov.au/biodiversity/threatened/species/pubs/25234-conservation-advice.pdf

[118] Threatened Species Scientific Committee (TSSC) (2002) *Commonwealth Listing Advice on Synemon plana (golden sun moth)*, prepared for the Department of the Environment and Heritage, Canberra.

dispersed beyond the nearest area of occupation. This is a common assessment method, however, and it will be a common bias in all data relating to golden sun moth distribution.

4.5.4.2 Current Condition and Threats

Prior to European settlement the species was widespread throughout southeast Australia; occupying primary and secondary native grasslands and open woodland. Now, it is estimated that less than one percent of this habitat remains; and the species is only found in a few small areas within its historical range. There is little information on the change in population abundance over this time due to the difficulty in identifying females and larvae (TSSC 2002; 2013c).

Key identified threats to this species are those associated with habitat distribution and abundance; that is loss, fragmentation, and degradation of habitat, isolation of populations, agricultural practices, and weed invasion (TSSC 2013d).

Recovery of the species is further hampered by the weak dispersal ability of the species. This has the effect of hampering the success of migration between fragments and re-colonisation of patches unlikely particularly given the poor flying ability of females (Rowell 2013; TSSC 2013d).

Within the broader west Belconnen area, there are several populations known along Ginninderra Creek and its tributaries. These occur on the north-eastern boundary of the Project Area and denote the western limit of ACT golden sun moth distribution (Rowell 2013). In 2010, David Hogg Pty Ltd (2010[119]) classified habitat throughout Canberra, based on vegetation quality and patch size. Whilst new populations have been identified since this study, it gives an indication of the importance of the broader west Belconnen area populations (labels B5, B6, B7, and B8 on **Figure 4-2**) for the region.

As shown in **Figure 4-2** the populations range from low to high in size and occur within habitat types B (small remnant natural temperate grassland or high quality native pasture), C (mixed native and exotic grasses in former natural temperate grassland), and E (Chilean needle-grass or other exotic grasses). The population at the Macgregor offset site is considered to be one of the largest in the ACT and the only one of its size to occupy exotic habitat; all other 'high' populations occur in habitat type A (natural temperate grassland or high quality native pasture), which is generally considered to be the most natural habitat for golden sun moth (David Hogg Pty Ltd 2010). Specifically, the Macgregor and Jarramlee offsets are one of three known areas that support more than a thousand moths; making it one of the largest known populations nationally. The relatively large habitat area also increases the importance of this population (A Lane 2016, pers. comm. 12 August).

[119] David Hogg Pty Ltd (2010) *A Strategic Approach to the Conservation and Environmental Assessment of Golden Sun Moth Sites in the Canberra Area*, prepared for the Land Development Agency, Canberra.

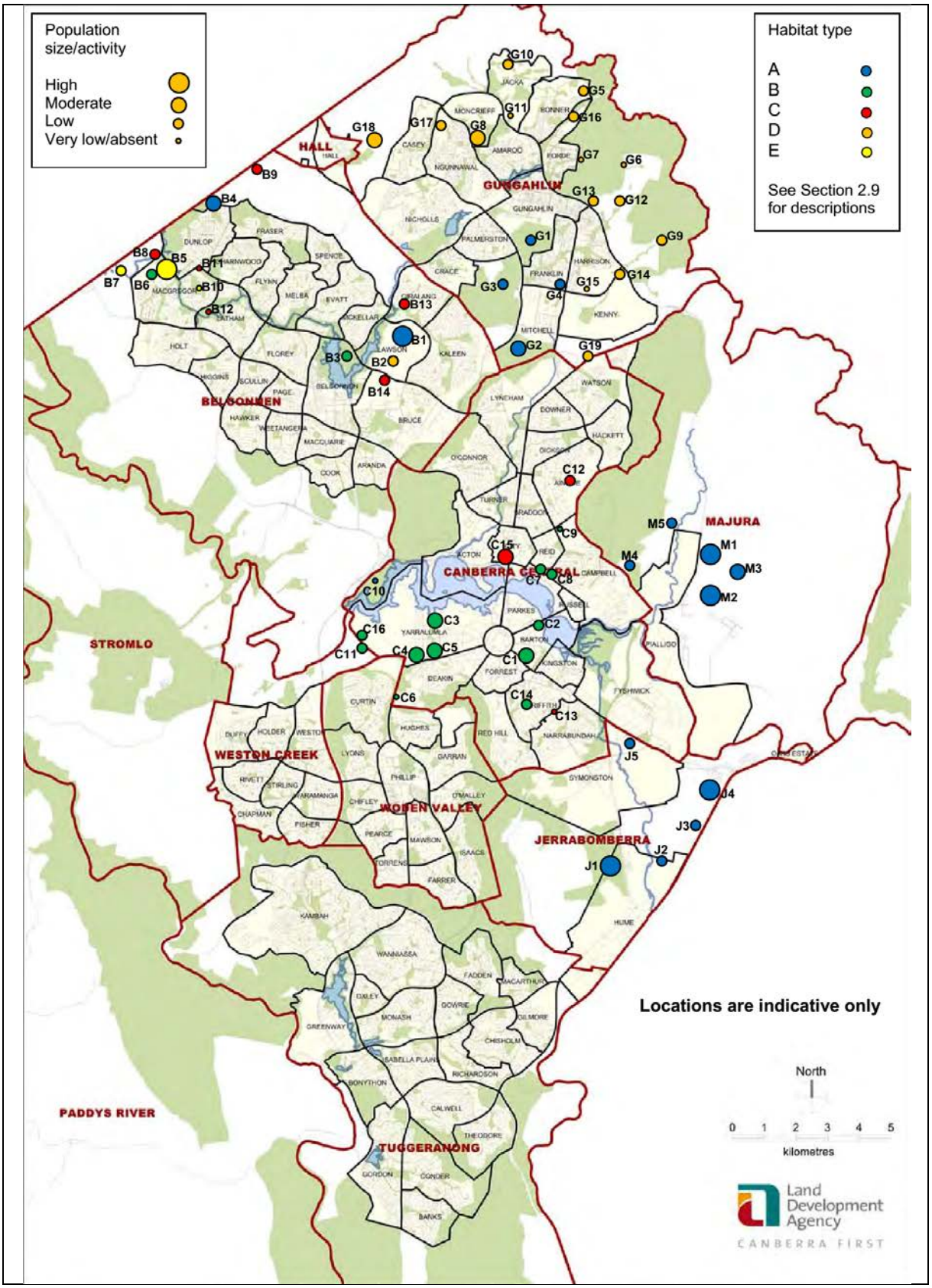

Figure 4-2

Golden Sun Moth Habitat Sites and Indicative Populations Sizes in Canberra
(Figure 2.1 in David Hogg Pty Ltd 2010)

4.5.4.3 Direct, Indirect and Cumulative Impacts

Rowell (2013) conducted golden sun moth survey across areas (17 hectares) identified within the development area as potentially suitable for the species. These surveys were conducted in accordance to the Commonwealth Guidelines and no golden sun moths were recorded. Records of golden sun moth also exist for Belconnen Block 1621, along Ginninderra Creek flats (Rowell 2013) in areas closely associated with the creek. This block is downstream of the west Macgregor offset and on the opposite side of Ginninderra Creek to the south western edge of the Jarramlee offset. As there are previous records of golden sun moth occurring over this parcel, it needs to be considered in accordance with the significant impact guidelines for the species as potential habitat. However, this does not acknowledge the limitations of surveying flying male moths and the margin of error that is likely to exist in defining the limits of:

- potential habitat – presence of forage grass species but no apparent moths
- occupied habitat – presence of both moths and forage grasses
- unsuitable but interconnecting grassland – absence of forage grasses but grassland formation adjacent to occupied habitat; and
- former habitat – grassland areas with or without suitable habitat characteristics but within which historical records of the species exist. Former habitat may also be either 'unsuitable' or 'potential' as described by this list.

It is probable that the majority of Block 1621 is unsuitable habitat given the grazing pressure and pasture improvement that has occurred on the land in the past. As the block directly adjoins Jarramlee offset and Ginninderra Creek, it is not unexpected that flying males will be recorded, however, with the absence of suitable forage species there will certainly be no females present. Owing to the limited dispersal ability of females it is highly unlikely re-colonisation of areas of formerly occupied habitat that are will occur naturally, especially where there is functional separation (e.g. Ginninderra Creek) or isolation (i.e. no direct connection). Therefore, impacts to these areas are not considered to be of relevance to golden sun moth (Rowell 2013).

Direct impacts to habitat for the species will occur as a result of the Ginninderra Drive extension. Whilst the areas with the greatest densities of golden sun moth within the existing offset areas will be avoided, the current preferred alignment (option 5) is proposed to remove 0.85 hectares of golden sun moth habitat. A further 0.96 hectares of habitat may be affected as a result of overshadowing by the proposed bridge over Ginninderra Creek. The total impact will, therefore, be in the order of 1.8 hectares of golden sun moth habitat affected.

Overshadowing of habitat has the potential to affect grass growth and as a result of reduced solar access, reduce the amount of evaporation the affected areas experience. This has an implication for locations where increased soil moisture has the potential to adversely affect larval survival rates either through poor root development of host grasses (loss of foraging areas), through lack of air, or other effects to soil chemistry.

Other factors that may be introduced as a result of the bridge construction include fragmentation of habitat. Although the grassy vegetation will be retained under the proposed Ginninderra Drive bridge and as such continuity of vegetation will not apparently be affected, it may introduce a reluctance by moths to fly underneath the bridge as a result of the dark overhead shadow. This potential impact in addition to the preceding issue regarding increased soil moisture is unquantified as there is no equivalent site on which to base an assessment. As a result, both of these factors are taken to be a

constraint that adversely affects the extent of golden sun moth habitat or the species' ability to disperse in the following assessment.

In summary, as a result of the Ginninderra Drive extension, golden sun moth habitat will be affected by a range of direct and indirect impacts. **Figure 4-3** illustrates the nature of impacts to the golden sun moth habitat while the following list summarises the anticipated impacts:

- **Fragmentation**: the Ginninderra Drive extension will bisect the currently contiguous habitat. The extent to which this will actually occur, however, is uncertain as in several locations where golden sun moth habitat has been bisected by roads the moth continues to move between patches that are separated by the road (e.g. dual carriageway, approximately 10 metres wide at Yarralumla). It is also noted that trees which have been planted within the area that the preferred road alignment follows also present an existing barrier to movement of moths. The residual effect of the Ginninderra Drive extension is unlikely to significantly increase the extent to which fragmentation affects golden sun moth, however, this will be subject to the successful implementation of measures to benefit golden sun moth post-construction.

- **Changes to hydrology**: concentration of surface water runoff from the road and changes to local topography (cut and fill for the road) may alter local hydrological conditions.

- **Weed invasion and changes to species composition**: this may result from changes to the hydrology or from the introduction of weed species during the construction and operational phase of the road.

- **Pollution**: run-off from the road is likely to be polluted with hydrocarbons and a range of heavy metals and chemicals associated with urban run-off.

- **Mortality**: some individuals may be inadvertently killed by cars while crossing over the road.

There are unlikely to be any facilitated impacts as a result of the Program that will affect golden sun moth.

As shown in **Figure 4-3** direct impacts resulting from the preferred alignment are minimised by route selection. The bridge is indicated by the grey section within which direct impacts from construction will be limited to the driving of piles in order to support the bridge with smaller areas of habitat removed as a result of the construction. The estimates of impact to habitat have been based on the footprint design with the addition of a further two metres buffer to account for access and other unavoidable impacts during construction.

As noted above, the alignment of the Ginninderra Drive extension has also been selected to correspond with an area that does not support golden sun moth as a result of tree plantings that are now well established. Golden sun moths are absent from this area potentially as a result of reduced grass growth under the trees and the barrier to flight created by the trees themselves. During the most recent surveys (Rowell 2015) in addition to earlier assessments (Braby 2005), there were no moths observed flying through this area of tree plantings supporting the conclusion that it presently represents a barrier to movement between proximate areas of habitat.

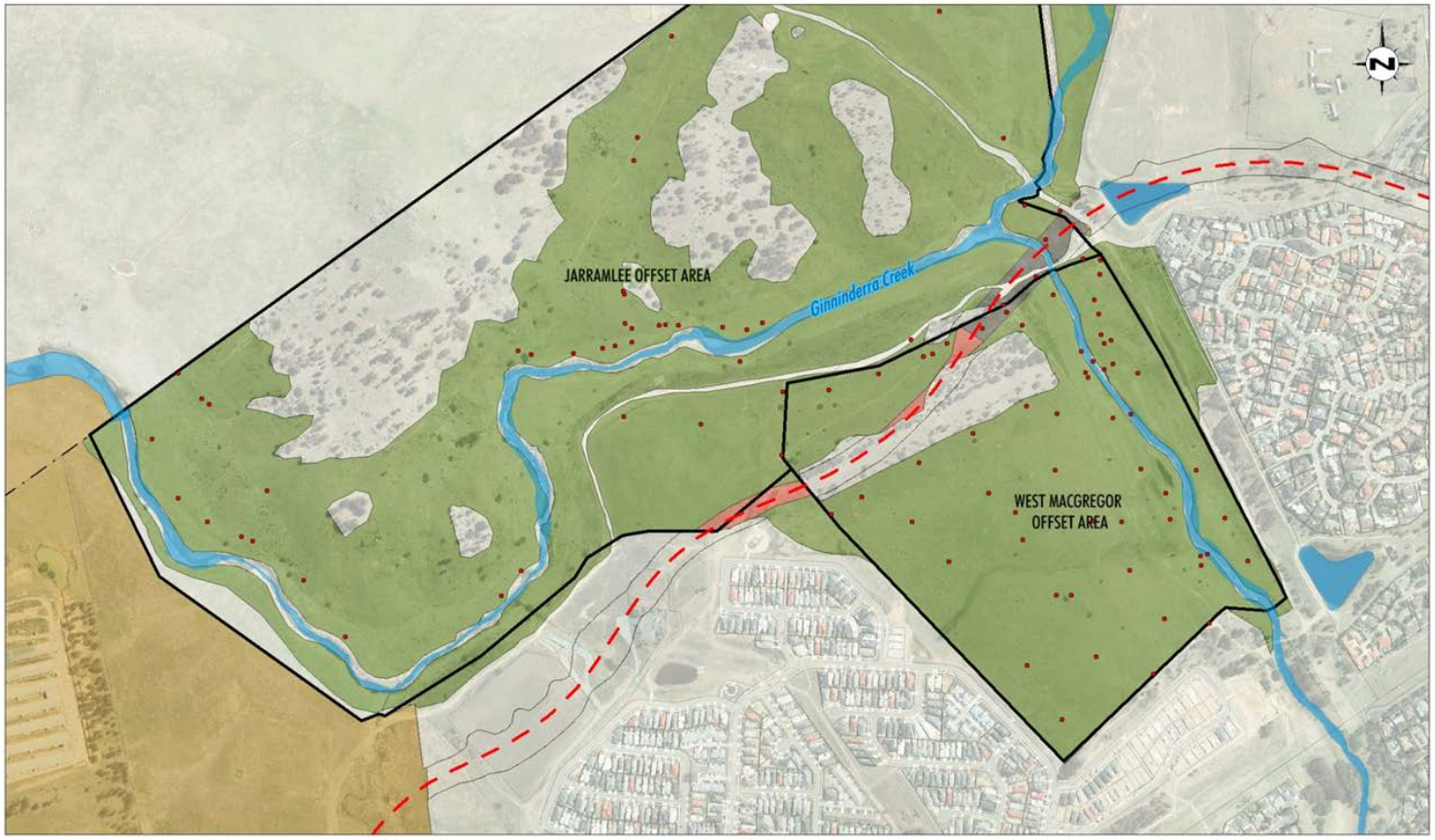

Figure 4-3

Impacts of Ginninderra Drive extension Option 5 on Golden Sun Moth

4.5.4.4 Measures to Avoid and Mitigate

Selection of the proposed Ginninderra Drive extension alignment has been based on a comprehensive assessment of alternative alignments from the perspective of social, economic, and environmental values (**Section 2.7.3**). In general it was found that:

- The alternative of not constructing the Ginninderra Drive extension results in no impacts to golden sun moth, however, has significant adverse impacts to the environment due to increased greenhouse gas emissions and overall sustainability as a result of increased travel time, compromised public transport options, and upgrades to existing infrastructure that are necessary to support the increased traffic volumes. This avoidance strategy is unacceptable.

- To completely avoid impacts to the existing offset areas and the golden sun moth habitat it supports would also have unacceptable impacts to community values in terms of aesthetics and noise as it requires constructing an arterial road within the power easement. This would be in a location where original planning for the affected communities did not allow for vehicle noise and the directly adjacent power line towers would pose a safety risk.

- Minimising the area of golden sun moth habitat affected by following the existing alignment of the Jarramlee homestead access road resulted in significant engineering costs (two bridges plus cut and fill due to terrain) and also had the effect of impacting other values for MNES such as woodland birds (e.g. superb parrot) and natural temperate grassland, while still resulting in fragmentation of golden sun moth habitat.

- Alternatives that included minor variants to the preferred option also had the effect of either increasing the footprint of the road construction over golden sun moth habitat or increasing other social and / or economic impacts.

- The preferred option represents the optimal outcome from a triple bottom line perspective.

By considering direct impacts to golden sun moth habitat throughout the design phase of the Ginninderra Drive extension, impacts to habitat along Ginninderra Creek have been minimised by selecting an alignment that coincides with unsuitable habitat (see **Section 2.7.3** and **Figure 4-2**) as defined by the presence of tree plantings. Given characteristics of all the other options, the preferred route represents the optimal outcome and no other avoidance option is considered feasible.

Road mortality is unlikely to be a significant threat to the local population, however, may be the cause of death for an occasional moth.

Mitigation measures that will further protect avoided areas of golden sun moth habitat include:

- Detailed design features of the road and bridge including:
    - measures to reduce surface water runoff
    - measures to allow adequate solar access to the verges to ensure native grass growth
    - post construction design such as landscaping with native grass species in order to restore golden sun moth habitat to sections that are ‘at grade’
    - bridge placed at highest practicable height over densest area of golden sun moth to improve willingness of moths to pass underneath it

- bridge design will also allow for a clear view of suitable habitat on the other side, and has limited obstacles (i.e. piles spaced at 50 metre intervals) to entice moths to cross.

- Removal of all trees within the areas of the Macgregor offset that currently do no support golden sun moth. The planting of trees in this area has reduced viability of the habitat although the ground layer vegetation in this area retains the necessary native grasses that would otherwise be suitable for golden sun moth. By restoring this area to grassland, the Program seeks to improve the potential for movement across the road. This would occur prior to construction commencing.

- CEMPs implemented during the construction phase of the Ginninderra Drive extension, which include the following measures that are specific to golden sun moth:

  - erosion and sediment control

  - fencing to ensure avoidance of retained areas of habitat

  - flow controls; and

  - weed management actions such as vehicle hygiene standards to ensure the control of the spread of weeds.

The Program commits to consolidate the management plans for Jarramlee and Macgregor in order to simplify management of golden sun moth and other environmental values. While this is effectively an administrative mitigation measure, the simplified approach to ongoing management will reduce overhead costs of maintaining separate reporting, monitoring, and review processes. This will lead to a reduced proportion of available resources being expended on measures that have no direct benefit on the environmental values of the affected area.

One of the factors that confound the management of golden sun moth and opportunities for mitigation on this site is the presence of Chilean needle-grass. The areas which support the highest number of golden sun moth are also sections along Ginninderra Creek on deeper and more fertile soils, which contain Chilean needle-grass. While golden sun moth have adapted to this exotic species, it is listed as a weed of national significance (WoNS), and there is a requirement for land managers to actively control and remove it. Since Chilean needle-grass also supports high numbers of golden sun moth, attempts at controlling or eradicating the grass will have a detrimental effect on moth populations.

Mitigation measures protecting golden sun moth populations against the impacts of Chilean needle-grass have been trialled in other locations in the ACT with mixed success. The translocation of soil containing larvae, as trialled along the Majura Parkway alignment, is not feasible for Ginninderra Drive. However, the method of translocating individual larvae from one grass tussock to another could have a beneficial effect on the overall impact of the proposed action. Some trials of similar methods have been undertaken, though translocation of larvae directly from the impact site to the receiving site has not been conducted and further research is required. This is discussed further in **Section 5.3** with respect to environmental offsets and other associated measures for golden sun moth, and the maintenance of values affected by the Ginninderra Drive extension, including impacts to established offset areas.

4.5.4.5 Impact Assessment

The Significant Impact Guidelines 1.1 was used to determine if any actions under the Program are likely to have a significant impact on the critically endangered golden sun moth. This is discussed in **Table 4.7** below.

Table 4.7 Significant Impact Criteria for Critically Endangered Golden Sun Moth

Significant Impact Criteria	Assessment of golden sun moth
Lead to a long term decrease in the size of a population.	The construction of the Ginninderra Drive extension will lead to the loss of larvae within the construction footprint. The extent of this loss cannot be quantified due to the destructive effects of golden sun moth larval survey methods. The effect of overshadowing on golden sun moth populations is also unknown, though is likely to be detrimental. These impacts will be temporary as the road verges will be landscaped with appropriate grass species to facilitate the re-colonisation of golden sun moth into the area. The impact will occur during the construction phase, expected to be in 2036 or later. As indicated in the discussion of mitigation options, it is possible that the translocation of larvae into restored habitat elsewhere along Ginninderra Creek and Gooromon Ponds Creek will mitigate the loss of Chilean needle-grass habitat. This is not considered as contributing to management of the direct impact of the Program due to a need for further research into this approach. Despite this, in consideration of the scale and intensity of the proposed action and high numbers of golden sun moth that are supported by Chilean needle-grass pasture in this location, it is unlikely that the Ginninderra Drive extension as described by the Program will lead to a long term decrease in the local golden sun moth population.
Reduce the area of occupancy of the species.	As a conservative estimate, the proposed action will result in a reduction of a total of 1.8 hectares of habitat for golden sun moth. This will be a reduction in the area of occupancy for the species and in excess of the significant impact threshold (0.5 hectares) established by the golden sun moth significant impact guidelines (Australian Gov't 2009b).

Significant Impact Criteria	Assessment of golden sun moth
Fragment an existing population into two or more populations.	Construction of the Ginninderra Drive extension will include design features based on other examples where roads have been constructed through native grasslands supporting golden sun moth where connectivity has been maintained. These measures include: • a single carriageway design (15 metres wide including shoulders and verges); • landscaping with native grasses (wallaby grasses) to the shoulder; • control of surface water runoff to avoid impacts to hydrology and grassland structure in adjoining areas; • battering slopes to ensure adequate solar access and support for native grass development. Bridge design has also considered minimising impacts to golden sun moth habitat connectivity and appreciation for the Chilean needle-grass paradox. The height of the bridge is proposed to be in the order of four metres above ground level at the point where it crosses Ginninderra Creek and the location where golden sun moth numbers are their highest along the alignment. This design option seeks to mitigate the potential impact of introducing an overhead structure which may impact the willingness for flying moths to move under the bridge. In comparison to the current situation in the Macgregor offset where the tree plantings are, the bridge scenario differs in at least one important aspect. Habitat on the other side of the trees may not be visible to the moths, plus the obstacles of the trees are likely to represent at flying height will limit the ability of moths to traverse the woodlot. The bridge by comparison will have a clear view from one side to the other with the only obstructions being the piles spaced at 50 metre intervals and the overhead structure itself which will be above usual moth flying height. Notwithstanding these design considerations, the lack of research into factors which might represent a barrier to golden sun moth movements suggests as a precautionary measure, it should be assumed that the bridge and road will both be a barrier to some extent to the movement of golden sun moths. Accordingly the extension to Ginninderra Drive is assumed, on the basis of a lack of information to verify otherwise, to contribute to fragmentation of the existing golden sun moth population occupying the Jarramlee and Macgregor offsets.

Significant Impact Criteria	Assessment of golden sun moth
Adversely affect habitat critical to the survival of a species	There is no critical habitat identified for golden sun moth at a National scale. Action Plan 28 defines 'key habitat' as natural temperate grassland dominated by low-growing wallaby grasses, and NSW Office of Environment and Heritage have identified three key management sites (north of Yass, between the Barton Highway and Lake George, and south of Queanbeyan) (NSW Gov't 2015d[120]). As the habitat within the Project Area does not meet either of these criteria it is not considered to be critical to golden sun moth survival. Furthermore, areas with the highest density of golden sun moth will be avoided under the Program. As such the Program will not adversely affect habitat critical to the survival of golden sun moth.
Disrupt the breeding cycle of a population	On the conservative assumption that the Program will result in a fragmentation of golden sun moth habitat, the result will be two populations separated by the Ginninderra Drive extension. Monitoring of other golden sun moth populations in the ACT has shown that relatively small patches of habitat can continue to support good numbers of golden sun moth, suggesting (within the limitations of the monitoring undertaken) that small fragments do not necessarily represent a short to medium term threat to population viability. On this basis, it is not considered likely that the fragmentation will disrupt the breeding cycle of golden sun moth as a result of the alignment option proposed. The relatively large remnant represented by the remaining Macgregor portion is expected to maintain viability for the population it currently supports. Similarly the larger remnant on the Jarramlee side will also continue to maintain its viability. It is also known that golden sun moth will cross relatively narrow roads (up to 15 metres) and as such the movement of genetic material is unlikely to be entirely interrupted by the Ginninderra Drive extension.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Program will result in the removal and modification of golden sun moth habitat within and directly adjacent to the Project Area. However, the relatively small area (1.8 hectares) affected in consideration of the scale and intensity of the proposed action is unlikely to lead the species to decline.

[120] NSW Government (2015d) *Golden Sun Moth (Synemon plana) Species Conservation Project*, accessed online (January 2016): http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10791.

Significant Impact Criteria	Assessment of golden sun moth
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Golden sun moth habitat along Ginninderra Creek and Gooromon Ponds Creek has been invaded by the exotic Chilean needle-grass which has a significant impact on the biodiversity of ground layer vegetation in areas where it establishes dominance. This invasive species has the potential to further reduce values in the rest of the Jarramlee and Macgregor offset sites in addition to other potential habitat along Ginninderra Creek, among others. The greatest threat to these areas is the risk of continued invasion of native communities by Chilean needle-grass that might occur in the event of poor weed management controls during construction, and poor maintenance during the operational phase. Despite the threats represented by this species, it will have a positive impact on golden sun moth population density. This outcome, however, will be avoided as a result of targeted measures in the CEMP and WBCC RMP for retained areas to avoid dispersal of Chilean needle-grass and control it where practicable. Such measures will also ensure other potentially invasive species are not introduced to the Jarramlee and Macgregor offset sites. Accordingly, the proposed action will not result in the introduction of new invasive species that will be harmful to golden sun moth.
Introduce disease that may cause the species to decline	The Program will result in no known disease or other pathogen likely to impact golden sun moth.
Interfere with the recovery of the species	The conservation advice for golden sun moth (TSSC 2013d) notes recovery actions targeted towards research priorities, control of invasive weeds, management of grazing impacts and fire, and minimisation of habitat loss, disturbance, and modification. As the Program contains measures to control invasive weeds, manage the offset sites appropriately for golden sun moth, and mitigate the habitat fragmentation, the Program will not interfere with the recovery of the species.

On the basis of assumed fragmentation of habitat and removal or modification of up to 1.8 hectares of golden sun moth habitat, it is likely that the proposed extension to Ginninderra Drive as described by the Program will meet the guidelines for a potentially significant impact. This considers the effect of proposed avoidance and mitigation measures and as such further consideration of compensatory measures is appropriate for this species. **Section 5** presents a discussion of the offsets relating to this species and the context within which the offsets are proposed.

4.5.5 Pink-Tailed Worm-Lizard

Pink-tailed worm-lizard is listed as vulnerable under the EPBC Act, the NC Act, and the TSC Act. It is most commonly found sheltering under small, shallowly embedded rocks where it may remain for long periods.

4.5.5.1 Methodology for Assessment

Information for the assessment of impacts to pink-tailed worm-lizard predominantly used data from targeted surveys conducted by Osborne and Wong (2013) throughout the Project Area, which also incorporated results from previous surveys. Osborne and Wong (2013) surveys were conducted in accordance with relevant methods outlined the Commonwealth survey guidelines for threatened reptiles (Australian Gov't 2011b[121]).

Data was also used from the following Government resources:

- Commonwealth Conservation Advice for pink-tailed worm-lizard (TSSC 2015b)
- ACT Government (2015a) ACTmapi ACT Government Online Interactive Maps
- ACT Government (2007) Action Plan No. 29 Ribbons of Life: ACT Aquatic Species and Riparian Zone Conservation Strategy; and
- Australian Government (2015b) Species Profile and Threats Database (SPRAT).

Quality of habitat was determined by the level of disturbance at a site (Osborne and Wong 2013). Suitable habitat was ranked as either high or moderate and contained areas that were well drained, with a partial cover of igneous or metamorphic embedded rocks (10 – 30 centimetres in diameter). Highest quality sites were dominated by kangaroo grass and other disturbance sensitive species. Moderate quality sites contained a less diverse ground cover, usually dominated by wallaby or spear grasses and had a lower abundance of native forb species. Low quality habitat was considered to be highly disturbed and degraded and would be likely to no longer support the species.

The maps produced by Osborne and Wong (2013) did not delineate high and moderate quality habitat due to the large amount of fragmentation of high quality habitat across the Project Area. Both habitat types have thus been treated equally within this impact assessment.

4.5.5.2 Current Condition and Threats

Pink-tailed worm-lizard has a patchy distribution along the western slopes of the Great Dividing Range between Bendigo (Victoria) and Gunnedah (NSW) (TSSC 2015b). The population within the ACT region occurs along the Murrumbidgee and Molonglo Rivers and is considered to be an important population due to its size (pink-tailed worm-lizard is considered locally common) and the connectivity values of the riparian habitat it occupies (Osborne and Wong 2013).

The Commonwealth Conservation Advice (TSSC 2015b) for pink-tailed worm-lizard identifies habitat loss, fragmentation, and degradation as known threats to the species. Habitat degradation in this context particularly refers to the loss of native grass cover, rock disturbance, and the disturbance of microhabitat requirements as a result of recreational activities. The following have been identified as potential threats to the species, pending further detailed assessment:

- removal of rocks
- inappropriate fire regimes; and
- predation particularly from feral cats and red foxes, and potentially from dogs (TSSC 2015b).

[121] Australian Government (2011b) *Survey Guidelines for Australia's Threatened Reptiles: Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Small population size is also identified as a threat in the ACT (ACT Gov't 2007).

4.5.5.3 Direct, Indirect and Cumulative Impacts

There is a total of 162.8 hectares of pink-tailed worm-lizard habitat within the Project Area. Of this area, approximately ten percent will be affected by the proposed action comprising 10.2 hectares of high / moderate quality habitat and 6.2 hectares of low quality habitat. Of these areas, a number are uninhabited, however, display attributes conducive to the species' requirements. **Table 4.8** summarises the split between quality and impact of the Program on pink-tailed worm-lizard habitat.

Table 4.8 Summary of Impacts to Pink-Tailed Worm-Lizard Habitat (hectares)

	Avoided	Impacted	Total
High Quality	141.9	10.2	152.1
Low Quality	4.5	6.2	10.7
Total	146.4	16.4	162.8

The areas affected by the urban footprint are generally small and isolated and have, therefore, been assessed as not playing an important role in the overall population's viability. These impacted areas have been mapped as 176 discrete patches of pink-tailed worm-lizard habitat, which have an average area of 0.09 hectares, with only three patches exceeding one hectare and none exceeding 1.4 hectares in size. However, it has been noted in a general sense by Osborne and Wong (2013) that:

> *Although the long-term survival of such small populations is very unlikely – it does indicate that small isolated patches of habitat should still be considered if these areas are subject to further development. Moreover if the patches occur close together they may act as a corridor for movement through poorer quality parts of the landscape. This highlights the importance of such small and less obvious habitat patches in maintaining connectivity and assisting in the long-term conservation of the species. Small patches located at important points in the landscape are likely to be important (for example near and within the Lower Molonglo Water Quality Control Centre and in the extreme north of the study area near Ginninderra Creek). It is very likely that they will act as steppingstones between larger areas of occupied habitat.*

The impacted patches occur on the eastern edge of pink-tailed worm-lizard habitat within the Project Area, and contribute very little (if any) to north-south habitat connectivity for the species. The areas of importance highlighted in the above excerpt from Osborne and Wong (2013) (i.e. near the Lower Molonglo Water Quality Control Centre and the extreme north of the study area) are retained under the Program.

Direct impacts to pink-tailed worm-lizard habitat within the WBCC as a result of the sewer alignment will be avoided by the Program. This includes the location of shafts and all access points for the construction of the pipeline which have been selected in order to ensure both access routes and infrastructure locations are not habitat for pink tailed worm lizard or other MNES. Direct impacts to pink-tailed worm-lizard habitat as a result of future infrastructure provision and maintenance activities within the WBCC will be avoided such that there is no net loss in pink-tailed worm-lizard habitat within the WBCC.

Indirect impacts to the habitat retained within the WBCC potentially include edge effects such as weed invasion, changes to hydrological conditions, pollution, sedimentation and erosion, increased

risk of predation by fox, or feral or domestic cat, and disturbance of micro habitat from increased public access to the WBCC.

Cumulative impacts will arise from increased public access to the WBCC for recreational purposes. The provision of infrastructure and services to accommodate visitor use combined with the promotion of the area as an important aspect of the lifestyle and identity of the west Belconnen community will facilitate further impacts in the foreseeable future as access and use are increased. These facilitated impacts are generally included in the range of activities proposed within the river corridor as part of the Program.

4.5.5.4 Measures to Avoid and Mitigate

The boundary of the WBCC has been designed so that the vast majority (146.4 hectares) of pink-tailed worm-lizard habitat will be avoided and subsequently protected under the Program. Potential direct impacts to approximately 5.3 hectares of habitat from the installation of sewer pipes through the WBCC have also been avoided through the choice of micro-tunnelling as the construction method and alignment options as discussed in **Section 2.7.4**. The micro-tunnelling option will result in no direct impacts to pink-tailed worm-lizard habitat within the WBCC.

Delineation of the WBCC boundary was considered by KMA (2014) in reference to the work undertaken by Osborne and Wong (2013). It is noted by KMA (2014) as follows:

When assessing whether to exclude any one isolate from the corridor consideration was given to the conservation of the population of Pink-tailed Worm Lizard in the locality. The omission of a small area of habitat or low number of lizards in these isolated rocky areas was assessed as not significant to the long term conservation of the species locally or more widely. In their report, Osborne and Wong (2013) acknowledge the presence of these "…very small and isolated populations…. that are not obviously within…a potential movement corridor" and that "it is hard to argue a strong case for their protection. It is very unlikely that there will be movement between these relict populations across agricultural landscapes with exotic pastures to more substantial areas of habitat….." (Osborne & Wong 2013 page 23). That report, therefore, accepts that the small, isolated areas of habitat are not significant to the survival of the species in this locality. Of far more importance is the way in which the conservation area and habitat connections are protected is managed in the future.

This assessment accepts the KMA (2014) position and considers the alignment of the WBCC boundary as an appropriate response to ecological values that occur throughout the Project Area. Notwithstanding the research value described by Osborne and Wong (2013) in relation to the isolated patches, the long term persistence of a viable population of pink tailed worm lizard in the Murrumbidgee River corridor would not be substantially enhanced by the inclusion of smaller isolated patches of habitat. As such the measures described by the Program to avoid and mitigate impact to this species as a result of the WBCC configuration are considered adequate and appropriate.

Direct impacts to the areas of habitat within the footprint of the proposed urban area are not considered important for maintenance of the local population due to the low occupancy rates of these small and isolated patches and the likelihood that they do not contribute to the gene pool of the rest of the population. Following the conclusions of Osborne and Wong (2013) such areas may retain importance for pink-tailed worm-lizard, however, given the spatial arrangement of these affected patches of habitat within the Project Area, they are unlikely to be considered important (i.e. they occur on the eastern extremity of habitat within the Project Area and contribute very little (if any) to the north – south connectivity values of the existing habitat). The majority of pink-tailed worm-lizard habitat that is retained within the WBCC occurs on steeper slopes and in areas that have a substantially better quality of understorey vegetation.

Direct impacts to pink-tailed worm-lizard habitat within the WBCC as a result of recreational infrastructure provision and maintenance activities will be avoided such that there is no net loss of pink-tailed worm-lizard habitat, as directed by the WBCC RMP. These impacts will be avoided where possible at the detailed design stage; and mitigated further by targeting poorest quality areas, incorporating raised grating (or similar) into pathway design to enhance connectivity between habitat patches that would otherwise be bisected, and keeping vehicle track widths to a maximum of six metres (6 m) and trail widths to a maximum of 2.5 metres wide. Existing tracks that currently fragment portions of the pink-tailed worm-lizard habitat within the WBCC will either be upgraded for use as part of the Program and where required be subject to the same design considerations as new tracks, or will be rehabilitated to enhance connectivity.

Illustrated in **Figure 4-4** is an example of a grated walkway which demonstrates the principle of allowing walking tracks through areas of ecological significance while maintaining values for environmental factors. In this photograph taken along the Settler's Walk loop from Brayshaw's Hut at the southern end of the ACT, it is apparent that the grassy structure is not compromised by the presence of the walking track and ensures uninterrupted connectivity of habitat for small reptiles, amphibians, and invertebrates. Although there would be different considerations for design configuration in the case of pink tailed worm lizard habitat, this example demonstrates the principles and expected outcome from implementation of the Program.

