Kama Interface Management Strategy

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Executive Summary

Capital Ecology has developed this management strategy for the interface between Kama Nature Reserve and the Molonglo 3 development in the Australian Capital Territory (ACT).

The purpose of the strategy is to provide sound, well-defined and scientifically supported advice and recommendations to the ACT Government regarding the characteristics required for the interface between Kama Nature Reserve and Molonglo 3 to achieve the relevant commitments of the *Molonglo Valley Plan for the Protection of Matters of National Environmental Significance* (ACT Government 2011) (the 'NES Plan'), specifically the following commitment –

> *Establish a buffer outside the Kama Nature Reserve between the reserve and the proposed development area, and allow for appropriate uses consistent with nature conservation uses of the reserve. The buffer will be developed to ensure that fire management is undertaken outside of the Kama Nature Reserve and will provide protection against urban edge effects*

In recognition of the value to conservation of 'softening' the transition across a reserve/development interface, the scope of this strategy includes the broader interface and each of its constituent components, namely Kama Nature Reserve itself, the buffer and the urban land adjacent.

This strategy provides the following:

- determination of what is required to *provide protection against urban edge effects*;
- identification and definition of interface arrangement options and assessment of the predicted efficacy of these in providing protection against urban edge effects; and
- based on the findings of the above, provision of a recommended interface arrangement which will most appropriately achieve the objectives of the interface.

Kama Nature Reserve supports the following Matters of National Environmental Significance (MNES): the critically endangered ecological communities Box-Gum woodland and Natural Temperate Grassland, being one of the only ACT reserves to support a good example of the ecotone between these communities; the Pink-tailed Worm-lizard; and foraging habitat for the Superb Parrot and Swift Parrot. Kama Nature Reserve is also significant for its high value as habitat for sensitive declining small woodland bird species, many of which are listed under ACT legislation and are key indicators of the ecological integrity and overall value of a patch of Box-Gum Woodland.

An assessment of the major threats upon ecological values (specifically the MNES listed above) was completed, based upon thorough research of ecological studies relating to reserve/development interface areas. The minimum buffer characteristics for each of the relevant significant ecological values was determined, based on the best available information.

Several potential interface options were developed based on the above, taking into account the pre-established requirement that the buffer contains a minimum 60 m wide Inner Asset Protection Zone (IAPZ) along its full length. An assessment of each potential option was completed, resulting in one recommended interface option, the characteristics of which are described below.

Summary of the recommended interface arrangements

- Kama Interface (refer Section 6.2). The recommended design characteristics are summarised below.
    - Buffer width of 200 m along the northern portion of the Kama Interface, tapering back to 70 m along the southern portion. This is the minimum required to provide the 200 m setback to core woodland bird habitat.
    - The establishment of four Interface Management Zones (IMZs): IMZ-1 Kama Nature Reserve, IMZ-2 Interface Buffer – Woodland Regeneration, IMZ-3 Interface Buffer – Inner Asset Protection Zone, and IMZ-4 Urban Development. This allows for targeted management (refer Section 6.2.3) to ensure each IMZ contributes to meeting the overall purpose of the interface.
    - Other characteristics described in Section 6.2 include: retention of native trees, an urban edge road and road verge with walking path, an urban edge retaining wall, a fire trail, public walking trails, types and locations of fences and gates, undergrounding of the 132kV powerline easement, measures to control artificial light and noise, and signage.
- Interface establishment and Initial Restoration (refer Section 6.3). This will include the following.
    - Initial weed control within the buffer, dictated by a baseline survey and an Initial Weed Control Plan.
    - Restoration planting within the buffer, according to three distinct restoration units: 1 – restored woodland canopy, 2 – restored woodland all strata, and 3 – managed mixed native and exotic grassland.
    - Utilisation of only native plants in the streetscape of IMZ4.
    - Staging of interface establishment, with the aim to soften the impact of urban development, particularly upon native fauna.
- Interface management and maintenance (refer Section 6.4). This will include the following.
    - Ongoing weed monitoring and management within the buffer.
    - Ongoing control of domestic animals.
    - Community education and involvement.
    - Control and management of access to reduce human impacts upon the buffer and Kama Nature Reserve.

Summary of threats, proposed mitigation measures, and threat level

The following table provides an overview of the threats assessed in this strategy, the key design and management mitigation measures for each threat provided by the recommended interface arrangements, and a summary of the assessment of threat (both with and without the mitigation measures).

Threat	Key Mitigation Measures	Threat Level to MNES and other values
1. Weed invasion	Interface Design • Buffer as sentinel zone. • Interface retaining wall. Management • Initial weed control. • Ongoing weed monitoring and control. • Community education and involvement. • Prohibition on planting of weed species.	**Without mitigation: Very High** • The most significant threat to the MNES within Kama Nature Reserve. • Particular threat to the condition and overall integrity of Box-Gum Woodland, Natural Temperate Grassland and Pink-tailed Worm-lizard habitat. **Residual Threat: High** • Intensive weed monitoring and control in the Kama Interface is likely to substantially reduce the impact of weeds, however the degree of threat from weeds will remain high.
2. 'Urban-adapted' native fauna	Interface Design • Buffer that provides a minimum 200 m setback from urban development to core woodland bird habitat. • Buffer restoration planting. Management • Community education and involvement.	**Without mitigation: Very High** • Predominantly a threat to sensitive woodland birds within Kama Nature Reserve, which could thereby reduce the value of the Box-Gum Woodland. **Residual Threat: High** • The proposed measures will likely reduce but not entirely mitigate the impacts of urban-adapted fauna on sensitive woodland birds.
3. Proximity of urban edge on 'urban avoiding' bird species	Interface Design • Buffer that provides a minimum 200 m setback from urban development to core woodland bird habitat. • Buffer restoration planting. • Native streetscape planting. Management • Domestic animal control. • Feral animal control. • Access provision and management. • Community education and involvement.	**Without mitigation: Very High** • Some of the impacts of the urban edge are felt up to five kilometres from the urban edge. **Residual Threat: High** • The proposed measures will not entirely mitigate the impacts of the urban edge on sensitive woodland birds within Kama Nature Reserve. Likely to be successful in ensuring that some (but potentially not all) species still occur and breed within the reserve.
4. Loss of remnant trees (east of Kama Nature Reserve)	Interface Design • Retention of 26 of the 36 remnant trees which occur within Molonglo 3 east of Kama Nature Reserve.	**Without mitigation: High** • These trees provide nesting habit and connectivity for many species. • Loss of these trees may reduce the value of the habitat within Kama Nature Reserve and reduce connectivity. • May not significantly impact the MNES, however loss would greatly reduce the value of the buffer. **Residual Threat: Moderate** • The retained trees, particularly those within the urban area, will be subject to pressures associated with proximity to urban development (i.e. altered hydrology etc.). These trees are also all very old and will have limited longevity.

Threat	Key Mitigation Measures	Threat Level to MNES and other values
5. Decreased foraging range	Interface Design • Buffer that provides a minimum 200 m area within which habitat can be retained and improved. • Retention of 26 of the 36 remnant trees. • Buffer restoration planting. • Native streetscape planting. Management • Community education and involvement, notably encouragement to plant native species on private land.	**Without mitigation: High** • Loss of all foraging habitat adjoining the eastern boundary of Kama Nature Reserve would likely reduce the value of the reserve for native fauna species, particularly urban avoiding woodland/forest birds. **Residual Threat: Low** • With the mitigation measures proposed, the residual threat from reduced foraging range will be negligible for most species.
6. Loss of connectivity	Interface Design • Buffer that provides a minimum 200 m area within which habitat can be retained and improved. • Retention of 26 of the 36 remnant trees. • Buffer restoration planting. • Native streetscape planting.	**Without mitigation: Moderate** • Loss of connectivity can lead to smaller effective population sizes and local extinction. This can lead to reduced condition and value of ecological communities. • Kama Nature Reserve is important for connectivity between the Molonglo River Reserve and The Pinnacle Nature Reserve. **Residual Threat: Low** • The residual threat from impacts to connectivity is likely to be low.
7. Noise and light spill	Interface Design • Buffer that provides a minimum 200 m setback between urban development and core woodland bird habitat. • Buffer restoration planting. • Urban edge road design. • Shielding of street lights. Management • Access provision and management. • Community education and involvement.	**Without mitigation: High** • Noise and light pollution is known to impact native fauna, resulting in modified behaviours and changes in distribution and abundance. **Residual Threat: Low** • The residual threat from noise and light spill is likely to be low.
8. Exotic pest animals	Interface Design • Buffer that provides a minimum 200 m setback between urban development and core woodland bird habitat. • Buffer restoration planting. • Fence Type 1 along eastern, northern and southern boundaries of the buffer. Management	**Without mitigation: Very High** • Exotic pest animals (feral pests) adversely impact upon natural ecosystems in numerous ways, including by: causing erosion and other degradation; preying upon native fauna; competing with native fauna for resources; introducing disease; and introducing and/or spreading weeds. • Impacts from exotic pest fauna such as Common Myna can occur kilometres from the urban edge, reducing species diversity and abundance.

Threat	Key Mitigation Measures	Threat Level to MNES and other values
	• Feral animal management, notably control of the Common Myna. • Community education and involvement.	**Residual Threat: High** • Incursions of exotic pest animals into Kama Nature Reserve will likely be reduced, however ongoing control of pest fauna species will be required to manage impacts, and it is unlikely that impacts can be entirely mitigated.
9. Domestic animals (pets)	Interface Design • Buffer that provides a minimum 200 m setback between urban development and core woodland bird habitat. • Buffer restoration planting. • Fence Type 1 along eastern, northern and southern boundaries of the buffer. Management • Cat containment. • Dog exclusion enforced for Kama Nature Reserve and dog-on-leash enforced for buffer. • Community education and involvement.	**Without mitigation: High** • Domestic dogs and cats will hunt native fauna, with cats being a particular threat to small woodland-dependant birds. **Residual Threat: Moderate** • The threat will be ever-present with the introduction of human occupation to the locality.
10. Increased human use/disturbance	Interface Design • Interface retaining wall. • Urban edge road. • Fence Type 1 along eastern, northern and southern boundaries of the buffer. • Designated public walking trails. • Limited public access points to Kama Nature Reserve (i.e. Gate Type 2). Management • Access provision and management. • Community education and involvement.	**Without mitigation: High** • Human use of Kama Nature Reserve could have a variety of impacts upon the significant values of the reserve: damage to flora and disturbance to fauna from recreational use, dumping of garbage and garden waste, disturbing or collecting rocks, etc. **Residual Threat: Moderate** • The threat from human impacts will be ever-present with introduction of human occupation to the locality.

1 Introduction

Capital Ecology has been commissioned to develop a strategy for the interface between Kama Nature Reserve and the Molonglo 3 development in the Australian Capital Territory (ACT).

Located west of the Canberra City Centre, the Molonglo Valley is being developed in three stages. Molonglo 3, the component of the development north of the Molonglo River, is currently being planned, and as such, the specifics of commitments to conservation outcomes must be determined.

Encompassing 154.76 ha and comprising Blocks 1419 and 1386 in the district of Belconnen, ACT, Kama Nature Reserve was established as a nature reserve and part of Canberra Nature Park in 2008. Kama Nature Reserve is bordered by William Hovell Drive to the north, the Molonglo River Corridor to the south, and land currently used for agriculture to the east and west. As illustrated in Figure 1 and Figure 2, the Kama Interface is the interface between Kama Nature Reserve and the adjoining future urban area of Molonglo 3 to the east, and runs generally south-east to north-west, centred on the 1,260 m administrative boundary between the relevant blocks.

The impacts of the development of Molonglo Valley upon *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Matters of National Environmental Significance (MNES) were assessed via a Strategic Assessment. The subsequently prepared *Molonglo Valley Plan for the Protection of Matters of National Environmental Significance* (ACT Government 2011) (the 'NES Plan') details the 'conservation outcomes' to which the ACT Government has committed as conditions of the EPBC Act approval.

One of the conservation outcomes involves the preservation and enhancement of MNES within Kama Nature Reserve. As part of this, the ACT Government is required to:

> *Establish a buffer outside the Kama Nature Reserve between the reserve and the proposed development area, and allow for appropriate uses consistent with nature conservation uses of the reserve. The buffer will be developed to ensure that fire management is undertaken outside of the Kama Nature Reserve and will provide protection against urban edge effects.*

This strategy provides detailed advice and recommendations to the ACT Government regarding the characteristics required for the interface between Kama and Molonglo 3 to achieve its purpose. It details the minimum widths required for the buffer to provide effective protection against edge effects, and how these differ where they adjoin the different ecological communities and habitat types within the Kama Nature Reserve (e.g. woodland vs grassland). It also provides details regarding the management regimes required for land within the interface area and assesses the residual threats to the significant biodiversity values of Kama Nature Reserve.

This strategy is based on:

- extensive review of the scientific literature relating to the mitigation of threats posed by urban development;
- review of documents relevant to the biodiversity values of the Molonglo Valley; and
- field surveys to verify the condition and boundaries of ecological values within Kama Nature Reserve and the interface area.

Structure of this Kama Interface Management Strategy

This strategy is structured in the following manner.

Section 2 – Describes the context of the Kama Interface.

- Subsection 2.1 outlines the key requirements of this strategy
- Subsection 2.2 outlines the purpose, objectives and scope of this strategy
- Subsection 2.3 details the manner in which this strategy is consistent with the other plans and strategies of relevance to the Kama Interface
- Subsection 2.4 describes the Kama Interface, its land management (current and historic) and ecological values
- Subsection 2.5 outlines the bushfire hazard management requirements relevant to the Kama Interface
- Subsection 2.6 provides an overview of the relevant context for the Kama Interface and this strategy

Section 3 – Describes the key potential threats from urban development of Molonglo 3 on the significant biodiversity values of Kama Nature Reserve.

Section 4 – Outlines the evaluation approach and process followed to determine the most appropriate arrangements for the Kama Interface.

Section 6 – Details the recommended interface arrangements as determined during the research and development of this strategy.

- Subsection 6.1 outlines the Kama Interface concept and purpose
- Subsection 6.2 describes the Kama Interface design
- Subsection 6.3 describes the Kama Interface establishment and initial restoration works
- Subsection 6.4 described the ongoing management and maintenance to be implemented for the Kama Interface
- Subsection 6.5 outlines the important interface design matters identified during the development of this strategy that will require further determination.
- Subsection 6.6 provides an assessment of the degree to which each identified potential threat is likely to be mitigated by the measures included in the recommended interface arrangements. A key outcome of this assessment is the identification and definition of the residual threats associated with the recommended interface arrangements.

2 Context

Informed by an extensive review of relevant published literature, previously completed studies, and ACT Government and Commonwealth Government resources, Section 2 provides the background and context to this strategy. Specifically, Section 2 describes and discusses the subject area of this strategy, its geographical characteristics, past and current land management regimes, and current ecological values.

2.1 Key Requirements

The development of this strategy is inherently linked to the *Molonglo Valley Plan for the Protection of Matters of National Environmental Significance* (ACT Government 2011) (the 'NES Plan'). The NES Plan details the 'conservation outcomes' to which the ACT Government has committed with the aim of protecting Matters of National Environmental Significance (MNES) during the development of East Molonglo. The relevant MNES are:

- 'White Box - Yellow Box – Blakely's Red Gum Grassy Woodland and derived native grassland' (Box-Gum woodland), listed as critically endangered;
- 'Natural Temperate Grassland of the Southern Tablelands of NSW and the ACT' (Natural Temperate Grassland), listed as endangered;
- Pink-tailed Worm-lizard *Aprasia parapulchella*, listed as vulnerable; and
- Superb Parrot *Polytelis swainsonii* and Swift Parrot *Lathamus discolor*, listed as vulnerable and endangered respectively.