Figure 4-4

Example of a grated walkway in Namadgi National Park

Areas of habitat have been included within the development footprint as a result of a process of design including consideration of the longer term viability of small isolated patches, feasibility of their management for conservation values, and determining an optimal configuration for retention of areas of conservation value. The avoidance strategy has incorporated all medium-high quality habitats in the WBCC in a configuration that minimises management costs and the risk of population collapse.

Indirect impacts to pink-tailed worm-lizard will be mitigated through the implementation of a number of mechanisms:

- WBCC RMP:
    - controls to public access within the WBCC
    - controls of permitted activities of within the WBCC
    - informed infrastructure design based on advice from relevant scientific experts, particularly with regard to protecting and avoiding impacts to MNES and their habitat areas as part of an adaptive approach to the management of ecological values
    - utilisation of existing infrastructure and resources, including the use of existing roads and tracks and upgrading them to improve connectivity where possible
    - vehicle track widths will be a maximum of six metres, other tracks and trails a maximum of 2.5 metres wide with further design considerations that can further reduce the width of roads, for example, passing bays
    - fox and other predator control measures
    - implementation of measures as appropriate that are prescribed by the ACT Government's Action Plan 29 (ACT Gov't 2007) and recovery planning documents specific to pink-tailed worm-lizard (ACT Gov't 1995[122]; ACT Gov't 2007; NSW Gov't 2015e[123])
    - consideration of pink-tailed worm-lizard habitat when designing infrastructure and services, including maintaining an effective buffer around known populations; and
    - implementation of habitat improvement strategies (such as weed control) targeting habitat requirements of pink-tailed worm-lizard.
- Incorporation of WSUD principles into the Master Plan to maintain stormwater run-off and associated pollutants to acceptable levels or better
- Implementation of CEMPs, particularly targeting
    - erosion and sediment controls
    - water treatment standards before release
    - flow controls

[122] ACT Government (1995) *Recovery Plan for the Pink-Tailed Worm-lizard (Aprasia parapulchella)*, Technical Report 10, prepared by Osborne, W. S. and Jones, S. R. for ACT Parks and Conservation Service, Department of the Environment, Land and Planning, Canberra.

[123] NSW Government (2015e) *Pink-tailed Legless Lizard (Aprasia parapulchella) Species Action Statement*, accessed online (April, 2015): http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10061.

- pollution and waste management; and
- avoidance of riparian habitat areas.

Operation phase management including domestic pet containment policies within the proposed residential development and prohibition of 'off-leash' areas for dogs within the WBCC. These mechanisms will be developed to the satisfaction of the Department of the Environment prior to construction and public access to the WBCC beginning.

Cumulative and facilitated impacts will be avoided or mitigated through the WBCC RMP which is considered an effective means to avoiding, managing and mitigating risks during the operational phase. Adoption of the adaptive management principles will ensure the WBCC RMP remains current and implements measures on the basis of the best available information.

4.5.5.5 Impact Assessment

The Significant Impact Guidelines 1.1 was used to consider if any actions under the Program are likely to have a significant impact on the vulnerable species, pink-tailed worm-lizard. This is discussed in **Table 4.9** below.

Table 4.9 Significant Impact Criteria for Vulnerable Pink-Tailed Worm-Lizard

Significant Impact Criteria	Assessment of pink-tailed worm-lizard
Lead to a long term decrease in the size of an important population of a species.	The pink-tailed worm-lizard habitat within the Project Area supports an important population of the species due to its size and context of the habitat with regard to breeding and dispersal (Osborne and Wong 2013). The majority (146.4 hectares) of the population will be avoided and habitat protected within the WBCC. The Program will impact 16.4 hectares of small and isolated patches of habitat, which survey has determined some of which as reported by Osborne and Wong (2013), contain small numbers of pink-tailed worm-lizard. These small patches are not considered likely to survive in the long-term and nor is their removal considered likely to affect the viability of the population as a whole (Osborne and Wong 2013). While there will be an initial reduction in the extent of habitat, the Program is unlikely to lead to a long-term decrease in the pink-tailed worm-lizard population.
Reduce the area of occupancy of an important population	The 16.4 hectares of habitat affected by the Program are generally very small and includes some patches where the species has not been recorded despite apparently suitable attributes. The total figure of 16.4 hectares adopted for this assessment assumes that while detailed survey has been undertaken by experts on the target species, pink tailed worm lizard may be present at very low densities such that its detectability is also low. This figure is a precautionary, worst-case area of maximum impact the Program is likely to incur. Despite this and the lack of long term viability for the species in the majority of these patches, implementation of the Program will lead to 16.4 ha reduction in the area of occupancy of the species.

Significant Impact Criteria	Assessment of pink-tailed worm-lizard
Fragment an existing important population into two or more populations	Areas of habitat affected by the Program are generally small and exist along the edge of the primary areas of the species' distribution within the Project Area. The urban development footprint does not bisect any areas of habitat, the sewer construction method avoids surface impacts to the species, and habitat fragmentation as a result of recreational and maintenance infrastructure development within the WBCC will be avoided through design and construction mechanisms (as discussed above). As such, implementation of the Program is unlikely to lead to a fragmentation of the pink-tailed worm-lizard habitat.
Adversely affect habitat critical to the survival of a species	There is no identified critical habitat for pink-tailed worm-lizard. Despite this, the impacted habitat patches are not considered likely to support individuals which contribute to the survival of the population as a whole. The Program will not affect habitat that is critical to the survival of pink-tailed worm-lizard.
Disrupt the breeding cycle of an important population	The proposed action will not disrupt the breeding cycle of the pink-tailed worm-lizard population within the Project Area as a result of avoidance of the majority of the habitat and implementation of measures to further mitigate the impact of adjacent urban development. These mitigation measures include the planning, design, and construction control mechanisms within the WBCC RMP; fox control measures and other ongoing habitat management actions outlined in the WBCC RMP; the implementation of CEMPs; and implementing domestic pet containment policies within the Urban Development Area and WBCC during the operational phase of the Program.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The limited impact of the Program action on pink-tailed worm-lizard is such that it is unlikely to lead to a decline in the species. Ongoing management of the WBCC will also ensure that retained habitat is maintained or improved within the protected area.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The inadvertent introduction of invasive species during the construction phase will be mitigated through control measures in the CEMPs. Post-construction, the WBCC RMP will include actions for ongoing weed reduction within pink-tailed worm-lizard habitat and fox control measures throughout the WBCC. A cat containment policy will be implemented for all residents of west Belconnen and 'off-leash' dog areas will be prohibited within the WBCC. While the policing of domestic dogs in the WBCC may include some challenges, education initiatives that would be within the scope of the EMT will assist in ensuring the community is informed and respect the ecological values of the WBCC, effectively minimising the potential for impacts from domestic dogs and other exotic species.

Significant Impact Criteria	Assessment of pink-tailed worm-lizard
Introduce disease that may cause the species to decline	The proposed action is unlikely to introduce a disease that could result in the decline of the species. The introduction of disease in pink-tailed worm-lizard populations has not been identified as a result of development activities.
Interfere substantially with the recovery of the species	The Program will not substantially interfere with the recovery of the species. Despite this, ongoing survey and monitoring will also be incorporated into the WBCC RMP and will occur in line with existing recovery plans (ACT Gov't 1995; ACT Gov't 2007; NSW Gov't 2015e; TSSC 2015b).

The 16.4 hectare reduction in area of occupancy meets the guidelines for a significant impact. Compensatory measures for this impact are considered in **Section 5**.

4.6 Threatened Flora

Small purple pea, Tarengo leek orchid, and hoary sunray are all listed as endangered under the EPBC Act. Pale pomaderris and austral toadflax are both listed as vulnerable under the EPBC Act.

Explorative vegetation surveys were undertaken in 2008, 2009, and 2013 throughout the Project Area, focusing on the Urban Development Area and targeting pale pomaderris and Ginninderra peppercress (KMA 2009b; 2013a; 2013b). The aim of these surveys was to determine and map the vegetation classes present and to record as many flora species as possible. These surveys did not detect any EPBC Act threatened flora species, however, it was assessed in **Section 3.3.1.8** of this report that habitat for these species may occur, particularly within the WBCC and their absence should not be guaranteed.

In the following section, impacts to these species will be assessed together as the impacts and the avoidance, mitigation, and offset measures are the same for each species.

4.6.1 Methodology for Assessment

Numerous flora and vegetation assessments have been undertaken within the Project Area. Earlier studies focused on classifying vegetation types to guide more targeted flora surveys that occurred on the developable land.

Information utilised for the impact assessment of threatened flora species has included the following data sources:

- Targeted Surveys:
    - KMA (2014) Ecological Studies West Belconnen Australian Capital Territory
    - KMA (2013a) West Belconnen Project NSW Land Flora and Fauna Studies
    - KMA (2009a) Further Flora and Fauna Studies: Land at West Molonglo and Ginninderra Creek New South Wales Australian Capital Territory
    - KMA (2009b) West Belconnen Project ACT and NSW Land Flora and Fauna Studies

- David Hogg Pty Ltd (2013) West Belconnen Woodland Areas: Confirmatory Ecological Assessment; and
- Geoff Butler and Associates (2000) The Revegetation of Ginninderra Creek Between Barton Highway and Macgregor, ACT.

- Government Resources:
  - National Recovery Plans for small purple pea (NSW Gov't 2012), Tarengo leek orchid (NSW Gov't 2010a), and hoary sunray (Victorian Gov't 2011a);
  - Commonwealth Conservation Advice for pale pomaderris (TSSC 2008) and austral toadflax (TSSC 2013b);
  - ACT Government (2015a) ACTmapi ACT Government Online Interactive Maps;
  - ACT Government (2004b) Action Plan No. 27 Woodlands for Wildlife: ACT Lowland Woodland Conservation Strategy; and
  - Australian Government (2015b) Species Profile and Threats Database.

Information in the targeted surveys was prioritised ahead of other Government sources as the data is recent and specific to the Project Area. These surveys were prioritised based on chronology, with the most recent surveys utilised first and followed by survey scale (i.e. targeted flora before vegetation classification). Government sources were used to corroborate information on habitat, overall condition for, and threats to the species; and provide a regional and national context for them.

The lack of records of threatened flora species within the Project Area should not be used as evidence of absence of these species as there are many variables which affect detection (e.g. survey timing, methodology, practitioner experience). Where elimination of species from further assessment did occur (in **Section 3.3.1.8**), this decision was based on factors such as known distribution, habitat, and biological limitations. For all other species, the following impact assessment is based on presence of potential habitat within the Project Area.

4.6.2 Current Condition and Threats

There are only two known population clusters of small purple pea in Australia. Reduced from its historical distribution along the western slopes of NSW and north-east Victoria, these clusters are in central east NSW and in the Canberra / Williamsdale district (ACT Gov't 2004b; NSW Gov't 2012). Agricultural practices have previously been the biggest threat to the species; however, current threats include weed invasion, grazing, erosion, herbicide use, recreational pressures, railway maintenance, soil dumping, absence of fire, infrastructure development, and small population size (NSW Gov't 2012). In the ACT small population size is noted as the key threat to local extinction (ACT Gov't 2004b).

Pale pomaderris is known from approximately 15 populations, generally within river corridors in the ACT, southern NSW, and eastern Victoria. Threats to this species include encroaching development, weed competition, feral goat grazing, inappropriate fire regimes, fragmentation, and loss of remnants (TSSC 2008).

Austral toadflax is currently distributed along the coast between south east Queensland and north east Victoria, and into the tablelands of NSW. Despite its vulnerable listing status, this species may be more widely distributed than currently thought due to the difficulty in detecting it. Identified threats

to this species include inappropriate fire regimes, intensive grazing, development (both urban and agricultural), and weed invasion (TSSC 2013b).

Tarengo leek orchid is only found in high quality native grassland and grassy woodland that are not subject to continuous grazing. Its past distribution is not known due to the species only being identified in 1991. Primary threats include weed invasion, native species encroachment, grazing pressure (particularly during flowering and fruiting time), mechanical injury from cemetery management, air pollutants, and small population size (ACT Gov't 2004b; NSW Gov't 2010a).

Historically, hoary sunray was widespread throughout eastern Australia, though this distribution has shrunk to an area roughly bounded by Goulburn, Albury, and Bega in the southeast of NSW and the ACT, and small sites in Victoria and Tasmania. Habitat destruction, with weed invasion, poor reservation status, small population sizes, lack of appropriate biomass reduction (i.e. open space for germination), and inappropriate fire and grazing regimes are listed as threats to the species (Victorian Gov't 2011a).

4.6.3 Direct, Indirect and Cumulative Impacts

There are no known threatened flora species within the Project Area and accordingly there will be no direct impacts expected to threatened flora species. In addition, all areas of potential habitat for these species will be incorporated into the WBCC. These habitats (excluding box gum woodland) may be impacted by future tourism and maintenance infrastructure development within the WBCC.

Indirect impacts from the Program that may affect the WBCC include edge effects such as weed invasion and changes to microclimates, changes to hydrological conditions, fire regimes, pollution, sedimentation, and erosion.

Cumulative and facilitated impacts to threatened flora habitat may occur as a result of increased public access to the WBCC for recreational use. These may include disturbance and destruction of habitat from the provision of infrastructure, pollution, and damage to plant growth as a result of informal track creation.

4.6.4 Measures to Avoid and Mitigate

There will be no direct impacts to threatened flora species under the EPBC Act as a result of the Program within the defined development area. Future development within the WBCC to provide tourism and maintenance infrastructure will be required to undertake site based flora surveys during the design phase. If any threatened flora species are identified at this time, all direct impacts to these species must be avoided. This will be controlled by the WBCC RMP.

Indirect impacts to the WBCC will be managed through the implementation of CEMPs during the construction phase, WSUD principles within the Master Plan, and the WBCC RMP during the operational phase of the Program. These mechanisms will specifically include:

- Implementation of CEMPs, particularly targeting
    - prescriptions for pre-clearing surveys for listed species prior to the commencement of any construction activities such that further avoidance and mitigation measures can be incorporated where cost effective and practicable
    - erosion and sediment controls
    - water treatment standards before release

- flow controls
- pollution and waste management
- weed management
- appropriate definition of clearing boundaries; and
- avoidance of the WBCC.

- Appropriate storm water management based on geotechnical, surface water, and groundwater assessments and WSUD principles to reduce impacts to hydrological systems.
- Implementation of the WBCC RMP, which will include the following mechanisms to adequately protect potential threatened flora species if present:
  - controls to public access and use of the habitats within the WBCC
  - bushfire hazard and fuel management prescriptions that are not inconsistent with biodiversity conservation objectives; and
  - conservation management actions that target the improvement of overall environmental and habitat values of the area (i.e. a landscape approach).

4.6.5 Impact Assessment

The Significant Impact Guidelines 1.1 were used to determine if any actions under the Program are likely to have a significant impact on the endangered species small purple pea, Tarengo leek orchid, and hoary sunray (**Table 4.10**) and vulnerable flora species pale pomaderris and austral toadflax (**Table 4.11**).

Table 4.10 Significant Impact Criteria for Endangered Flora Species

Significant Impact Criteria	Assessment of small purple pea, Tarengo leek orchid, and hoary sunray
Lead to a long-term decrease in the size of a population.	The Program will not lead to a long-term decrease in the size of a population given that there are no known populations of critically endangered or endangered flora species within the Project Area. Furthermore, if any endangered flora species are identified during site-scale survey prior to development within the WBCC, these will be avoided.
Reduce the area of occupancy of the species.	The Program will not reduce the area of occupancy of any critically endangered or endangered flora species given that there are no known populations within the Project Area. Furthermore, if any endangered flora species are identified during site-scale survey prior to development within the WBCC, these will be avoided.

Significant Impact Criteria	Assessment of small purple pea, Tarengo leek orchid, and hoary sunray
Fragment an existing population into two or more populations.	No fragmentation of existing populations will occur as there are no known populations of critically endangered or endangered flora species within the Project Area. Any potential habitat for these species will be protected within the WBCC and if any endangered flora species are identified during site-scale survey prior to development within the WBCC, these will be avoided.
Adversely affect habitat critical to the survival of a species.	Due to the small number of extant populations all habitat that supports a population of small purple pea or Tarengo leek orchid is considered to be critical to the survival of the species (NSW Gov't 2012; NSW Gov't 2010a). In the case of the Tarengo leek orchid, critical habitat also includes sufficient area (undefined) surrounding the populations to sustain the required pollinator and fungal partners (NSW Gov't 2010a). There is no identified critical habitat for hoary sunray (Victorian Gov't 2011a). As no populations of small purple pea or Tarengo leek orchid have been recorded within the Project Area and the Project Area is highly unlikely to be important for pollinators or fungal partners of the Hall cemetery population of Tarengo leek orchid, it does not constitute critical habitat for these species. Furthermore, if these species are identified within the WBCC in the future, impacts to them will be avoided. Similarly, as no critical habitat has been identified for hoary sunray, therefore, the Program will not adversely affect it. Again all direct impacts to this species (should it be recorded within the Project Area) will be avoided.
Disrupt the breeding cycle of a population.	The breeding cycle of a population will not be disrupted by the Program given that there are no known populations within the Project Area. Furthermore, if any endangered flora species are identified during site-scale survey prior to development within the WBCC, these will avoided.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The species are not considered likely to decline as a result of the Program as no areas of known habitat will be affected. The quality of potential habitat within the Project Area will be improved within the WBCC via strategies set out in the WBCC RMP.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat.	The Program will not result in the introduction of invasive species into known habitat for critically endangered or endangered flora species. The control of invasive species introduction into potential habitat for critically endangered or endangered flora species will be managed throughout the construction phase via CEMPs and post construction via the WBCC RMP. The WBCC RMP will also include weed management strategies targeting the reduction of existing weed species within the WBCC.

Significant Impact Criteria	Assessment of small purple pea, Tarengo leek orchid, and hoary sunray
Introduce disease that may cause the species to decline.	There are no endangered or critically endangered flora species that are susceptible to *Phytophtora cinnamomi* (Australian Gov't 2014b[124]) present within the Project Area. The Program will not introduce disease that may cause critically endangered or endangered flora species to decline.
Interfere with the recovery of the species.	The National Recovery Plan for small purple pea targets increased survey and monitoring (including understanding genetic differences and the impacts of fragmentation), weed control, formal protection of sites, improved understanding and implementation of fire management strategies, and increased community awareness of the recovery effort (NSW Gov't 2012). Recovery actions for Tarengo Leek Orchid include continued monitoring of populations, weed (including natives) removal, further survey into the effects of fire and grazing, and extension of the Hall cemetery into adjacent land (NSW Gov't 2010a). The National Recovery Plan for hoary sunray targets an improved understanding of the distribution, abundance, population structure, habitat requirements, and biological characteristics of the species; protecting key populations especially by managing their threats; and increasing community awareness of the species' recovery (Victorian Gov't 2011b). The Program will not interfere with the recovery of any critically endangered or endangered flora species.

On the basis of the assessment of endangered flora species, it is not anticipated there will be the potential for a significant impact. The following **Table 4.11** considers the potential impacts of development on threatened flora species which are listed as being vulnerable.

Table 4.11 Significant Impact Criteria for Vulnerable Flora Species

Significant Impact Criteria	Assessment of pale pomaderris and austral toadflax
Lead to a long-term decrease in the size of an important population of a species	The Program will not lead to a long-term decrease in the size of an important population of vulnerable flora species given that there are no known populations of threatened flora species within the Project Area.
Reduce the area of occupancy of an important population	The Program will not reduce the area of occupancy of an important population of a vulnerable flora species given that there are no known populations of vulnerable flora species within the Project Area.

[124] Australian Government (2014b) *Threat Abatement Plan for Disease in Natural Ecosystems caused by Phytophthora cinnamomi*, Department of the Environment, Canberra.

Significant Impact Criteria	Assessment of pale pomaderris and austral toadflax
Fragment an existing important population into two or more populations	No fragmentation of important populations will occur as there are no known populations of vulnerable flora species within the Project Area.
Adversely affect habitat critical to the survival of a species	There is no nationally identified critical habitat for pale pomaderris or austral toadflax. Four NSW 'key management sites' have been identified for pale pomaderris, all of which are to the south-east of the ACT (NSW Gov't 2015f[125]). Austral toadflax is classed as a 'keep-watch species' in NSW, which means there is no targeted habitat management for the species, therefore, no identified critical habitat (NSW Gov't 2015g[126]) No habitat critical to the survival of a vulnerable flora species will be adversely affected by the Program.
Disrupt the breeding cycle of an important population	The breeding cycle of an important population will not be disrupted by the Program given that there are no known populations of vulnerable flora species within the Project Area.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species are not considered likely to decline as a result of the Program as no areas of known vulnerable flora species' habitat will be affected. The quality of potential habitat within the Project Area will be improved within the WBCC via strategies set out in the WBCC RMP.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Program will not result in the introduction of invasive species into known habitat for vulnerable flora species. The control of invasive species introduction into potential habitat for vulnerable flora species will be managed throughout the construction phase via CEMPs, and post construction via the WBCC RMP. The WBCC RMP will also include weed management strategies targeting the reduction of weed species that currently occur within threatened flora habitat.
Introduce disease that may cause the species to decline	There are no vulnerable flora species that are susceptible to *phytophtora cinnamomi* (Australian Gov't 2014b) present within the Project Area. The Program will not introduce disease that may cause vulnerable flora species to decline.

[125] NSW Government (2015f) *Pale Pomaderris (Pomaderris pallida) Species Conservation Project*, Office of Environment and Heritage, accessed online (January 2016): http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10653.

[126] NSW Government (2015g) *Austral Toadflax (Thesium australe) Species Action Statement*, Office of Environment and Heritage, accessed online (January 2016): http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10802.

Significant Impact Criteria	Assessment of pale pomaderris and austral toadflax
Interfere substantially with the recovery of the species	There are no national recovery plans for pale pomaderris or austral toadflax. The Commonwealth conservation advice for pale pomaderris (TSSC 2008) and austral toadflax (TSSC 2013b) outline similar priority actions for each species. These actions target the identification of populations of conservation importance, management within areas known to contain the species (including fire and grazing regimes), develop and implement formal conservation arrangements, and investigate options for recruitment or translocation. The Program will not interfere with the recovery of any vulnerable flora species.

As there are no known populations of threatened flora species within or directly adjacent to the Project Area, it is believed that the Program will not have a significant impact on any listed species. The avoidance, mitigation, and offset measures as described will be targeted at protecting the values of potential habitat within the Project Area.

4.7 Defined Process Strategy

In order to provide an assessment of the appropriateness of the Defined Process Strategy, two hypothetical examples have been provided to illustrate how the application of the Process will ensure unacceptable impacts to MNES are avoided:

- 'Scenario One' considers impacts to natural temperate grassland as a result of development within the Urban Development Area.
- 'Scenario Two' demonstrates the application of the Defined Process Strategy in the event that detailed design of infrastructure within the WBCC exceeds the impacts assessed in this report.

In each scenario, the design process will address feasible alternatives in terms of the key components of sustainability. This would adopt a triple bottom line approach to cost-benefit analysis triggered by a previously unquantified impact to any MNES. Considerations will include the cumulative effect of previous small scale impacts that have not been addressed through a targeted offset in addition to the current matter being considered. Specifically this will involve the following considerations (but not be limited to):

- Ecological benefit / cost for avoidance, including consideration of:
    - connectivity to other retained areas
    - relative condition of the vegetation
    - overall area / size of impacted patch; and
    - presence of other MNES or species of statutory conservation value in NSW or the ACT.
- Economic implications of avoidance, including consideration of:

- ongoing cost of maintenance to conserve ecological benefits in perpetuity; and
- cost implications of service provision and construction.

- Social aspects including consideration of:
  - practicality of protection of avoided area from uncontrolled access and other threats to biodiversity from unrestrained dogs and vehicles
  - impacts to urban connectivity; and
  - other potential social costs or benefits through opportunities for education, research, and monitoring.

4.7.1 Scenario One

Due to the revised listing criteria for natural temperate grassland, vegetation that meets the current definition of the CEEC has not been identified prior to the preparation of the Strategic Assessment; therefore, impacts have not been quantitatively assessed to the same level of detail as other MNES.

In this hypothetical scenario, a two hectare patch of pink-tailed worm lizard habitat within the urban development area has been identified within an area to be impacted. While this assessment report has considered the impacts to pink-tailed worm-lizard, due to natural temperate grassland also being generally coincident consideration of the impact to the grassland community is required. Due to this, the Defined Process will be applied to determine the significance of this impact and identify the need for and what represents an appropriate offset in the event that offsets are required.

4.7.1.1 Step 1 – Identify Extent and Quality of Affected Area

Targeted survey for natural temperate grassland be undertaken in accordance with criteria set out in the Commonwealth Conservation Advice (TSSC 2016), including consideration for survey timing and plot size and number. In addition, surveys will gather data sufficient for determining the quality of habitat using the criteria established in this report; and map the results at a refined scale.

The data provided by the surveys will then be used to assess the potential impacts of the Program on natural temperate grassland. The impact assessment will be undertaken in accordance with EPBC Policy with consideration for the Significant Impact Guidelines 1.1.

For this scenario, it is found through field survey that the area of natural temperate grassland is approximately 3.5 hectares and includes the entirety of the pink-tailed worm-lizard habitat.

4.7.1.2 Step 2 – Assess Relative Benefits of Avoidance

Once the extent and condition of the natural temperate grassland is known in the area to be affected, avoidance and mitigation measures will be considered for their practicality and cost effectiveness. At Step 2 the triple bottom line considerations identified above will be addressed in order to determine the most appropriate design response from a sustainability perspective.

For the purpose of this scenario, it has been determined that avoidance is impractical as a result of adverse social and economic impacts that cannot be balanced against the potential ecological benefits of avoiding the area of the community.

Mitigation measures consistent with those discussed in **Section 4.3** will be incorporated into the preferred option to ensure that indirect impacts do not affect reserved areas, including MNES within the WBCC.

4.7.1.3 Step 3 – Assess Significance of Impact

As natural temperate grassland is a critically endangered ecological community, assessment against the Significant Impact Guidelines 1.1 determines that a significant impact would result from most instances. For the scenario, impact to 3.5 hectares is considered a significant impact; therefore, an offset is required.

Using the criteria set out in **Section 5.2.4**, the quality of natural temperate grassland would need to be quantified.

4.7.1.4 Step 4 – Identification and Assessment of Suitable Offset

In order to consolidate the ecological benefits of the WBCC and in acknowledgement that the extent of the endangered ecological community is probably more extensive than the mapped habitat of pink-tailed worm-lizard, the first offset opportunity to be investigated are areas within the WBCC. Based on the ecological principles outlined in general for the Defined Process Strategy, areas of pink-tailed worm-lizard habitat will be targeted to identify natural temperate grassland. This will include addressing for each potential offset area, consideration of Steps 1-2 for the offset scenario as opposed to the development scenario.

Once identified and described in terms of its extent and habitat quality the potential offset area will be assessed against the criteria described in **Section 5**. The preferred offset will be the outcome that is consistent with the EPBC Act offset policy in meeting more than 90 percent of the required offset as a land-based offset.

Once identified, the WBCC RMP will be updated to designate the relevant area as also being an offset for natural temperate grassland. Management measures will be incorporated into the RMP to ensure appropriate actions including monitoring and reporting in accordance with the RMP framework are implemented.

In the event that no suitable areas are available within the WBCC, additional locations may be considered in order to meet the offset requirement. This should initially consider the Lot 2 Wallaroo Road offset site and then subsequently any other site with a preference for locations closer to the impact area.

4.7.1.5 Scenario 1 Outcome

The outcome for MNES under scenario one would include:

- loss of 3.5 hectares of natural temperate grassland
- dedication of an area of appropriate size and quality to be recognised as being an offset for natural temperate grassland; and
- consolidation of offset areas within the WBCC.

In most circumstances it is anticipated that pink-tailed worm-lizard habitat will also be natural temperate grassland. However, it is also anticipated that areas of natural temperate grassland will be more extensive than the lizard habitat.

As the offset outcome for each MNES is being considered under this strategic assessment concurrently and in recognition of the patchiness of the pink-tailed worm-lizard habitat, a good environmental outcome would be for the concurrent development of offsets for the lizard and the grassland in the WBCC. This would result in a more coherent offset strategy and conservation area of greater overall ecological value.

This outcome is considered appropriate and consistent with the EPBC Act offset policy.

4.7.2 Scenario Two

While the Program considers the river access road and sewer construction in addition to a range of recreational facilities within the WBCC, this scenario considers the potential for a previously unidentified infrastructure requirement within the WBCC, which results in an impact to any MNES. This scenario only applies to development activities associated with and as described by the Program or as necessary to implement the Program. Ancillary and third party infrastructure is not considered part of the Strategic Assessment and would not be consistent with actions associated with implementing the Program.

For the purpose of this hypothetical scenario, the need for a sewer rising main from a recreational facility which forms part of the Program is identified as being necessary to give effect to the Master Plan. As this has not been a specifically identified component of the master plan and implementation would affect areas of MNES within the WBCC, this triggers the need to apply the Defined Process Strategy.

4.7.2.1 Approach

This approach would initially consider the Strategic Design Principles (**Section 1.2.3**); however, in the event that those principles cannot be complied with the second scenario would need to apply Steps 1-3 of the Defined Process (discussed above). This would identify the impact, assess the relative impact, and determine the need for an offset.

The likely outcome in this scenario if the Strategic Design Principles cannot be satisfied is that any impacts to MNES within the WBCC from activities not addressed by the Program would result in an impact to an existing offset. In this case the infrastructure must either be reconsidered through an alternative design solution that does not compromise on the ecological outcomes or be abandoned.

Where an existing offset is not impacted, the offset identification process generally as described by Step 4 in **Section 4.7.1.4** would be implemented.

For the purpose of this scenario, an existing offset would include:

- any area of pink-tailed worm-lizard habitat within the WBCC as mapped by Osborne and Wong (2013)
- any part of the Jarramlee or West Macgregor offset areas
- any part of the golden sun moth habitat dedicated as offset on Lot 2 Wallaroo Road; or
- any area of natural temperate grassland already dedicated as offset through implementation of the Defined Process Strategy.

In the event that an existing offset will be affected, the action cannot be considered through the Defined Process Strategy and must be referred to the Minister for the Environment under Part 3 of the EPBC Act.

4.7.2.2 Outcome for Scenario 2

Under Scenario Two, outcomes are guided by the intent of the offset policy to establish offsets in perpetuity and drive to solutions that do not compromise the perceived strategic benefits of implementing the Program as it has been considered in this assessment. As an impact to an offset introduces a greater deal of complexity to an assessment (refer to **Section 5**), it is considered appropriate that should this eventuality arise, it is appropriate that it be subject to additional public scrutiny and assessment by DoEE through the referral process.

4.8 Data Sources and Limitations

This section outlines the source of data used in the impact assessment and includes an analysis of information gaps and limitations within it, the uncertainties that this causes, and identifies areas for further research.

4.8.1 Information Gaps

The approach utilised throughout the design phase of the Program has been to collect all data necessary to allow an appropriate assessment of environmental impacts. In particular this information gathering has been targeted toward defining the correct alignment of the WBCC so that the largest majority of MNES may be protected whilst allowing for the ease of management.

Overall, data utilised within this assessment includes:

- comprehensive mapping and quality assessment of EPBC Act listed box gum woodland (David Hogg Pty Ltd 2013)
- comprehensive mapping and quality assessment of pink-tailed worm-lizard habitat (Osborne and Wong 2013)
- targeted golden sun moth surveys (Rowell 2013 and 2015; Braby 2005; ACT Gov't 2013a; Biosis 2015)
- targeted bird surveys (KMA 2013c), complemented by data from the Canberra Ornithologists Group (2011; 2012; 2014; 2015a; 2015b)
- targeted surveys for EPBC Act listed flora species Ginninderra peppercress and pale pomaderris (KMA 2009b)
- widespread flora and fauna studies, including vegetation classification (KMA 2009a; 2009b; 2013a; 2014); and
- cultural and aboriginal heritage assessments (Biosis 2014a and 2014b).

As these studies were conducted generally utilising the current boundaries of the Project Area, there are no information gaps resulting from a lack of or inconsistent study across it.

Outside of the studies undertaken specifically for the Program, information has also been gained from:

- Territory Plan, NCP, cadastre and general base mapping as accessed via ACTmapi (ACT Gov't 2015a)

- Commonwealth Government Species Profile and Threats (SPRAT) database (Australian Gov't 2015b)

- Commonwealth Conservation or Listing Advice (ESSS 2000; TSSC 2002; 2006; 2007; 2008; 2011a; 2011b; 2012; 2013a; 2013b; 2013c; 2013d; 2015a; 2015b; 2015c; 2015d)

- Recovery Plans (ACT Gov't 1995; NSW Gov't 2007a; 2009; 2010; 2011a; 2011b; 2012; Saunders and Taws 2005; Victorian Gov't 1999; 2008a; 2008b; 2010a; 2010b; 2011a; 2011b)

- Referral / Significant Impact Guidelines (Australian Gov't 2009b; 2009c; 2011a; 2013b; 2015c)

- ACT Action Plans (ACT Gov't 1998; 1999; 2004b; 2005a; and 2007) and NSW species action statements and conservation programs (NSW Gov't 2015c; 2015d; 2015e; 2015f; 2015g)

- avifauna records of all species as provided by COG (2011; 2012; 2014; 2015a); and

- regional scale mapping (Fallding 2002).

The information contained in these datasets applies to a much coarser landscape level, is older, or is compiled from a number of different sources with varying degrees of reliability.

4.8.2 Limitations

The limitations of the above data can be summarised as follows:

- **Scale:** Limitations occur in the instances where information within broader scale datasets was applied to the Project Area level (such as the presence of fish species in the Project Area). In these instances a conservative approach to the likelihood of occurrence was taken, whereby unless a complete lack of habitat was recorded it was considered to be either 'likely' or 'potential' and assessed accordingly. Other datasets were also NSW or ACT specific (e.g. ACTmapi (ACT Gov't 2015a)), and were limited in their regional application. Where possible information from both NSW and ACT was utilised to determine regional context.

- **Timing and Climate:** Many of the datasets available are comprised of a significant amount of data that was collected over the last ten years, a period during which a significant and protracted drought affected the ACT, in particular for the years preceding 2010. The extreme weather conditions during these years are highly likely to have affected flora and fauna records both during the drought conditions and subsequently during the recovery. Where possible the most recent appropriate records were used that were most likely to represent current conditions.

- **Timing and Seasonality:** Similarly to the above point, seasonality may influence the detectability of some species, especially when determining their presence at a site. By conducting targeted surveys in accordance with the relevant Commonwealth survey guidelines and at an appropriate time of year, the effect of seasonality on detectability has been mitigated. In addition, a precautionary approach has been utilised in this assessment by not assuming a lack of record equates to the absence of a species. Where relevant, other factors (such as habitat requirements or biological characteristics) have been utilised to declare the absence of a species within the Project Area.

- **Methods:** Differences in method were apparent only between the studies conducted at different scales. This may result in an under or over representation of particular taxa giving an unrealistic indication of rarity or distribution. All of the surveys specifically conducted for the Program were streamlined so that methodology was consistent across them. These methodologies were not

necessarily consistent with those used at a broader scale. Where possible information was used from the surveys within the Project Area.

- **Reliability:** There is inevitably observer bias within all of the datasets. Limitations introduced by this include false-positives and false-negatives if an observation is not recorded, dismissed, or misidentified. This has been mitigated to a certain extent by streamlining the surveys so that only one consultant group is conducting each survey type, reducing the number of observers for each.

- **Presence vs. Absence:** For a number of the targeted threatened species, records exist that confirms their presence within the Project Area (e.g. pink-tailed worm-lizard); however, a lack of records for a particular species or community cannot confirm its absence. Except in the case where a species has very specific habitat requirements that guide where it will not occur (e.g. golden sun moth), the data presented above does not provide proof of absence of threatened species. This limitation has been mitigated somewhat by assigning threatened MNES with a 'likelihood of occurrence', which allows for some ambiguity in records within the Project Area. This limitation creates uncertainty with regard to the completeness and effectiveness of the WBCC and other strategies to avoid, mitigate, and offset impacts to MNES within the Program.

These limitations are not unique to this study or datasets, and cannot be completely avoided. They were addressed through the prioritisation of data (giving greater importance to information gathered at the Project Area scale, and is most recent), and in the regional approach to the design of the WBCC that aims to improve connectivity and habitat quality at the community level, not just at a species level. This will help to improve the quality of the habitat as a whole and not simply for the species that are known to be present within the Project Area.

4.8.3 Uncertainties

There are also a number of uncertainties associated with the implementation of the Program. These are discussed in detail in the Program Report. In summary they relate to:

- Timeframes:
    - changes of political will, priorities, and policy; and
    - ensuring that offsets match the stages of urban development.
- Achievement of the habitat quality objectives within the WBCC and the amount of improvement that is required to do this.
- Offset success and its dependence upon assumptions of practicability.
- Unforeseen influences and factors for which the Program has limited ability to respond to (e.g. climate change); and
- New species listings.

As identified in relation to golden sun moth, it is uncertain if some aspects of the proposed action are likely to have an adverse impact on the species or its habitat. These uncertainties include:

- Whether construction of the proposed bridge will lead to overshadowing of golden sun moth habitat to the extent that affected areas no longer support the species due to a change in soil moisture and temperature levels.