It is noted that the EPBC Act listing for the Natural Temperate Grassland community was revised effective from 6 April 2016, with the name changed to 'Natural Temperate Grassland of the South Eastern Highlands and New England Tablelands' and the conservation status elevated to critically endangered. For the purposes of this strategy, the listing revision and associated elevated conservation status is applied when referring to the community, however the community itself is considered to be consistent across the current and previous listings.

The NES Plan was endorsed on 7 October 2011 by the then Minister for Sustainability, Environment, Water, Population and Communities, the Honourable Tony Burke. On endorsement of the NES Plan and subsequent approval of the associated suite of actions on 20 December 2011 under Section 10 of the EPBC Act, the commitment to achieving the conservation outcomes detailed in the NES Plan became binding and nonadjustable beyond the flexibility built into the NES Plan.

The protection of Kama Nature Reserve, and thereby the protection of the MNES it contains or directly supports, is a key commitment of the NES Plan. As detailed on page 22 of the NES Plan, *Conservation outcome (b)* states that –

> *Three offset sites will be established within the strategic assessment area (Kama Nature Reserve, Molonglo River Park, Patch GG) that will provide for the long term protection of 234 ha of Box-Gum Woodland (see Figure 6). The three offset sites will be adaptively managed to maintain and enhance the ecological condition of the Box-Gum Woodland that occurs there.*

The three 'actions' committed to with the aim of achieving this conservation outcome are (note: numbering is from the NES Plan):

5. *Develop a management plan for the Kama Nature Reserve to provide for the maintenance and enhancement of the ecological condition of Box-Gum Woodland within the reserve (approximately 117 ha).*

6. *Implement the management plan for the Kama Nature Reserve to provide for the maintenance and enhancement of the ecological condition of Box-Gum Woodland within the reserve.*

7. *Establish a buffer outside the Kama Nature Reserve between the reserve and the proposed development area, and allow for appropriate uses consistent with nature conservation uses of the reserve. The buffer will be developed to ensure that fire management is undertaken outside of the Kama Nature Reserve and will provide protection against urban edge effects.*

Actions 5 and 6 have been addressed through the development and implementation of the *Molonglo River Reserve (Kama) Operational Plan 2014-2017* (ACT Government 2014a). A logical deconstruction of Action 7 finds that the ACT Government has committed to:

> *Establish a buffer outside the Kama Nature Reserve between the reserve and the proposed development area, and allow for appropriate uses consistent with nature conservation uses of the reserve.*

And that the width, position and other characteristics of this buffer are such that its establishment will:

a. ensure that fire management is undertaken outside of the Kama Nature Reserve; and

b. will provide protection against urban edge effects.

Given the above, the characteristics for the Kama Nature Reserve buffer must be defined with the primary objective of achieving *a.* and *b.* It is therefore important to determine the characteristics that the buffer must have for it to achieve *a.* and *b.*, not to define the buffer's characteristics and then work out what can be done to facilitate the buffer's achievement of its purpose.

As detailed in Section 2.5, the bushfire management regime for Kama Nature Reserve and its interface with Molonglo 3 has been determined by the ACT Government, the outcome being reflected in Section 6.7.4 of the *Molonglo River Reserve – Draft Management Plan 2016* (ACT Government 2016). This regime will achieve *a.*, provided that the Kama Nature Reserve buffer includes a minimum 60 m wide Inner Asset Protection Zone (IAPZ) along the urban interface.

In accordance with the above, the key requirements which must be achieved by this strategy are to:

1. include the required IAPZ within the Kama Nature Reserve buffer; and

2. develop a Kama Nature Reserve buffer with characteristics that will *provide protection against urban edge effects*.

2.2 Purpose, Objectives and Scope

The overarching objective of this strategy is to provide sound, well-defined and scientifically supported advice and recommendations to the ACT Government regarding the characteristics required for the interface between Kama Nature Reserve and Molonglo 3 to achieve the NES Plan commitments.

More specifically, this strategy will:

- determine what is required to *provide protection against urban edge effects* (as per Actions 7, 27 and 34 of the NES Plan);
- identify and define interface arrangement options (e.g. buffer width/s, treatments etc.) and assess the predicted efficacy of these in providing protection against urban edge effects, taking into account all relevant factors; and
- based on the findings of the above, develop a recommended interface arrangement which will most appropriately achieve the objectives of the interface.

It is important to note the following regarding the purpose, objectives and scope of this strategy, and the approach taken for its development.

1. The Kama Nature Reserve buffer does not form the entire interface, rather it is a component of the interface. The benefits of measures implemented a distance from a reserve's boundary for the conservation of ecological values and ecosystem function within that reserve, are well documented (Gleeson & Gleeson 2012; Ikin *et al.* 2012; Ikin *et al.* 2013a; Ikin *et al.* 2014; Rayner *et al.* 2015). 'Softening' the transition across an interface can positively influence the perception of the interface and land uses beyond by many native fauna groups, notably urban sensitive woodland birds (Ikin *et al.* 2013a; Rayner *et al.* 2015). In recognition of this, the scope of this strategy includes the broader interface and each of its constituent components, namely Kama Nature Reserve itself, the buffer and the urban land adjacent.

2. It is unlikely that urban edge effects upon the MNES within Kama Nature Reserve can be entirely avoided or mitigated under any interface arrangement. Some of the impacts of urban development can be experienced several kilometres from the urban edge and thus they cannot be entirely avoided or mitigated (Rayner *et al.* 2015). In this regard, the objective must be to apply all reasonable and practicable measures to *provide protection against urban edge effects*.

3. A balanced and purposefully objective approach has been taken, providing measured consideration of all relevant aims and agendas. Whilst the ACT Government has a responsibility to ensure that estate planning incorporates measures sufficient to conserve significant biodiversity values, it is also recognised that the ACT Government has a responsibility to ensure that the financial costs (i.e. impacts on revenue, implementation costs etc.) of conservation measures are justified by the conservation gains.

4. The purpose of this strategy is not to describe elements relevant to interface design in minute detail, nor is it to prescribe the characteristics for the recommended interface arrangements beyond a conceptual basis. In this regard, the objective of this strategy is to achieve a balance between providing the detail required to inform evaluation of the efficacy of prescribed measures in achieving the requirements of the interface, whilst recognising

that many of the particulars of such measures must be defined at a later time (i.e. during detailed design, structure planning etc.).

5. Whilst it is understood that there are currently some substantial gaps in our understanding of the impacts of certain edge effects, when decisions regarding significant and permanent actions are to take place in such a context, the precautionary principle must apply. As described by Kriebel *et al.* (2001), the precautionary principle as a guideline in environmental decision making, has four central components: (i) taking preventive action in the face of uncertainty; (ii) shifting the burden of proof to the proponents of an activity; (iii) exploring a wide range of alternatives to possibly harmful actions; and (iv) increasing public participation in decision making. This strategy, in particular the recommended interface arrangements (Section 6), has been developed in a manner guided by the application of the precautionary principle.

2.3 Consistency with other Management Plans and Strategies

The context, scope and content of this strategy is informed by and/or relates to numerous management plans and strategies. Some of these have been approved and implemented, whilst others are currently in draft form. Given the complexity of the land management context along the Kama Interface, development of interface arrangements that are consistent and complimentary with these plans and strategies is paramount to successful establishment and management of the interface. Accordingly, each of the management plans and strategies relevant to the Kama Interface has been reviewed during the development of this strategy. A brief description of each of the management plans and strategies of direct relevance to this strategy, and the relationship between these documents and this strategy, is provided below.