- Whether golden sun moths are willing to fly under a structure such as the proposed bridge in order to move between proximate areas of habitat.

- Whether habitat enhancement in new locations to facilitate translocation of individual golden sun moth larvae is an effective measure to mitigate the potential loss of habitat and subsequently improve connectivity between currently isolated patches of habitat.

These uncertainties with respect to golden sun moth represent research opportunities that can be considered in the broader suite of activities that could be undertaken as a part of implementing the Program. The potential for this is in part derived from the long lead time until any impacts to golden sun moth habitat are likely to occur as a result of the Ginninderra Drive extension.

An adaptive management framework (discussed in detail in the Program Report) will be incorporated into the WBCC RMP to address these uncertainties in the long-term. It will be the responsibility of the EMT to ensure the delivery of conservation gains that are efficient, effective, timely, transparent, scientifically robust and reasonable.

4.8.3.1 Climate Change

The phenomenon of climate change also introduces an element of uncertainty in regards to its effects on the conservation outcomes under the Program. Given the long time frames involved and the uncertainty associated with climate change predictions, it is difficult to determine how climate change may further impact or increase pressure on issues associated with enhancement of the preserved vegetation communities or individual species / habitats.

At present future climate scenarios for Australia (CSIRO and BOM 2014[127]) include:

- Australian temperatures are projected to continue to increase, with more hot days and fewer cool days.

- A further increase in the number of extreme fire-weather days is expected in southern and eastern Australia, with a longer fire season in these regions.

- Average rainfall in southern Australia is projected to decrease, with a likely increase in drought frequency and severity.

- The frequency and intensity of extreme daily rainfall is projected to increase.

- Tropical cyclones are projected to decrease in number but increase in intensity.

- Projected sea-level rise will increase the frequency of extreme sea-level events.

The first four of these are considered relevant to the broader west Belconnen area.

In response to these predicted changes and the inherent uncertainty in other aspects of what climate change represents, Webb (2010[128]) identifies three key aspects to an adaptation strategy for biodiversity. These are as follows:

[127] Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BOM) (2014) *State of the Climate*, accessed online (April, 2015): http://www.bom.gov.au/state-of-the-climate/documents/state-of-the-climate-2014_low-res.pdf?ref=bottom.

[128] Webb, B. (2010) *Climate Change, Biodiversity and the Australian Capital Region*, a presentation to the National Climate Change Adaptation Research Facility Workshop, Canberra, 8 December 2010, accessed online (April, 2015): http://nccarf.jcu.edu.au/terrestrialbiodiversity/documents/roadshow/act/act_se_nsw_presentation_bob_webb.pdf.

- Maintaining fundamental ecosystem processes and services by reducing pressures / disturbances and restoration.
- Enhancing resilience for self-adaptation via multiple pathways, such as the following:
    - including habitat variety and connectivity
    - responding dynamically over time; and
    - changing conservation goals.
- Knowledge development and adaptive management through allowing cumulative knowledge access and sharing.

These will be taken into account when formulating mitigation and offset strategies and developing the WBCC RMP. The approach proposed in the Program is to focus on the conservation of larger (and hence more viable) habitat areas by enhancing the existing reserve network with resulting improvements in connectivity, edge to core ratios and structural functionality. This approach will encourage the development robust ecosystems with greater resilience to climate extremes and the uncertainties of climate change.

4.8.4 Further Research

The WBCC RMP will include specific provision for the facilitation of further research that will assist with the management of MNES in the future and help to address some of the uncertainty discussed above. This will occur as required and feed into general scientific and educational activity that is proposed to be incorporated into the use of the WBCC.

A baseline condition assessment has commenced that will provide background data to inform the future management of the WBCC. This assessment will enable:

- identification of vegetation zones, based on similarity of structure and composition
- identification of the vegetation community that occurs within each vegetation zone
- development of a condition score for each vegetation zone (or significant species subzone) based on Biometric assessment (NSW Gov't 2014[129])
- development of a floristic value score for each vegetation zone (or significant species subzone) containing native grassy ecosystems based on the Rehwinkel method (NSW Gov't 2007b[130]) and subsequent modifications
- identification of the diversity of plant species and vegetation structure present
- identification of habitat features that may be supporting fauna species; and
- identification of issues present that require management intervention (e.g. rabbit disturbance, dumping, erosion, and invasive weeds).

[129] NSW Government (2014) *BioBanking Assessment Methodology 2014*, Office of Environment and Heritage, Sydney.

[130] NSW Government (2007b) *A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Site's Quality,* (version 2) prepared by Rehwinkel, R. Department of Environment and Climate Change, Sydney.

Additionally, skill sharing, environmental stewardship and awareness, and capacity building programs are to be incorporated into the objectives of the EMT. This includes facilitating tertiary level research opportunities within WBCC.

The broader context of this data will also be considered, particularly with regard to existing methodologies used across the ACT and NSW. The methods used for baseline and ongoing monitoring will be consistent with those used across these areas and developed in consultation with relevant stakeholders, so results may be readily integrated with existing data.

These measures are considered both adequate and appropriate in avoiding and minimising potential impacts to MNES. Principal among these is the holistic management of the WBCC across NSW and ACT jurisdictions under a common EMT. This will ensure a consistent approach and avoid unnecessary spending in the coordination of conservation and management activities.

5.0 Environmental Offsets

Notwithstanding the avoidance and mitigation measures that have been adopted as part of the Program, residual impacts were still determined in **Section 4** to be significant under the Significant Impact Guidelines 1.1. Given this, it is appropriate to consider further measures that may be applied in order to compensate for the anticipated or assumed impacts to these species and their habitats. This section, therefore, assesses the effectiveness of the program offset strategy that will be implemented as part of the Program and that has been prepared on the basis of 'The EBPC Act Environmental Offsets Policy' (EPBC Act Offset Policy) (Australian Gov't 2012a) and the accompanying guide (EPBC Act Offset Guide) (Australian Gov't 2012b[131])

While both the ACT and NSW have offset policies and assessment tools, given the scope of a Strategic Assessment and the range of factors it encompasses, it is appropriate to apply the EPBC Act Offset Policy. This provides a greater level of flexibility in the approach to delivering offsets, whilst still being consistent with the policy and avoids potential issues with seeking to apply the individual offset tools of NSW and the ACT to a multijurisdictional project.

Golden sun moths are affected by the proposed extension to Ginninderra Drive which will result in a reduction in the area of occupancy of the species and fragment an existing important population. The area of occupancy for the species will be reduced by an estimated 1.8 hectares, which exceeds the Significant Impact Guideline threshold of a loss of 0.5 hectares (Australian Gov't 2009b). The offset strategy for impacts to golden sun moth includes discussion of the challenge of managing the contradictory need to control noxious weeds, including the designated WoNS Chilean needle-grass, which support golden sun moth.

The likely impacts of the Program to pink-tailed worm-lizard result from a 16.4 hectare reduction in the area of occupancy of the species. As described in **Section 4.5.5** this impact generally affects very small remnant patches that are on average 0.09 hectares (900 square metres) in area and occur along the edge of the urban development area.

Despite not being an MNES, a third matter that is affected by the Program requires consideration in the preparation of the offset strategy: the impact of constructing the Ginninderra Drive extension through the established Jarramlee and Macgregor offset sites. The EPBC Act Offset Policy does not exclude the ability for a new development to impact an environmental offset area; however, this is undesirable and in this instance, in conflict with the concept that Jarramlee and Macgregor offset sites were established in order to be permanent. The benefit of an offset should last for the duration of the impact; therefore, in the case where habitat is cleared (as it was for the Lawson and Macgregor West developments that led to the establishment of Jarramlee and Macgregor offset sites), the impact is considered permanent and the offset should be also. This is in accordance with the then draft EPBC Act Offset Policy (Australian Gov't 2007[132]) under which these offsets were established.

Despite the intended permanency of the two offset sites, their identification and establishment did not fully account for matters outside of the environmental values and landscape context of the western edge of the ACT. Primary among these was omission of an easement to allow for a future extension to Ginninderra Drive, as included in the Program, which is necessary to allow for the planned expansion of west Belconnen. The following proposed offset strategy addresses this impact

[131] Australian Government (2012b) *How to Use the Offsets Assessment* Guide, online (accessed June, 2015): http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy

[132] Australian Government (2007) *Draft Policy Statement: Use of Environmental Offsets Under the Environment Protection and Biodiversity Conservation Act 1999*, Department of the Environment and Water Resources, Canberra (August 2007).

by assuming responsibility for commitments made as a part of the conditions of establishment for Jarramlee and Macgregor offset sites and by protecting an additional area to offset the impacts to established offset sites (including habitat and non-habitat for MNES).

5.1 General Approach

The approach to development of the offset strategy is guided by the EPBC Act Offset Policy and Guide and has been conceived on the basis of:

1. compensation for the residual, significant impacts to MNES and their habitats; and

2. compensation for unavoidable impacts to established offsets.

The first element draws directly from the EPBC Act policy, which provides the framework for assessing the relative suitability of an environmental offset area in comparison to the magnitude of the impact of the development. This includes consideration of the type, importance, and size of the habitat being impacted and the scale of improvement and averted loss as a result of the offset. The following principles from the EPBC Act Offset Policy have been used to guide the development of this offset strategy:

- Deliver an overall conservation outcome that improves the viability of the protected matter.
- The minimum conservation gain will be achieved with direct offsets, with the option to incorporate other measures as appropriate.
- Consideration will be given to the level of statutory protection for each MNES.
- Offsets will be proportionate to the impact.
- The Offset Strategy will account for and manage the risk of not succeeding.
- Offsets will be additional to what is required by law or other agreements.
- Offsets will be delivered in an efficient, timely, transparent, scientifically robust, and reasonable manner and have transparent governance arrangements.

Details of the calculations and considerations for each MNES affected are discussed in detail in **Section 5.2**. The governance arrangements for the offset strategy are discussed in the Program Report.

The second element is based on an understanding of Section 7.2.2 of the EPBC Act Offset Policy which states:

> *Where a proposed action is likely to impact on an existing EPBC Act offset, the person proposing to take the action should refer it to the department to determine whether or not it will require further assessment under the EPBC Act. There is an increased likelihood of significant impacts arising from actions on an existing offset site due to the nature of such sites containing and/or supporting protected matters. Where such actions are determined to be controlled actions, irrespective of the ownership or tenure of the impacted offset, the person proposing to take the action must develop an offsets package to compensate for both the impact of the proposed action, as well as the original action for which the offset was a condition of approval. The subsequent offset conditions would not amount to a variation of the original conditions of approval or excuse non-compliance with those conditions.*

While this is written in the context of an EPBC Act Referral process for which approval under Part 9 of the EPBC Act would be sought, the principles apply equally with respect to the Part 10 Strategic Assessment process. Given this, the approach to offsetting significant impacts of the Program considers not only the impact of the Program itself (discussed above), but also the impacts of the original proposals that necessitated the offsets to be established and the strategic context of these impacts. The Program (**Section 5.3.1**) commits to consolidating management of the existing offset areas, new offsets and the rest of the WBCC under the consistent management of the EMT as part of the WBCC RMP. For the purpose of assessment this is interpreted as follows:

- Replacement of the impacted golden sun moth habitat within the offsets on a like-for-like basis in addition to offsets for impacts to MNES as a result of the Program. This includes consideration of the impacts to habitat connectivity and patch size within the offsets.

- Assuming responsibility for implementation of all remaining obligations for the establishment of Jarramlee environmental offset area.

- Assuming responsibility for the habitat restoration project in the area between Jarramlee environmental offset area and the Dunlop Grassland Nature Reserve.

- Assuming responsibility for the ongoing management of Jarramlee environmental offset area and Macgregor environmental offset area as a part of the Program.

From review of the conditions of approval for the west Macgregor development, it is apparent that apart from responsibility for ongoing management, the only outstanding action relating to the associated offset is to incorporate it into the ACT nature reserve system. The ongoing management responsibilities will be built into the WBCC RMP (Program Section 5.3.1) while recognition of the combined offsets under the ACT nature reserve system would also occur under the Program (**Section 3.6).**

The offset strategy will deliver an additional parcel of land at Lot 2 DP 1144979 on Wallaroo Road, Wallaroo. This parcel comprises a total of 86.8 hectares and has been selected on the basis of its ability to provide a biodiversity offset local to the area of impact and also provide effective compensation for other factors relevant to the impacts of the Program.

There are no existing offsets for pink-tailed worm-lizard that may be impacted by the Program. As such, offsets for this species will only be bound by considerations under the first element discussed above (i.e. impacts to an MNES or its habitat as a result of the Program). It is proposed that the offset site for pink-tailed worm-lizard is within the WBCC and comprises all currently mapped occupied and potential habitat. Areas designated as offsets within the WBCC will be recognised for this and will have specific management requirements to ensure Program outcomes with regards to the protection and enhancement of pink-tailed worm-lizard habitat are achieved.

These principles are considered further in the following sections as they relate to specific elements of the Offset Strategy.

5.2 Offset Strategy Elements

The Offset Strategy has been developed with reference to the EPBC Act Offset Policy and Guide and the ecology and habitat requirements of each threatened species considered.

The EPBC Act Offset Guide has been used to determine the sufficiency of the proposed Offset Strategy to offset the residual impacts of the Program on golden sun moth (from both the Program

directly and as a result of impacting existing offset sites) (**Section 5.2.1**), and pink-tailed worm-lizard (**Section 5.2.2**). The following sections outline the calculation processes and rationale.

5.2.1 Golden Sun Moth

The EPBC Act Offset Guide was used to determine whether the proposed offset site is sufficient for offsetting the impacts to golden sun moth. The following sections and **Table 5.9** and **Table 5.10** outline the scores used for each component of the guide with an associated rationale.

The exception to this is the habitat quality score, which is discussed in detail in **Section 5.2.1.1**.

5.2.1.1 Golden Sun Moth Habitat Quality Score

The EPBC Act Offset Guide outlines the key considerations for determining the habitat quality for threatened species. This is summarised in **Figure 5-1** below.

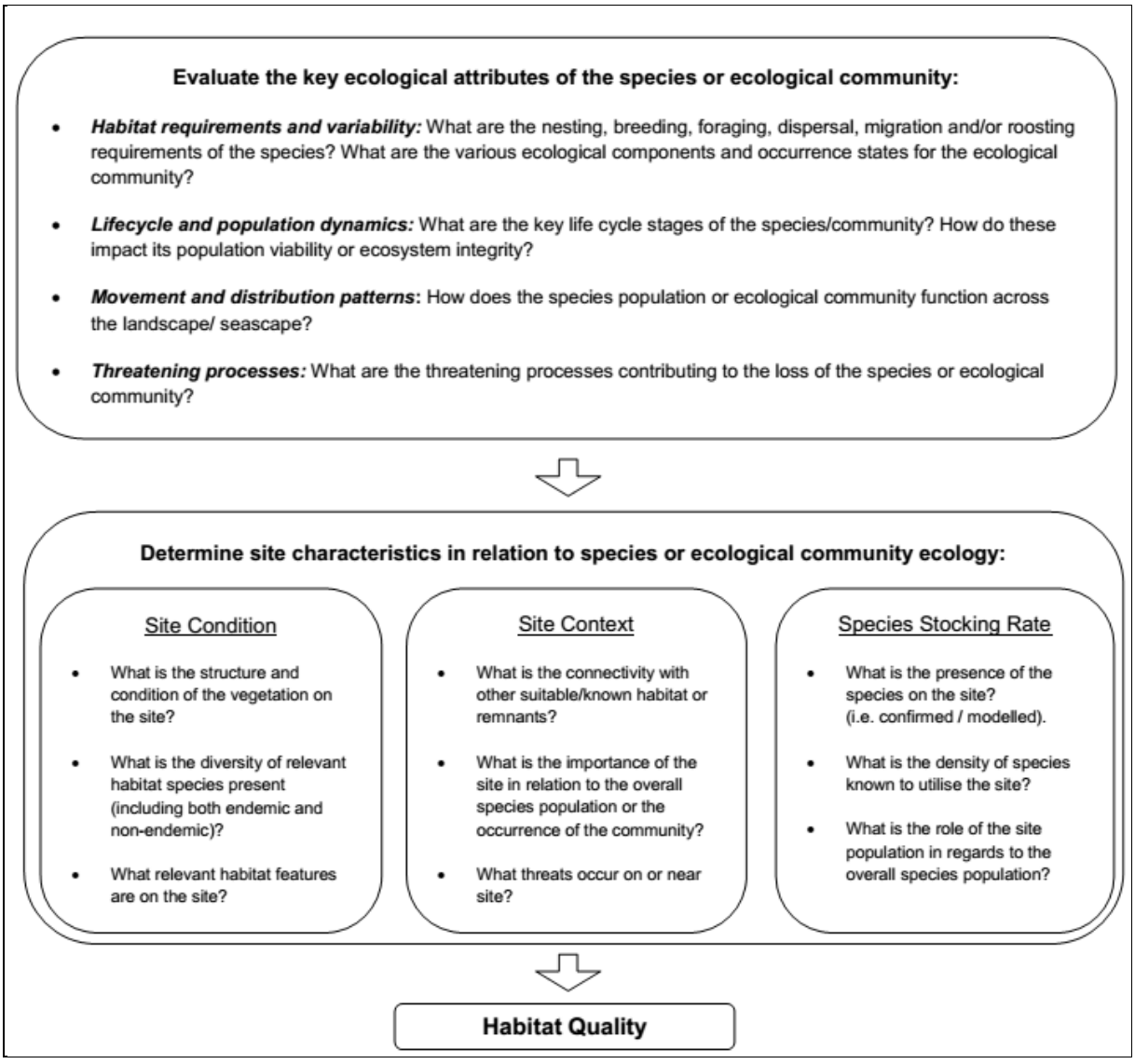

Figure 5-1

Key Considerations in Determining the Quality of Threatened Species and Ecological Community Habitat (*Figure 2 Australian Government 2012)*

The parameters used to determine the habitat quality score for golden sun moth were based on the three site characteristics defined in the EPBC Act Offset Guide: Site Condition, Site Context, and Species Stocking Rate (see **Figure 5-2**). Each of these Characteristic Scores has been broken down into sub-scores, the parameters of which are based on the key ecological attributes of golden sun moth. These have been selected as being representative of the issues facing golden sun moth, however, additional variables could be added with further analysis or available data. The parameters and the role they play in determining golden sun moth habitat are discussed in detail in the following sections with the analysis presented in **Table 5.9**.

Each score is based on current available information for the site and reflects the site quality at the time of assessment. The quality of these habitats may change over time, in response to climatic influences.

Site Condition

The Site Condition Characteristic Score has been separated into three component sub-scores: (a) vegetation structure, (b) vegetation condition, and (c) forage species diversity. Relevant habitat features (as noted under 'site condition' in **Figure 5-1**) is not included as a specific sub-score as habitat features important to golden sun moth (e.g. inter-tussock space and presence of forage species) are incorporated in the vegetation structure and species diversity sub-scores. This is in part an indication of the limitations to knowledge of this species and further research may identify habitat features (such as soil moisture, soil structure, etc.) that are important indicators of the suitability and condition of a site for golden sun moth.

A. Vegetation Structure

Vegetation structure is a reflection of the habitat type (i.e. grassland or open woodland) and the amount of inter-tussock space available (i.e. rank or open grassland). Golden sun moth typically occupies grassland; therefore, grassland structures score higher than woodland. This is important for sites that were originally in a woodland form but through habitat modification exist as derived grassland into which golden sun moths have migrated. For such sites, there is often a sparse shrub or remnant tree component in addition to a soil seed bank that if left unmanaged would result in the area reverting to a woodland overtime. This noted, however, habitat structure as with all site characteristics is assessed on what is observable in the present and includes no consideration of possible future states as these are subject to future management decisions which are not certain.

The species also requires inter-tussock space in which the females bask to attract males during breeding (i.e. flying) season, therefore, open grassland scores higher than rank grassland (Australian Gov't 2009b). The range of vegetation structure scores is shown in **Table 5.1**. Any vegetation type that does not fit into one of these categories is not considered to be golden sun moth habitat from a structural perspective and is highly unlikely to support the species.

Table 5.1 Vegetation Structure Sub-Scores for Golden Sun Moth

Score	Rationale
1	Grassy open woodland or shrubland. It is the least suitable of habitats that are occupied by golden sun moth.
2	Rank (i.e. overgrown) grassland.
3	Open grassland. Provides optimal habitat structure.

The vegetation condition sub-score considers the proportion of exotic to native species and the availability of golden sun moth forage species at the site. Scores are determined based on dominance to give an overall impression of the types of grass species that occur. Exotic species dominance is ranked lowest as it is considered to be a sign of poor ecosystem health and a detriment to biodiversity as a whole. It is noted that some exotic species (namely Chilean needle-grass) also provide habitat for golden sun moth (Australian Gov't 2015b). Often in such circumstances the population of golden sun moth within these exotic pastures is much higher than native communities. That aspect, however, is considered by the Species Stocking Rate Characteristic Score and is not a relevant consideration in the vegetation condition sub-score. This decision is justified on the basis that the ability for a weed species to provide habitat for one species (albeit critically endangered) should not be valued over the detriment such species pose to native ecosystems as a whole.

B. Vegetation Condition

Sites with mixed dominance, or dominance of native non-forage species (e.g. kangaroo grass) are given an equal score. This is considered appropriate as it is believed that the presence (not dominance) of forage species is enough to provide habitat for golden sun moth in some circumstances. Despite this, sites with a dominance of forage species are ranked the highest as they provide the most habitat resources for golden sun moth and are considered to be of a higher quality (Australian Gov't 2015b). The range of habitat vegetation scores that may be assigned is shown in **Table 5.2**.

Table 5.2 Vegetation Condition Sub-Scores for Golden Sun Moth

Score	Rationale
1	Dominated by exotic species (e.g. Chilean needle-grass).
2	Mixed exotic and native forage species dominance.
3	Dominated by native forage species (e.g. short wallaby grass and spear grasses).

C. Forage Species Diversity

The forage species diversity sub-score demonstrates the species richness (i.e. the number of species present at a site) and the evenness of the percentage cover for each species. It is important to note the difference between species richness (total number of species present) and species diversity (a function of species richness and abundance). Ideally, this score would be based on forage species diversity, however, this information has not been available for all golden sun moth habitats within the Project Area, and as such a general habitat diversity score has been applied to ensure consistency in the assessment. The range of scores presented here is outlined in **Table 5.3**.

Table 5.3 Forage Species Diversity Sub-Scores for Golden Sun Moth

Score	Rationale
1	Low species diversity.
2	Medium species diversity.
3	High species diversity.

Site Context

The Site Context Characteristic Score is a more complex component of habitat quality and is considered for the purpose of golden sun moth to be a function of the following sub-scores: (a) site connectivity, (b) site importance, and (c) threats.

A. Site Connectivity

For the purpose of this offset strategy, site connectivity is considered to be a function of the size of a habitat area, the distance between habitat areas, and the ability for individual golden sun moths to traverse this distance (termed 'permeability' herein).

Before a discussion of the range of values that may be assigned for connectivity, the concept of isolation must be articulated as it relates to golden sun moth. This species is known to be limited in its ability to disperse. Females are not able to traverse over any non-habitat substrate due to their inability or poor flying ability (ACT Gov't 2005a), and as such any break in habitat connectivity is considered an absolute barrier that females cannot cross. The distance that males will traverse depends upon the substrate they are travelling over. A substrate that consists of non-habitat grassland will be permeable for male golden sun moths up to a distance of 200 metres (ACT Gov't 2005a); whilst a substrate of concrete, water, bare ground or the like is taken on the basis of observation to be permeable up to a distance of 15 metres. Beyond this distance they are considered absolute barriers and male moths will not cross. In addition, features such as trees, shrubs, or buildings are an absolute barrier for male golden sun moth (Australian Gov't 2009c[133]). Effectively, any structure at the flying height of moths (up to 1.5 metres) will obstruct movement. It is unclear whether overhead structures are also a barrier as discussed in **Section 4.5.4;** however, for the purpose of this assessment it is assumed they are.

The connectivity sub-score expands the scale of analysis to a landscape level. For the purposes of this next calculation, all known occupied golden sun moth habitats that are not isolated by absolute barriers are considered a single patch. **Figure 5-2** presents a conceptual scenario where 'patch 1' is being assessed. In this scenario, the primary connections to proximate patches are considered for the purpose of the calculation. Assuming 'patch 2' is within 200 metres of 'patch 1' and the intervening space is unoccupied grassland/pasture, these two patches would be considered as one but with an internal connectivity affected by the distance and nature of the intervening space. 'Patch 3' being a secondary connection to 'patch 1' is not included despite being within 200 metres of 'patch 2'. This approach seeks to minimise the complexity of the model for the purpose of this assessment, however, there would be no limitation to the number of patches that might be considered should the information be available.

[133] Australian Government (2009c) *Background Paper to EPBC Act Policy Statement 3.12 – Nationally Threatened Species and Ecological Communities Significant Impact Guidelines for the Critically Endangered golden Sun Moth (Synemon plana)*, Department of the Environment, Water, Heritage and the Arts, Canberra.

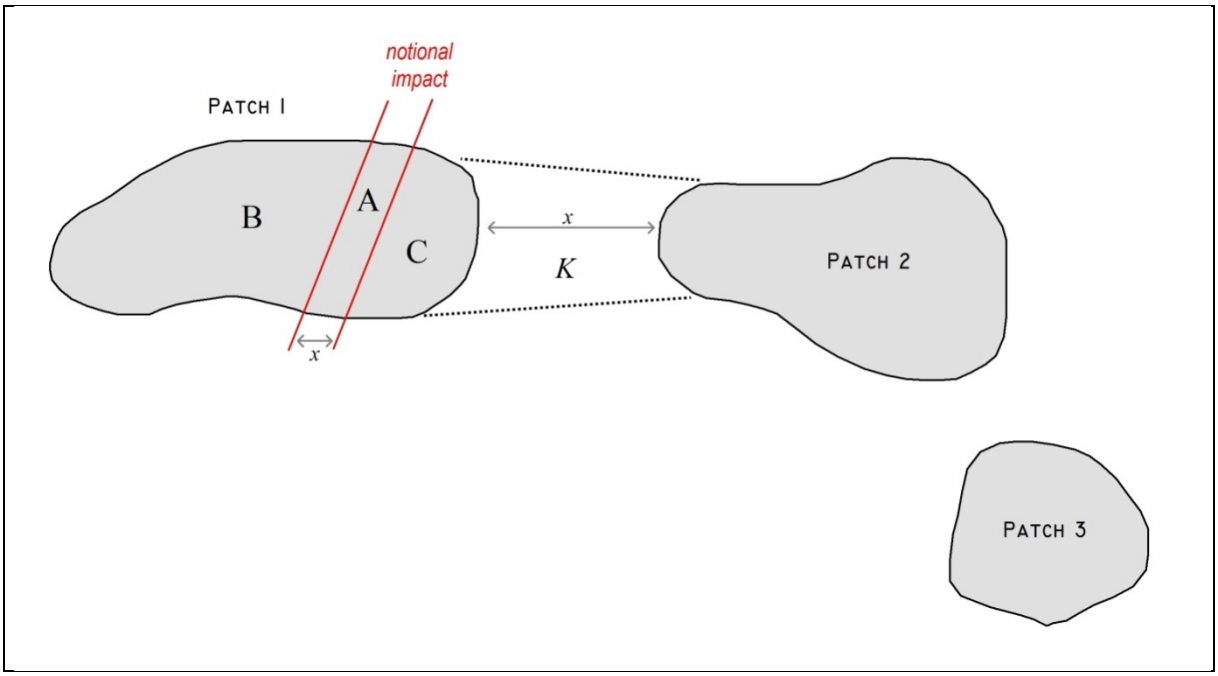

Figure 5-2

Habitat Connectivity Concept for Golden Sun Moth (not to scale)

Using this definition of a patch, all sub-patches are considered connected and golden sun moth movement between them is possible. However, as the distance between patches varies, the ease with which this may occur also varies. To assess the ease of movement between patches, the concept of permeability is used. Permeability is considered a function of distance and substrate, whereby the greater the distance between sub-patches, the less permeable the non-habitat substrate between them becomes.

Permeability (as a score out of 1) across different non-occupied (potential) or non-habitat grassland is determined using **Equation 1**. This equation is applied to different scenarios but with different values for X_{max} depending on the nature of the area across which permeability is being assessed. This calculation is completed for the shortest distance between all sub-patches that are not isolated ('X_n' values in **Figure 5-2**).

Equation 1: $P_{gsm} = 1 - (\frac{X}{X_{max}})$

Where:

P_{gsm} = the permeability score for golden sun moth

X = the smallest distance (metres) between two sub-patches, or the width of the impact area at its narrowest point through the patch

Constants for golden sun moth X_{max}:

Unoccupied grassland X_{max} = 200 metres

Non-habitat (e.g. road) X_{max} = 15 metres

The scenario presented in **Figure 5-2** indicates a notional impact area (labelled 'A') which in the pre-development stage would have a permeability of 100 percent meaning there is no limitation to movement. Post-development, assuming this represents the Ginninderra Drive extension the permeability will be a function of the width of the non-habitat substrate (road and shoulders) and the relevant X_{max} constant value. Should the width of the road in this hypothetical scenario exceed 15 metres, the resultant permeability would be zero meaning that it is an absolute barrier.

For a patch that contains an absolute barrier within a permeable substrate, such that golden sun moths are able to move around the barrier (e.g. a patch of trees or a building surrounded by grassland), the permeability score for the area containing the building will be zero. The permeability score of the permeable substrate would be calculated using the methods described above.

The permeability score for the entire patch is taken as the average of all permeability scores applicable to that patch.

The connectivity sub-score of a patch is determined by applying the patch permeability score to the total area of permeable non-habitat substrate within the patch and adding this to the total area of habitat, per **Equation 2**. This gives a weighted average of the permeability of a patch based on area by assigning a permeability of 1 to the habitat sub-patches.

Equation 2: $C = \sum_{1 \to n} (A_i \times P_i)$

Where:

C = connectivity raw score

A_i = area of each discrete patch

P_i = permeability score for each discrete patch

By calculating connectivity in this way, the maximum score will be achieved when the entire patch contains golden sun moth habitat. Patches will score lower depending upon the proportion of golden sun moth habitat to permeable substrate within it and the level of permeability of the substrate. See **Box 1** for a worked example of this concept.

Box 1 – Determining the Connectivity Score of the Patch Shown in Figure 5-2

In this example, patches 1 and 2 represent the extent of the patch being assessed relative to an impact in patch 1. The non-habitat substrate between the patches for this example is taken to be pasture and the X_{max} score to be used is 200 in the application of **Equation 1**.

If it is assumed the 'X' value between patch 1 and 2 is 133 metres; the corresponding P score for the area 'K' would be 0.335 (33.5%) as follows:

Equation 1*

$$P_K = 1 - \frac{133}{200}$$

$$P_K = 0.335$$

Secondly, it is assumed the area of patch 1 is 7.07 hectares and the area of patch 2 is 5.8 hectares, the effective patch area (occupied habitat) is 12.87 hectares despite being distributed across a much larger area. The total patch area is also considered to include intervening non-habitat which is permeable to golden sun moth and facilitates movement between proximate patches (indicated as area 'K' in **Figure 5.2**, assumed to be 3.09 hectares).

The connectivity sub-score of this patch is calculated using the formula in the following worked example which assumes the permeability within patches 1 and 2 is 100%. It is also noted that in this example, the sub-patches 'A', 'B' and 'C' are not relevant as they depict the post development scenario:

Equation 2*

$$C = (A_1 \times P_1) + (A_2 \times P_2) + (A_K \times P_K)$$

$$C = (7.07 \times 1) + (5.8 \times 1) + (3.09 \times 0.335)$$

$$C = 13.91$$

The result of this calculation is 13.91, which represents the effective habitat inclusive of occupied and unoccupied habitat or areas of non-habitat providing connectivity. It should not be interpreted as the area in hectares but as a figure for comparison to the post development scenario where the impact of removing sub-patch 'A' can be assessed for its importance to the overall patch. This score is taken as the initial raw connectivity score for the patch which is converted to a score out of 5 based on the proportion that the value of '*C*' represents in comparison to the sum of areas used in **Equation 2**.

There are some assumptions inherent in this methodology due to the simplification of the movement of golden sun moth between patches. The first is that it has been assumed that golden sun moth will use the shortest route between patches. This decision has been made so all sub-patches with a least one point of connectivity will be included within a patch and because it is considered inefficient to calculate the distances of all possible straight line routes between sub-patches patches that golden sun moth could take. This may have the effect of over-valuing the connectivity between sub-patches as calculations are based on the best point of connection as opposed to the average or marginal points of connection.

In addition, by applying the same permeability score to the entire non-habitat substrate within a patch, the permeability variability throughout this substrate is also highly simplified. With more detailed field assessment of habitat variability and with the use of larval count, pupal case count or counts of female moths as opposed to flying males, a greater level of detail would be possible with which to characterise internal patchiness of an occupied area. This level of information is not available and as described in **Section 3.3.1.5** would be inefficient and impractical to collect.

Whilst these limitations are noted, they are not believed to affect the overall effectiveness of the offset strategy as the same calculations are being applied to quality assessments for impacted and offset areas. Also the connectivity sub-score represents one ninth of the overall habitat quality score being used for the proposed offset strategy, which in itself is one score of many that are utilised in the EPBC Offset Guide. Given this, and the fact that only integers may be input in the EPBC Act Offset Guide, the effect of these limitations on one sub-score is considered negligible.

B. Site Importance

The site importance sub-score is considered to be a function of habitat size and the permeability of the patch (calculated by **Equation 1**); and demonstrates the importance of the impacted habitat in relation to the affected population based on other known golden sun moth habitat within the ACT. The following matrix (**Figure 5-3**) has been used to derive this score for the impact and offset sites respectively. It is important to note that when assessing the offset site the 'curve' and values in this matrix are reversed, this recognises that a small isolated patch is a poor offset (i.e. has low importance) due to a greater influence of edge effects and maintenance costs. Whereas an impact that removes an isolated patch is of greater importance to the species' conservation.

Impact Site – Importance Matrix

size class (patch)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
5	1	1	1	1	1	1	1	1	1	1
4	2	2	2	2	2	2	2	1	1	1
3	3	3	3	3	3	2	2	2	1	1
2	4	4	4	3	3	3	3	2	2	1
1	5	5	4	4	4	3	3	2	2	1

Residual permeability of impacted area

Offset Site – Importance Matrix

size class (patch)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
5	2	3	3	4	4	4	5	5	5	5
4	2	2	3	3	3	4	4	4	4	4
3	1	2	2	2	3	3	3	3	3	3
2	1	1	1	2	2	2	2	2	2	2
1	1	1	1	1	1	1	1	1	1	1

Residual permeability of offset

Figure 5-3

Impact and Offset Site Importance Matrices

The site importance matrix is based on two inputs: size class of the affected patch (e.g. Patch 1 in **Figure 5-2**) and residual permeability for the impacted area (e.g. sub-patch 'A' in **Figure 5-2**). The range of scores presented has been based on a general risk assessment matrix where the combination of area and permeability gives a score for importance for use in the calculation. This describes the importance of the affected area to the population and indicates that a large impact to permeability (low number on X-axis) will be very important in a small patch but of only minor importance to a big patch. It assumes that very large patches are highly resilient to any impacts while the smaller patches are increasing susceptible to more substantial impacts.

The size class is determined based on the categories outlined in **Table 5.4**, noting that this is the patch size, not necessarily the area of golden sun moth habitat. The reasons for this are explained below.

Table 5.4 Patch Size Score for Golden Sun Moth

Score	Patch Size (ha)
1	0 – 14.9
2	15 – 74.9
3	75 – 124.9
4	125 – 159.9
5	160 and greater

The range of the size classes are determined using existing knowledge of occupied golden sun moth habitats in the ACT. Action Plan 27 identifies the areas of lowland grasslands known to contain golden sun moth populations. The areas of these grasslands were graphed in size order from smallest to largest, and a logarithmic curve fitted to the data (refer to **Figure 5-4**). This curve was used to define the size classes such that an equal weight was given to small or moderate size habitat patches, and higher scores given to the larger patches to reflect the pattern of habitat size distribution in the ACT.

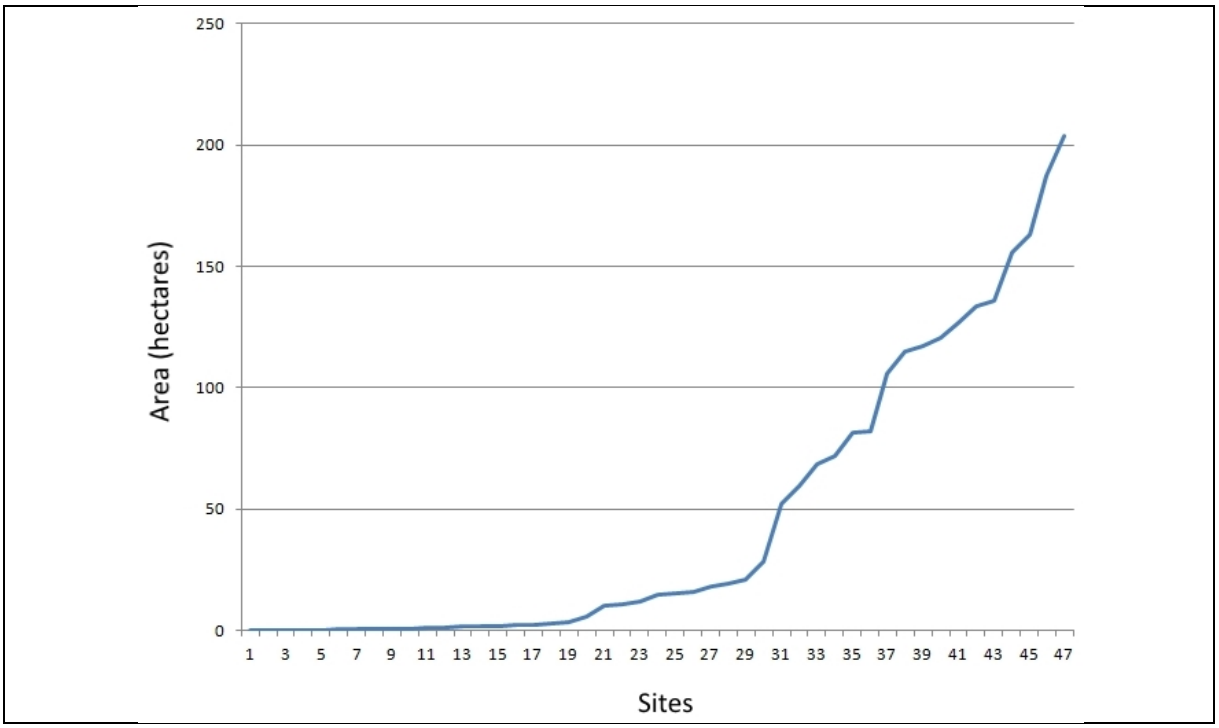

Figure 5-4

Size of golden sun moth patches in Action Plan 7

This system is based on the general assumption that bigger habitat areas are better than smaller ones. However it is unknown what the minimum thresholds are for habitat size in relation to golden sun moth population viability. In future, pending further scientific investigation, a minimum patch size may be incorporated into this scoring system to reflect the minimum habitat size that can host a viable golden sun moth population. The same may be said for larger patches, and identifying the point (if any) after which patch size does not affect the viability or size of a golden sun moth population.

The key limitation of this methodology is that the data set used is ten years old, and since this time many more golden sun moth populations have been identified in Canberra (Mulvaney 2012). Despite not having access to a full inventory of current ACT golden sun moth habitat areas, it is considered likely that the sample is large enough to reflect the size trend of the population as most of the new sites described as being small and isolated (Rowell 2013).

This data is also based on the size of the grasslands, and this does not necessarily reflect the total area of golden sun moth habitat present. Due to the variety in reporting methods for the species, it is difficult to access data in the same format. It is, therefore, most likely that these areas have all been overestimated, however, the effect of this on the Habitat Quality Score is considered negligible, given that it applies to all data being utilised for the golden sun moth habitat quality assessments.

The threats sub-score is based on the presence and intensity of the threats identified in the Commonwealth species profile for golden sun moth. The Commonwealth Golden Sun Moth Conservation Advice (Australian Government 2013) noted six types of threats: habitat loss, habitat fragmentation, isolation of populations, habitat degradation, agricultural practices, and weed invasion. Given the considerable overlap and multiple drivers of these threats, they were narrowed into five specific threats for the purposes of this offset calculation:

- weed invasion (i.e. non-forage species, not necessarily exotic plants)
- under or over grazing
- pesticide use
- inappropriate fire; and
- fertiliser use.

It should be noted that both grazing and fire may be used as management tools without being considered a threat to golden sun moth as long as they occur within the tolerance thresholds of the species.

Each of the five threats above is assigned a score out of 2 based on the presence and intensity of threats at the site, the criteria for which is outlined in **Table 5.5**. The overall threat sub-score is the sum of scores for each threat and has a maximum of 10.

Table 5.5 Threat Intensity Scores for Golden Sun Moth

Score	Rationale
0	Threat absent.
1	Low intensity threat.
2	High intensity threat.

Species Stocking Rate

The Species Stocking Rate Score is an estimate of the number of golden sun moth that occupies a site. For the purpose of this assessment, this score has been separated into three sub-scores: species presence, species density, and role of site.

The species presence sub-score is a simple three-tiered scoring system (**Table 5.6**) that scores highest when golden sun moth are known to occupy a site.

Table 5.6 Species Presence Scores for Golden Sun Moth

Score	Rationale
0	Golden sun moth are absent from the site.
1	Models predict that golden sun moth might occupy a site.
2	The presence of golden sun moth at the site has been confirmed.

Species density has been scored based on the following six tiered system. This sub-score is somewhat subjective given the variability of golden sun moth observations between and during survey efforts and the lack of objective methods to determine the species density at a site. The justification for the score given will be provided. The sub-score values are presented in **Table 5.7**.

Table 5.7 Species Density Scores for Golden Sun Moth

Score	Rationale
0	No golden sun moth present.
1	Very low numbers of golden sun moth observed during surveys.
2	Low numbers of golden sun moth observed during surveys.
3	Low to moderate numbers of golden sun moth observed during surveys.
4	Moderate numbers of golden sun moth observed during surveys.
5	High numbers of golden sun moth observed during surveys.

The role of site sub-score relates to the importance of the population from a national perspective. The aim of this is to reflect the role of the site in population dynamics of the species and thus provide higher scores to populations that play a larger role in this regard, regardless of their density. The scores are assigned based on the number of important population criteria that are met, as defined in the Significant Impact Guidelines in relation to species listed as vulnerable under the EPBC Act. Criteria for an 'important population' are:

- key source population for either breeding or dispersal
- population that is necessary for maintaining genetic diversity; and
- population that is near the limit of the species' range.

These criteria are considered appropriate as they are established in policy and although intended to be applied to an impact assessment for vulnerable species, they describe characteristics of populations that are ecologically important. Where these criteria are applied for assessment of a vulnerable species, should a population meet any criterion it would be considered as being 'important' for the purpose of impact assessment. As the intention of the assessment under the offset calculation is to determine relative importance, it is appropriate to recognise a population meeting all three criteria as being of greater importance that a population meeting only one criterion.

Scores are assigned based on the system defined in **Table 5.8**.

Table 5.8 Role of Site Sub-Score for Golden Sun Moth

Score	Rationale
0	None of the important population criteria met.
1	One important population criterion met.
2	Two important population criteria met.
3	Three important population criteria met.

Determining Habitat Quality

As the EPBC Act Guide requires integer scores out of 10, each of the above raw scores was transformed prior to being combined for the final Habitat Quality Score. The transformation is described by **Equation 3.**

Equation 3: $X' = bX$

Where:

X' = transformed score

$$b = \frac{maximum\ transformed\ score}{maximum\ raw\ score}$$

X = raw score

For the purpose of this calculation, all components of the Habitat Quality Score were considered equal. As such, the final Habitat Quality Score is an equally weighted average of the transformed component scores, rounded to the nearest integer.

Despite each sub-score being weighted equally, due to the raw score range of some of the scores being different, it is noted that a single step change in some individual components will have a larger effect on the overall habitat quality score than others.

5.2.1.2 Offset Package Analysis for Golden Sun Moth

The offset package for golden sun moth is comprised of four components reflecting the intent of the EPBC Act Offset Policy Australian Government (2012a). The constituent elements are as follows:

1. Replacement of the offset areas established for prior developments. This component of the offset package preserves the original area of land set aside under the offset packages for the Lawson south and Macgregor west developments. This includes replacement of:

    a. areas of habitat for MNES

    b. other areas of offset land impacted which are not habitat for MNES; and

    c. implementation of measures to ensure outcomes of managing the replacement offset areas are consistent with the commitments established under the original approvals and offset management plans for Jarramlee and Macgregor

2. Offset of the impact on GSM from the current development proposal (the Program). This component seeks to establish an offset consistent with the policy that compensates for the residual significant impacts of the current development. This is in addition to the offset component in item 1 above and includes impacts to GSM habitat which is not within the existing offset areas.

3. Compensation for the loss of strategic benefits for overall patch size and connectivity between patches provided by the original decision to collocate the Jarramlee and Macgregor offset sites. This component which is less quantitative than the first two focuses on enhancing connectivity over a larger area than what was possible under the EPBC Act Part 9 approvals for the Lawson south and Macgregor west development approvals. This component is addressed in part through the commitments for habitat quality improvement under item 2 above.

Items 1 and 2 above are described further in the following sections while the broader strategic component of the offset package relating to golden sun moth and biodiversity in general is discussed in **Section 5.3**.

The offset is comprised of both occupied and unoccupied habitat. Areas described as unoccupied habitat are those where the requisite site condition and context categories are met but through field survey, presence of golden sun moth has not been confirmed. The inclusion of unoccupied habitat allows for the consideration of translocation techniques in compensating for impacts elsewhere. Typically, translocation is not desirable as generally habitat which is suitable for certain species will be occupied and the effect of translocation is to simply increase competition for resources in the receiving site and is likely to result in population decline regardless. In the case of the offset package proposed for golden sun moth, translocation of larvae from areas affected by the Ginninderra Drive extension into an area that is presently unoccupied would not adversely affect an existing resident population in the receiving site. Also given the relative inability for golden sun moth to naturally expand into new areas, by reintroducing moth larvae into areas that presently do not support them, not only will the area of occupied habitat increase but the connectivity will be enhanced through improving permeability between existing patches on the offset sites.

Accordingly the strategy for golden sun moth is appropriate.

Replacing the Offset

As compensation for the impacts to the established Jarramlee and Macgregor offset sites, an area of 1.8 hectares of golden sun moth habitat of equivalent quality will be protected within Lot 2 Wallaroo Road. This area is comprised of occupied golden sun moth habitat which occurs along the ACT-NSW border adjacent to the Dunlop Grasslands Nature Reserve. Given the shared boundary with the Dunlop Grasslands Nature Reserve, this presents an equivalent context to which the original Jarramlee and Macgregor offsets presented. It is characterised by a high degree of connectivity to a larger population within the ACT which is also within an existing protected area. Active management for conservation of golden sun moth in this section of Lot 2 Wallaroo Road will complement conservation values within Dunlop Grasslands Nature Reserve and ensure the expected improvements to habitat quality in the original offsets are achieved through this component of the Lot 2 offset site.

As a consequence of this, the original quantum of offset will be replaced with equivalent habitat with the incorporation of all management commitments in existing management plans into a consolidated offset management plan as part of the WBCC RMP. This will achieve all the stated outcomes of the original offsets and further contribute to the offsets committed to under the Program.

Offsetting the impact

Surveys undertaken during the 2014 – 15 flying season for golden sun moth were undertaken across both of the existing offsets and across sites considered suitable for use as offsets (Rowell 2015). In addition to existing information for the established offsets, the updated surveys provided data relevant to the entire area. This was important as previously information for the Macgregor offset relied on moth densities as an estimate of habitat quality. By comparison, the data for the Jarramlee offset was based on a habitat suitability assessment correlated with historical observations of golden sun moth and an understanding of the species' habitat preferences. The differing data sets limited the ability to undertake an assessment of the quality of the existing offset sites and potentially compare them with other available offsets.

The following **Table 5.9** considers the direct impacts of the Program on golden sun moth and corresponding performance of the proposed offset package's preferred option of Lot 2 Wallaroo Road.

Table 5.9 Assessment of the Direct Offset Component for Golden Sun Moth

Variable	Value	Rationale
Impacted Site		
area of habitat (Ha)	1.8	Impact is comprised of the direct removal of up to 0.85 hectares of habitat and a likely reduction in quality to approximately 0.96 hectares of habitat as a result of overshadowing. A conservative approach is taken by assuming all directly and indirectly affected habitat will not retain functionality for golden sun moth and as such requires offsetting.
quality	7	The golden sun moth habitat to be removed or overshadowed by the Program is classified as native pasture or degraded native pasture (ACT Gov't 2013a; David Hogg Pty Ltd 2010). A moderate quality score of 7 is attributed to these areas, based on the sub-scores shown in the table below. The score predominantly arises from the Site Context components of the Habitat Quality Score. It should be noted that other areas within the Macgregor offset are of lower condition, however, this score reflects only the quality of the 1.8 hectares to be directly impacted.

	Impact site			Offset site		
	Raw	Trans.	Score	Raw	Trans.	Score
Site Condition						
structure (raw max=3)	*2.5*	*8.3*	*6.1*	*2.8*	*9.4*	*7.2*
diversity (raw max=3)	*1.5*	*5.0*		*2.3*	*7.7*	
habitat features (raw max=3)	*1.5*	*5.0*		*1.4*	*4.6*	
Site Context						
connectivity (raw max=5)	*4.1*	*8.3*	*6.4*	*4.8*	*9.5*	*5.9*
ACT importance (raw max=5)	*3.0*	*6.0*		*1.1*	*2.3*	
threats (raw max=10)	*8*	*8*		*6*	*6*	
Species Stocking Rate						
presence (raw max=2)	*2.0*	*10.0*	*7.1*	*0.8*	*3.8*	*2.6*
density (raw max=5)	*3.0*	*6.0*		*0.8*	*1.5*	
population importance (raw max=3)	*1.0*	*3.3*		*0.8*	*2.5*	
Start Quality (max=10)			**7**			**5**

Variable	Value	Rationale
Offset Site		
Averted Loss Factors		
time over which loss is averted	20	This is the maximum time period over which the EPBC Act Offset Guide is designed to function, it is appropriate for permanent impacts.
start area (Ha)	31	Lot 2 Wallaroo Road contains a total of 31 hectares of golden sun moth habitat including one section of EPBC listed natural temperate grassland (not considered in this assessment or required to be offset). This area includes both occupied (11.9 Ha) and unoccupied habitat (19.4 Ha) which under the offset package will be all enhanced to achieve the predicted connectivity and quality improvements. This area excludes a further 1.8 hectares of golden sun moth habitat which is to be assigned as replacement for impacts to golden sun moth habitat under the footprint of the Ginninderra Drive extension.
risk of loss without offset	5%	The land is currently vested in the ACT Government (recently under ownership of the Commonwealth) and has been purchased for the purpose of providing a biodiversity offset for this project. It is unlikely that golden sun moth will be lost even in the event that the Program is abandoned. This represents risk of loss due to unpredictable stochastic events only.
risk of loss with offset	5%	Rezoning and management actions implemented as a result of the transfer to offset will ensure the golden sun moth population is secure and accordingly there is only a very low risk of loss. Only unforeseeable factors would result in the species loss from the offset sites.
confidence in result	90%	The change in tenure will facilitate the implementation of a management plan for the site. This management plan will be targeted towards the protection and enhancement of golden sun moth habitat within the proposed environmental offset area. This allows there to be a high confidence in the result.
Habitat Quality Factors		
time until ecological benefit (**see*	10	Lot 2 Wallaroo Road has been purchased by the ACT Government for the purpose of establishing a biodiversity offset. This will facilitate early commencement of grassland rehabilitation activities on the offset site well in advance of the impact occurring. Consequently, it is anticipated that although there is in the order of 20 years from the present until the likely timing of the impact, the ecological benefits predicted will be realised within 10 years after the impact occurring, some 30

<table>
<tr><th>Variable</th><th>Value</th><th>Rationale</th></tr>
<tr><td>note below)</td><td></td><td>years from present. This reflects the challenges in rehabilitating native grassland and reintroduction of golden sun moth.</td></tr>
<tr><td>start quality</td><td>5</td><td>Golden sun moth habitat within Lot 2 Wallaroo Road occurs in natural temperate grassland and Austrostipa spp. grassland. Part of this habitat is connected to Dunlop Grassland Nature Reserve, which also contains golden sun moth.

The Start Habitat Quality Score of 5 reflects the overall condition of the occupied golden sun moth habitat and its connectivity to Dunlop Grassland Nature Reserve. The remainder of the component sub-scores remain fairly average.</td></tr>
<tr><td>future quality without offset</td><td>5</td><td rowspan="2">Without the establishment of an offset, it is expected that the habitat quality within Lot 2 Wallaroo Road will decline marginally, however, not to the extent that quality over the life of the Program diminishes substantially below current quality. This figure can be calculated following the example of habitat quality provided above with impacts to quality affecting site condition and stocking rate. A value of 5 has been calculated here, per the scores defined in the table below.

The establishment of the offset is proposed to reduce the threats present at the site, and improve the condition of the golden sun moth habitat and greatly improve connectivity through existing and future golden sun moth habitat. A value of 8 has been calculated here, per the scores defined in the table below. Given the proposed enhancement of existing unoccupied habitat and creating connectivity through grassland rehabilitation, the table below gives the weighted scores for assessment of areas that include occupied and unoccupied habitat which as a result of the offset package will all be considered occupied habitat upon realisation of the strategy.
<table>
<tr><th></th><th colspan="3">Without offset</th><th colspan="3">With offset</th></tr>
<tr><th></th><th>Raw</th><th>Trans.</th><th>Score</th><th>Raw</th><th>Trans.</th><th>Score</th></tr>
<tr><td>Site Condition</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>structure (raw max=3)</td><td>2.0</td><td>6.7</td><td rowspan="3">5.6</td><td>3.0</td><td>10.0</td><td rowspan="3">8.3</td></tr>
<tr><td>diversity (raw max=3)</td><td>2.0</td><td>6.7</td><td>2.5</td><td>8.3</td></tr>
<tr><td>habitat features (raw max=3)</td><td>1</td><td>3.3</td><td>2</td><td>6.7</td></tr>
<tr><td>Site Context</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>connectivity (raw max=5)</td><td>4.4</td><td>8.9</td><td rowspan="3">5.7</td><td>8.9</td><td>10.0</td><td rowspan="3">9.7</td></tr>
<tr><td>ACT importance (raw max=5)</td><td>3.0</td><td>2.3</td><td>2.3</td><td>10.0</td></tr>
<tr><td>threats (raw max=10)</td><td>5</td><td>6</td><td>6</td><td>9</td></tr>
<tr><td>Species Stocking Rate</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>presence (raw max=2)</td><td>0.8</td><td>3.8</td><td rowspan="3">2.4</td><td>2.0</td><td>10.0</td><td rowspan="3">7.1</td></tr>
<tr><td>density (raw max=5)</td><td>0.4</td><td>0.8</td><td>2.4</td><td>4.8</td></tr>
<tr><td>population importance (raw max=3)</td><td>0.8</td><td>2.5</td><td>2.0</td><td>6.7</td></tr>
<tr><td>Future Quality (max=10)</td><td colspan="3">5</td><td colspan="3">8</td></tr>
</table>
</td></tr>
<tr><td>future quality with offset</td><td>8</td></tr>
</table>

Variable	Value	Rationale
confidence in result	50%	The proposed improvement in habitat quality comes predominantly from a reduction in the threats to golden sun moth and implementation of measures to improve connectivity, habitat quality and the extent of occupied habitat. A moderate level of confidence is justified given that many areas of the existing Jarramlee offset that presently support golden sun moth were formerly part of a sewerage treatment works which has been rehabilitated to native grassland and supports golden sun moth. However achievement of the quality improvement within the timeframe introduces some uncertainty.
Overall Performance	**181.6 %**	**In adjusted hectares (as calculated by the offset calculator), the net performance of the proposed offset is as follows:** • **Quantum of impact = 1.26 hectares (adjusted)** • **Offset net present value = 2.29 hectares (adjusted)** • **Balance = 0.78 hectares (adjusted)** **The overall performance of the offset package to address the direct impacts of the Program result in an offset that significantly exceeds the 100 percent target.** **The overall 86.8 hectare offset site at Lot 2 Wallaroo Road caters for the following components:** • **1.8 hectares as replacement of impacted areas of occupied golden sun moth habitat;** • **11.9 hectares of occupied golden sun moth habitat;** • **19.4 hectares of unoccupied golden sun moth habitat; and** • **implementation of habitat restoration as a connectivity measure between Jarramlee and Dunlop Grasslands Reserve as committed to under the Jarramlee offset management plan. This will occur in areas not already committed to as offsets for the Program.** •

** Note regarding the consideration of ecological benefit:*

Although in real terms the ecological benefit in relation to golden sun moth will not be realised for 30 years, as the timing of the impact is the baseline for assessing suitability of the offset, it is appropriate to use the timing of the impact as the point from which the estimate of ecological benefit will be realised. Notwithstanding this, activities to facilitate the delivery of ecological benefit at 10 years subsequent to the impact occurring will commence with implementation of the WBCC RMP and associated offset management plans relevant to the Ginninderra Drive extension. Accordingly, a substantial amount of the overall ecological benefit will be delivered in advance of the offset occurring including dedication of Lot 2 Wallaroo Road and its management as an offset at least 20 years before the impact will occur. While this could be factored into a consideration of advance values delivered by the project, the analysis has taken a conservative approach by valuing only the end state wherein golden sun moth will be translocated and demonstrated to be occupying formerly unoccupied habitat. This is illustrated conceptually by **Figure 5-5**.

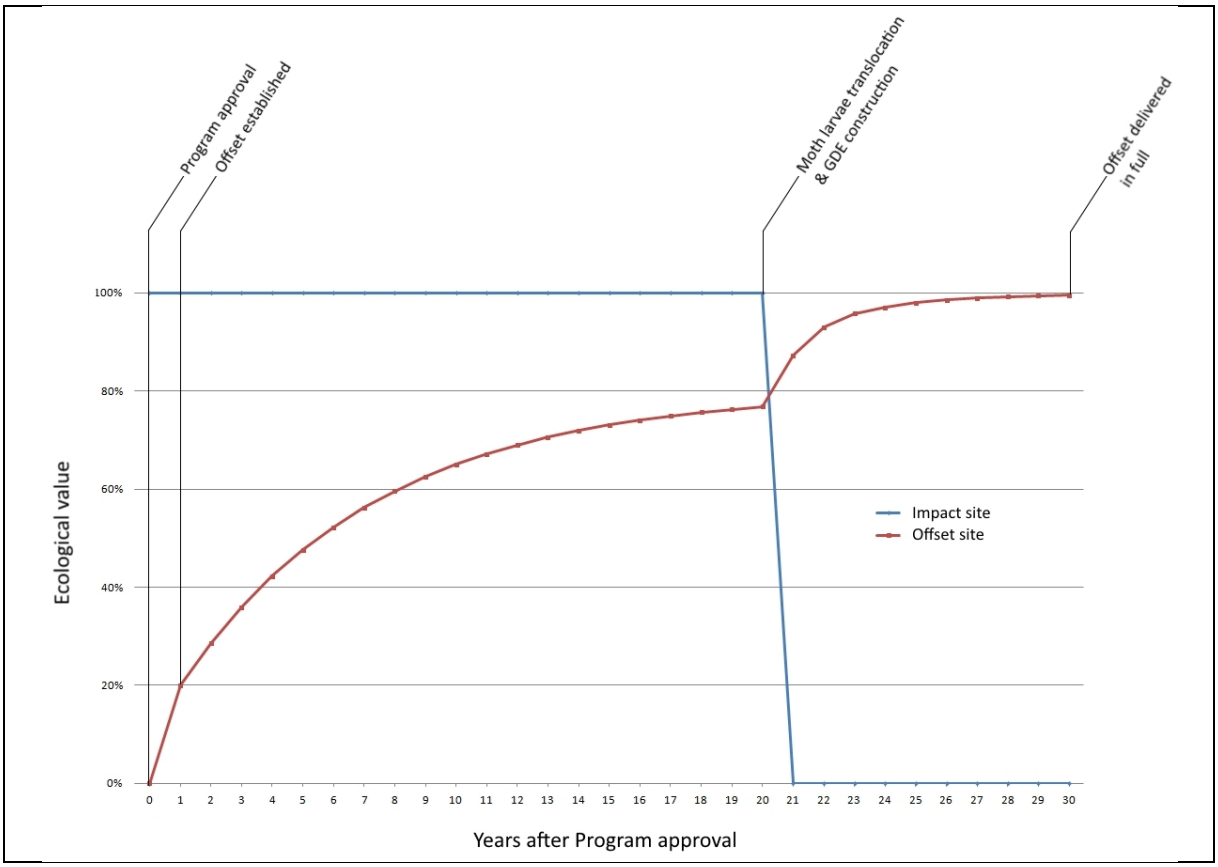

Figure 5-5

Comparison of Ecological Values on the Offset and Impact Sites

As illustrated in **Figure 5-5**, delivery of the golden sun moth offset will commence some 20 years prior to the impact that will result in the removal of up to 1.8 hectares of occupied golden sun moth habitat occurring. It is important to note that the blue line representing the impact site reflects ecological values within 1.8 hectares of habitat, while the red line representing the offset site reflects the gain in ecological values across 33.1 hectares of occupied and unoccupied golden sun moth habitat.

The initial 20 years of improvement will be the result of habitat management of the 11.9 hectares of occupied habitat in addition to restoration of the 19.4 hectares of unoccupied habitat in preparation for larvae translocation. While these works are being delivered, routine management of the existing offset areas would also continue, the effect of which is not modelled in **Figure 5-5**. At the point when larvae translocation occurs, it is predicted that the majority of ecological values will have been achieved in the combined 33.1 hectares of the offset on Lot 2 Wallaroo Road. This is comparable to industry experience in assessing offsets generally with the exception that the bulk of the golden sun moth offset for Ginninderra Drive extension will occur before the ecological effects of construction occur.

5.2.2 Pink-Tailed Worm-Lizard

As for golden sun moth, the EPBC Act Offset Guide was used to assess suitability of the proposed offset site for offsetting impacts to pink-tailed worm-lizard. The following sections outline the scores used for each component of the guide with an associated rationale.

The exception to this is the habitat quality score, which is discussed in detail in **Section 5.2.2.1**.

5.2.2.1 Pink-Tailed Worm-Lizard Habitat Quality Score

The EPBC Act Offset Guide outlines the key considerations for determining the habitat quality for threatened species. This is summarised in **Figure 5-1**. Similar to golden sun moth, the parameters used to determine the Habitat Quality Score for pink-tailed worm-lizard were based on the three site characteristics defined in the EPBC Act Offset Guide: Site Condition, Site Context, and Species Stocking Rate (see **Figure 5-1**). Each of these Characteristic Scores has been broken down into sub-scores, the parameters of which are based on the key ecological attributes of pink-tailed worm-lizard. These have been selected as being representative of the issues facing pink-tailed worm-lizard, however, additional variables could be added with further analysis or available data.

Additional variables to describe the 'quality' of a given site may be derived through a review of the scientific literature pertaining to pink-tailed worm-lizard. However as a result of a lack of available data across the species' ACT distribution (at least) the variables for this analysis were selected on the basis of information which allows for an assessment of relative quality on a consistent basis. Additional variables that may become better understood with future research may include factors such as:

- presence, diversity and dominance of different species of ants that may be predated upon by pink-tailed worm-lizards; and

- presence or abundance of other habitat features that provide resources for prey ant species such as *Iridomyrmex* spp., in particular *I. rufoniger* (Wong *et al.* 2011[134]) and their associated prey or symbionts that may be more easily detected than the largely subterranean pink-tailed worm-lizard, e.g. larvae/pupae of imperial blue butterflies (*Jalmenus evagoras*) are attended by ants, often *I. rufoniger* (Pierce and Nash 1999[135]) which is also strongly associated with pink-tailed worm-lizard.

Parameters selected for the analysis and the role they play in determining pink-tailed worm-lizard habitat are discussed in detail in the following sections.

Site Condition

The Site Condition Characteristic Score has been separated into three component sub-scores: (a) vegetation structure, (b) species diversity, and (c) relevant habitat features. Site condition (as noted under 'site condition' in **Figure 5-1**) is not included as a specific sub-score as condition variables that are important for pink-tailed worm-lizard are addressed as part of the species diversity sub-score.

Unlike the scoring system for golden sun moth, each of these component sub-scores is not weighted equally when combined to create the Site Condition Score for pink-tailed worm lizard. The assigned weights are based on the results of an environmental factor analysis by Wong (2013), which determined that percent cover of large native tussock forming grasses, FVS, and percent cover of rocks had a 46 percent, 33 percent, and 10 percent influence respectively on pink-tailed worm-lizard abundance at the patch scale in the ACT. While it is noted that the presence of rocks is a variable factor determining the abundance of pink tailed worm lizard across its distribution, in the ACT it is positively associated with the presence of the species.

[134] Wong DTY, Jones SR, Osborne WS, Brown GW, Robertson P, Michael DR and Kay GM (2011) 'the life history and ecology of the Pink-tailed Worm-lizard *Aprasia parapulchella* Kluge – a review', *Australian Zoologist* **35(4)**, pp. 927-940

[135] Pierce NE and Nash DR (1999) 'The Imperial blue: *Jalmenus evagoras* (Lycaenidae)' chapter 18 in *Monographs on Australian Lepidoptera Volume 6: Biology of Australian Butterflies*, eds. RL Kitching, E Scheermeyer, RE Jones and NE Pierce. CSIRO Publishing

Based on this, the vegetation structure sub-score is transformed so as the maximum is 5 and the species diversity sub-score is transformed so as the maximum is 3. The relevant habitat features sub-score has not been transformed so the maximum score remains at 1. The proportional distribution of these scores generally follows the results of Wong (2013).

The Site Condition Characteristic Score is the sum of these transformed scores, and has a maximum of 9. The vegetation sub-score contributes a maximum of 5 of the 9 points, the species diversity sub-score contributes a maximum of 3 of the 9 points, and the relevant habitat features sub-score contributes to the final point.

A. Vegetation Structure

The vegetation structure sub-score is considered to be the percentage cover of native tussock forming grasses (e.g. kangaroo grass), expressed as a decimal. Given that pink-tailed worm-lizards occur in woodland, mallee, and forest in addition to grassland, the presence of trees is not considered a good indication of their presence at a site (Australian Gov't 2015b). Instead, the percentage cover of native tussock forming grasses has been shown to account for 46.1 percent of pink-tailed worm-lizard abundance at a patch scale in the ACT; more than floristic value score, percentage cover of rock, number of rocks, or density of ants (Wong 2013) which are also indicators of abundance. As a cover of tussock grasses at 100 percent would represent effectively a monoculture and rank grassland, a maximum of 60 percent tussock grass cover has been adopted as the optimal cover. As such the score used to derive this value is the proportion of 60 percent that the actual cover of tussock grasses represents. In the event that a site scores more than 60 percent, the maximum score possible is assigned as other measures contributing to site condition such as floristic value score (FVS) will reflect reduced species richness.

B. Species Diversity

The species diversity sub-score is a measure of the flora diversity at the site, and is a function of both the number of species and their percentage cover. For the purposes of this offset strategy, the FVS as defined by Rehwinkel (NSW Gov't 2007) has been used as a proxy for species diversity. This is appropriate as the FVS is in its most basic application is a measure of species diversity in grasslands, albeit with much wider applications and considerations. In addition the FVS has been shown to account for 32.9 percent of pink-tailed worm-lizard abundance at a patch scale in the ACT (Wong 2013). As such, the species diversity sub-score is considered to be a percentage of the maximum FVS (40), expressed as a decimal. Whilst a FVS may be higher than 40, this is rare and in an ACT context, all sites with a FVS of 40 or greater are considered to be of the highest quality (based on Umwelt's experience assessing ACT grasslands using this method).

C. Relevant Habitat Features

The final component of the Site Condition Characteristic Score is relevant habitat features, which in the case of pink-tailed worm-lizard is the presence and abundance of lightly embedded metamorphic surface rocks. There is little agreement as to the relationship between and thresholds of rock characteristics and pink-tailed worm-lizard abundance other than an acknowledgement that the presence of rocks is a positive influence on the abundance of pink-tailed worm-lizards in the ACT. As such, the relevant habitat features sub-score is simply a binary system based on the values described in **Table 5.10**.

Table 5.10 Relevant Habitat Features Sub- Score for Pink-Tailed Worm-Lizard

Score	Rationale
0	No lightly embedded metamorphic surface rocks present.
1	Lightly embedded metamorphic surface rocks are present.

Site Context

The Site Context Score is a more complex component of pink-tailed worm-lizard habitat quality and is considered to be a function of the following sub-scores: (a) site connectivity, (b) site importance, and (c) threats.

A. Site Connectivity

Site connectivity for pink-tailed worm-lizard is conceptualised in a similar manner as golden sun moth; that is as a function of the size of the habitat area, the distance between habitat areas, and the permeability of the non-habitat substrate.

The permeability of a patch is defined by a pink-tailed worm-lizard's limited dispersal abilities. A substrate of non-habitat native grassland is considered to be 100 percent permeable for the species (including if it forms the understorey of open grassy woodland); exotic tussock grassland is considered permeable up to distance of 20 metres; and bare ground permeable to a distance of two metres. These substrates will form an absolute barrier at distances greater than this. Absolute barriers also include paved roads, footpaths, or the like and buildings.

Similarly to golden sun moth (see **Section 5.2.1.1**), all occupied pink-tailed worm-lizard habitats that are not separated by an absolute barrier are considered a single patch (**Figure 5-2**) with all areas of occupied habitat considered sub-patches. The ease with which the species can move through a non-habitat substrate will vary based on distance, with sub-patches further away being less likely to be reached than closer sub-patches. As such, the permeability of the non-habitat substrate is determined using **Equation 1** but with appropriate constants reflecting the biological and life history characteristics of pink-tailed worm-lizard.

Equation 1: $P_{ptwl} = 1 - (\frac{X}{X_{max}})$

Where:

P_{ptwl} = the permeability score for pink-tailed worm-lizard

X = the smallest distance (metres) between two sub-patches

Constants for pink-tailed worm-lizard X_{max}:

Exotic tussock grassland X_{max} = 20 metres

Non-habitat (e.g. road) X_{max} = 2 metres

The permeability score for the entire patch is calculated by taking the average of all permeability scores applicable to that patch. The connectivity sub-score of a patch is determined using the same method described for golden sun moth in **Section 5.2.1.1** and **Equation 2**, and the same limitations apply.

Equation 2: $C = \sum_{1 \to n} (A_i \times P_i)$

Where:

C = connectivity raw score

A_i = area of each discrete patch

P_i = permeability score for each discrete patch

B. Site Importance

The site importance sub-score for pink-tailed worm-lizard is also conceptualised in a similar way as for golden sun moth. The aim of this sub-score is to demonstrate the importance of the site in relation to other known pink-tailed worm-lizard habitat areas within the ACT.

The matrix in **Figure 5.3** has also been used to calculate the site importance sub-score. This matrix scores habitats that are of a larger size class and with high permeability the highest.

The residual permeability is the patch permeability score from above, multiplied by 10. The size class is based on the categories outlined in **Table 5.11**.

Table 5.11 Patch Size Scores for Pink-Tailed Worm-Lizard

Score	Patch Size (m^2)	Patch Size (Ha)
1	0 – 1,000	0 – 0.1
2	1,001 – 4,000	0.1 – 0.4
3	4,001 – 22,000	0.4 – 2.2
4	22,001 – 99,000	2.2 – 9.9
5	99,001 and greater	9.9 and greater

The range of the size classes described in **Table 5.13** was determined using the habitat distribution within the Project Area as an analogue for the ACT. The areas of occupied pink-tailed worm-lizard habitat within the Project Area were graphed in size order from smallest to largest, and a sigmoidal curve fitted to the data on a logarithmic scale (refer to **Figure 5-6**). This curve was used to define the size classes such that larger habitat patches were given a higher score to reflect the shape of the curve and the rarity of patches of such size.

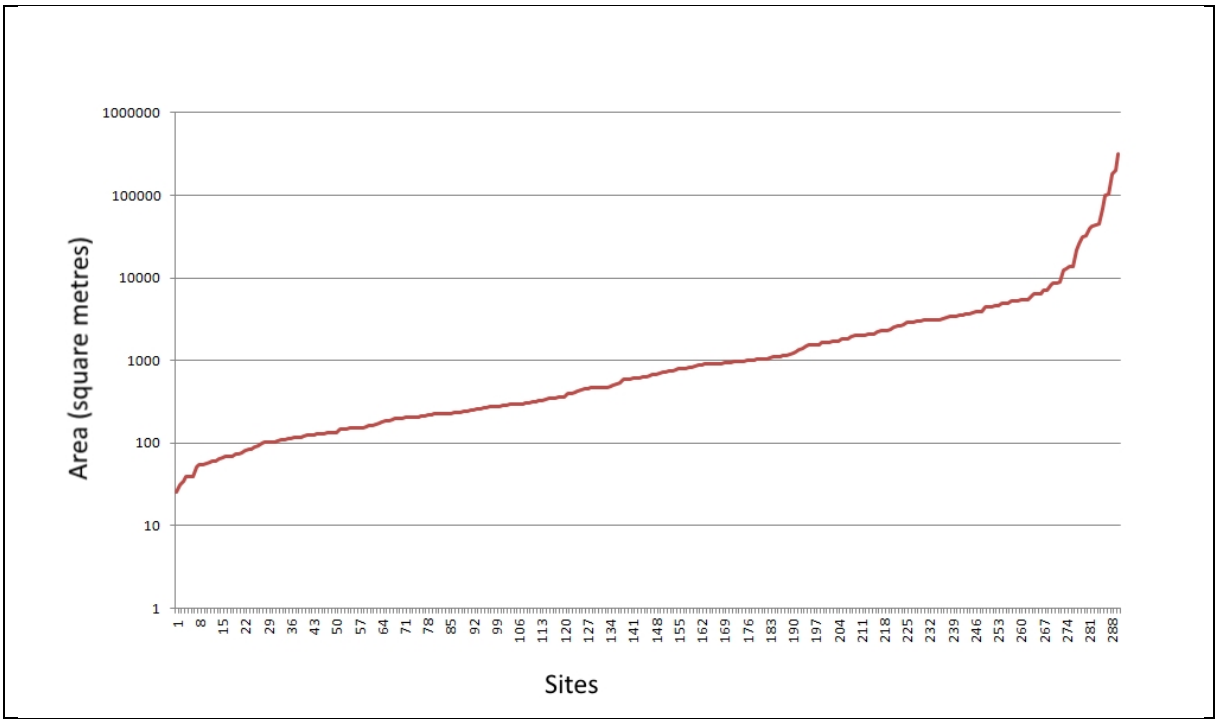

Figure 5-6

Size of pink-tailed worm-lizard patches in the Project Area

Again, this system is based on the assumption that bigger habitat areas are better than smaller ones, however, it is not known if there is a minimum patch size threshold to support a viable population of pink-tailed worm-lizard. Nor is it fully understood if there is a limit to patch size, above which it does not affect the viability of the population.