2.3.2 Molonglo Valley Plan for Matters of National Environmental Significance

The *Molonglo Valley Plan for the Protection of Matters of National Environmental Significance* (NES Plan) (ACT Government 2011) was developed as an approval requirement of the EPBC Act strategic assessment which was undertaken to assess the potential impacts of the proposed development within the Molonglo Valley. The NES Plan outlines the ACT Government's commitments in relation to avoidance and mitigation of impacts upon MNES. Where such impacts cannot be sufficiently and/or practicably avoided or mitigated, the NES Plan details the offset measures that will be implemented to offset the residual impacts. Key commitments include the establishment of conservation areas containing Box-Gum Woodland, Natural Temperate Grassland and Pink-tailed Worm-lizard habitat, together with the development and implementation of management plans and strategies to guide the ongoing management of these conservation areas.

As detailed in Section 2.1, the NES Plan was endorsed on 7 October 2011 by the then Minister for Sustainability, Environment, Water, Population and Communities, the Honourable Tony Burke.

2.3.3 Molonglo Adaptive Management Strategy

The *Molonglo Adaptive Management Strategy* (Molonglo AMS) (ACT Government 2013) is a key commitment of the NES Plan. The Molonglo AMS describes the ongoing improvement measures and management practices that will be applied to protect and enhance the MNES in the NES Plan application area.

The Molonglo AMS achieves the requirements of the NES Plan by setting out the way in which the MNES values of the area will be assessed, monitored, and adaptively managed. The AMS gives

practical effect to the recognition that MNES exist in an area subject to the increasing and ongoing pressures of urban development. These pressures are not always known and their effects may be uncertain (ACT Government 2013).

The Molonglo AMS addresses these anthropogenic uncertainties as well as natural uncertainties (such as climate variability) by prescribing monitoring and assessment processes which iteratively update the state of knowledge and the subsequent direction of management (ACT Government 2013). The Molonglo AMS also identifies the key threats to MNES conservation as well as uncertainties in relation to management and the achievement of performance targets and objectives. The AMS establishes measures to deal with these threats and uncertainties (ACT Government 2013).

Whilst this strategy does not directly implement or impact elements of the Molonglo AMS, it has been developed in a manner that is consistent with, and complimentary to, the Molonglo AMS.

2.3.4 Molonglo River Reserve: Kama – Operational Plan 2014-17

The *Molonglo River Reserve: Kama – Operational Plan 2014-17* (Kama Operational Plan) (ACT Government 2014a) has been developed to help guide on-ground works and activities that will implement key components of the NES Plan, Molonglo AMS, and the numerous other plans and strategies of relevance to the management of Kama Nature Reserve.

The Kama Operational Plan is the primary planning tool providing for adaptive management approaches based on the results of monitoring, evaluation and review. This Kama Operational Plan will be reviewed every three years and will be put into effect through works programs, which will be reviewed and updated annually (ACT Government 2014a).

The management arrangements for Kama Nature Reserve outlined in the Kama Operational Plan have been treated as a given during the development of this strategy, and as such, this strategy has been developed in a manner that is consistent with, and complimentary to, the Kama Operational Plan.

2.3.5 Molonglo River Reserve – Draft Management Plan 2016

The *Molonglo River Reserve – Draft Management Plan 2016* (ACT Government 2016) is a statutory plan, developed under the ACT *Planning and Development Act 2007* (P&D Act) and as a 'reserve management plan' as defined in the ACT *Nature Conservation Act 2014* (NC Act). The plan's purpose is to provide a clear and agreed-upon set of long term objectives for the Molonglo River Reserve, to outline the planned pathways for achieving them, and to give clear guidance on how the land and waters of Molonglo River Reserve will be managed and used (ACT Government 2016. The plan is structured by topic, each with a nested set of management objectives, policies and actions (ACT Government 2016).

In addition to the above, the *Molonglo River Reserve – Draft Management Plan 2016* describes the manner in which the commitments of the NES Plan will be met throughout the reserve (including Kama Nature Reserve).

Kama Nature Reserve is a key component of the Molonglo River Reserve, and therefore, this strategy has been developed in a manner that is consistent with, and complimentary to, the *Molonglo River Reserve – Draft Management Plan 2016*.

2.3.6 ACT Strategic Bushfire Management Plan Version 3

The *ACT Strategic Bushfire Management Plan Version 3* (SBMP) (ACT Government 2014b) was prepared as a requirement of the ACT *Emergencies Act 2004*. The SBMP is the overarching document that directs all levels of bushfire planning throughout the ACT. The SBMP is a dynamic document that allows emergency services and fire managers the flexibility they require to implement measures that reduce bushfire risk, and to apply improved methods and knowledge as they are developed (ACT Government 2014b).

Prepared under the SBMP, the *ACT Bushfire Management Standards* (ACT Government 2014c) detail the measurable outcomes required under the current and ongoing management policies and procedures detailed in Part 2 of the SBMP. This document, which includes standards for matters such as fuel management and fire trail access, is prepared for the fire services, land managers, developers and the general community, to assist them to effectively manage bushfire risk (ACT Government 2014b).

Determined in accordance with the SBMP and the associated standards, the bushfire hazard mitigation measures required along the Kama Interface are described in Section 2.5. This strategy has adopted these measures and is therefore consistent with the SBMP.

2.4 Kama Interface Description

Encompassing 154.76 ha and comprising Blocks 1419 and 1386 in the district of Belconnen, ACT, Kama Nature Reserve was established as a nature reserve and part of Canberra Nature Park in 2008. Kama Nature Reserve is bordered by William Hovell Drive to the north, the Molonglo River Corridor to the south, and land currently used for agriculture but designated for future urban development or associated buffers to the east (Blocks 12 and 44, Molonglo) and west (Block 1596, Belconnen) (refer Figure 1).

As illustrated in Figure 1 and Figure 2, the Kama Interface is the interface between Kama Nature Reserve and the adjoining future urban area of Molonglo 3 to the east. The Kama Interface runs generally south-east to north-west, centred on the 1,260 m administrative boundary between the relevant blocks.

The elevation along the Kama Interface ranges from 545 m Australian Height Datum (AHD) at its southern end upslope of the Molonglo River, to 600 m AHD at its northern end abutting William Hovell Drive. As illustrated in Figure 2, the Kama Interface occurs across undulating land with a predominant fall to the south-east from Kama Nature Reserve towards the Molonglo River and its tributary, Deep Creek. No substantial watercourses traverse the Kama Interface itself, however a number of minor seeps and drainage lines flow east from Kama Nature Reserve, downslope to Deep Creek.

Existing built infrastructure currently within the Kama Interface area is limited to stock fences and 132 kV overhead powerlines and towers. Kama Nature Reserve also contains numerous small constructed farm dams and unsealed maintenance tracks.

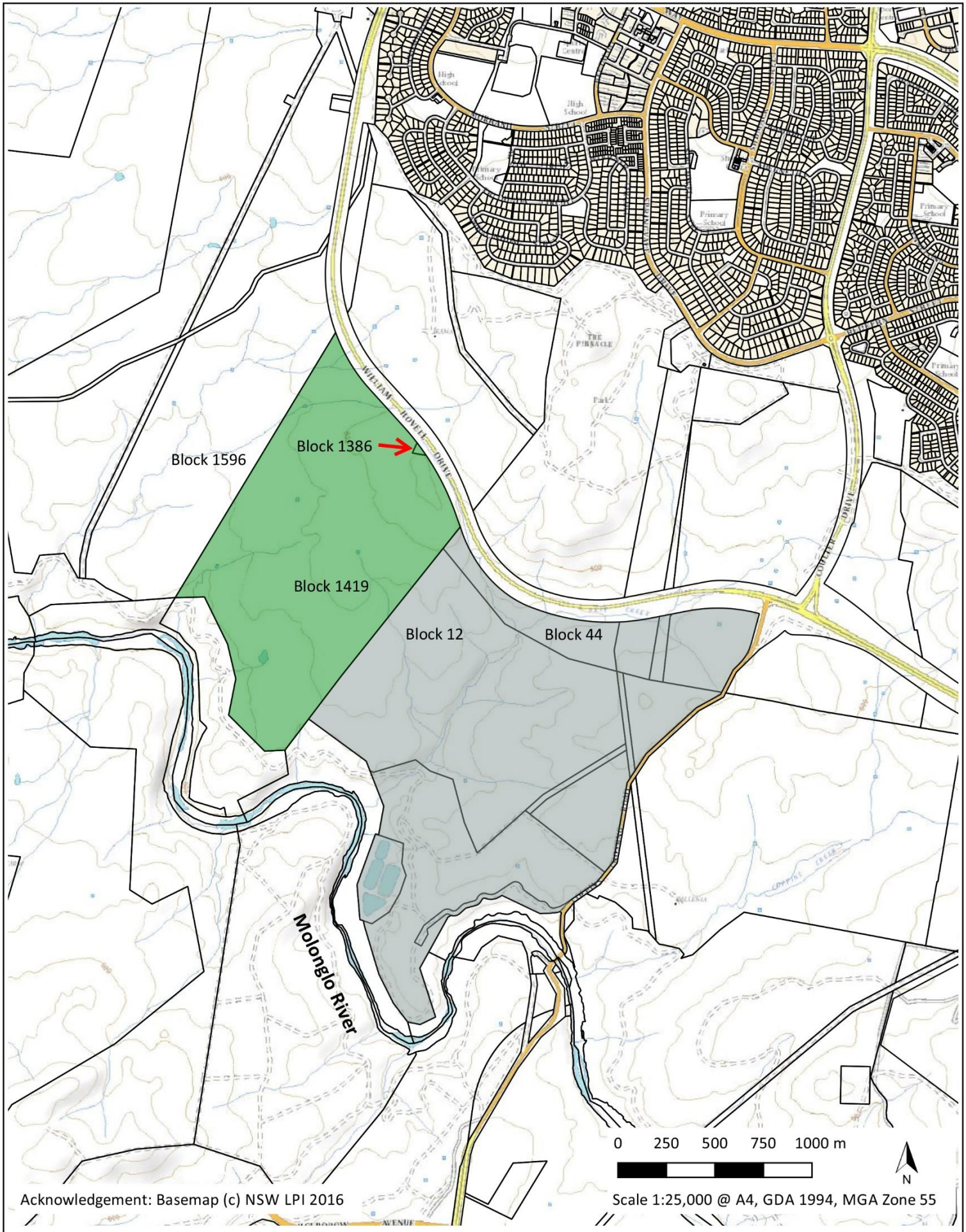

Figure 1. Locality Plan

Capital Ecology Project No: 2717
Drawn by: R. Speirs
Date: 29 September 2016

Legend

- ACT Blocks
- Kama Nature Reserve
- Molonglo 3 Urban Area

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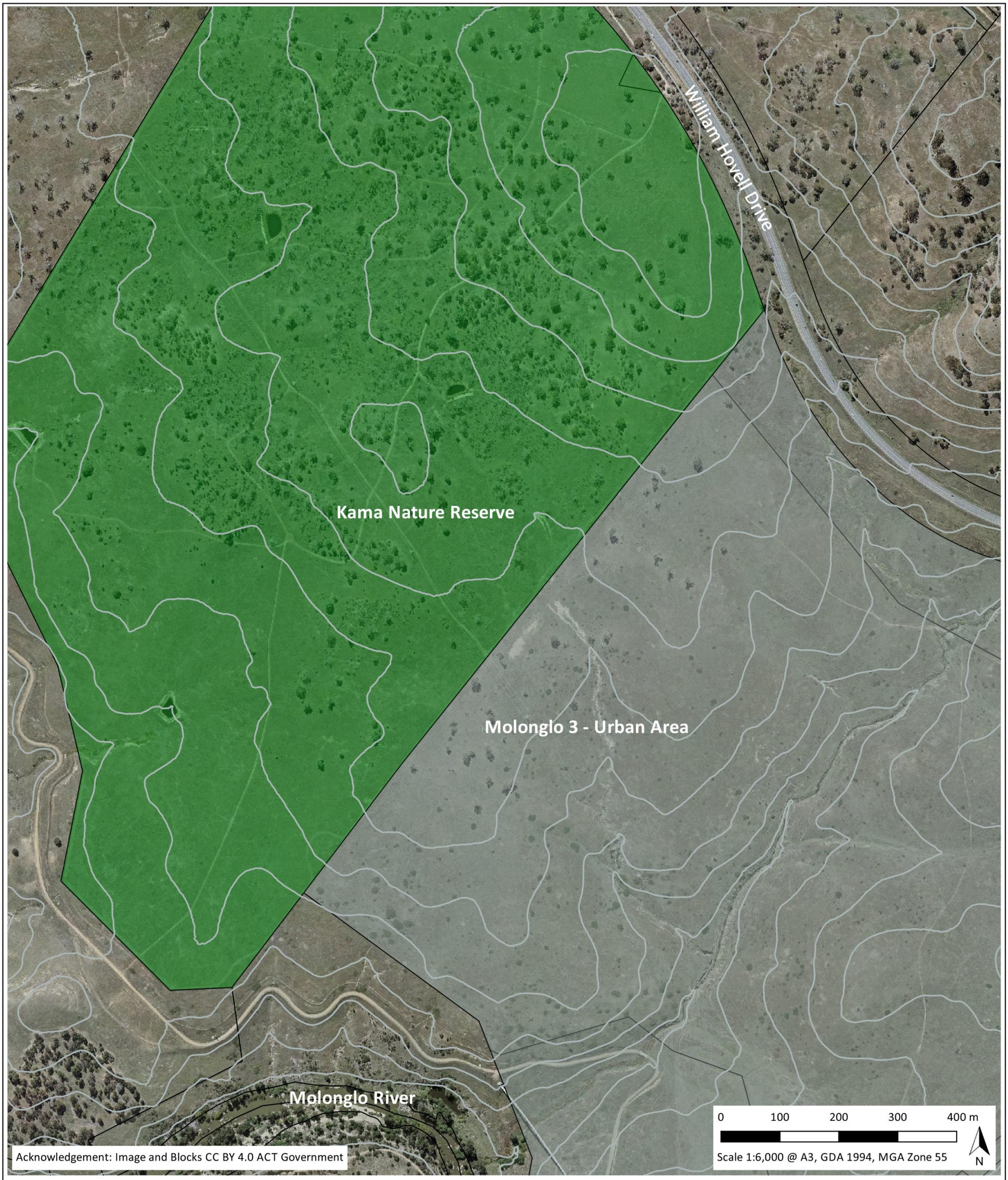

Figure 2. Kama Interface

Legend

- ACT Blocks
- 2004_5m_Contours
- Kama Nature Reserve
- Molonglo 3 Urban Area

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2.4.2 Land Management

The current type and condition of the natural values of a parcel of land are often a direct result of the historical management of that land. The management of land for stock grazing, cropping or other agricultural purposes has altered the composition, structure and overall condition of the majority of the low to mid elevated land throughout the Southern Tablelands of New South Wales and the ACT. The degree of this alteration ranges from minor changes to complete transformation and loss of the original ecological community.

Consideration of the land use history of the Kama Interface locality is useful for this strategy as it provides information, and explanation, regarding the type and condition of the existing natural values. It can explain why floristic diversity and structure varies vastly within one paddock from that over the fence. It can also explain observed peculiarities in the site-scale occurrence of certain flora and fauna species. In this regard, the following sections provide a brief account of the land use history of the Kama Interface locality.