The Project Area was used as an analogue for the ACT as there was no ACT-wide patch scale data available for pink-tailed worm lizard. This is a limitation of the data set that is acknowledged, however, it is not believed that this would have a great effect on the overall Habitat Quality Score, given the number of components of the score and that the final score must be an integer for use in the EPBC Offset Guide.

C. Threats

The threats sub-score is based on the presence and intensity of key threats, as identified in Wong (2013) and the EPBC Act Conservation Advice for pink-tailed worm-lizard. These threats were identified as:

- pasture improvement
- overgrazing
- soil disturbance
- rock removal
- weed invasion
- inappropriate fire regimes and fire management activities

- recreational activities; and
- predation, especially increased vulnerability to foxes, cats following fires.

Each of these eight threats is assigned a score out of 2 based on the presence and intensity of the threats at the site (**Table 5.12**). The overall threat sub-score is the sum of scores for each threat and has a maximum of 16.

Table 5.12 Threat Intensity Scores for Pink-Tailed Worm-Lizard

Score	Rationale
0	Threat absent.
1	Low intensity threat.
2	High intensity threat.

Again, it should be noted that both grazing and fire may be used as management tools in sites that contain pink-tailed worm-lizard. These actions will only be considered a threat if they exceed the tolerance thresholds of the species which would be evidenced by degradation of habitat structure and diversity.

Species Stocking Rate

The Species Stocking Rate Characteristic Score is an estimate of the number of pink-tailed worm-lizard that occupies a site. For the purpose of assessing the suitability of the proposed offset strategy, this score has been separated into three sub-scores: species presence, species density, and role of site. The parameters for these sub-scores are the same for pink-tailed worm-lizard as for golden sun moth.

The species presence sub-score is calculated using the same three-tiered system as for golden sun moth (**Table 5.13**), whereby the score is highest when pink-tailed worm-lizard is known to occupy a site.

Table 5.13 Species Presence Scores for Pink-Tailed Worm-Lizard

Score	Rationale
0	Pink-tailed worm-lizard are absent from the site.
1	Models predict that pink-tailed worm-lizard might occupy the site.
2	The presence of pink-tailed worm-lizard at the site has been confirmed.

Similarly, the species density sub-score has also been based on the same six-tiered system as for golden sun moth (**Table 5.14**). Again, the definitions associated with each score bracket are subjective and rely on the assessor's knowledge of other pink-tailed worm-lizard populations as a point of reference.

Table 5.14 Species Density Scores for Pink-Tailed Worm-Lizard

Score	Rationale
0	No pink-tailed worm-lizard observed during surveys.
1	Very low numbers of pink-tailed worm-lizard observed during surveys.
2	Low numbers of pink-tailed worm-lizard observed during surveys.
3	Low – moderate numbers of pink-tailed worm-lizard observed during surveys.
4	Moderate numbers of pink-tailed worm-lizard observed during surveys.
5	High numbers of pink-tailed worm-lizard observed during surveys.

The role of site sub-score aims to reflect the importance of the population from a national perspective. The scores are assigned based on the number of 'important population criteria' that are met by the population in question. The 'important population criteria' are defined in the Significant Impact Guidelines as a:

- key source population for either breeding or dispersal
- population that is necessary for maintaining genetic diversity; or
- population that is near the limit of the species range.

Scores are assigned based on the system defined in **Table 5.15**

Table 5.15 Role of Site Sub-Score for Pink-Tailed Worm-Lizard

Score	Rationale
0	Not an important population.
1	One important population criterion met.
2	Two important population criteria met.
3	Three important population criteria met.

Determining Habitat Quality

As the EPBC Act Offset Guide requires integer scores out of 10, each of the above raw scores (as well as the transformed Site Condition Score) needs to be transformed prior to being combined for the final Habitat Quality Score. The transformation follows the same **Equation 3** as the golden sun moth score transformation, which is repeated below for convenience.

Equation 3: $X' = bX$

Where:

X' = transformed score

$$b = \frac{maximum\ transformed\ score}{maximum\ raw\ score}$$

X = raw score

Apart from the weighting of the Site Condition sub-scores, no further weighting is applied to the scores. The final Habitat Quality Score is an equally weighted average of the transformed component scores. Note that the average will be of seven component scores for pink-tailed worm-lizard given that the Site Condition Score has already been combined.

5.2.2.2 Offset Analysis for Pink Tailed Worm Lizard

The values used for offset calculations for direct impacts to pink-tailed worm-lizard from the Program are presented in **Table 5.16**. These are based on surveys conducted by Osborne and Wong (2013) and the direct impacts as a result of the Program.

Table 5.16 Assessment of Offset Performance for Pink-Tailed Worm-Lizard

<table>
<tr><th>Variable</th><th>Value</th><th>Rationale</th></tr>
<tr><td colspan="3">Impacted Site</td></tr>
<tr><td>area of habitat (Ha)</td><td>16.4</td><td>The area of affected habitat was introduced in Section 4.5.5 and is comprised of habitat of varying quality based on the assessment of Osborne and Wong (2013).</td></tr>
<tr><td>quality</td><td>5</td><td>Based on descriptions by Osborne and Wong (2013) the site condition criterion was taken to be equivalent to the habitat quality described in that report. Based on the proportion of ‘low quality’ or ‘high quality’ habitat in the impacted and offset sites, a weighted value for site condition was calculated. Findings of occupancies within these areas have also been translated into relative scores for stocking rate. Reflecting the poor quality of impacted areas in comparison to avoided areas, an average habitat quality score is appropriate.
<table>
<tr><td></td><td colspan="3">Impact site</td><td colspan="3">Offset site</td></tr>
<tr><td></td><td>Raw</td><td>Trans.</td><td>Score</td><td>Raw</td><td>Trans.</td><td>Score</td></tr>
<tr><td>Site Condition</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>structure (raw max=5)</td><td>0.6</td><td>3.0</td><td rowspan="3">6.2</td><td>0.7</td><td>3.5</td><td rowspan="3">7.4</td></tr>
<tr><td>diversity (raw max=3)</td><td>0.5</td><td>1.6</td><td>0.7</td><td>2.2</td></tr>
<tr><td>habitat features (raw max=1)</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Site Context</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>connectivity (raw max=5)</td><td>3.1</td><td>6.2</td><td rowspan="3">3.8</td><td>4.0</td><td>8.0</td><td rowspan="3">7.2</td></tr>
<tr><td>ACT importance (raw max=5)</td><td>1.0</td><td>2.0</td><td>4.0</td><td>8.0</td></tr>
<tr><td>threats (raw max=16)</td><td>11</td><td>3.1</td><td>7</td><td>5.6</td></tr>
<tr><td>Species Stocking Rate</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>presence (raw max=2)</td><td>2.0</td><td>10.0</td><td rowspan="3">6.2</td><td>2.0</td><td>10.0</td><td rowspan="3">8.2</td></tr>
<tr><td>density (raw max=5)</td><td>1.0</td><td>2.0</td><td>4.0</td><td>8.0</td></tr>
<tr><td>population importance (raw max=3)</td><td>2.0</td><td>6.7</td><td>2.0</td><td>6.7</td></tr>
<tr><td>Start Quality (max=10)</td><td colspan="3">5</td><td colspan="3">8</td></tr>
</table></td></tr>
</table>

Variable	Value	Rationale
Offset Site		
Averted Loss Factors		
time over which loss is averted	20	This is the maximum time period over which the EPBC Act Offset Guide is designed to function, it is appropriate for permanent impacts.
start area (Ha)	146.4	The entirety of the avoided area of habitat will be brought into the 549.9 hectare WBCC and managed as a conservation area. This is comprised of numerous patches of habitat separated by areas of native vegetation within the river corridor and currently by exotic pastures across the proposed urban development area
risk of loss without offset	5%	Steep, rocky slopes that define much of the area within which the pink-tailed worm-lizards occur are unsuitable for most pastoral activities and offer little opportunities for other forms of development. There is accordingly a low level of risk that the habitat will be lost.
risk of loss with offset	5%	With protection provided by the WBCC and management regime, the risk of loss will be low, however, given the risk of loss is low already as a result of terrain, no additional gain is proposed as a consequence of this variable.
confidence in result	90%	There is a high level of confidence in these values given there are few assumptions or uncertainties.
Habitat Quality Factors		
time until ecological benefit	5	Upon approval of the Program measures to transfer the entirety of the WBCC into secure tenure and conservation zoning will be implemented in addition to commencement of management consistent with the Program objectives. A further five years has been allowed for in order to implement management practices that reduce the effect of threatening processes, improve connectivity and habitat quality.
start quality	8	Refer to analysis above of quality on impact site compared with start quality of the offset area. On the basis of the assessment by Osborne and Wong (2013) a high proportion of the habitat in the proposed offset is considered to be of high quality. Together with the other factors, this has contributed to a relatively high starting condition. It is indicative of the significance of the avoided habitat and proposed environmental offset area which, as has been

<table>
<tr><th>Variable</th><th>Value</th><th>Rationale</th></tr>
<tr><td></td><td></td><td>explained, is of national importance.</td></tr>
<tr><td>future quality without offset</td><td>7</td><td rowspan="2">Without the proposed offset, the calculations predict a decline in quality of the pink-tailed worm-lizard habitat. This is based on the encroachment of weeds and an associated change in diversity, particularly within areas along the upper slope, nearer to the pasture. As a result of the change in management there will also be improvements in to habitat quality variables as a result of a decrease in threats and weed management in addition to increased certainty from the transition to a conservation zoning.

It is noted in the calculation of future quality of the offset, recreation has been included, this is appropriate given the threat identified in various documents including the EPBC Act Conservation Advice for this species. Without scoring the presence of this particular threat, the quality score would be 9 and the overall performance of the package significantly greater. While the Program would not permit intensive recreational activities within the pink-tailed worm-lizard habitat, it is not possible to exclude rare/occasional visitation of areas supporting this species by visitors to the WBCC. It is the intent of the Program to establish the WBCC with a formalised plan for recreation that would direct human activity away from areas of greatest ecological sensitivity such as pink tailed worm lizard habitat. This concept would be effective in avoiding incursions into areas of ecological value. With implementation of the management plan and avoidance of pink-tailed worm-lizard habitat in the layout of proposed facilities and movement corridors (e.g. access. Walking trails, etc.), the effect of any future recreation is likely to be negligible.

<table>
<tr><td></td><td colspan="3">Without offset</td><td colspan="3">With offset</td></tr>
<tr><td></td><td>Raw</td><td>Trans.</td><td>Score</td><td>Raw</td><td>Trans.</td><td>Score</td></tr>
<tr><td>Site Condition</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>structure (raw max=5)</td><td>0.6</td><td>3.0</td><td rowspan="3">5.8</td><td>0.7</td><td>3.5</td><td rowspan="3">7.7</td></tr>
<tr><td>diversity (raw max=3)</td><td>0.4</td><td>1.2</td><td>0.8</td><td>2.4</td></tr>
<tr><td>habitat features (raw max=1)</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Site Context</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>connectivity (raw max=5)</td><td>4.0</td><td>6.2</td><td rowspan="3">7.6</td><td>4.8</td><td>9.6</td><td rowspan="3">8.2</td></tr>
<tr><td>ACT importance (raw max=5)</td><td>3.0</td><td>2.0</td><td>5.0</td><td>10.0</td></tr>
<tr><td>threats (raw max=16)</td><td>7</td><td>5.6</td><td>2</td><td>8.8</td></tr>
<tr><td>Species Stocking Rate</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>presence (raw max=2)</td><td>2.0</td><td>10.0</td><td rowspan="3">6.5</td><td>2.0</td><td>10.0</td><td rowspan="3">9.5</td></tr>
<tr><td>density (raw max=5)</td><td>3.0</td><td>2.0</td><td>4.0</td><td>8.0</td></tr>
<tr><td>population importance (raw max=3)</td><td>2.0</td><td>6.7</td><td>2.0</td><td>6.7</td></tr>
<tr><td>Future Quality (max=10)</td><td colspan="2"></td><td>7</td><td colspan="2"></td><td>8</td></tr>
</table>
</td></tr>
<tr><td>future quality with offset</td><td>8</td></tr>
</table>

Variable	Value	Rationale
confidence in result	90%	The main improvements resulting from improved internal connectivity between existing patches, reduction in threatening processes and implementation of a management program designed to enhance habitat quality for pink-tailed worm-lizard.
Overall Performance	**109.86 %**	**In adjusted hectares (as calculated by the offset calculator), the net performance of the proposed offset is as follows:** • **Quantum of impact = 8.20 hectares (adjusted)** • **Offset net present value = 9.01 hectares (adjusted)** • **Balance = 0.81 hectares (adjusted)** **The overall performance of the proposed measures for pink-tailed worm-lizard, exclusive of the commitments for management as described in the mitigation measures is one that exceeds the 100 percent target for an offset. This confirms the appropriateness of establishing the WBCC for the benefit of pink-tailed worm-lizard and other threatened species and communities that are not affected by the Program.**

5.2.3 Box Gum Woodland

By comparison to the analysis required to assess offsets to individual species, the assessment of offset requirements for an ecological community is relatively simpler. This is based on the concept of 'species stocking rate' being irrelevant in determining habitat quality. While the complexity of this analysis is also guided by the conservation advice or recovery plans as appropriate, the ability to model habitat quality to the same degree for an ecological community would be infinitely more complex should the interactions of each of the component parts be considered as they have been for the interactions of golden sun moth or pink tailed worm lizards and their environments.

Accordingly, the concepts of site condition and site context are considered on the basis of broader factors that include landscape scale metrics to understand the relative importance of a patch in addition to patch scale data such as floristics to understand condition. The relevant components are described in the following sections which also follow the concepts to some extent already established for assessment of golden sun moth and pink tailed worm lizard.

Site Condition

Structure and condition of the vegetation within the area affected by the Drake Brockman Drive upgrade is variable with some small elements being of moderate condition but overwhelmingly low quality and dominated by derived native grassland with low floristic diversity.

Components of the calculation for condition are based on three elements including: (a) structure, being the physical characteristics of the vegetation; (b) condition, defined by the presence or absence of non-native species; and (c) diversity of relevant habitat species, a measure of the extent to which the patch is recognisable as box gum woodland based on the floristic composition.

A. Structure

The following tables summarise the scores that have been attributed to these criteria with **Table 5.17** representing the structure sub-score.

Table 5.17 Structure Sub-Score for Box Gum Woodland

Score	Rationale
1	Derived native grassland only, no trees present or only very sparse to less than 5% canopy cover
2	Open woodland with between 5% and 15% canopy cover
3	Woodland formation with greater than 15% canopy cover

B. Condition

Condition is taken to be an indication of community resilience with the indicator being the presence or absence of non-native species within the patch. Although this is to some extent also reflected in the site context score as part of the threats aspect, it considers the present condition as opposed to the potential for future and ongoing degradation. Accordingly **Table 5.18** describes the sub-score for condition of a box gum woodland patch.

Table 5.18 Condition Sub-Score for Box Gum Woodland

Score	Rationale
0	Non-native species conspicuous and widespread
1	Mixed or patchy conspicuousness of non-native species
2	Non-native species generally absent

C. Diversity of Relevant Habitat Features

The diversity of relevant habitat species considers the community listing advice and recovery plan and the circumstances under which the community may be considered to be present. This generally follows the identification flow chart provided in Appendix 2 to the national recovery plan (NSW Gov't 2010b).

Table 5.19 Diversity of Relevant Habitat Species Present Sub-Score for Box Gum Woodland

Score	Interpretation	Rationale
1	Marginal	Low diversity derived native grassland, not independently assessable as box gum woodland but connected to a patch that meets other criteria.
2	Very low	Native grassy understorey and meeting criteria for box gum woodland at the 2Ha scale (20+ trees/Ha or presence of canopy regeneration).
3	Low	Low diversity but with potentially 12 non-grass native species and one important species.
4	Moderate	Moderate diversity, exceeding 12 non-grass native species and or multiple important species
5	High	High diversity of grass and non-grass native species, well exceeding minimum criteria for box gum woodland

The scores across each criterion are totalled and converted to a score out of a total of 10 in order to provide an indication of overall site condition.

Site Context

Site context is comprised of a number of factors based on landscape scale assessment of inter-patch relationships (connectivity) together with an understanding of the relative importance of the subject site and threats which might act against future potential quality.

A. Connectivity

For an ecological community, there would be many levels of connectivity relevant to different aspects of its quality. For example, small wasps may be the pollination vector for one or more species of orchid and their dispersal is limited to within 100 metres of their place of emergence/hatching.

Alternately, flying foxes and a range of honeyeaters would likely provide pollination services for canopy species and would range up to 100 kilometres in a single foraging event.

From this very basic description of the diversity of factors it is clear that the concept of connectivity could become exceedingly complicated and is likely beyond the capacity of the current study to definitively resolve. Despite this, the following approach has been developed with respect to connectivity on the principle that the less distance between patches is a preferable outcome and at distances of greater than 1,000 metres, the ability for many of the smaller fauna species to move between patches is substantially compromised, particularly in fragmented landscapes. Accordingly **Figure 5-7** provides the basis for estimating a score for connectivity between adjacent patches on the basis of a logarithmic scale.

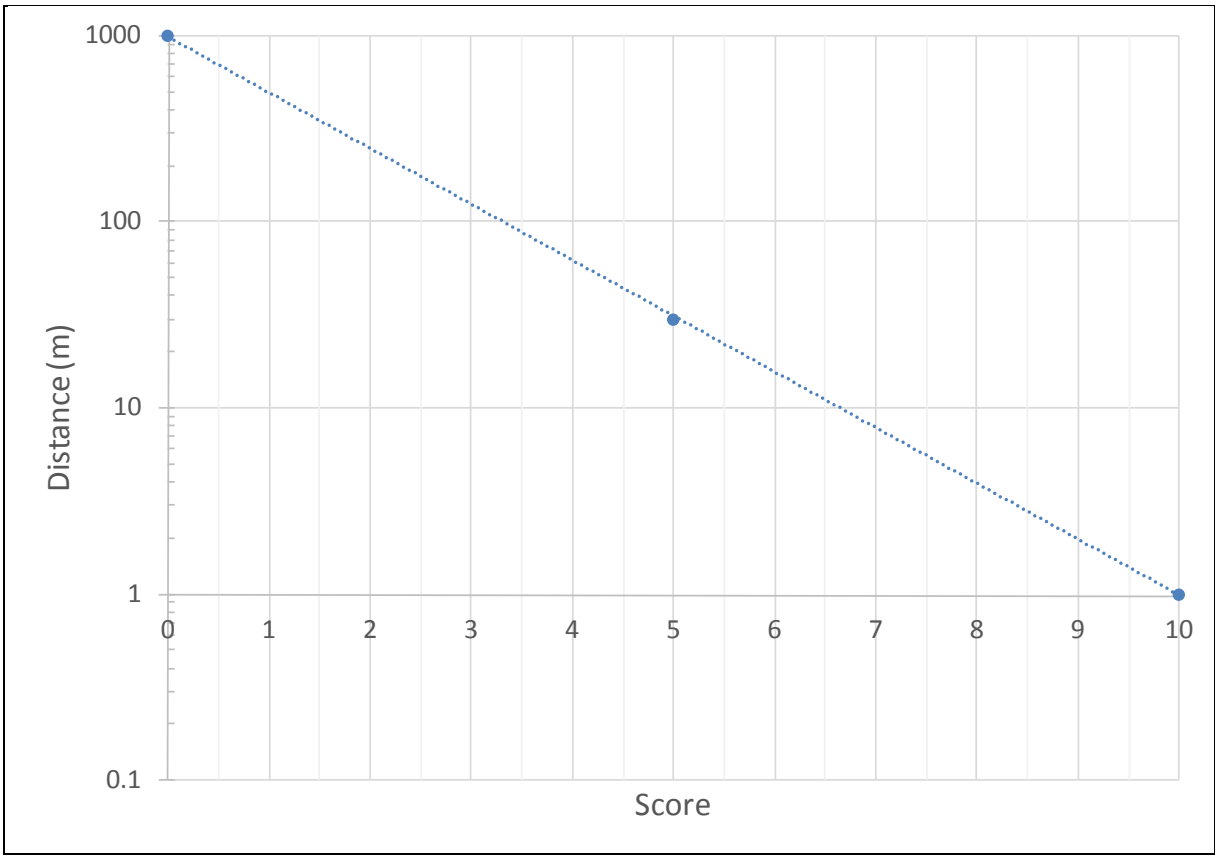

Figure 5-7

Relationship between Score and Distance to Nearest Patch

B. Importance

The concept of importance follows the examples already established by the assessment of golden sun moth and pink tailed worm lizard in using a combination of patch area and resultant permeability as the basis to determine how important any given element of a box gum woodland patch is. For an ecological community such as box gum woodland the analysis includes the characteristics of box gum woodland as prescribed by the listing advice and recovery plan. A contiguous area of the community that is only broken by minor tracks or trails would not be regarded as compromised as it would retain its internal connectivity particularly if those tracks were not sealed and did not carry large volumes of traffic. This would not necessarily be the case with a sealed road or other intensive type of development. Given the complexity of the likely scenarios for all the constituent components a much simpler approach to describing the importance of an impacted area or conversely a proposed offset

has been applied. Using the area of the impacted or new offset component as a proportion of the total area of the patch when converted to a figure out of 5 will provide a relative measure of its importance.

Further consideration of the effect of fragmentation in the event of a patch being bisected by an activity could also be incorporated, however, for the purpose of the current assessment this is not relevant. The approach as described will penalise impacts that reduce an overall patch size and reward an offset that increases the area of conserved box gum woodland. This is consistent with the philosophy of the offset policy.

C. Threats

The threats sub-score is based on the presence and intensity of key threats, as identified in NSW Gov't (2010b) and the EPBC Act Listing Advice for box gum woodland. The extensive list of threats provided by the guidance material covers a wide range of land use activities and processes that are the consequence of four main categories of threat as follows:

- Land use and management change:
    - agricultural and horticultural development
    - rural residential and urban development
    - mining
    - public infrastructure
- Conflicting management practices:
    - gazing regimes and pasture management
    - firewood collection and 'tidying up'
    - changed fire regimes
    - increased soil nutrients and use of chemicals
    - mowing or slashing regimes
    - revegetation management
- Degrading processes:
    - weed invasion
    - climate change
    - salinity
    - acid-sulphate soils
    - declining tree health and regeneration
- Other threats:

- animal pests
- disease; and
- collection/removal of native flora.

Each of these eighteen threats is assigned a score out of 2 based on the presence and intensity of the threats at the site (**Table 5.20**). The overall threat sub-score is the sum of scores for each threat and has a maximum of 36.

Table 5.20 Threat Intensity Scores for Box Gum Woodland

Score	Rationale
0	Threat absent.
1	Low intensity threat.
2	High intensity threat.

Determining Habitat Quality

Habitat quality for box gum woodland is derived by combining the final scores that contribute to each category of site condition and context and deriving a final score out of 10. For this calculation all elements are considered equally important and no weightings have been applied. This allows for the final figure to be used in the Offset calculator.

5.2.3.1 Offset Analysis for Box Gum Woodland

The values used for offset calculations for direct impacts to box gum woodland from the Program are presented in **Table 5.21**. These are based on surveys conducted by David Hogg (2013) and from observations of woodland along the Drake Brockman Drive alignment by Umwelt.

Table 5.21 Assessment of Offset Performance for Box Gum Woodland

<table>
<tr><th>Variable</th><th>Value</th><th>Rationale</th></tr>
<tr><td colspan="3">Impacted Site</td></tr>
<tr><td>area of habitat (Ha)</td><td>3.8</td><td>The area of affected habitat was described in Section 4.4.1 and is comprised of both derived native grassland (3.1 Ha) and woodland form (0.7 Ha) box gum woodland. In each instance where this community exists, it is at the edge of a much larger patch that extends into private land.</td></tr>
<tr><td>quality</td><td>1</td><td>Based on descriptions by David Hogg (2013) the site condition criterion was taken to be equivalent to the habitat quality described in that report for the offset site and derived from a combination of desktop analysis and an inspection of the Drake Brockman Drive area by Umwelt. The average score for quality for both the impact area (Drake Brockman Drive) and the offset area are quite low. The primary differences between the sites are a greater degree of threats operating along Drake Brockman Drive, better site condition characteristics at the offset and differences in site context that are the result of greater connectivity into private lands adjoining Drake Brockman Drive. The importance value for the offset is described as ‘0’ because the area has already been committed to be protected and no further value can be gained in committing it to conservation. However as is demonstrated in subsequent sections, opportunities exist to improve aspects of quality beyond what the Molonglo Strategic Assessment committed to.
<table>
<tr><th></th><th colspan="3">Impact Site</th><th colspan="3">Offset Site</th></tr>
<tr><th></th><th>Raw</th><th>Trans.</th><th>Score</th><th>Raw</th><th>Trans.</th><th>Score</th></tr>
<tr><td>Site Condition</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>structure (raw max=3)</td><td>1</td><td>1</td><td rowspan="3">2.2</td><td>2.5</td><td>2.5</td><td rowspan="3">7.2</td></tr>
<tr><td>condition (raw max=2)</td><td>0</td><td>0</td><td>1.0</td><td>1.0</td></tr>
<tr><td>diversity (raw max=5)</td><td>1</td><td>1</td><td>3.0</td><td>3.0</td></tr>
<tr><td>Site Context</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>connectivity (raw max=5)</td><td>3.0</td><td>3.0</td><td rowspan="3">3.5</td><td>1.0</td><td>1.0</td><td rowspan="3">2.9</td></tr>
<tr><td>importance (raw max=5)</td><td>1.0</td><td>2.0</td><td>0.0</td><td>0</td></tr>
<tr><td>threats (raw max=46)</td><td>14</td><td>5.6</td><td>7</td><td>7.8</td></tr>
<tr><td>Start Quality (max=10)</td><td colspan="3">1</td><td colspan="3">3</td></tr>
</table>
</td></tr>
</table>

Variable	Value	Rationale
Offset Site		
Averted Loss Factors		
time over which loss is averted	20	This is the maximum time period over which the EPBC Act Offset Guide is designed to function, it is appropriate for permanent impacts.
start area (Ha)	68.2	The entire area of box gum woodland within the WBCC will be subject to offsetting actions under the Program above the commitment by the Molonglo Strategic Assessment which proposed only to protect the woodland from future development.
risk of loss without offset	5%	There is a low likelihood of loss of the box gum woodland within the WBCC as a consequence of the commitments under the Molonglo Strategic Assessment and through implementation of those commitments by the Program.
risk of loss with offset	5%	The risk of loss of the box gum woodland will not be substantially less under the Program as it would still be subject to stochastic events and other unpredictable events.
confidence in result	90%	There is a high level of confidence in these values given there are few assumptions or uncertainties and the measures to be implemented are commonly employed in conservation management throughout the ACT.
Habitat Quality Factors		
time until ecological benefit	20	Upon approval of the Program measures to transfer the entirety of the WBCC into secure tenure and conservation zoning will be implemented in addition to commencement of management consistent with the Program objectives. A further twenty years has been allowed for in order to implement management practices that will enhance the site condition by targeting diversity of ground layer vegetation, condition in relation to the prevalence of non-native species and improvements in structure by encouraging natural and assisted regeneration of currently degraded sections.
start quality	3	Refer to analysis above of quality on impact site compared with start quality of the offset area. The start quality is introduced briefly above; it principally reflects differences in threats and site condition.
future quality	3	As the commitment of the Molonglo Strategic Assessment as to protect box gum woodland in the 'west Molonglo' area but

<table>
<tr><th>Variable</th><th>Value</th><th>Rationale</th></tr>
<tr><td>without offset</td><td></td><td rowspan="2">not to enhance it or derive any predicted improvements in quality, it is anticipated that within the life of the approval, there would be no appreciable gain in quality should the offset action not be undertaken.

The modest improvement in quality is achieved by targeting site condition. This would result in a wider extent of box gum woodland that is recognisable by its woodland form as opposed to the derived native grassland, a reduced incidence of non-native species and an increase in the diversity of associated diagnostic flora species.</td></tr>
<tr><td>future quality with offset</td><td>4</td></tr>
<tr><td>confidence in result</td><td>90%</td><td>The measures proposed are achievable within the predicted 20 year timeframe and as such there is a high level of confidence in the outcome.</td></tr>
<tr><td>Overall Performance</td><td>411.66 %</td><td>The overall performance of the proposed measures for box gum woodland is one that substantially exceeds the 100 percent target for an offset. This confirms the appropriateness of undertaking additional conservation management activities for the benefit of box gum woodland beyond the commitments of the Molonglo Strategic Assessment.

In adjusted hectares (as calculated by the offset calculator), the net performance of the proposed offset is as follows:

• Quantum of impact = 0.38 hectares (adjusted)
• Offset net present value = 1.56 hectares (adjusted)
• Balance = 1.18 hectares (adjusted)</td></tr>
</table>

	Without offset			With offset		
	Raw	Trans.	Score	Raw	Trans.	Score
Site Condition						
structure (raw max=3)	*2.5*	*2.5*	*7.2*	*3.0*	*3.0*	*10.0*
condition (raw max=2)	*1.0*	*1.0*		*2.0*	*2.0*	
diversity (raw max=5)	*3.0*	*3.0*		*4.0*	*4.0*	
Site Context						
connectivity (raw max=5)	*1.0*	*1.0*	*2.9*	*1.0*	*1.0*	*2.9*
importance (raw max=5)	*0*	*0*		*0*	*0*	
threats (raw max=46)	*7*	*7.8*		*7.0*	*7.8*	
Future Quality (max=10)			**3**			**4**

5.2.4 Natural Temperate Grassland

As noted with the introduction to the box gum woodland approach to offset assessment, the assessment of offset requirements for an ecological community is relatively simpler than that for species. This is based on the concept of 'species stocking rate' being irrelevant in determining habitat quality. In the case of a grassland, the approach is further simplified as a result of the structure being a non-variable and in the case of natural temperate grassland, owing to the detailed conservation advice and its prescribed assessment techniques, the aspect of 'diversity' is also irrelevant.

The relevant components are described in the following sections which also follow the concepts to some extent already established for assessment of preceding MNES.

Site Condition

The conservation advice for natural temperate grassland includes detailed information and methods for determining the presence and condition of natural temperate grassland. By following the guidance provided in determining which condition threshold any given example meets, the floristic diversity, presence of weeds projected foliage cover and presence of other diagnostic characteristics will be determined. Accordingly, the only aspect of the site condition component of the offset calculation for habitat quality that remains relevant is 'condition'.

The other components being structure and diversity of relevant habitat species are unnecessary to include specific scores for as they are addressed by the prescribed field assessment methods.

Condition

Condition is taken to be an indication of community resilience with the indicator being the presence or absence of non-native species within the patch. Application of the methodology in the Conservation Advice results in determining that natural temperate grassland if present exists in one of three conditions described as:

- Moderate-high
- High-Very High
- Excellent or 'benchmark / reference'.

These have been adopted by this analysis method in addition to the point also raised in the Conservation Advice that some sites may not meet the threshold to be the community, however, with remedial work may be enhanced to qualify. This is also recognised in the assessment method. Accordingly **Table 5.22** describes the sub-score for condition of a natural temperate grassland patch.

Table 5.22 Condition Sub-Score for Natural Temperate Grassland

Score	Rationale
0	Not presently meeting the definition of natural temperate grassland due to poor floristic diversity, however, may be subject to recovery actions in order to improve quality to meet the community definition.
1	Moderate-High
2	High-Very High
3	Excellent / Benchmark / Reference

Site Context

Site context is comprised of a number of factors based on landscape scale assessment of inter-patch relationships (connectivity) together with an understanding of the relative importance of the subject site and threats which might act against future potential quality.

A. Connectivity

As described in the example of box gum woodland, connectivity is relative to individual taxa and for consideration of a community this will by necessity be an average. Given the structural characteristics of grassland communities and the dispersal range of likely pollination vectors, a figure of 200 metres has been adopted as the point beyond which function connectivity no longer exists. Further, as the structural aspect of a grassland is somewhat simpler than woodland, a linear relationship for calculating connectivity has been adopted.

Principles guiding the calculation of connectivity also include an understanding of permeability as previously discussed in relation to golden sun moth. For natural temperate grassland patches, impermeable barriers in inter-patch areas would include:

- Gaps over grassy communities (including grassy woodlands, secondary grassland and native pasture) greater than 200 metres
- Gaps over constructed, non-habitat areas such as paving, concrete and other hard-stand in excess of 50 metres; and
- Urban development (comprised of residential houses, commercial facilities and associated services and infrastructure).

It is likely additional factors could influence connectivity between patches of natural temperate grassland such as the height of structures, however, as there are a wide variety of possible pollination vectors for grassland communities such that an obstacle is unlikely to cause impermeability. It should also be noted that many of the fauna that provide ecosystem services to grassland communities include ants and other small invertebrates which are unable or unlikely to cover large distances through areas of non-habitat.

On the basis of the above, the connectivity measure for natural temperate grassland has been calculated on the basis of the following **Equation 4**. Scores will be a number out of a total of 10 and are to be rounded to the nearest whole number. For any number less than zero, it is assumed connectivity has been lost.

Equation 4: $C = 1 - d/20$

Where:

C = Connectivity score

$d =$ *distance between patches*

B. Importance

The site importance sub-score for natural temperate grassland closely follows the approach and structure of the pink-tailed worm-lizard method. The aim of this sub-score is to demonstrate the importance of the site in relation to other known natural temperate grassland habitat areas within the ACT.

The matrix previously discussed in **Figure 5.3** has also been used to calculate the site importance sub-score. This matrix scores habitats that are of a larger size class and with high permeability the highest.

The residual permeability is the patch permeability score from above, multiplied by 10. The size class is based on the categories outlined in **Table 5.23**.

Table 5.23 Patch Size Scores for Natural Temperate Grassland

Score	Patch Size (m^2)	Patch Size (Ha)
1	0 – 10,000	0 – 1
2	10,001 – 40,000	1 – 4
3	40,001 – 220,000	4 – 22
4	220,001 – 990,000	22 – 99
5	990,001 and greater	99 and greater

The range of the size classes described in **Table 5.23** was determined using the habitat distribution for the ACT. The areas of natural temperate grassland within the ACT were graphed in size order from smallest to largest, and a generally sigmoidal curve fitted to the data on a logarithmic scale (refer to **Figure 5-8**). This curve was used to define the size classes such that larger habitat patches were given a higher score to reflect the shape of the curve and the rarity of patches of such size.

It was noted that a very similar distribution of patches was observed for pink-tailed worm-lizard, however, the scale of patches is an order of magnitude higher for natural temperate grassland.

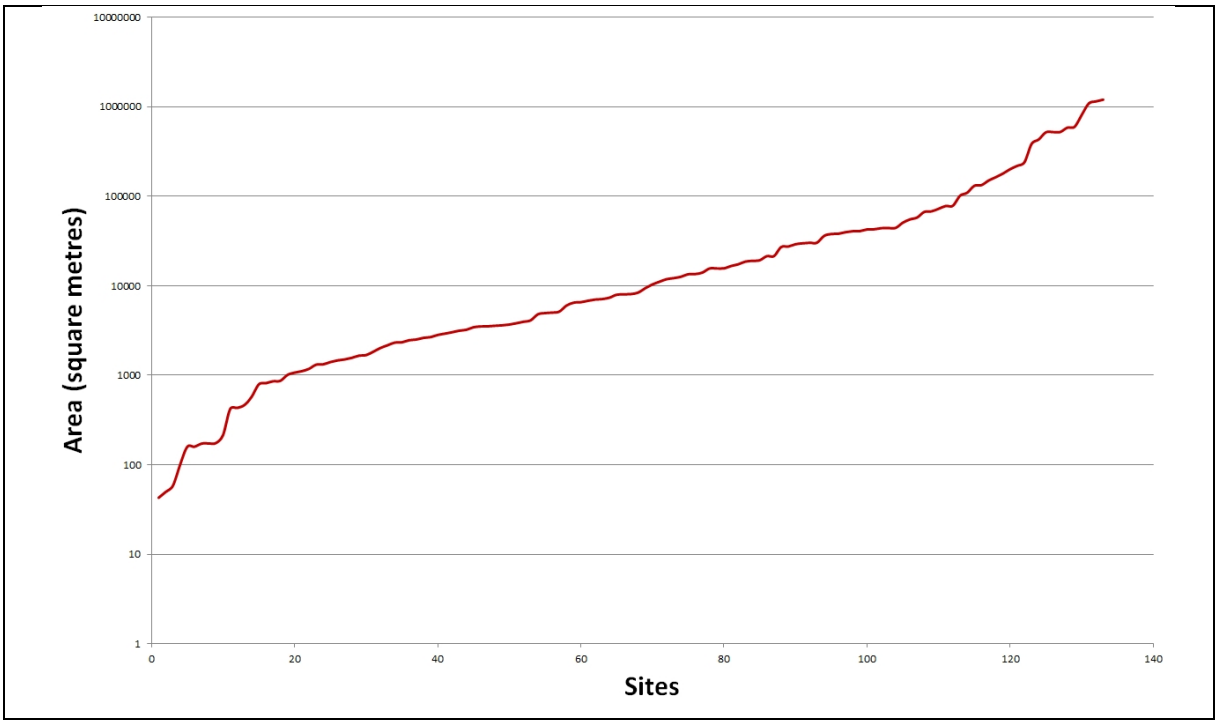

Figure 5-8

Size of natural temperate grassland patches in the ACT

C. Threats

The threats sub-score is based on the presence and intensity of key threats, as identified in the EPBC Act Conservation Advice for natural temperate grassland. There are seven threats identified but of those, only six provide a meaningful basis upon which to consider the relative threats applicable to both the impact and offset sites. The seventh being climate change is a pervasive threat and beyond the control of land managers to have any meaningful impact on.

The remaining six threats considered relevant for consideration within the calculation of habitat quality include:

- agricultural intensification
- urban development
- fragmentation
- inappropriate management
- invasive flora; and
- invasive fauna.

Each of these threats is assigned a score out of 2 based on the presence and intensity of the threats at the site (**Table 5.24**). The overall threat sub-score is the sum of scores for each threat and has a maximum of 12.

Table 5.24 Threat Intensity Scores for Natural Temperate Grassland

Score	Rationale
0	Threat absent.
1	Low intensity threat.
2	High intensity threat.

It is important to note that these threats must be assessed from the perspective of their potential to affect biodiversity as opposed to historical impacts. Past actions will have created conditions responsible for the vegetation and habitat quality evident in the present and it is on the present values that the sites must be assessed. As such a site that is at risk of being imminently lost to one or a combination of threats would be more highly valued as a target for protection if it could be secured as an offset. This addresses a consideration in the offset policy that seeks to avert risk through identification and protection of areas that are at greater risk of being lost and protecting them as offsets.

For all threats with the exception of 'urban development' the scores in **Table 5.24** apply. In the case of urban development, these scores are reversed such that where no threat is apparent, the score awarded is 2 while in the case where a high intensity threat from urban development is present, a score of 0 is awarded.

Determining Habitat Quality

Habitat quality for natural temperate grassland is derived by combining the final scores that contribute to each category of site condition and context and deriving a final score out of 10. For this calculation all elements are considered equally important and no weightings should be applied. This allows for the final figure to be used in the Offset calculator.

5.3 Other Measures

Existing approvals for the Jarramlee and Macgregor offset sites include a range of obligations and commitments that will be incorporated into the overall management structure for implementation of the Program. In particular, this includes a commitment under the 'Jarramlee Offset Management Plan' (ACT Gov't 2013a) to implement a project to enhance the connectivity of golden sun moth habitat between the Dunlop Grassland Reserve and the existing Jarramlee environmental offset area.

As a result of the NSW / ACT border, the originally conceived plan for the connection between Jarramlee and Dunlop Grassland Reserve was to restrict the habitat improvement activities to the ACT side of the border. However with the inclusion of Lot 2 Wallaroo Road into the conservation network (as managed by the EMT) it will be possible to take a more strategic approach to implementing this commitment. In addition to providing more space, the additional area is also not as constrained for the operation of plant and machinery that would be used to assist in preparing the site prior to reinstatement of native vegetation for golden sun moth.

It is also proposed as part of the overall conservation works within the environmental offset area to enhance connectivity between the existing habitat patches supporting golden sun moth and other patches supporting the species. This will also be accompanied by stream bank restoration along Gooromon Ponds Creek as part of a riparian strategy that extends from the Murrumbidgee River, along Ginninderra Creek and further on Gooromon Ponds Creek up to Wallaroo Road. This will further enhance the environmental outcomes of the Program by addressing a regional connectivity objective to improve linkages along the western side of the ACT, between the northern woodlands and the Murrumbidgee River. This opportunity is illustrated in **Figure 5-8** by the expansive gap in habitat connectivity along the western edge of the ACT from the Project Area, north-east to the woodlands comprising Mulligans Flat Nature Reserve and other woodland reserves created as offsets under the Gungahlin Strategic Assessment.

This measure (highlighted in **Figure 5-8**) addresses connectivity on a riparian system of over 14 kilometres in length and represents a substantial contribution to enhancement of ecosystem function and regional connectivity. Implementation of this measure will return a level of functionality to the landscape for a wide range of species in addition to leading to water quality and aquatic health improvements.

Together with activities to restore native vegetation to a condition that is capable of supporting golden sun moth, it is also a component of the Program to implement a translocation of golden sun moth larvae. Sites from where larvae would be taken are limited to those that will be impacted by construction of the Ginninderra Drive extension. While it would be preferable to conduct the translocation by transplanting topsoil and grass containing the larvae, as most of the area affected is heavily infested by Chilean needlegrass, this method would result in a translocation of a weed of national significance. This would subsequently pose a significant risk to remnant areas of natural temperate grassland and other ecological values locally.

Research undertaken by the University of Canberra and in association with the Majura Parkway construction has demonstrated the potential benefit of translocating golden sun moth larvae which are individually extracted from the ground. This would also accelerate the pace by which golden sun moth are able to recolonise areas that have been restored given the poor flying abilities of female moths. Through consultation with the ACT Government Conservation Planning and Research branch in addition to other specialists, the EMT will engage with appropriately experienced and qualified experts to guide the translocation efforts and habitat restoration. This measure will greatly accelerate achievement of the commitments of not only the Program but also enhance the values of commitments of other existing offset management plans through an integrated approach to offset management.

Owing to the long lead time until when construction of the Ginninderra Drive extension will be required, there will be sufficient time to undertake a range of activities to ensure success of the golden sun moth habitat restoration and translocation. These activities principally include:

- trialling translocation methods and site preparation techniques; and
- trialling and implementing habitat restoration of native grasslands capable of supporting golden sun moth.

The Program will upon approval commence with implementation of the offset package and will generally follow the timeframe set out below in **Table 5.25**.

Table 5.25 Indicative timeframe for implementation of golden sun moth translocation

Item	Timing	Description
WBCC RMP preparation (offset components)	Approval + 6 months	Develop a combined offset management plan (OMP) as part of the WBCC RMP incorporating the management commitments and programs of the west Macgregor and Jarramlee offsets into a plan that considers both sites in addition to the new offset at Lot 2 Wallaroo Rd. The new OMP will be approved by the DoEE prior to implementation.
Initial OMP and research	OMP implementation +5 years	Actions identified in the OMP will include early research and trials to be undertaken in ensuring habitat restoration and golden sun moth larvae translocation can occur successfully. These research programs and trials will begin with commencement of the OMP.
commence habitat restoration	completion of research +15 years	restoration of habitat areas into which golden sun moth will be translocated will commence following concurrence by the EMT that sufficient evidence exists to ensure a successful outcome. This phase may also include further translocation trials of golden sun moth subject to consultation and approval by the DoEE.
Ginninderra Drive extension and moth translocation	Approval +20 years	It is estimated that approximately 20 years from approval of the Program, the need to extend Ginninderra Drive will be realised. By this stage it is expected that suitable translocation sites will have been established and that methods for translocation have been refined for implementation.
Ongoing monitoring and maintenance	Approval ++	Throughout the entire period of the OMP operation, a feedback process to incorporate the lessons learned will help to evolve the OMP under an adaptive management framework.

These additional enhancement measures are proposed to compensate for the strategic impact to the existing offset sites and are targeted to the aspect of those offsets impacted by the Ginninderra Drive extension, namely connectivity. It is demonstrated through the assessments presented that the

outcome more than compensates for the direct impacts of the Program on MNES and also resolves deficiencies in the original offsets such that the overall outcome is well in excess of the offset requirement. The combination of an offset package that substantially exceeds the policy requirements and also includes additional measures to address regional connectivity for golden sun moth and other MNES in addition to biodiversity in general, demonstrates the Program will deliver a net benefit to conservation in the northern ACT – NSW area.

This outcome would not be achievable without the implementation of the Program which has been guided by comprehensive assessment and planning of strategic opportunities to the benefit of social, economic and environmental values.

The offset package and associated measures are an appropriate response to the anticipated impacts of the project and are considered to adequately compensate for the residual significant impact of the Program.

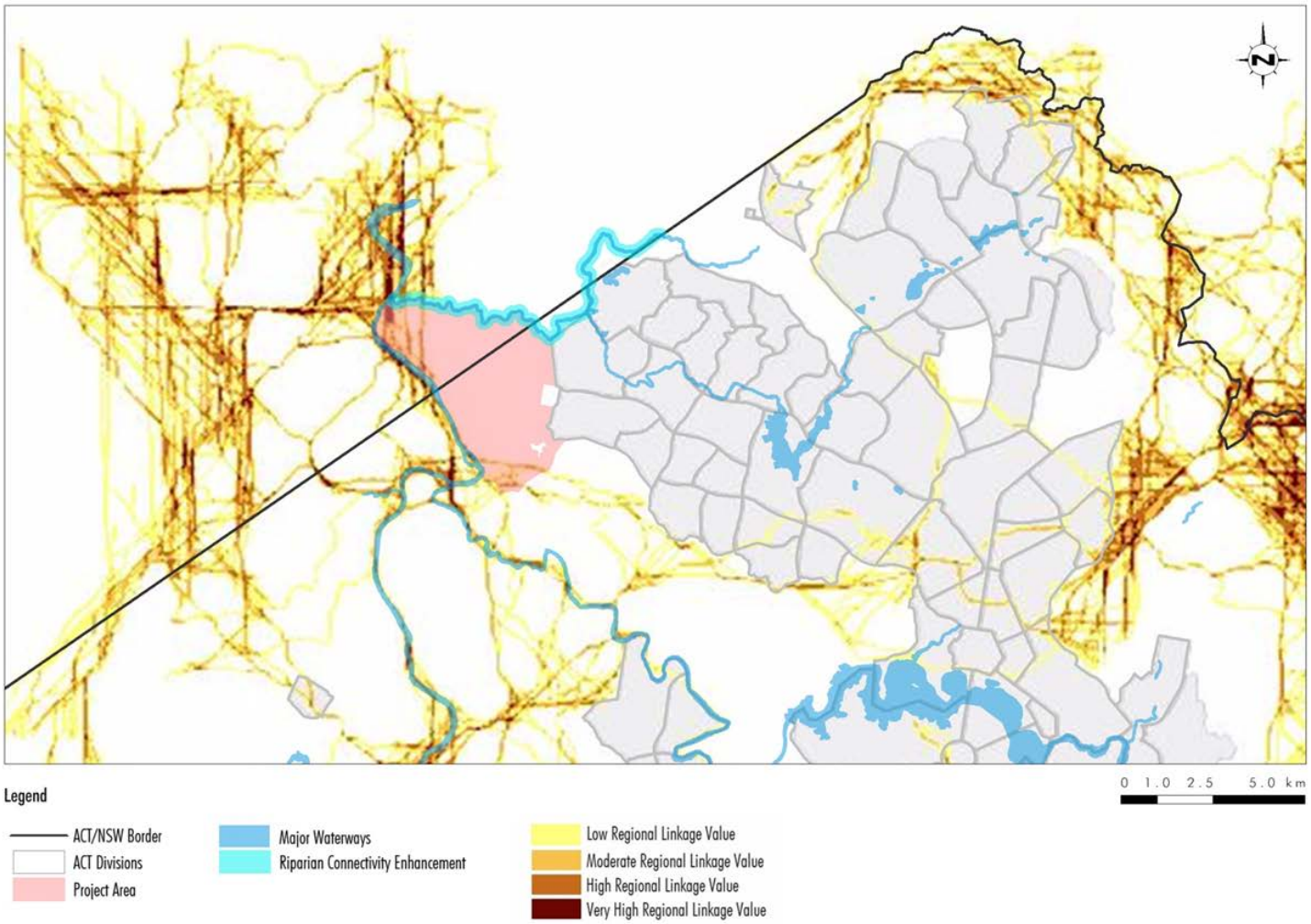

Figure 5-9

Habitat and riparian linkages in the Northern ACT and bordering NSW (base map from ACT Gov't 2015)

6.0 Assessment of ACT and NSW Matters

The following considerations relate specifically to the ACT and NSW planning and assessment processes. They have been considered as part of the Strategic Assessment despite having no direct relevance to Part 10 of the EPBC Act. Inclusion of these factors allows for concurrent consideration of alternatives and other responses to potential impacts in a manner that not only addresses the need to minimise impacts to MNES, but also with respect to biodiversity in general and the broader environment. Consideration of these factors also assists the impact assessment and approval process under ACT and NSW legislation such that measures for locally important and listed species, in addition to other legislative triggers, are understood in the context of measures that target MNES.

Matters are protected in NSW under the TSC Act (terrestrial) or the FM Act (aquatic), and in the ACT under the NC Act. Despite differences in implementation mechanisms, in general all three of these Acts target the protection and conservation of native plants and animals. They identify species, populations, and ecological communities that are at risk of extinction; habitat critical for the survival of these matters; management strategies that target their recovery; a regime of offences, licences, and penalties; and monitoring and compliance measures.

The NC Act, TSC Act, and FM Act also work in conjunction with relevant planning legislation (PD Act and the EP&A Act) that provides the statutory process for development approvals and environmental impact assessment. Depending on the impact a proposed development is likely to have on the matters protected at a State or Territory level, the relevant planning legislation may require more detailed impact assessment and, therefore, a more stringent approvals process for the development. This may include assessments that consider the 'whole of the environment', which is likely for the Program.

The following sections consider ACT and NSW listed species that are not protected under the EPBC Act. This information will form a base for considerations required for NSW and ACT development approval processes.

To reduce the list of NSW protected species to consider, a BioNet (NSW Gov't 2016b[136]) database search was conducted and results are in **Appendix 2**. All species not listed under the EPBC Act are included below for consideration.

6.1 Locally Important, ACT, and NSW Listed Species

The following section considers potential impact to species listed under the NC Act, TSC Act, or FM Act that are not also protected by the EPBC Act.

Tables 6.1 and **6.2** define the definitions and abbreviations used in this section of the report.

Table 6.1 Definitions of Presence

Presence	Definition
known	Recent and reliable records of this matter exist within the Project Area.
likely	Despite a lack of records, it is probable that the matter occurs in the Project Area.

[136] NSW Government (2016b) *NSW BioNet,* accessed online (November 2016): http://www.bionet.nsw.gov.au/.

Presence	Definition
potential / potential habitat	Characteristics of the broader west Belconnen area are not inconsistent with requirements of the threatened ecological community or species, however, use of this area would be infrequent and episodic, potentially associated with unusual or extreme climatic events e.g. prolonged drought.
unlikely	There are no records for this species or community, habitat requirements are not met or normal distribution range does not coincide with the broader west Belconnen area. Despite this, the species or community may be present in rare circumstances.
no	There is no potential for the species to occur in the broader west Belconnen Area.

Table 6.2 Key to Threatened Communities and Species Status

Abbreviation	Status
Ecological Communities	
CEEC	critically endangered ecological community
EEC	endangered ecological community
Species	
V	vulnerable
E	endangered
CE	critically endangered
X	extinct
M	EPBC Act listed migratory species

6.1.1 Ecological Communities

There are no additional ecological communities listed under the NC Act or TSC Act that are not also listed under the EPBC Act identified as occurring within or near the Project Area.

Despite this, it should be noted that a community described as natural temperate grassland is listed as an EEC under the NC Act. Whilst natural temperate grassland (NC Act) is similar to the EPBC community, it does not include the 'rocky natural grassland' association. As 'rocky natural grassland' is only associated with natural temperate grassland (EPBC), there is no grassland that meets the definition of the NC Act listed EEC within the Project Area.

6.1.2 Birds

The following birds are listed as threatened under the TS Act or NC Act, are not listed under the EPBC Act, and have been identified in database searches or by members of the public as potentially occurring in the broader west Belconnen area (**Table 6.3**).

Table 6.3 ACT and NSW Threatened Bird Species in the Project Area

Scientific Name	Common Name	Status		Presence
		NC Act	TSC Act	
Ninox connivens	barking owl	-	V	known
Falco subniger	black falcon	-	V	known
Climacteris picumnus victoriae	brown treecreeper (eastern subspecies)	V	V	known
Stagonopleura guttata	diamond firetail	-	V	known
Artamus cyanopterus cyanopterus	dusky woodswallow	-	V	known
Petroica phoenicea	flame robin	-	V	known
Callocephalon fimbriatum	gang-gang cockatoo	-	V	known
*Melanodryas cucullata cucullata^*	hooded robin (south-eastern form^)	V	V	known
Hieraaetus morphnoides	little eagle	V	V	known
Glossopsitta pusilla	little lorikeet	-	V	known
Petroica rodinogaster	pink robin	-	V	known
*Petroica boodang**	scarlet robin	V	V	known
Chthonicola sagittata	speckled warbler	-	V	known
Circus assimilis	spotted harrier	-	V	known
Daphoenositta chrysoptera	varied sittella	V	V	known
Haliaeetus leucogaster	white-bellied sea eagle	-	V	known
Lalage sueurii	white-winged triller	V	-	known
Tyto novaehollandiae	masked owl	-	V	potential
Lophoictinia isura	square-tailed kite	-	V	potential

Scientific Name	Common Name	Status		Presence
		NC Act	TSC Act	
Epthianura albifrons	white-fronted chat	-	V	potential
Oxyura australis	blue-billed duck	-	V	unlikely
Stictonetta naevosa	freckled duck	-	V	unlikely
Calyptorhynchus lathami	glossy black cockatoo	V	V	unlikely
Lophochroa leadbeateri	Major Mitchell's cockatoo	-	V	unlikely
Ninox strenua	powerful owl	-	V	unlikely
Tyto tenebricosa	sooty owl	-	V	unlikely

*Scarlet robin is listed under *Petroica multicolor* in the ACT.
^Hooded robin is listed at species level in the ACT, and subspecies in NSW.

Of these species, blue-billed duck (*Oxyura australis*), freckled duck (*Stictonetta naevosa*), glossy black cockatoo (*Calyptorhynchus lathami*), Major Mitchell's cockatoo (*Lophochroa leadbeateri*), powerful owl (*Ninox strenua*), and sooty owl (*Tyto tenebricosa*) are unlikely to be present and will not be considered further in this assessment. The basis for this conclusion is as follows:

- Blue-billed duck prefer large, deep (greater than one metre), permanent wetlands or swamps that have dense, emergent, aquatic vegetation. This type of wetland does not occur within the Project Area; therefore, the species is not expected to occur. However the species is known to use sub-optimal wetland areas (including rivers) during times of drought, thus during times of extreme pressure the species may be sighted along the river (NSW Gov't 2015a).

- Freckled duck occupy a similar habitat to Blue-billed duck, as they prefer permanent freshwater swamps and creeks with heavy growth of cumbungi (*Typha* spp.), lignum (*Muehlenbeckia florulenta*), or tea-tree (*Leptospermum* spp.). This type of wetland does not occur within the Project Area; therefore, the species is not expected to occur (NSW Gov't 2015a).

- Glossy black cockatoo is known in the ACT as an uncommon visitor, with most records from Mount Ainslie and Mount Majura in the north-east (COG 2015b). In NSW, it is not known to occur within the Murrumbateman sub-region (NSW Gov't 2015a). Glossy black cockatoos feed almost exclusively on sheoak species (*Allocasuarina* spp. Or *Casuarina* spp.); specifically drooping sheoak (*A. verticillata*) in the ACT region (ACT Gov't 2013b[137]). Drooping sheoak has not been identified within the Project Area, therefore, is not considered to contain habitat for the species.

- Major Mitchell's cockatoo has only been recorded once in the ACT since the mid-1960s, when it was recorded in southern Canberra (COG 2015b). It is generally associated with the arid and semi-arid areas of inland Australia, as such these records are considered to be very rare examples and the Project Area is not considered to constitute suitable habitat.

[137] ACT Government (2013b) *Action Plan No. 33: Glossy Black-Cockatoo (Calyptorhynchus lathami)*, Environment and Sustainable Development Directorate, Canberra.

- Powerful owl requires large tracts of forest or woodland habitat that contain tree hollows and a shrub layer for foraging. Records from the ACT are associated with the Brindabella Ranges, whilst the species has occasionally been recorded in the lowlands and suburbs; these areas do not contain sufficient habitat to support the species (NSW Gov't 2015a).

- Sooty owl has not been recorded in the ACT (COG 2015b), with nearest records in NSW occurring in Tarago and Tallaganda State Forest (Canberra Nature Map 2016). The species occurs in rainforest and moist eucalypt forest, which only occur in the Brindabella Ranges in Canberra (NSW Gov't 2015b). The Project Area is not considered to contain habitat suitable to support this species.

6.1.2.1 Barking Owl

Barking owl (*Ninox connivens*) is listed as vulnerable under the TSC Act. It is widely distributed throughout continental Australia, except the central arid regions, though is considered sparse throughout NSW (NSW Gov't 2015a).

The species occupies woodland and open forest habitats. It is recorded in fragmented remnants, though prefers larger more intact patches due to their prey requirements. Similar to other birds of prey, barking owl foraging habitat extends into more dense forest and grassland habitats over large home ranges (generally 2,000 hectares). They preferentially hunt on small arboreal mammals, though feed species will diversify as they become more difficult to come by (NSW Gov't 2015a).

Barking owls are generally considered rare, vagrant visitors to the ACT; however, were recorded directly adjacent to the Project Area at Shepard's Lookout in 2011 and there is an unsubstantiated record from 2014 from Charnwood (COG 2016[138]). Given the species' requirement for moderately large tree hollows (greater than 20 centimetres) for nesting, it is unlikely that the Project Area would provide nesting habitat. The forest and woodland habitats would provide foraging habitat for the species. In times when preferred prey items are sparse, barking owls may hunt over grasslands for terrestrial species such as rabbits.

The Program will protect forest and woodland habitat, including that along the Murrumbidgee River, within the WBCC. In addition, implementation of a landscape scale approach to management, and retention of mature trees within the urban landscape as practicable will mitigate any residual impacts to barking owl.

Given the above, the rare status of the species in the ACT region, and that areas of exotic grassland and native pasture within the urban development area are marginal foraging habitats only, it is not expected that the Program would have significant adverse impacts on this species.

6.1.2.2 Black Falcon

Black falcon (*Falco subniger*) is listed as vulnerable under the TSC Act. It is widely, though sparsely, distributed throughout NSW and the ACT. It is believed to occur as one population due to the highly mobile nature of the species, with individuals travelling hundreds of kilometres (NSW Gov't 2015a).

Primary habitat for black falcon includes tree-lined watercourses and isolated woodlands in arid and semi-arid areas. COG (2015b) have a small number of records of the species in the Project Area; though note that its presence in the ACT region is likely dictated by habitat condition inland.

[138] Canberra Ornithologists Group (COG) (2016) *Annual Bird Report: 1 July 2014 to 30 June 2015*, Canberra Bird Notes: 41(1): 1-117, Canberra Ornithologists Group, Canberra.

The Program will protect forest and woodland habitat, including that along the Murrumbidgee River, within the WBCC. In addition, avoidance of construction during threatened bird breeding seasons, implementation of a landscape scale approach to management, and retention of mature trees within the urban landscape as practicable will mitigate any residual impacts to black falcon. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

It is not expected that the Program would have significant adverse impacts on this species.

6.1.2.3 Brown Treecreeper

Brown treecreeper (*Climacteris picumnus*) is listed as vulnerable under the NC Act and the eastern subspecies (*C. picumnus victoriae*) is listed as vulnerable under the TS Act.

In the ACT region, the species occurs in lowland, dry woodland and open forest, including those along the Murrumbidgee River corridor where numbers are reportedly in decline (ACT Gov't 2004b). Brown treecreepers require complex habitats that include fallen timber and large living and dead trees for foraging and roosting; it relies heavily on habitat connectivity and prefers larger habitat patches of relatively undisturbed woodland with a native understorey.

The species is known to occur in the woodland habitat of the Project Area (COG 2015b), though it was not identified during targeted survey by KMA (2013c). The Program will protect forest and woodland habitat, including that along the Murrumbidgee River, within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including its structural complexity, site-based pre-construction surveys, avoidance of construction during threatened bird breeding seasons, and considering ecological requirements when implementing fire and grazing regimes within the WBCC. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.4 Diamond Firetail

Diamond firetail (*Stagonopleura guttata*) is listed as vulnerable in NSW under the TSC Act.

Diamond firetails are sedentary and are often recorded in groups of five to 40 birds. The species occurs in grassy eucalypt woodlands, open forest, mallee, and native grasslands with low levels of disturbance; often following river corridors. Native grass species are particularly important for foraging. During breeding the species also requires small patches of shrubs in which their nests are built (NSW Gov't 2015a).

Diamond firetails have been recorded in the Project Area, including the Jarramlee and Macgregor West Offset Areas (COG 2015b; Canberra Nature Map 2016). The Program will protect forest and woodland habitat, including that along the Murrumbidgee River, within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality, undertaking weed management measures within the WBCC, site-based pre-construction surveys, avoidance of construction during threatened bird breeding seasons, and considering ecological requirements when implementing fire and grazing regimes within the WBCC. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species due to the history of disturbance at these sites.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.5 Dusky Woodswallow

Dusky woodswallow (*Artamus cyanopterus*) has only recently (August 2016) been listed as vulnerable under the TSC Act. It is not listed in the ACT.

The species is widespread in eastern, southern, and south-western Australia, though largely absent from the Upper Western region. In the ACT region it is considered migratory, though exact timings depend on climatic variables and some individuals may spend a large majority of the year here. If it does migrate, it breeds in the ACT region and then over-winters in the north.

It generally occurs in woodlands and dry, open sclerophyll forests with or without an open shrub mid-storey; though has been recorded in shrubland and heathland. Records in areas such as farmland or road are associated with adjacent areas of habitat. The species has also shown a tendency for larger habitat remnants rather than small ones (NSW Scientific Committee 2015[139]).

Within and near the Project Area, dusky woodswallow has been recorded at Shepherds Lookout, Jarramlee Offset Area, Parkwood, and Dunlop Ponds (Canberra Nature Map 2016). The Program will protect forest and woodland habitat, within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including structural diversity, controlling grazing and fire regimes based on ecological constraints, site-based pre-construction surveys, and avoidance of construction during threatened bird breeding seasons. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.6 Flame Robin

Flame robin (*Petroica phoenicea*) is listed as vulnerable under the TSC Act. Flame robins occur in south-eastern Australia between the Queensland / NSW boarder and south-east South Australia, including Tasmania. It is an altitudinal migrant, breeding in upland tall moist eucalypt forests and moving to dry open habitats in the lowlands over winter.

In the ACT region upland habitats occur in the Brindabella Ranges. Preferred lowland habitats include dry forests, open woodlands, and grasslands (both pasture and native). The presence of perches (e.g. low branches or fence posts) where flame robin can pounce on its insectivorous prey is a key habitat characteristic (NSW Gov't 2015a).

Flame robin was recorded by KMA (2013a) during NSW land surveys throughout the Project Area and is recorded in all nearby areas with some regularity (COG 2015b). The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including structural diversity for perches, and controlling grazing and fire regimes based on ecological constraints.

Grassland within the Urban Development Area will be impacted by the Program, however, due to its high proportion of exotic grasses, it is not considered important habitat for flame robin. In addition, the WBCC will protect a range of woodland and native grassland habitats of higher quality for the species. This combined with the management measures described above is expected to minimise residual impacts to flame robin.

[139] NSW Scientific Committee (2015) *Preliminary Determination*, *Dusky Woodswallow Artamus cyanopterus cyanopterus*, accessed online (October 2016): http://www.environment.nsw.gov.au/resources/threatenedspecies/determinations/PDDuskyWoodswallowVS.pdf.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.7 Gang-Gang Cockatoo

Gang-gang cockatoo (*Callocephalon fimbriatum*) is listed as vulnerable under the TSC Act.

Gang-gang cockatoo occurs between southern Victoria and central eastern NSW, extending west into the central tablelands and southwest slopes (NSW Gov't 2015a). Within the ACT, the species is considered common, whilst numbers decline towards the edge of its range (COG 2015b). It is an altitudinal migrant, spending spring and summer in tall mountain forests and woodlands and migrating to lowland woodlands or urban areas over autumn and winter (NSW Gov't 2015a).

Gang-gang cockatoos have been recorded throughout Canberra and into the surrounding NSW region, predominantly in the Brindabella Ranges and central Canberra (Canberra Nature Map 2016; COG 2015b). KMA (2013a) recorded the species during bird surveys in the NSW portion of the Project Area; COG (2015b) also has records of the species in the Project Area.

The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including recognising the value of tree hollows, controlling fire regimes based on ecological constraints, and site-based pre-construction surveys. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.8 Hooded Robin

Hooded robin (*Melanodryas cucullata)* is listed as vulnerable under the NC Act, and the south-eastern form (*M. cucullata cucullata*) is listed as vulnerable under the TSC Act. It is widespread, but sparsely distributed across mainland Australia, except for the driest deserts and the wetter coastal areas. The south-eastern form occurs between Brisbane and Adelaide, including much of inland NSW except the north-west (NSW Gov't 2015a; ACT Gov't 2004b).

It is a sedentary species, preferring lightly wooded habitats such as open eucalypt woodland, *Acacia* woodland, and mallee with an understorey of long grass, low shrubs, or fallen logs. It has also been recorded in cleared paddocks with tree stumps or regrowth. It is often sighted in or near clearings and open areas, though avoids urban areas. Similar to the flame and scarlet robins, hooded robin requires structurally diverse habitats for foraging that are generally larger than 10 hectares (NSW Gov't 2015a; ACT Gov't 2004b).

The species has been recorded in Jarramlee Offset Area and at Sheppard's lookout. Other habitat for the species is likely to be in the woodland in the south, which will be incorporated into the WBCC. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species. The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including structural diversity for perches, and controlling grazing and fire regimes based on ecological constraints.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.9 Little Eagle

Little eagle (*Hieraaetus morphnoides*) is listed as vulnerable under the TSC Act and the NC Act.

The species is found throughout mainland Australia, excluding the densest forests of the Great Dividing Range escarpment. Occurring as one population across NSW and the ACT, little eagle occupy open forest and woodland, including some with a shrub layer. Highest abundances are associated with hillsides where a mosaic of lowland woodland and grassland provide diversity of foraging habitat. Nests are built during winter in tall, living trees within remnant patches of woodland or forest. Prey varies throughout its distribution and seems to be determined by the availability and size of items. Generally, prey consists of birds, reptiles, and rabbits with occasional feeding on large insects or carrion. Nesting and foraging sites are often disjunct; therefore, impacts must consider both habitat types (NSW Gov't 2015a; ACT Gov't 2013c[140]).

Little eagles have been recorded across most of the ACT and NSW, with nesting generally occurring in the north, especially along the Murrumbidgee and Molonglo Rivers (NSW Gov't 2015a; COG 2015b). Between 1988 and 2011 the number of known little eagle active nests declined from 13 to one. In recent years up to three nesting pairs have been identified one of which occurring in the Strathnairn property, adjacent to the Project Area. This pair is known to have also nested in six different locations in the lower Molonglo area since 2001(A Lane 2016, pers. comm. 12 August).

The Program will enforce a 200 metre development buffer around the known nest site at Strathnairn, avoiding direct impact from the proposed development. It will also mitigate the indirect impact of proximate human presence to the nest site. This measure has been developed in consultation with and endorsed by ACT Conservation Planning and Research Unit, Environment, Planning and Sustainable Development Directorate and is considered appropriate for managing impacts to nesting habitat. Furthermore, given the presence of nearby nesting territories in lower Molonglo, it is anticipated that the little eagles will favour these following development (A Lane 2016, pers. comm. 12 August). Maintaining a treed movement corridor within the Urban Development Area will facilitate the use of the lower Molonglo nesting territories.

Little eagle forage over a wide range of habitats, including native and exotic pasture as is present in the Urban Development Area. Initial results from radio tracking of the breeding pair at Strathnairn spend little time within the Urban Development Area. Despite the proximity of the nest tree to the Urban Development Area, the wide ranging nature of little eagle, its non-specialised diet, and the protection of foraging habitat within the WBCC; the Program is considered unlikely to result in the loss of essential foraging habitat (A Lane 2016, pers. comm. 12 August).

A full assessment of impacts to little eagle will be included within State and Territory approval processes as appropriate. To aid this process, information gathered from ACT Government radio tracking of the male of the nesting pair at Strathnairn and food analysis will be utilised, following analysis of the results.

6.1.2.10 Little Lorikeet

Little lorikeet (*Glossopsitta pusilla*) is listed as vulnerable under the TSC Act. The species occurs along coastal and Great Dividing Range regions between Cape York, Queensland and South Australia. Within NSW, little lorikeet are found as far west as Dubbo and along the coast; however, records are not as high within the ACT region (NSW Gov't 2015a).

Little lorikeet is somewhat nomadic, with movement determined by food availability and season. It forages gregariously on nectar and pollen in the canopy of forest and woodlands, especially those dominated by eucalypts or in riparian habitats. If possible, nesting generally occurs close to feeding areas, using hollows repeatedly over a number of seasons. Connectivity of food sources, including as provided by flowering isolated paddock trees, is integral to the survival of little lorikeet during

[140] ACT Government (2013c) *Action Plan No. 35: Little Eagle (Hieraaetus morphnoides)*, Environment and Sustainable Development Directorate, Canberra.

drought (NSW Gov't 2015a). Little lorikeet are considered rare, non-breeding migrants to the ACT (COG 2015b), with most records associated with the hills and ridges of the lowlands.

Little lorikeet has been recorded within the Project Area (COG 20155b). Though the exact location is unknown, it is most likely within the Murrumbidgee River corridor where the highest quality of feeding habitat occurs.

The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including recognising the value of tree hollows and weed control, controlling fire and grazing regimes based on ecological constraints, and site-based pre-construction surveys. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.11 Pink Robin

Pink robin (*Petroica rodinogaster*) is listed as vulnerable under the TSC Act. It occurs throughout far south-eastern Australia and Tasmania. During spring and summer pink robins generally occur through the uplands of eastern Victoria north to Bombala in NSW. Over winter, the species then migrates north and westward to Wollongong and Cootamundra (NSW Gov't 2015a).

Pink robin primary habitat consists of rainforest and tall open eucalypt forest, particularly in dense gullies. As they migrate over winter, the species moves through other drier forest and woodland types (NSW Gov't 2015a). It is considered a rare, non-breeding winter migrant to Canberra and there are very few records of the species (COG 2015), though it has been recorded adjacent to the Project Area at Sheppard's lookout (Canberra Nature Map 2016).

Habitat within the Project Area is considered to be woodland and forest habitat within riparian corridors. The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including structural diversity, and control fire regimes based on ecological constraints. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.12 Scarlet Robin

Scarlet robin (*Petroica boodang*) is listed as vulnerable under the TSC Act and the NC Act.

The species is distributed between south-east Queensland and south-east South Australia, Tasmania, and south-west Western Australia. It is a highly mobile altitudinal migrant, breeding in the drier highland eucalypt forests west of the ACT then spending winter in the lowlands. Foraging habitat consists of many types of forest, woodland, and grassland environments including those of poor quality (NSW Gov't 2015b). Important habitat components include shrub cover, native grasses, a healthy eucalypt canopy, and abundant logs and fallen timber (ACT Gov't 2016[141]).

Similar to flame robin, scarlet robin forage on their insectivorous prey from low perches (e.g. tree trunks or fence posts), therefore, can be found in exotic pastures if adjacent (i.e. within 200 metres)

[141] ACT Government (2016) *Action Plan for Scarlet Robin Petroica boodang: A Vulnerable Species*, Environment and Planning Directorate, Canberra.

to tree cover. Numbers increase with habitat patch size, and they are particularly uncommon in patches less than 30 hectares (ACT Gov't 2016).

Scarlet robin has been recorded in the Murrumbidgee River Corridor (Canberra Nature Map 216) and in grassland areas of the Urban Development Area (KMA 2013a). The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including structural diversity for perches, and controlling grazing and fire regimes based on ecological constraints.

Grassland within the Urban Development Area will be impacted by the Program, however, due to the high proportion of exotic grasses, it is not considered important habitat for scarlet robin. In addition, the WBCC will protect a range of woodland and native grassland habitats of higher quality for the species. This combined with the management measures described above is expected to minimise residual impacts to scarlet robin, such that the Program is not expected to have significant adverse impacts to the species.

6.1.2.13 Speckled Warbler

Speckled warbler (*Chthonicola sagittata*) is listed as vulnerable under the TSC Act. It has a patchy distribution throughout south-east Queensland, eastern half of NSW, and into Victoria; particularly along the hills and tablelands of the Great Dividing Range.

It is a ground dwelling sedentary species that occupies woodlands and open forest with a grassy understorey, often on rocky ridges or in gullies. Breeding territories are approximately 10 hectares in size, though proximate large habitat patches (i.e. greater than 100 hectares) are critical to survival.