2.4.2.1 Historical Land Management

Prior to the 1970s the land throughout the Kama Interface locality was managed for agriculture under long-term rural leases. In the 1970s the ACT Government resumed the lease over the Blocks comprising Kama Nature Reserve and, until 2009, managed the land under agistment to an adjoining lessee who used it primarily for cattle grazing.

The presence of large eucalypt stumps and areas unnaturally clear of trees indicate that extensive tree clearing activities occurred historically throughout much of the Kama Interface locality. Such tree clearing or thinning was undertaken across most areas supporting lowland woodland in the region, usually for the purposes of 'opening-up' the land to promote growth of native and introduced grasses, thereby increasing the grazing productivity. As is evidenced by the now patchy distribution, varied density and other characteristics of the remnant vegetation in the locality, this clearance did not occur uniformly within or across blocks.

The introduced pasture plant species Phalaris *Phalaris aquatica*, Tall Fescue *Festuca elatior*, Cocksfoot *Dactylis glomerata* and various Clovers *Trifolium* spp. dominate the groundstorey vegetation throughout portions of Kama Nature Reserve and much of the adjoining land. These species were historically sown or spread to improve the grazing value of the pasture for stock. Given these species do not spread readily by wind or animals, the dominance of these species within portions of the higher elevated areas of Kama Nature Reserve and adjoining land indicates that they were deliberately introduced.

2.4.2.2 Current Land Management

The land adjoining Kama Nature Reserve (east and west) continues to be used for agriculture, primarily cattle and sheep grazing, albeit at considerably lower than historical grazing intensity, as indicated by the site visit and by discussions with local land managers (M. Wallace "Lands End" 2015 pers. comm.). Following establishment of Kama Nature Reserve in 2008, the land within has been strategically grazed for positive ecological outcomes, under the direction of ACT Government ecologists and on-ground management personnel.

The north-west corner of Kama Nature Reserve was burnt in a bushfire in 1985 and the southern half of Kama Nature Reserve, together with substantial portions of the adjoining properties, was subject to a very high intensity burn in the 2003 bushfires. In accordance with the Kama Operational Plan (ACT Government 2014a), ACT Parks and Conservation Service periodically carry out controlled low

intensity mosaic burns within Kama Nature Reserve. These burns are conducted for the dual purposes of enhancing ecological community condition and managing fuel levels.

As detailed in Kama Operational Plan (ACT Government 2014a), ACT Parks and Conservation Service undertake numerous other activities within Kama Nature Reserve with the objective of protecting and enhancing the values of the reserve. Such activities include: weed control; slashing and other maintenance of firebreaks, tracks and the powerline easement; vertebrate pest control; native herbivore population control; and fence and gate maintenance.

2.4.3 Ecological Values

As described in the NES Plan (ACT Government 2011) and outlined in Section 2.1, Kama Nature Reserve supports the MNES Box-Gum woodland, Natural Temperate Grassland, and the Pink-tailed Worm-lizard, together with foraging habitat for the Superb Parrot and Swift Parrot. However, it is useful to establish that the MNES of greatest significance within Kama Nature Reserve are threatened ecological communities, namely Box-Gum Woodland and Natural Temperate Grassland. Whilst Kama Nature Reserve provides intermittent foraging habitat for the Superb Parrot, occasionally utilised foraging habitat for the Swift Parrot, and patches of high and moderate quality Pink-tailed Worm-lizard habitat (Osborne and Wong 2010), the habitat within Kama Nature Reserve is not considered critical to the conservation of these species.

Whilst the protection of MNES from edge-effects is the primary focus of this strategy, it is important to recognise that Kama Nature Reserve also supports other significant values. The below sections describe these values, together with the relevant MNES.

2.4.3.1 Vegetation Community Classification and Condition

The classification and condition of the vegetation communities present within the Kama Interface locality is mapped inconsistently across the numerous reports, plans and associated datasets relating to the area (ACTMAPi, ACT Government 2004b; ACT Government 2011; ACT Government 2012; ACT Government 2013; Umwelt 2013a and 2013b). As discussed in detail in both Umwelt (2013a) and Biosis (2015), this inconsistency can in part be attributed to the differing classification and survey methods employed. Seasonal timing and variation between seasons (i.e. extended drought vs consecutive seasons of above average rainfall) are also likely factors contributing to the inconsistency in mapping. A thorough review of each of the previously completed vegetation mapping projects was undertaken to inform this strategy, together with a field visit to inspect the on-ground location of mapped boundaries between patches of specific vegetation classification and condition classes. Whilst it is unnecessary to again compare and contrast the vegetation mapping products available for the Kama Interface area, the following points are pertinent to this strategy.

1. The vegetation mapping prepared by Umwelt (Umwelt 2013a) provides the most accurate representation available of the existing vegetation communities within Kama Nature Reserve and adjoining land. Accordingly, the polygon data from Umwelt (2013a) has been used as a base for this strategy. The following alterations to these data have been made by Capital Ecology for presentation in Figure 3.

    a. The vegetation classifications have been renamed to provide more direct and easily interpreted classification of ACT Plant Community Type (PCT) (Sharp *et al*. 2007) (i.e. the pre-1750 'climax' community) and condition. Vegetation classifications which are consistent with the EPBC Act listing definition for a listed endangered ecological community (i.e. a MNES) are identified as such in the name (i.e. ACT-16-1 EPBC Act Box-

Gum Woodland). Each vegetation classification used for this strategy, together with a brief description of its values, is listed in Table 1.

b. The vegetation classification polygon boundaries have been refined at fine scale in GIS to more accurately reflect the on-ground boundaries and reduce the unnatural 'blockyness' of polygons drawn at a larger scale. This process was informed by observations made during the site visit and by interpretation of the ACT Government's May 2016 high-resolution aerial imagery.

2. As described in Umwelt 2013a, the area of EPBC Act Box-Gum Woodland within Kama Nature Reserve (refer to Figure 3) is considerably less than that identified for the NES Plan. Indeed, GIS calculations prepared by Biosis (Biosis 2015) found that, based on the Umwelt (2013a) mapping, Kama Nature Reserve contains only 58.68 ha of the 118.02 ha (i.e. approximately half) identified for the NES Plan. This is of key relevance to this strategy as much of the Kama Interface area, including the patch east of the Kama Nature Reserve boundary, was incorrectly mapped as EPBC Act Box-Gum Woodland in the NES Plan. As illustrated in Figure 3, the proximity of the EPBC Act Box-Gum Woodland within Kama Nature Reserve ranges from 12 m to 340 m from the reserve's eastern boundary.

Table 1. Vegetation classifications

PCT	Condition	Vegetation Classification ID	Description	MNES?
ACT01 - Tablelands Dry Tussock Grassland	Mod-High	ACT-01-1 EPBC Act Natural Temperate Grassland	Relatively intact Natural Temperate Grassland.	**Yes – Natural Temperate Grassland**
	Low	ACT-01-2 Exotic Pasture	Exotic pasture derived from Natural Temperate Grassland.	No
ACT16 - Tableland Grassy Woodland	Mod-High	ACT-16-1 EPBC Act Box-Gum Woodland	Relatively intact Box-Gum Woodland.	**Yes – Box-Gum Woodland**
	Low	ACT-16-2 Exotic Pasture with Remnant Eucalypts	Exotic pasture derived from Box-Gum Woodland. Some scattered remnant Yellow Box and Blakely's Red Gum trees remain.	No
	Low	ACT-16-3 Exotic Pasture	Exotic pasture derived from Box-Gum Woodland. Cleared of trees.	No
ACT25 - Tableland Grass / Shrub Forest	Mod-High	ACT-25-1 Grassy Dry Forest	Relatively intact Grassy Dry Forest, dominated by Scribbly Gum *E. rossii* and Red Stringybark *E. macroryncha*.	No
	Low	ACT-25-2 Exotic Pasture	Exotic pasture derived from Grassy Dry Forest.	No

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0 100 200 300 400 m

Scale 1:4,000 @ A3, GDA 1994, MGA Zone 55

N

Figure 3. Vegetation Community Classification and Condition

Legend

ACT Blocks

Tree Assessment

- Blakely's Red Gum (E.blakelyi)
- Broad-leaved Peppermint (E.dives)
- Scribby Gum (E.rossii)
- Yellow Box (E.melliodora)
- Apple Box (E.bridgesiana)
- ✖ Tree Assessment - Removal Recommended

Vegetation Communities

PCT ACT01 Tableland Dry Tussock Grassland

- ACT01-1 EPBC Act Natural Temperate Grassland
- ACT01-2 Exotic Pasture

PCT ACT16 YellowBox-RedGum Tableland Grassy Woodland

- ACT16-1 EPBC Act Box-Gum Woodland
- ACT16-2 Exotic Pasture With Remnant Eucalypts
- ACT16-3 Exotic Pasture

PCT ACT25 Tableland Grass/Shrub Forest

- ACT25-1 Grassy Dry Forest
- ACT25-2 Exotic Pasture

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2.4.3.2 Significant Flora Species

No EPBC Act or NC Act listed threatened flora species have been recorded in Kama Nature Reserve. However, the Box-Gum Woodland and Natural Temperate Grassland communities with Kama Nature Reserve support numerous uncommon flora species which, although not listed, indicate the high value of the patches of these communities. Rare flora species recorded within Kama Nature Reserve include: Dawson's Wattle *Acacia dawsonii*, Leafless Indigo *Indigofera adesmiifolia*, Bristly Cloak Fern *Cheilanthes distans*, Smooth Flax-lily *Dianella longifolia*, Narrow Plantain *Plantago gaudichaudii,* and Zornia *Zornia dyctiocarpa* (ACT Government, Conservation Research, unpublished data).

2.4.3.3 Habitat for Significant Woodland Birds

As described in the NES Plan, Kama Nature Reserve supports foraging habitat for the Superb Parrot and Swift Parrot, both of which are MNES. Kama Nature Reserve also provides habitat for several other sensitive and significant woodland bird species. Accordingly, the significance of the habitat within Kama Nature Reserve to these MNES species and other significant bird species is discussed in the following.

- Superb Parrot

  Kama Nature Reserve provides intermittent foraging habitat for the Superb Parrot which visits the ACT between September and March and breeds at locations in West Molonglo and North Gungahlin (Davey 2012). Kama Nature Reserve, together with the Pinnacle Nature Reserve directly to the north, provides characteristically suitable breeding habitat for the Superb Parrot, however there is only a single record of a pair utilising a tree hollow within Kama Nature Reserve to breed (M. Mulvaney 2016, pers. comm.). Notwithstanding this, the foraging habitat within Kama Nature Reserve is located within an easy flight distance from the recorded core breeding habitat nearby to the west (Davey 2012).

  An Australian National University study currently in preparation (Manning *et al.* in prep) predicts that the impacts of climate change will increase the importance of the habitat in the Canberra region for the breeding of the Superb Parrot. As such, the habitat within Kama Nature Reserve may now, or in future, provide an important contribution towards the Superb Parrot's presence and breeding success within the Molonglo Valley and across its broader range. The possible consequence of this may be even greater at the ACT or regional scale should development in North Gungahlin deter future breeding in that area.

  It is also relevant to consider the possibility that Kama Nature Reserve may support Superb Parrot breeding in the future. The core breeding area to the west supports only very old trees, many of which will senesce and die in the next few decades, potentially decreasing the suitability of the area for breeding. Kama Nature Reserve however, contains substantial eucalypt regeneration under a land administration and management regime which will actively support the development of this regeneration in perpetuity. It is therefore reasonable to assert that Kama Nature Reserve may constitute a future 'bank' of habitat which may be crucial to the long-term persistence of the Superb Parrot in the ACT.

- Swift Parrot

  The Swift Parrot is a non-breeding migrant to the ACT. Together with the other substantial patches of Box-Gum Woodland within the ACT region, the Box-Gum Woodland within Kama Nature Reserve provides potential transient foraging habitat for the species (Saunders & Tzaros 2011). Kama Nature Reserve is not known to constitute habitat of any particular

importance to the Swift Parrot, and in this regard, the specific consideration of potential impacts to the species in the Strategic Assessment (EcoLogical Australia 2010), NES Plan, and Molonglo AMS is probably unwarranted.

- Other significant woodland bird species

  The woodland/forest habitat within Kama Nature Reserve is of greatest and most direct significance to the numerous ACT *Nature Conservation Act 2014* (NC Act) 'vulnerable' listed and/or regionally declining woodland birds known to breed and/or forage within, including the: Brown Treecreeper *Climacteris picumnus*, White-winged Triller *Lalage tricolor*, Varied Sittella *Daphoenositta chrysoptera* and Scarlet Robin *Petroica boodang* (Davey 2012; ACT Government 2014a). Notably, Kama Nature Reserve is one of the few sites in the ACT region known to support a resident family group of Brown Treecreeper (Davey 2012). Kama Nature Reserve is also likely to provide an important component of the hunting range of the pair of Little Eagles observed to nest nearby, that location being the only recorded nest in the ACT in 2011 (COG 2012). Whilst these NC Act listed and/or regionally declining species are not currently themselves listed as MNES, their occurrence within a patch of Box-Gum Woodland is a key indicator of the ecological integrity and overall value of the patch.

The vegetation classifications within Kama Nature Reserve of key habitat value to woodland birds are 'ACT-16-1 EPBC Act Box-Gum Woodland' and 'ACT-25-1 Grassy Dry Forest' (refer Figure 3 and Figure 4). These communities are considered to be the primary preferred habitat types for most of the woodland birds of the region (ACT Government 2004b) and the patches retained and protected within Kama Nature Reserve are relatively intact examples. Whilst the woodland birds utilising these vegetation communities would also intermittently venture out into the other more modified or naturally open areas to forage, as is supported by the point data from numerous bird surveys (Davey 2012; Doerr *et al*. 2014), the patches of moderate to high quality woodland and forest constitute the 'core woodland bird habitat' within Kama Nature Reserve. The extent of this core woodland bird habitat is shown in Figure 4.