Speckled warbler has been recorded throughout woodland nature reserves and the Murrumbidgee River Corridor in the ACT (Canberra Nature Map 2016). KMA (2013a) recorded one bird in the Project Area during targeted bird surveys.

The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including improving structural diversity and weed control measures, grazing regimes that are based on ecological constraints, pest management including cat containment and dog control measures, construction activities must occur outside of threatened bird species' breeding times, and site-based pre-construction surveys. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.14 Spotted Harrier

Spotted harrier (*Circus assimilis*) is listed as vulnerable in NSW under the TSC Act. It occurs throughout the Australian mainland except dense forest and woodland habitats on the coast and the Great Dividing Range, but is mostly associated with arid and semi-arid regions.

Spotted harrier habitat consists predominantly of open grassy woodland including mallee, *Acacia*, riparian, and shrub steppe; and native grasslands. It may also be recorded in agricultural areas and on the edges of inland wetlands. Prey items generally include native terrestrial mammals (e.g. bandicoots (*Perameles* spp. and *Isoodon* spp.), bettong (*Bettongia* spp.) and rodents), birds, and reptiles; and will also include rabbits dependent on the availability of other prey.

Spotted harrier was recorded in the Project area by KMA (2013a), COG (2015b), and Canberra Nature Map (2016). Despite this, it's presence within the ACT is irregular and thought to be dictated by habitat condition inland (COG 2015b).

The Program will protect forest, woodland, and native grassland habitat within the WBCC. In addition, avoidance of construction during threatened bird breeding seasons, implementation of a landscape scale approach to management, and retention of mature trees within the urban landscape as practicable will mitigate any residual impacts to spotted harrier.

The Program will impact on exotic grassland within the Urban Development Area, which constitutes marginal foraging habitat for spotted harrier. As the quality of this habitat is degraded and there is significant similar habitat nearby to the Project Area that is being avoided – including higher quality woodland and forest within the WBCC, it is not expected that the Program would have significant adverse impacts on this species.

6.1.2.15 Varied Sittella

Varied sittella (*Daphoenositta chrysoptera*) is listed as vulnerable under the NC Act and the TSC Act. It occurs throughout most of Australia, except for treeless deserts, grasslands, and rainforests (ACT Gov't 2004b; NSW Gov't 2015b).

Habitat for varied sittella includes most treed vegetation types, particularly eucalypt forests and woodlands containing rough-barked species and mature smooth-barked gums with dead branches, mallee, and *Acacia* woodland. The species is known to feed on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. As a sedentary species, varied sittella require tree connectivity to move through a landscape, any open grassland is considered a barrier to movement (ACT Gov't 2004b; NSW Gov't 2015b).

The species has been recorded in the woodland and riparian corridor of the Project Area (Canberra Nature Map 2016). The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including improving structural diversity and weed control measures, fire and grazing regimes that are based on ecological constraints, pest management including cat containment and dog control measures, construction activities must occur outside of threatened bird species' breeding times, and site-based pre-construction surveys. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.16 White-Bellied Sea Eagle

White-bellied sea eagle is listed as vulnerable in NSW under the TSC Act. It is also listed as marine and has previously been listed as migratory under the EPBC Act. It is a large raptor that is predominantly white and grey, with black tipped wings.

Globally the species occurs across India, Sri Lanka, southern China, south-east Asia, the Philippines, Papua New Guinea, and Australia. It is suggested that approximately 10 – 20 per cent of the global population occurs in Australia (Marchant and Higgins 1993[142]).

[142] Marchant, S. and Higgins, P. J. (eds) (1993) *Handbook of Australian, New Zealand and Antarctic Birds*, Volume 2 – Raptors to Lapwings, Oxford University Press, Melbourne.

In Australia, the species is predominantly distributed along the coastline and off shore islands, though it does occur inland along the larger waterways. Breeding mostly occurs on the eastern coastline; though it has been recorded along the Murray, Murrumbidgee, and Lachlan Rivers in northern Victoria and southwest NSW (Australian Gov't 2015b).

White-bellied sea eagles are uncommon visitors to the ACT region. Sightings are usually of individuals and always occur close to a major water body, with a majority of them occurring at the Jerrabomberra Wetlands in eastern Canberra (COG 2015b). KMA (2013c) recorded an individual flying over the Project Area during the targeted bird surveys and they have previously been recorded in the broader west Belconnen area by COG (2015).

As all riparian habitats in the Project Area would be protected under the Program, which includes a mosaic of grassland and grassy woodland habitats, as well as the Murrumbidgee River itself, for foraging; significant adverse impacts to this species are not anticipated as a result of the Program.

6.1.2.17 White-Winged Triller

White-winged triller (*Lalage sueurii*) is listed as vulnerable under the NC Act. The species is found across Australia, but is nomadic and seasonally migratory through central and southern Australia.

In the ACT region, the species is an uncommon, breeding, summer migrant and numbers vary year to year. In the ACT, records for the species are widespread; however, the majority come from Hall, Mulligan's Flat, Goorooyaroo, the Pinnacle, Campbell Park and the Gigerline-Tharwa area (ACT Gov't, 2004b).

White-winged trillers eat insects, including winged termites, ants, grasshoppers and caterpillars, and feed both on the ground and in the air. Critical habitat features for the species include large living and dead trees for perching, roosting, nesting, and foraging, and foraging areas of grass and fallen timber. In the ACT, the species is found in and around grassy woodland areas such as box gum woodland (ACT Gov't, 2004b). White-winged triller has been recorded in the Project Area at Jarramlee, Parkwood, and in the Murrumbidgee River Corridor (KMA 2013c; COG 2015a; Canberra Nature Map 2016).

The Program will protect forest and woodland habitat within the WBCC through the implementation of a landscape scale approach to management that will protect connectivity values, improve woodland habitat quality including improving structural diversity and weed control measures, fire and grazing regimes that are based on ecological constraints, construction activities must occur outside of threatened bird species' breeding times, and site-based pre-construction surveys. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

The Program is not expected to have significant adverse impacts on this species.

6.1.2.18 Masked Owl

Masked owl (*Tyto novaehollandiae*) is listed as vulnerable under the TSC Act. Within NSW, the species is most abundant along the coast, though its range extends inland excluding the most arid regions (NSW Gov't 2015a). It is considered a rare, non-breeding vagrant to the ACT (COG 2015b).

Records for the surrounding NSW region are concentrated on the forested habitat, west from the ACT, generally between Wee Jasper and Adaminaby (NSW Gov't 2015a and 2016b). It has only been recorded from two places within the ACT: in Mulligan's Flat Nature Reserve and Pialligo South.

It is a forest owl, preferring to live in dry eucalypt forests and woodlands, hunting along their edge. Nesting and roosting habitat occurs in moist eucalypt forested gullies in large (greater than 40 centimetres) tree hollows or caves (NSW Gov't 2015a). No hollows of this size nor caves occur within the Project Area (KMA 2013c); however, the forest and woodland habitat may provide marginal foraging habitat for the species.

As the species does not rely on habitat within the Project Area and areas of greatest potential habitat (i.e. forest and woodland) will be protected within the WBCC, the Program is not expected to have significant adverse impacts on masked owl.

6.1.2.19 Square-Tailed Kite

Square-tailed kite (*Lophoictinia isura*) is listed as vulnerable under the TSC Act. The species ranges along the coastal and sub-coastal areas between south-western and northern Australia, including Queensland, NSW, and Victoria (NSW Gov't 2015b).

The species is recorded across a variety of wooded habitats; though show a preference for timbered watercourses, especially within the Murray-Darling Basin. Square-tailed kite occupy large hunting ranges of more than 100 square kilometres. It is a specialist hunter of passerines, especially honeyeaters, picking most prey items from the outer foliage (NSW Gov't 2015b).

There are no records of the species within or near the Project Area, and only a couple across the ACT as a whole (Canberra Nature Map 2016; COG 2015b). Potential habitat for the species would occur along the Murrumbidgee River in the associated forests and woodlands. Use of this habitat, similar to other raptors would likely be dependent on the presence of prey species and condition of habitat areas outside of the ACT region.

As the species does not rely on habitat within the Project Area and areas of greatest potential habitat will be protected within the WBCC, the Program is not expected to have significant adverse impacts on square-tailed kite.

6.1.2.20 White-Fronted Chat

White-fronted chat (*Epthianura albifrons*) is listed as vulnerable under the TSC Act. It occurs in southern Australia from the southern parts of Queensland and Carnarvon Western Australia, to southern Tasmania.

It is considered to be a rare, breeding resident of the ACT (COG 2015b) and in the region it occupies lowland habitats that are most often associated with damp open habitats and riparian and wetland areas. In particular, white-fronted chat is associated with open grassy plains and salt lakes and pans along the margins of rivers. It is not found in urban areas (NSW Gov't 2015b).

Most records within the ACT region are from the Molonglo River west from Lake Burly Griffin, Mount Stromlo, Lake George, and Lake Bathurst (Canberra Nature Map 2016). White-fronted chat may use the riparian vegetation to move through the landscape; however, the Project Area does not contain any of their preferred habitat. The Program is not expected to have significant adverse impacts on the species.

6.1.3 Aquatic Species

The following aquatic species are listed as threatened under the FM Act or NC Act, are not listed under the EPBC Act, and have been identified in database searches as potentially occurring in the broader west Belconnen area (**Table 6..4**).

Table 6.4 ACT and NSW Threatened Fish Species in the Project Area

Scientific Name	Common Name	Status		Presence
		NC Act	FM Act	
Tandanus tandanus	eel-tailed catfish (Murray-Darling Basin population)	-	E	known
Euastacus armatus	Murray river crayfish	V	V	known
Gadopsis bispinosus	two-spined blackfish	V	-	none

Two-spined blackfish (*Gadopsis bispinosus*) is restricted to the Cotter River Catchment in the ACT and is not known to occur within the Murrumbidgee River (ACT Gov't 2007). It will not be impacted by the Program.

6.1.3.1 Eel-Tailed Catfish

The Murray-Darling Basin population of eel-tailed catfish (*Tandanus tandanus*) is listed as an 'Endangered Population' under the FM Act.

Eel-tailed catfish occur throughout the eastern drainages north of Newcastle and the Murray-Darling Basin. It occupies a range of habitats, though prefers sluggish or still waters such as lakes, billabongs, or lagoons. The species is non-migratory and benthic, living, feeding, and breeding near the bottom (FSC 2008).

Historic records show that the species was once widespread in the western rivers of NSW and was much more abundant than it is today. The Murray-Darling Basin population is in decline due to the impacts of habitat loss caused by river regulation and siltation, invasive species, habitat degradation from chemical pollution and the loss of aquatic plants, cold water pollution, and historic commercial fishing pressures.

Most records for the population occur in northern NSW within the Darling River catchment. Despite this, the NSW Gov't (2016c[143]) has mapped the eel-tailed catfish within Ginninderra Creek. As the Program will not directly impact on the waters of Ginninderra Creek and indirect impacts as a result of urban development will be managed, it is unlikely to have a significant adverse impact on eel-tailed catfish.

6.1.3.2 Murray River Crayfish

Murray River crayfish (*Euastacus armatus*) is listed as vulnerable in both NSW and the ACT under the FM Act and NC Act respectively.

Murray River crayfish is the largest of the freshwater spiny crayfish and occur within the southern tributaries of the Murray-Darling Basin. Specific habitats within this area vary; including a variety of stream sizes within pastures to sclerophyll forest, and over a broad altitudinal range. Despite this, it

[143] NSW Government (2016c) *Freshwater Threatened Species Distribution Maps*, Department of Primary Industries, Sydney, available online (accessed September 2016): http://www.dpi.nsw.gov.au/fishing/species-protection/threatened-species-distributions-in-nsw/freshwater-threatened-species-distribution-maps

appears that deep flowing water close to clay banks, with wood or rock cover are important for the species. Murray River crayfish feed on sub-aquatic plant beds (ACT Gov't 2007).

Threats to the species include habitat degradation by willows (*Salix* spp.), sedimentation, and loss of in-stream habitat (e.g. rock spaces); illegal take and fishing; predation by alien species (ACT Gov't 2007). Recreational fisheries are closed in the ACT, but are regularly fished in the NSW portion of the lower Murrumbidgee.

Murray River crayfish are known to occur within the Murrumbidgee River, including the reach that is adjacent to the Project Area (NSW Gov't 2016; ACT Gov't 2015a). As the Program will not directly impact on the waters of the Murrumbidgee River and indirect impacts as a result of urban development will be managed, it is unlikely to have a significant adverse impact on the species.

6.1.4 Frogs

There are no additional frog species listed in the ACT or NSW that are not already discussed in **Section 3** as part of EPBC Act listed matters.

6.1.5 Invertebrates

There is one additional invertebrate species that is listed in either NSW or the ACT that has been identified in database searches (**Table 6.5**).

Table 6.5 ACT and NSW Threatened Invertebrate Species in the Project Area

Scientific Name	Common Name	Status		Presence
		NC Act	TSC Act	
Perunga ochracea	perunga grasshopper	V	-	likely

6.1.5.1 Perunga Grasshopper

Perunga grasshopper (*Perunga ochracea*) is listed as vulnerable under the NC Act. It is a recently described species, with specimens taken from Wagga Wagga, Boorowa, Galong, Murrumbateman, Jeir, Queanbeyan, and the ACT.

Perunga grasshoppers are associated with natural temperate grasslands that are dominated by wallaby grass, kangaroo grass, and spear grasses; native pasture; and open woodland with a native grassy understorey. In the ACT, most records are from the Jerrabomberra and Majura Valleys, and large grassland reserves such as Mulanggari and Gungaderra Nature Reserves. The closest records to the Project Area are from the Molonglo River corridor, south from the National Arboretum.

Whilst the species has not been recorded within the Project Area, native grasslands and woodland areas with a native grassy understorey are likely to be habitat for perunga grasshopper. Exotic grasslands are not considered habitat for the species.

The Program will impact on natural temperate grassland within the Urban Development Area. A full assessment of potential impacts to perunga grasshopper will be included within State and Territory approval processes as appropriate.

6.1.6 Mammals

Five additional mammal species that are not listed under the EPBC Act were identified in database searches as having the potential to occur within the Project Area (**Table 6.6**).

Table 6.6 ACT and NSW Threatened Mammal Species in the Project Area

Scientific Name	Common Name	Status		Presence
		NC Act	TSC Act	
Miniopterus schreibersii oceanensis	eastern bent-wing bat	-	V	known
Myotis macropus	southern myotis	-	V	potential
Cercartetus nanus	eastern pygmy possum	-	V	unlikely
Petaurus norfolcensis	squirrel glider	-	V	none
Petaurus australis	yellow-bellied glider	-	V	none

Of these species, eastern pygmy possum (*Cercartetus nanus*), squirrel glider (*Petaurus norfolcensis*) yellow-bellied glider (*Petaurus australis*) are unlikely to occur within the Project Area and will not be considered further in this assessment. The basis for this conclusion is as follows:

- Eastern pygmy possums are known from a range of habitat types including sclerophyll forest and woodland. The species feeds largely on nectar from *Banksia* spp., eucalypts, and bottlebrushes (*Callistemon* spp.) (NSW Gov't 2016). Most records of the species in the ACT are in the Brindabella Ranges, with one record from 1986 in woodland south-east from the Project Area (Canberra Nature Map 2016). As the only food source for the species in the Project Area is flowering eucalypts, and nearly all records are from the Brindabella Ranges, it is considered unlikely that the species is present.

- Squirrel glider occurs in mature or old growth box or box-ironbark woodlands, or river red gum (*Eucalyptus camaldulensis*) forest with a flowering shrub or *Acacia* spp. mid-storey (NSW Gov't 2015b). This habitat does not occur within the Project Area.

- Yellow-bellied glider occurs in tall, typically moist, mature eucalypt forest (NSW Gov't 2015b). This habitat type does not occur within the Project Area; therefore, the species is unlikely to occur here.

6.1.6.1 Eastern Bent-Wing Bat

Eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) is listed as vulnerable under the TSC Act. The species occurs along the east and north-west coasts of Australia, extending into the western slopes of NSW.

Eastern bent-wing bat is dependent on caves for roosting and breeding, around which their discrete populations form. During breeding seasons, the species does not travel too far from the caves; however, outside of this time they can travel up to 300 kilometres away to forage. Forage habitat consists of forests and woodlands, including riparian, where the bats prey on insects above the treetops (NSW Gov't 2015b).

The species has been recorded in the Project Area (KMA 2013a), and it is likely that these individuals are part of the known maternity colony at Wee Jasper. There are no suitable caves or roosting habitat within the Project Area, however, the species would utilise the forest and woodlands within the Murrumbidgee River corridor for foraging. Areas of exotic and native pasture within the Urban Development Area are not considered habitat for the species.

Given the high mobility of the species and that forest and woodland habitat will be protected within the WBCC, the Program is not expected to have significant adverse impacts on the species.

6.1.6.2 Southern Myotis

Southern myotis (*Myotis macropus*) is listed as vulnerable under the TSC Act. It occurs along the coast from north-west Australia, across the top-end and south to western Victoria. It is rarely found more than 100 kilometres inland, except along major rivers such as the Murrumbidgee River (NSW Gov't 2015b).

The species generally roost in groups of 10 – 15, close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges, and in dense foliage. They will forage over streams and water bodies, hunting for small insects and fish. Southern myotis are found in a variety of vegetation types, including box gum woodlands and river oak forest.

Forest and woodland vegetation within the Murrumbidgee Corridor of the Project Area is potential habitat for the species. However, given its preference for coastal areas and the lack of nearby records it is considered unlikely to be utilised except in rare circumstances. In addition, the forest and woodland habitat along the Murrumbidgee River will be incorporated into the WBCC.

The Program is unlikely to have significant adverse impacts to the species.

6.1.7 Reptiles

Two additional reptile species that are not listed under the EPBC Act were identified in database searches as having the potential to occur within the Project Area (**Table 6.7**).

Table 6.7 ACT and NSW Threatened Reptile Species in the Project Area

Scientific Name	Common Name	Status		Presence
		NC Act	TSC Act	
Varanus rosenbergi	Rosenberg's goanna	-	V	known
Suta flagellum	little whip snake	-	V	potential

6.1.7.1 Rosenberg's Goanna

Rosenberg's goanna (*Varanus rosenbergi*) is listed as vulnerable under the TSC Act. The species occurs in southern Australia; from south-west Western Australia, between Port Lincoln, Kangaroo Island, and Adelaide in South Australia, and between Newcastle and the Victoria boarder in NSW.

Rosenberg's goanna is found in heath, open forest, and woodland. Individuals require large areas of habitat and are associated with termite mounds in which they nest. They feed on carrion, birds, eggs, reptiles, and small mammals. Hollow logs, rock crevices, and burrows (either dug by the goanna or by other species) are used for shelter.

The species is known to occur within the Project Area, with habitat occurring in the woodland and forested areas along the Murrumbidgee River Corridor. The species may be sighted in the exotic and native pasture grasslands; however, this is likely associated with movement through the landscape rather than habitat for the species. The habitat within the WBCC is likely to be an important habitat link for the species, connecting the individuals present to those across the northern areas of Namadgi National Park and the lower Cotter Catchment (A Lane 2016, pers. comm. 12 August).

The Program will protect habitat within the WBCC including termite mounds, and enforce a cat containment policy across the entire development area. These measures will reduce the impact of the Program on Rosenberg's goanna.

A full assessment of impacts to Rosenberg's goanna will be included within State and Territory approval processes as appropriate. This will be aided by information from surveys currently being undertaken targeting a better understanding of habitat requirements and use of the Project Area.

6.1.7.2 Little Whip Snake

Little whip snake (*Suta flagellum*) is listed as vulnerable under the TSC Act. It is only found in NSW, in an area bound by Crookwell, Bombala, Tumbarumba, and Braidwood.

The species occurs in natural temperate grassland, secondary grassland, and native grassy woodland on well drained hillsides with loose scattered rocks. Little whip snake feed on lizards and frogs, but little else is known of their ecology.

There are no records of little whip snake within the Project Area, with most in the ACT region occurring to the east of the Territory in the Bungendore area (Canberra Nature Map 2016).

Habitat for the species occurs within the Project Area, and it is likely to co-occur with pink-tailed worm-lizard habitat (**Section 3.3.1.7**). However, given the distance between the Project Area and other known records of the species, this habitat is considered to be potential for little whip snake.

Given that a majority of the pink-tailed worm-lizard habitat will be protected by the Program and that the habitat is unlikely to be critical for little whip snake, it is unlikely that the Program will have significant adverse impacts on the species.

6.1.8 Flora

Three additional flora species that are not listed under the EPBC Act were identified in database searches as having the potential to occur within the Project Area (**Table 6.8**).

Table 6.8 ACT and NSW Threatened Flora Species in the Project Area

Scientific Name	Common Name	Status		Presence
		NC Act	TSC Act	
Bossiaea grayi	Murrumbidgee bossiaea	E	-	potential
Swainsona sericea	silky swainson pea	-	V	potential
Senecio garlandii	woolly ragwort	-	V	no

Woolly ragwort (*Senecio garlandii*) occurrence in the Murrumbateman area is restricted to within ten kilometres of Burrinjuck Dam. It is, therefore, not expected to occur within the Project Area.

6.1.8.1 Murrumbidgee Bossiaea

Murrumbidgee bossiaea (*Bossiaea grayi*) is listed as endangered under the NC Act and occurs exclusively in the ACT along the Murrumbidgee River and its tributaries (ACT Gov't 2012b[144]).

Habitat for the species occurs on shallow sandy substrates amongst rock outcrops near or above the edge of the riparian zone. The nearest record of the species is from Woodstock Nature Reserve, west from the Project Area. It has not been recorded within the Project Area, despite being a readily identifiable shrub (ACT Gov't 2012b).

Habitat for the species occurs within the Project Area within the riparian zone of the Murrumbidgee River Corridor. Whilst the species has not been recorded here, the Program will protect riparian habitats within the WBCC including through site based pre-construction surveys and ongoing flora and vegetation management.

The Program is unlikely to have significant adverse impacts to the species.

6.1.8.2 Silky Swainson Pea

Silky swainson pea (*Swainsona sericea*) is listed as vulnerable under the TSC Act. It is distributed along the tablelands and slopes of NSW, central Victoria, and some isolated records in South Australia.

On the southern tablelands and south-west slopes, habitat for silky swainson pea is box gum woodland. This species was targeted during threatened flora surveys for the Project Area and was not identified despite surveys being undertaken at the appropriate time of year for identification.

It is unlikely to occur in the low quality box gum woodland along Drake Brockman Drive. All other box gum woodland in the Project Area would constitute habitat for the species. As it is being protected by the Program, it is not expected to have significant adverse impacts to the species.

6.1.8.3 ACT Locally Significant Flora Species

The ACT Government have also identified a number of locally uncommon or rare species that are present within the Project Area. These are not afforded any formal protection under Commonwealth or Territory legislation, however, will be the focus of future conservation actions undertaken by the government.

The following species have been recorded within the WBCC:

- small crowea (*Crowea exalata* subsp. *exalata*)
- currawong (*Acacia doratoxylon*); and
- varnish wattle (*Acacia verniciflua*).

[144] ACT Government (2012b) *Action Plan No. 34: Murrumbidgee Bossiaea (Bossiaea grayi)*, Environment and Sustainable Development Directorate, Canberra.

Whilst not specifically addressed within the WBBC RMP, these species will likely benefit from the overall conservation measures that will be implemented as part of the Program. They are not present within the Urban Development Area and will not be directly impacted by urban development.

7.0 Consistency with Endorsement Criteria

This section provides information on how the Program meets the relevant objectives of the EPBC Act (as stated in the Terms of Reference (ToR)). Each objective is addressed with reference to information provided within the Program.

7.1 Environment Protection

The Program seeks to protect the existing environmental attributes of the Project Area, the broader west Belconnen area, and relevant MNES (as identified in this report) by proposing a detailed strategy designed to lead to significant improvements to the ACT Nature Reserve System, both in terms of total land area and also configuration, viability, and connectivity. This will be achieved through the:

- creation of the WBCC that is designed to protect 549.9 hectares of existing environmental values within the Project Area and connect them to other areas of value within the region
- creation of the EMT and WBCC RMP, the objectives of which include the enhancement of natural environmental values within the WBCC
- placement of 146.4 hectares of vulnerable pink-tailed worm-lizard habitat and 68.2 hectares of critically endangered box gum woodland into the protected WBCC
- creation of direct land offsets to ameliorate the potential impacts on MNES, in particular golden sun moth, pink-tailed worm-lizard, and box gum woodland, and to increase the connectivity of reserve areas across the region; and
- implementation of commitments established for box gum woodland as a result of the Molonglo Strategic Assessment.

7.2 Ecologically Sustainable Development

The EPBC Act establishes principles for ESD that all development must follow so that it does not occur to the great detriment of social, environmental, or economic values. These principles are derived from the 'Intergovernmental Agreement on the Environment' (Australian Gov't 2010[145]) and the 'National Strategy for Ecologically Sustainable Development' endorsed by all Australian jurisdictions in 1992[146], and are aimed at the achieving the following goal:

'Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends' (Australian Gov't 1992).

In summary, ESD is development which aims to meet the current needs of the population, while still conserving our natural environment for the benefit of future generations. To achieve this, the environmental resources which form the basis of our economy must be used in a way which maintains their range, variety, and quality, while still utilising them to develop industry and generate employment (Australian Gov't 1992).

[145] Australian Government (2010) *Intergovernmental Agreement on the Environment*, Department of Water, Sustainability, Environment, Population, and Communities, accessed online (March 2015): http://www.environment.gov.au/about-us/esd/publications/intergovernmental-agreement.

[146] Australian Government (1992) *National Strategy for Ecologically Sustainable Development*, prepared by the Ecologically Sustainable Development Steering Committee and endorsed by the Council of Australian Governments (December, 1992).

Section 3A of the EPBC Act discusses the following ESD principles:

- **The Integration Principle:** decision-making processes should effectively integrate both long-term and short-term economic, environmental, social, and equitable considerations.
- **The Precautionary Principle:** if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- **The Principle of Intergenerational Equity:** the present generation should ensure that the health, diversity, and productivity of the environment is maintained or enhanced for the benefit of future generations.
- **The Biodiversity Principle:** the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.
- **The Valuation Principle:** improved valuation, pricing, and incentive mechanisms should be promoted.

The following sections discuss the ways in which the Program addresses these principles.

7.2.1 The Integration Principle

The Program considers both long and short term economic, environmental, social, and equity values.

The aim of the Program is to create '*an innovative, sustainable community*' (RobertsDay 2014 pp. 5) as defined and audited under the Green Building Council of Australia's Green Star Community pilot rating program. This has been the aim of the Program since the outset, allowing for consideration and incorporation of sustainability values throughout the design phase. To achieve this, existing values of the Project Area were used as the major design constraint when developing the Master Plan.

Information regarding the location of environmental values within the Project Area and the broader west Belconnen area was gathered first, so that the development boundary could be designed around the areas of highest value. In particular this included thorough, targeted survey for pink-tailed worm-lizard, golden sun moth, and box gum woodland. The areas of highest quality, connectivity, and greatest probability of long-term viability were incorporated into the WBCC and will be protected from development.

The liveability of the final suburbs has also been considered. By incorporating Walter Burley Griffin's vision of a 'city set in nature' into the design of the Program, not only are the environmental values protected within the WBCC, they are connected and integrated with the community. The transition from natural to built environments defines the character zones within the Master Plan and the associated housing types, structures, and lifestyle types that will be available under the Program. This adds to the amenity of the area, creates a sense of place, and allows for public recreation, local tourism, and public appreciation of the conservation values.

The provision of 'neighbourhoods' as part of the Master Plan also promotes social connectedness by providing community areas where people can gather and participate in community activities and provide local employment opportunities. These neighbourhoods are also linked to the WBCC in 'green' areas that form part of the urban open space system. Through these, the vistas of the WBCC will be continued through the urban areas and will form a key part of the community identity. By integrating the social and environmental values of the Project Area, the west Belconnen community

will be able to take ownership of the environmental values and protecting them will also help to protect the social identity of the community. The EMT will also include key community stakeholder representatives, who will be able to continue the integration of social and environmental values throughout the life of the Program.

The Master Plan has also considered the location of existing infrastructure throughout the broader west Belconnen area. By utilising these efficiently, the Program is able to reduce the cost and impact of service provision. Transport routes are designed to be extensions of those already present within the surrounding suburbs, the sewer and arterial road designs have considered alternate routes and construction methods to avoid environmental values, reduce costs, and benefit the community.

The Master Plan also allows for a diversity of housing types to provide affordable housing options. This, in conjunction with the social design considerations will help to maintain interest in the Program and ensure people continue to purchase houses in the area and maintain the economic value of the Program in the long-term. In addition, the Program aligns with existing short-term and long-term policy outcomes by providing sustainable greenfield land release. Housing is required in the region to provide for the projected increase in population. The Program proposes to provide this in a manner consistent with future housing demand, whilst considering neighbourhood design, community facilities, infrastructure, accessibility, recreation, and amenity to create an affordable and diverse place in which to live.

7.2.2 The Precautionary Principle

A precautionary approach has been used throughout the design phase of the Program, so that environmental impacts may be pre-empted and avoided where possible.

The environmental values of the Project Area were treated as a development constraint so that impacts may be avoided from the outset, rather than mitigated or offset during later stages of the development. This is evidenced by the creation of the WBCC and the numerous site scale studies that have been conducted in an effort to close information gaps.

In addition to this, the Strategic Assessment process is precautionary in nature as it provides a procedure to assess and evaluate the uncertainty of environmental impacts (including in the presence of threatened species and communities) prior to the development proceeding.

Within the WBCC a landscape scale approach will be used for conservation. This allows for the enhancement of habitats for a range of species, in addition to the protection of key threatened species and communities habitat (e.g. pink-tailed worm-lizard and box gum woodland). This approach has also extended the size of the WBCC so that it may be become a part of the existing corridor system, providing habitat links for pink-tailed worm-lizard and woodland birds.

As set out in the Program and discussed in this report, environmental offsets have been proposed to compensate for the residual significant impacts to golden sun moth, pink-tailed worm-lizard, and box gum woodland. These have been designed to be larger than necessary to incorporate the added benefit of habitat connectivity, and to protect environmental values from any unknown or cumulative impacts resulting from the Program.

An adaptive management approach will be used for the protected areas to ensure that as knowledge in regards to these impacts change, the way they are addressed also changes. This will help to address any mismanagement that may occur if knowledge gaps and change are not addressed.

7.2.3 The Principle of Intergenerational Equity

Economic, social, and environmental values will be sustainable in the long-term under the Program.

The basic need for adequate and affordable housing for future generations will be achieved under the Program; however, this will be enhanced by providing access to employment, retail, education, and community facilities within and outside of the Project Area. By providing different housing types and character zones a broad range of lifestyles suited to all stages of life will be possible within the urban development. This will ensure that not only are the suburbs functional, they are also liveable and sustainable places to live in the long-term.

The protection of environmental values within the WBCC allows future generations to enjoy the natural values associated with it. These benefits include the protection of MNES, improvements to the reserve system and landscape function, and the provision of recreation areas that are easily accessible and help to define the sense of well-being within the community. The WBCC RMP and the funding policy for the EMT also ensure that these values will be conserved in perpetuity.

7.2.4 The Biodiversity Principle

The Program considered biodiversity values as a constraint when first defining the urban development area. This allowed for 549.9 hectares of the most environmentally valuable land within the Project Area to be protected within the WBCC.

The ongoing management of the WBCC will add to the biodiversity values of the region by protecting nationally important pink-tailed worm-lizard habitat and improving the quality of box gum woodland retained in accordance with commitments of the Molonglo Strategic Assessment. Furthermore, these values, as well as other landscape functions, will be rehabilitated and enhanced over time.

The design of the Program has also considered regional connectivity values. The WBCC links with other protected riparian and woodland habitats. Stepping stone woodland trees are to be retained within the urban development area to increase these links for woodland birds in particular. Wetland habitat is also to be provided through the design of the stormwater management system that will be integrated into the existing ephemeral creek system across the Project Area.

The combination of a wide ranging consultation process during the design phase and an adaptive management process during the operational stage allows for new ecological information and flexibility to be integrated into the management of these biodiversity values.

The target of a six star Green Community rating also encourages the incorporation of new development principles that will decrease the impact of future development on the environment and natural resources. These include the area's ability to enhance Canberra's compact design, allow for less travel time between home and work for locals, increase public transport use, implementation of ecological urbanism practices such as urban farming, allowing for environmental education as a part of the management of the WBCC, implementation of WSUD principles for stormwater management, and the consideration of the role of aspect in solar efficiency of housing.

7.2.5 The Valuation Principle

The Program has been staged so that it may be implemented in line with future housing needs. This will help to minimise the impacts supply changes will have on housing prices, keeping them as affordable as possible. The provision of various housing and land types also improves the affordability of the development for home buyers.

The desirability of the development in the long-term also affects the price of housing. The Program has considered a number of factors during the design phase to ensure the liveability, access, and stability of the community remains high so that the value of the precinct remains.

A funding plan for the WBCC is being completed. This will ensure that funding remains in the long-term, allowing for the conservation outcomes of the Program to be achieved. Furthermore the WBCC RMP and the creation of offsets will result in a net improvement of biodiversity values over time, beyond what might be expected under statutory obligations.

The Strategic Assessment process increases the value of the Program by allowing the minimisation of administrative costs associated with undertaking site by site referrals and establishing numerous small offsets. The result is an effective, efficient, and equitable process that increases the value of the Program overall.

7.3 Biodiversity Conservation

The objective of biodiversity conservation has underpinned the Program the entire way through the design phase, and will continue to drive the ways in which the Program will be implemented and managed in the long-term.

This is demonstrated by the protection of 549.9 hectares of land through the creation of the WBCC, and a further 33 hectares of golden sun moth habitat will be protected within the additional environmental offset area. At establishment, the golden sun moth offset will be comprised of:

- 11.9 hectares of occupied habitat
- 19.4 hectares of unoccupied habitat; and
- a further 1.8 hectares of occupied habitat replacing the impacted Jarramlee and Macgregor offsets.

These areas will protect the general environmental values held within the riparian areas of the Project Area, key habitat for the vulnerable pink-tailed worm-lizard, critically endangered golden sun moth, and critically endangered box gum woodland patches.

Furthermore, these values will also be enhanced through the implementation of the WBCC RMP. This plan will take a landscape scale approach to biodiversity conservation, not only enhancing the habitat within the corridor for the targeted species, but also to improve the viability of the ecosystems as a whole.

The value of the WBCC as a habitat corridor has also been incorporated into the Program. The boundary of the WBCC was defined based on its links to riparian habitat outside of the Project Area. Woodland links will also be maintained via the retention of stepping stone trees throughout the urban development area. This will not only improve the biodiversity values within the Project Area, but also throughout the region.

7.4 Cooperative Approach to Biodiversity Protection

The Program represents the first cross-border settlement for the ACT and NSW. This requires cooperation from both the Yass Valley Council and the ACT Government to ensure that the planning of the Program and associated biodiversity protection schemes will be in line with both their policies. This cooperation has been achieved thus far by including government representatives in the consultation and planning process (RobertsDay 2014). The creation of the EMT, which will be

responsible for managing the protected biodiversity values as a whole, will allow for an integrated approach to managing the WBCC that includes government representatives to guide decision-making for the duration of the Program.

Comprehensive engagement with key stakeholders commenced in 2007. This allowed for their views to be incorporated into the Master Plan, with sustainability (including biodiversity protection) at the centre of discussions. This process will be continued, culminating the EMT which will include community stakeholders.

In addition, by integrating the environmental values with the social identity of the community, the Program will be able to protect the environmental values by increasing public appreciation of their conservation. This in turn will be used to drive community engagement with ongoing management of the WBCC.

The EMT will also provide access to tertiary education institutions to the WBCC for research purposes. This will provide opportunities for the EMT to access and utilise ongoing, up-to-date scientific knowledge to guide the future management of the WBCC, fill information gaps, and undertake monitoring actions. This will facilitate monitoring and an adaptive management approach and assist to ensure the biodiversity values are protected and enhanced.

7.5 Australia's International Environmental Responsibilities

This Assessment Report has considered Australia's obligations under international environmental agreements. In particular, obligations under the Bonn Convention, JAMBA, CAMBA, and ROKAMA for migratory species conservation were considered, as were responsibilities under the Ramsar Convention for significant wetland protection.

It has been determined through this assessment process that there is unlikely to be any significant impacts to matters listed under these agreements as a consequence of implementing the Program.

8.0 Consistency with Terms of Reference

The ToR establish the scope for the strategic assessment, forming a part of the Strategic Assessment Section 146 Agreement between the Commonwealth Government and the Riverview Group.

Table 8.1 lists the ToR and relates them to the relevant sections within this report.

Table 8.1 Summary of Terms of Reference and where they are addressed within the Strategic Assessment

Terms of Reference	Report Section (s) where Addressed
Purpose and Description	
The Program Report must describe: • The geographic extent and description of the area to which the Program applies, including tenures, identification of current protected lands and the location of developable and non-developable land. • The ACT and NSW context (environmental, social, and economic) in which the Program applies. • Component legislation, plans, statutes, planning instruments, and policies that underpin the Program and its implementation. • Specific outcomes and commitments to protect Protected Matters. • Key studies and investigations that have informed the Program and Strategic Assessment Report. • Description and justification for methodologies used to identify and prioritise desirable conservation outcomes for the area to which the Program applies. • Mechanisms including avoidance, mitigation, and offset arrangements to achieve the identified conservation outcomes. • Identification of the relevant authorities responsible for implementation of the Program, particularly in relation to conservation commitments, adaptive management approaches, monitoring , auditing, report and compliance arrangements.	Program Report
Matters of National Environmental Significance (Protected Matters) **Identification of affected Protected Matters**	
The Strategic Assessment Report must describe Protected Matters likely to be impacted by actions envisaged in the Program. The following matters must be addressed:	
• listed threatened species and communities (sections 18 and 18A);	Section 3.3.1
• listed migratory species (sections 20 and 20A); and	Section 3.3.2

Terms of Reference	Report Section (s) where Addressed
• any other Protected Matters that may be triggered.	Sections 3.3.3, 3.3.4, and 3.3.5
The Strategic Assessment Report must describe the Protected Matters within the geographic extents of the Program. This includes Protected Matters likely to be directly or indirectly impacted. The assessment must:	
• Describe the current condition of Protected Matters, and past and projected trends and existing threats.	Sections 3 and 4
• Identify those aspects of the environment, including landscape-scale ecosystem functions and connectivity corridors, considered critical to the continued presence and functioning of Protected Matters identified as potentially at risk.	Sections 3 and 4
• Describe the methodology for identifying Protected Matters and supporting landscape ecosystem functions and connectivity, and for identifying priority areas for conservation, together with an analysis of the strengths, limitations and expected effectiveness of methodologies used.	Sections 3 and 4
• Identify any key information gaps, further studies needed and any proposals to address critical information needs.	Section 4.8
Matters of National Environmental Significance (Protected Matters) **Identification and analysis of potential impacts**	
The Strategic Assessment Report must identify and analyse the likely direct and indirect impacts of development on biodiversity and Protected Matters within the strategic assessment area, and against the desired conservation outcomes identified in the Program Report. The Strategic Assessment Report must include analysis of the:	
• Nature of potential development and description of the types of impacts considered, including cumulative impacts.	Sections 2.6 and 4
• Potential impacts on Protected Matters and those aspects of the environment considered critical to the continued presence and functioning of Protected Matters.	Section 4
• Sensitivity analysis of different development scenarios on achieving the desired conservation outcomes identified in the Program.	Section 2.6 and 2.7
• Consideration of climate change and other long term influences on Protected Matters and supporting landscape ecosystems in assessing likely risks and impacts to biodiversity from development.	Section 4.8.3

Terms of Reference	Report Section (s) where Addressed
Matters of National Environmental Significance (Protected Matters) **Measures to avoid, mitigate, offset and adaptively manage impacts**	
The Program Report and Strategic Assessment Report must identify specific measures that have been, or will be, implemented to avoid, mitigate and offset impacts on Protected Matters, including:	
• Measures to identify and avoid areas of high conservation or biodiversity value.	Sections 4.2 and 4.3
• Requirements for mitigation of impacts where direct or indirect impacts are expected or likely.	Sections 4.4, 4.5, and 4.6
• Offset mechanisms and approaches to be applied where clearing of native vegetation is proposed within development area, and to direct offsets to priority conservation areas identified in the Program.	Section 5
• The agencies responsible for undertaking the proposed measures.	Program Report
The Strategic Assessment Report must include an analysis of the likely effectiveness of the Program in protecting Protected Matters and in achieving good conservation outcomes at the regional landscape scale, including associated regulatory and policy arrangements to implement commitments.	Sections 4 and 5
Promoting Ecologically Sustainable Development	
The Strategic Assessment Report must describe how the principles of ecologically sustainable development (section 3A of the EPBC Act) have been applied in developing the Program and how these will be implemented.	Section 7.2
Adaptive Management: Addressing Uncertainty and Managing Risk	
The Program Report and Strategic Assessment Report must identify key adaptive management measures addressing uncertainties and inherent risks. Uncertainties could, for example, include knowledge gaps in scientific understanding and the timing, effectiveness, or capacity to implement, maintain, operate and enforce management measures.	Sections 4.3.2 and 4.8

Terms of Reference	Report Section (s) where Addressed
The Program Report must describe how the adaptive management strategies will be implemented to ensure Protected Matters are effectively protected over the life of the Program Report. This includes: • How monitoring of Protected Matters will occur, including monitoring of progress in achieving the desired conservation outcomes identified in the Program Report, how the monitoring will be analysed throughout the life of the Program and how the results of the monitoring will influence the Program. • How new information relating to Protected Matters or the Program Report is to be assessed and accounted for in management of the area affected by the Program Report.	Program Report
Auditing and Reporting	
The Program Report must set out: • monitoring, public reporting and independent or third party auditing to be undertaken; • a process that will incorporate these findings into ongoing management; • who is responsible for overseeing and taking these actions; and • record keeping and review processes under the Program Report.	Program Report
Endorsement Criteria	
The Program Report must set out how the Program meets the objectives of the EPBC Act. In determining whether or not to endorse the Program, the Minister will have regard to the extent to which the Program meets the objectives of the EPBC Act including how the Program: • protects the environment, especially Protected Matters; • promotes ecologically sustainable development; • promotes the conservation of biodiversity; • promotes a cooperative approach to the protection and management of biodiversity and Protected Matters; and • assists in the cooperative implementation of Australia's international environmental responsibilities.	Section 7 and the Program Report
In determining whether or not to endorse the Program the Minister must be satisfied that commitments for the protection and management of Protected Matters must be enforceable and achievable over the life of the Program. The Program must demonstrate an effective system of adaptive management that addresses uncertainty and contingency management as well as procedures for monitoring, auditing and public reporting on implementation.	Program Report

Terms of Reference	Report Section (s) where Addressed
Information Sources	
For information and data used in the assessment, the Strategic Assessment Report must state: • the source and currency (date) of the information; and • the reliability and limitations of the information.	Section 4

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N.B. Mapping Data Sources: Spatial Data used in maps is derived from specialists reports as indicated in the accompanying text, where not otherwise indicated, all broad-scale spatial data has been sourced from the ACT Government' online mapping product, ACTmapi [http://actmapi.act.gov.au/]

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Threatened Species Scientific Committee (TSSC) (2015b) *Conservation Advice Aprasia parapulchella Pink-tailed worm-lizard*, approved by the Minister for the Environment's Delegate on 01/10/2015, Canberra.

Threatened Species Scientific Committee (TSSC) (2015c) *Conservation Advice Eucalyptus aggregata black gum*, approved by the Minister for the Environment on 17/11/2015.

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Victorian Gov't (2011a) *National Recovery Plan for the Hoary Sunray Leucochrysum albicans var. tricolor*, prepared by Sinclair, SJ. for Department of Sustainability and Environment, Melbourne.

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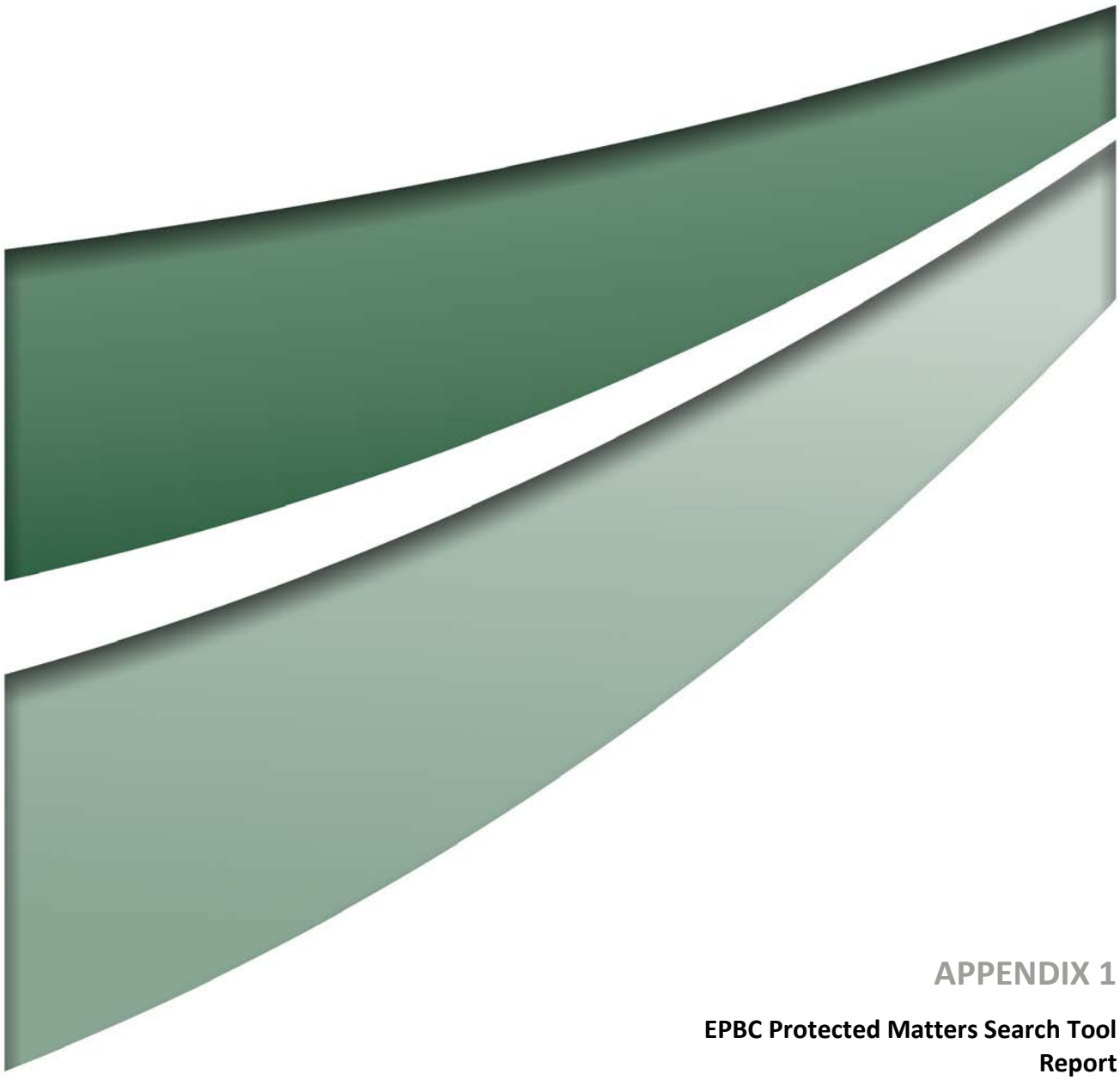

APPENDIX 1

EPBC Protected Matters Search Tool Report

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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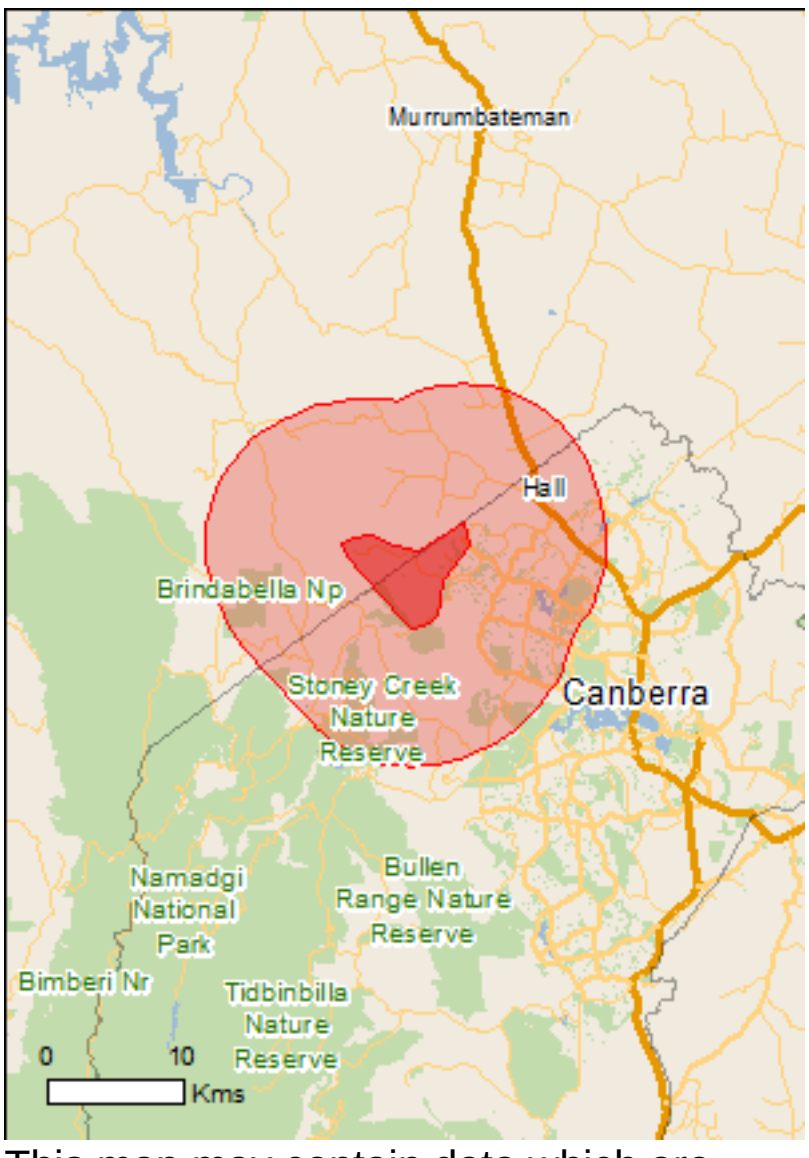

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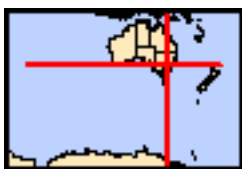

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	35
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	5
Commonwealth Heritage Places:	4
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	1
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	14
Regional Forest Agreements:	1
Invasive Species:	37
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
Australian Alps National Parks and Reserves	NSW	Listed place

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Banrock station wetland complex	700 - 800km upstream
Hattah-kulkyne lakes	500 - 600km upstream
Riverland	700 - 800km upstream
The coorong, and lakes alexandrina and albert wetland	800 - 900km upstream

Listed Threatened Ecological Communities		[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Alpine Sphagnum Bogs and Associated Fens	Endangered	Community may occur within area
Natural Temperate Grassland of the South Eastern Highlands	Critically Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		

Name	Status	Type of Presence
Maccullochella macquariensis Trout Cod [26171]	Endangered	Species or species habitat may occur within area
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat known to occur within area
Frogs		
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat may occur within area
Litoria booroolongensis Booroolong Frog [1844]	Endangered	Species or species habitat likely to occur within area
Litoria castanea Yellow-spotted Tree Frog, Yellow-spotted Bell Frog [1848]	Endangered	Species or species habitat likely to occur within area
Pseudophryne pengilleyi Northern Corroboree Frog [66670]	Critically Endangered	Species or species habitat may occur within area
Insects		
Synemon plana Golden Sun Moth [25234]	Critically Endangered	Species or species habitat known to occur within area
Mammals		
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat may occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Eucalyptus aggregata Black Gum [20890]	Vulnerable	Species or species habitat likely to occur within area
Lepidium ginninderrense Ginninderra Peppercress [78474]	Vulnerable	Species or species habitat known to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
[Leucochrysum albicans var. tricolor](#) Hoary Sunray, Grassland Paper-daisy [56204]	Endangered	Species or species habitat likely to occur within area
[Pelargonium sp. Striatellum (G.W.Carr 10345)](#) Omeo Stork's-bill [84065]	Endangered	Species or species habitat may occur within area
[Pomaderris pallida](#) Pale Pomaderris [13684]	Vulnerable	Species or species habitat likely to occur within area
[Prasophyllum petilum](#) Tarengo Leek Orchid [55144]	Endangered	Species or species habitat known to occur within area
[Prasophyllum sp. Wybong (C.Phelps ORG 5269)](#) a leek-orchid [81964]	Critically Endangered	Species or species habitat known to occur within area
[Pterostylis oreophila](#) Blue-tongued Orchid, Kiandra Greenhood [22903]	Critically Endangered	Species or species habitat likely to occur within area
[Swainsona recta](#) Small Purple-pea, Mountain Swainson-pea, Small Purple Pea [7580]	Endangered	Species or species habitat likely to occur within area
[Thesium australe](#) Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
[Aprasia parapulchella](#) Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat known to occur within area
[Delma impar](#) Striped Legless Lizard [1649]	Vulnerable	Species or species habitat known to occur within area
[Tympanocryptis pinguicolla](#) Grassland Earless Dragon [66727]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
[Hirundapus caudacutus](#) White-throated Needletail [682]		Species or species habitat known to occur within area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat known to occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Scientific & Industrial Research Organisation
Defence - BELCONNEN RADIO STATION ; BELCONNEN COMMUNICATIONS STATION
Defence - HEWLETT PACKARD BUILDING - FERNHILL PARK

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Synemon Plana Moth Habitat	ACT	Listed place
Historic		
Cameron Offices (Wings 3, 4 and 5, and Bridge)	ACT	Listed place
Mount Stromlo Observatory Precinct	ACT	Listed place
Royal Australian Naval Transmitting Station	ACT	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Critical Habitats	[Resource Information]
Name	Type of Presence
Lepidium ginninderrense (Ginninderra Peppercress) - Northwest corner Belconnen Naval Transmission Station, ACT	Listed Critical Habitat

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Aranda Bushland	ACT
Brindabella	NSW
Brindabella	NSW
Bullen Range	ACT
Dunlop Grassland	ACT
Gossan Hill	ACT
Kama	ACT
Lower Molonglo River Corridor	ACT
Mt Painter	ACT
Percival Hill	ACT
Stony Creek	ACT

Name	State
Swamp Creek	ACT
The Pinnacle	ACT
Woodstock	ACT

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Southern RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Feral deer		
Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis		
Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus		
House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus		
Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus		
Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus		
Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides		
Alligator Weed [11620]		Species or species habitat likely to occur within area
Asparagus asparagoides		
Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. monilifera		
Boneseed [16905]		Species or species habitat likely to occur within area
Cytisus scoparius		
Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista monspessulana		
Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana		
Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana		
Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma		
Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-35.186521 149.015437,-35.200268 149.019214,-35.218221 149.001876,-35.230702 149.000331,-35.237572 148.997928,-35.240517 148.994838,-35.243741 148.98883,-35.245423 148.981277,-35.240797 148.975783,-35.205739 148.937846,-35.198445 148.934928,-35.195499 148.943339,-35.194517 148.953811,-35.199707 148.970634,-35.203635 148.985396,-35.186801 149.015437,-35.186521 149.015437

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Parks and Wildlife Commission NT, Northern Territory Government
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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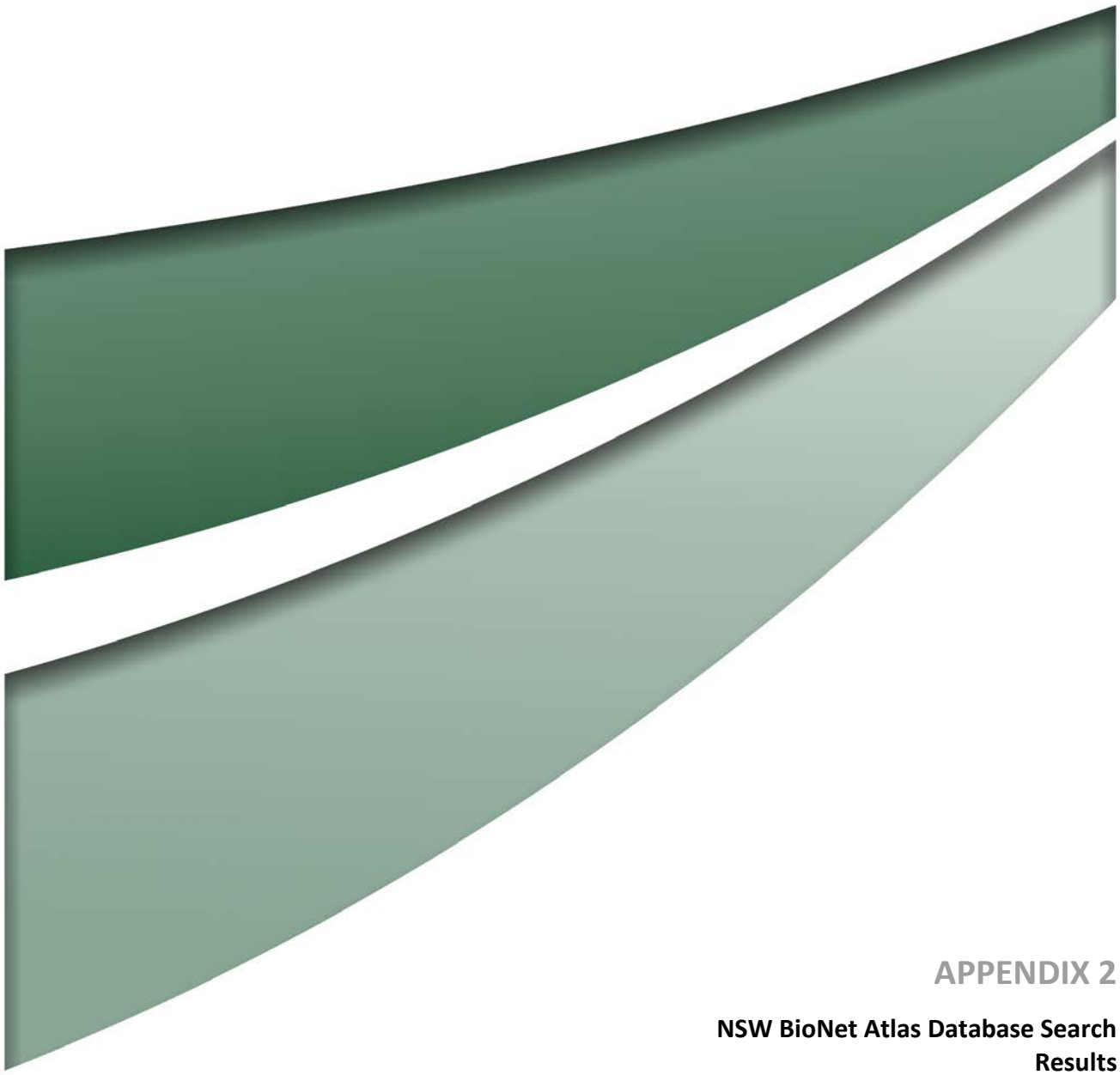


APPENDIX 2

NSW BioNet Atlas Database Search Results

Data from the BioNet Atlas of NSW Wildlife website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1Â°; ^^ rounded to 0.01Â°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria : Public Report of all Valid Records of Threatened (listed on TSC Act 1995) Entities in Murrumbidgee - Murrumbateman CMA cut by IBRA Subregion returned a total of 814 records of 86 species.

Report generated on 10/11/2016 5:01 PM

Kingdom	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW status	Comm. status	Records
Animalia	Amphibia	Hylidae	3166	*Litoria aurea*		Green and Golden Bell Frog	E1,P	V	3
Animalia	Amphibia	Hylidae	3168	*Litoria booroolongensis*		Booroolong Frog	E1,P	E	4
Animalia	Amphibia	Hylidae	3172	*Litoria castanea*		Yellow-spotted Tree frog	E4A,P	E	1
Animalia	Reptilia	Pygopodidae	2144	*Aprasia parapulchella*		Pink-tailed Legless Lizard	V,P	V	6
Animalia	Reptilia	Pygopodidae	2159	*Delma impar*		Striped Legless Lizard	V,P	V	1
Animalia	Reptilia	Varanidae	2287	*Varanus rosenbergi*		Rosenberg's Goanna	V,P		3
Animalia	Reptilia	Elapidae	2727	*Suta flagellum*		Little Whip Snake	V,P		3
Animalia	Aves	Anatidae	0216	*Oxyura australis*		Blue-billed Duck	V,P		1
Animalia	Aves	Anatidae	0214	*Stictonetta naevosa*		Freckled Duck	V,P		K
Animalia	Aves	Ardeidae	0197	*Botaurus poiciloptilus*		Australasian Bittern	E1,P	E	P
Animalia	Aves	Accipitridae	0218	*Circus assimilis*		Spotted Harrier	V,P		1
Animalia	Aves	Accipitridae	0225	*Hieraaetus morphnoides*		Little Eagle	V,P		31
Animalia	Aves	Accipitridae	0230	*^^Lophoictinia isura*		Square-tailed Kite	V,P,3		1
Animalia	Aves	Falconidae	0238	*Falco subniger*		Black Falcon	V,P		K
Animalia	Aves	Cacatuidae	0268	*^^Callocephalon fimbriatum*		Gang-gang Cockatoo	V,P,3		22
Animalia	Aves	Cacatuidae	0270	*^Lophochroa leadbeateri*		Major Mitchell's Cockatoo	V,P,2		1
Animalia	Aves	Psittacidae	0260	*Glossopsitta pusilla*		Little Lorikeet	V,P		1

Animalia	Aves	Psittacidae	0277	*^^Polytelis swainsonii*	Superb Parrot	V,P,3	V	52
Animalia	Aves	Strigidae	0248	*^^Ninox strenua*	Powerful Owl	V,P,3		2
Animalia	Aves	Tytonidae	0252	*^^Tyto longimembris*	Eastern Grass Owl	V,P,3		1
Animalia	Aves	Climacteridae	8127	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V,P		55
Animalia	Aves	Acanthizidae	0504	*Chthonicola sagittata*	Speckled Warbler	V,P		67
Animalia	Aves	Meliphagidae	0603	*Anthochaera phrygia*	Regent Honeyeater	E4A,P	CE	7
Animalia	Aves	Meliphagidae	0448	*Epthianura albifrons*	White-fronted Chat	V,P		1
Animalia	Aves	Meliphagidae	0598	*Grantiella picta*	Painted Honeyeater	V,P	V	1
Animalia	Aves	Neosittidae	0549	*Daphoenositta chrysoptera*	Varied Sittella	V,P		21
Animalia	Aves	Artamidae	8519	*Artamus cyanopterus cyanopterus*	Dusky Woodswallow	V,P		31
Animalia	Aves	Petroicidae	8367	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	V,P		33
Animalia	Aves	Petroicidae	0380	*Petroica boodang*	Scarlet Robin	V,P		99
Animalia	Aves	Petroicidae	0382	*Petroica phoenicea*	Flame Robin	V,P		19
Animalia	Aves	Petroicidae	0383	*Petroica rodinogaster*	Pink Robin	V,P		1
Animalia	Aves	Estrildidae	0652	*Stagonopleura guttata*	Diamond Firetail	V,P		25
Animalia	Mammalia	Dasyuridae	1008	*Dasyurus maculatus*	Spotted-tailed Quoll	V,P	E	2
Animalia	Mammalia	Phascolarctidae	1162	*Phascolarctos cinereus*	Koala	V,P	V	13
Animalia	Mammalia	Burramyidae	1150	*Cercartetus nanus*	Eastern Pygmy-possum	V,P		2
Animalia	Mammalia	Petauridae	1136	*Petaurus australis*	Yellow-bellied Glider	V,P		P
Animalia	Mammalia	Petauridae	1137	*Petaurus norfolcensis*	Squirrel Glider	V,P		P
Animalia	Mammalia	Vespertilionidae	1834	*Miniopterus schreibersii oceanensis*	Eastern Bentwing-bat	V,P		110
Animalia	Mammalia	Vespertilionidae	1357	*Myotis macropus*	Southern Myotis	V,P		K
Animalia	Insecta	Castniidae	I003	*Synemon plana*	Golden Sun Moth	E1	CE	113

Plantae	Flora	Asteraceae	1264	*Ammobium craspedioides*	Yass Daisy	V,P	V	42
Plantae	Flora	Asteraceae	7097	*Senecio garlandii*	Woolly Ragwort	V,P		P
Plantae	Flora	Fabaceae (Faboideae)	3056	*Swainsona recta*	Small Purple-pea	E1,P	E	P
Plantae	Flora	Fabaceae (Faboideae)	8538	*Swainsona sericea*	Silky Swainson-pea	V,P		3
Plantae	Flora	Myrtaceae	4038	*Eucalyptus aggregata*	Black Gum	V,P	V	P
Plantae	Flora	Orchidaceae	9523	*^Caladenia concolor*	Crimson Spider Orchid	E1,P,2	V	P
Plantae	Flora	Orchidaceae	9478	*^Prasophyllum petilum*	Tarengo Leek Orchid	E1,P,2	E	P
Plantae	Flora	Proteaceae	8305	*^Grevillea iaspicula*	Wee Jasper Grevillea	E4A,P,2	E	34
Plantae	Flora	Rhamnaceae	5588	*Pomaderris pallida*	Pale Pomaderris	V,P	V	1
Plantae	Flora	Santalaceae	5871	*Thesium australe*	Austral Toadflax	V,P	V	P
Community				*Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions*	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	E3		P

Community	*Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions*	Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions	E3		K
Community	*White Box Yellow Box Blakelyâ€™s Red Gum Woodland*	White Box Yellow Box Blakelyâ€™s Red Gum Woodland	E3	CE	K
Threat	*Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners Manorina melanocephala*	Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners Manorina melanocephala	KTP	KTP	P
Threat	*Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands*	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	KTP		P
Threat	*Anthropogenic Climate Change*	Anthropogenic Climate Change	KTP	KTP	P
Threat	*Bushrock removal*	Bushrock removal	KTP		P
Threat	*Clearing of native vegetation*	Clearing of native vegetation	KTP	KTP	P

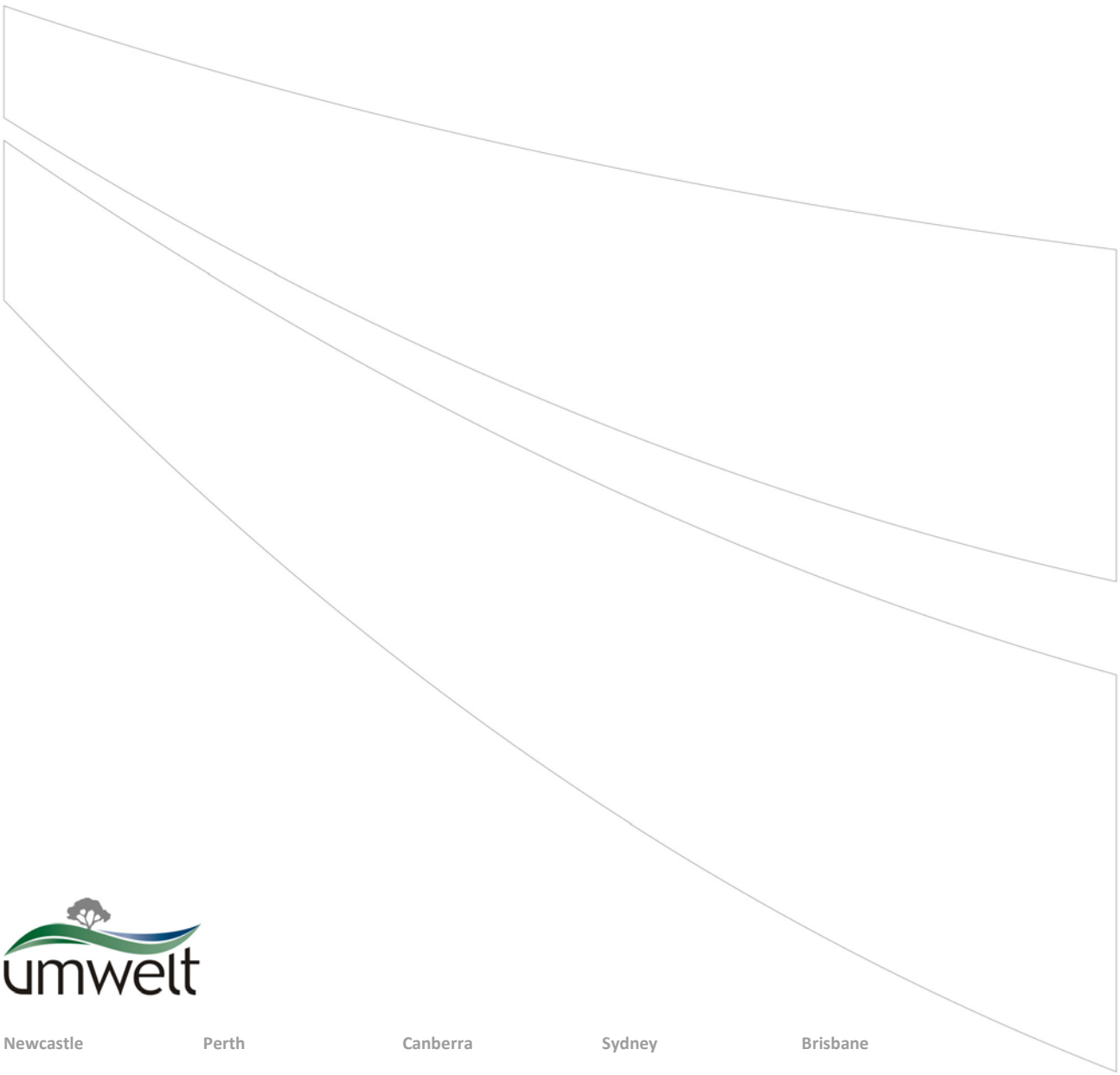
Threat	*Competition and grazing by the feral European Rabbit, Oryctolagus cuniculus (L.)*	Competition and grazing by the feral European Rabbit, Oryctolagus cuniculus (L.)	KTP	KTP	P
Threat	*Competition and habitat degradation by Feral Goats, Capra hircus Linnaeus 1758*	Competition and habitat degradation by Feral Goats, Capra hircus Linnaeus 1758	KTP	KTP	P
Threat	*Competition from feral honey bees, Apis mellifera L.*	Competition from feral honey bees, Apis mellifera L.	KTP		P
Threat	*Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners*	Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	KTP		P
Threat	*Herbivory and environmental degradation caused by feral deer*	Herbivory and environmental degradation caused by feral deer	KTP		P
Threat	*High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition*	High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	KTP		P

Threat	*Importation of Red Imported Fire Ants Solenopsis invicta Buren 1972*	Importation of Red Imported Fire Ants Solenopsis invicta Buren 1972	KTP	KTP	P
Threat	*Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations*	Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations	KTP	KTP	P
Threat	*Infection of frogs by amphibian chytrid causing the disease chytridiomycosis*	Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	KTP	KTP	P
Threat	*Infection of native plants by Phytophthora cinnamomi*	Infection of native plants by Phytophthora cinnamomi	KTP	KTP	P
Threat	*Introduction of the Large Earth Bumblebee Bombus terrestris (L.)*	Introduction of the Large Earth Bumblebee Bombus terrestris (L.)	KTP		P
Threat	*Invasion and establishment of exotic vines and scramblers*	Invasion and establishment of exotic vines and scramblers	KTP		P
Threat	*Invasion and establishment of Scotch Broom (Cytisus scoparius)*	Invasion and establishment of Scotch Broom (Cytisus scoparius)	KTP		P

Threat	*Invasion and establishment of the Cane Toad (Bufo marinus)*	Invasion and establishment of the Cane Toad (Bufo marinus)	KTP	KTP	P
Threat	*Invasion of native plant communities by African Olive Olea europaea subsp. cuspidata (Wall. ex G. Don) Cif.*	Invasion of native plant communities by African Olive Olea europaea subsp. cuspidata (Wall. ex G. Don) Cif.	KTP		P
Threat	*Invasion of native plant communities by Chrysanthemoides monilifera*	Invasion of native plant communities by Chrysanthemoides monilifera	KTP		P
Threat	*Invasion of native plant communities by exotic perennial grasses*	Invasion of native plant communities by exotic perennial grasses	KTP		P
Threat	*Invasion of the Yellow Crazy Ant, Anoplolepis gracilipes (Fr. Smith) into NSW*	Invasion of the Yellow Crazy Ant, Anoplolepis gracilipes (Fr. Smith) into NSW	KTP		P
Threat	*Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat)*	Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat)	KTP		P

Threat	*Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants*	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	KTP	KTP	P
Threat	*Loss of Hollow-bearing Trees*	Loss of Hollow-bearing Trees	KTP		P
Threat	*Loss or degradation (or both) of sites used for hill-topping by butterflies*	Loss or degradation (or both) of sites used for hill-topping by butterflies	KTP		P
Threat	*Predation and hybridisation by Feral Dogs, Canis lupus familiaris*	Predation and hybridisation by Feral Dogs, Canis lupus familiaris	KTP		P
Threat	*Predation by Gambusia holbrooki Girard, 1859 (Plague Minnow or Mosquito Fish)*	Predation by Gambusia holbrooki Girard, 1859 (Plague Minnow or Mosquito Fish)	KTP		P
Threat	*Predation by the European Red Fox Vulpes Vulpes (Linnaeus, 1758)*	Predation by the European Red Fox Vulpes Vulpes (Linnaeus, 1758)	KTP	KTP	P
Threat	*Predation by the Feral Cat Felis catus (Linnaeus, 1758)*	Predation by the Feral Cat Felis catus (Linnaeus, 1758)	KTP	KTP	P

Threat	*Predation, habitat degradation, competition and disease transmission by Feral Pigs, Sus scrofa Linnaeus 1758*	Predation, habitat degradation, competition and disease transmission by Feral Pigs, Sus scrofa Linnaeus 1758	KTP	KTP	P
Threat	*Removal of dead wood and dead trees*	Removal of dead wood and dead trees	KTP		P



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