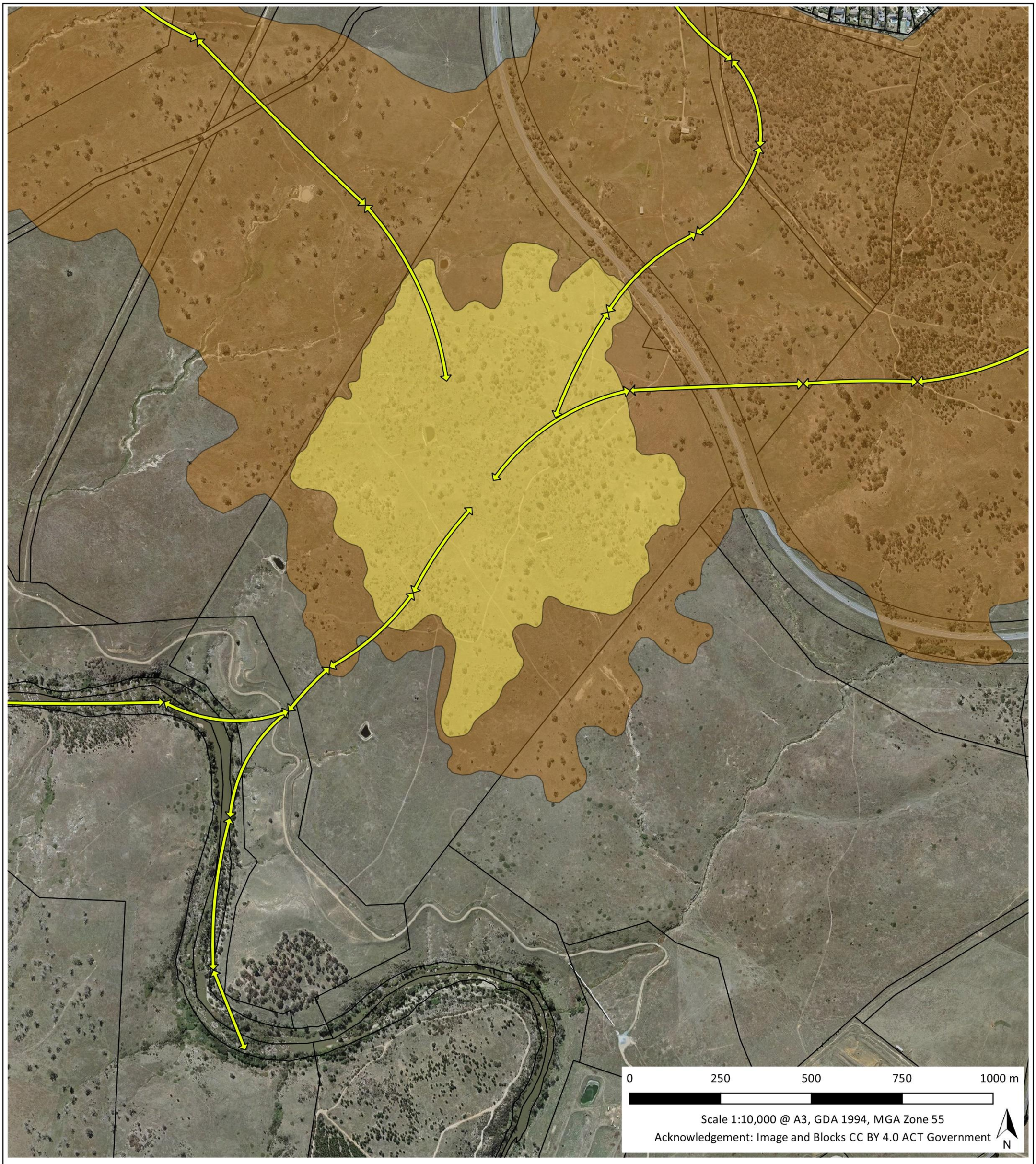

Figure 4. Woodland Bird Habitat

Legend

- ACT Blocks

Woodland Bird Habitat

- Kama NR - Core Woodland Bird Habitat
- Woodland Bird Habitat (150 m max distance between trees)
- Primary Woodland Bird Connectivity

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2.4.3.4 Landscape Scale Ecological Connectivity

As stated in ACT Government (2014a) –

> *Kama is a key connectivity link from Black Mountain and Bruce Ridge through the Belconnen woodlands (The Pinnacle, Mount Painter, Aranda Bushland nature reserves) to the Molonglo River corridor and Murrumbidgee River. Kama is the only lowland reserve in the ACT that links forest (in Kama North and The Pinnacle) through woodland and grassland (Kama) to riparian ecosystems in the Molonglo River.*

Doerr *et al*. (2014) found that woodland specialists (i.e. native birds which are generally solely associated with woodland and open dry forest communities) almost exclusively move through the landscape in directions where gaps were <150 m. Connectivity for such species is largely severed where suitable 'stepping stone habitat' (retained isolated trees, tree corridors etc.) is not retained. Doerr *et al* (2014) suggest that keeping gaps <150 m is one action in the management of the landscape that could improve prospects for at-risk movement-limited bird species, many of which are threatened or declining species.

As illustrated in Figure 4, the woodland bird habitat within Kama Nature Reserve comprises a component of an extensive landscape-scale patch of woodland/forest where gaps between habitat patches or stepping stones is <150 m. Observations and targeted studies (Davey 2012; Doerr *et al*. 2014) into the dispersal of woodland birds in the Kama Nature Reserve locality point to the use of broad habitat corridors by numerous species; these dispersal corridors are illustrated in Figure 4.

The above described unique contextual features add further significance to the ecological communities within Kama Nature Reserve and their associated fauna habitat. It is relevant to note however that the habitat connectively value of Kama Nature Reserve is primarily relevant to birds and arboreal mammals (i.e. microbats, Sugar Glider *Petaurus breviceps*). Connectivity along the corridors to the north is largely severed for ground dwelling fauna (i.e. highly mobile reptiles and mammals) by William Hovell Drive. Ground dwelling fauna which traverse William Hovell Drive are subject to high risk of mortality from vehicle strike, as is evidenced by the identification of the location as a kangaroo collision 'hotspot' in the *ACT Kangaroo Management Plan* (ACT Government 2010).

Further to the above, while small numbers of the small, predominantly ground-dwelling marsupial, Common Dunnart *Sminthopsis murina,* still occur in limited portions of the Mt Majura / Mt Ainslie and Goorooyaroo reserves, neither of the two *Antechinus* species, historically recorded widely across Canberra's urban reserve network, have been detected in these reserves for many years (ACT Government 2009). The ACT Government (ACT Government 2009) has attributed the decline in small mammal populations within Canberra's urban reserves to increases in:

- fire frequency and extent resulting in reduced complexity of the ground layer (i.e. less litter, and fewer branches, logs, hollows, and other habitat features), which provides vital habitat for small mammals;
- predation from feral animals, particularly cats, foxes and dogs, exacerbated by loss of cover;
- increased fragmentation of urban bushlands (preventing recolonisation, reducing effective population sizes etc.); and
- illumination from the urban area creating more favourable environments for nocturnal predators (e.g. owls and cats).

2.5 Bushfire Hazard Management Requirements

It is well established that fire is important to the maintenance of the structure, diversity and ecological function of many Australian ecological communities. Box-Gum Woodland and Natural Temperate Grassland (being the dominant communities within Kama Nature Reserve) are examples of such communities. Believed to benefit from fire at intervals of 10 to 40 years and 4 to 10 years respectively, burning these communities at shorter intervals tends to result in a decline in biodiversity (ACT Government 2014b).

Given the above, the application of fire as a management tool within Kama Nature Reserve is entirely appropriate. In fact, as noted in ACT Government (2014a), mosaic burning of portions of Kama Nature Reserve is proposed to be key management tool to enhance the condition of the woodland and grassland within the reserve.

The appropriateness of managing Kama Nature Reserve as a Strategic Firefighting Advantage Zone (SFAZ) was considered at length by a working group of expert bushfire planners and representatives from all relevant ACT Government directorates. The outcome of the working group's considerations was the consensus that the performance criteria of a SFAZ, as required by the SBMP, can be achieved whilst achieving the NES plan commitments for the protection and enhancement of the MNES within Kama Nature Reserve. This outcome is reflected in Section 6.7.4 of the subsequently prepared *Molonglo River Reserve – Draft Management Plan 2016* (ACT Government 2016) –

> *Kama is proposed to be zoned as an SFAZ. Fire protection requirements will be achieved using a number of biomass management techniques that are not inconsistent with the conservation objectives for BGW and NTG. These include: ecological burns and planned fuel reduction burns, strategic grazing and herbicide to control high biomass grassy weeds, clumping of restoration plantings so they can be protected from fuel reduction measures, no further planting of Red Stringybark (Eucalyptus macrorhyncha) and tree by tree charring of the lower bark of existing Red Stringybark trees. If these measures do not achieve the necessary fuel reduction, fuel management may be undertaken in accordance with the Ecological Guidelines for Fuel and Fire Operations and the Molonglo River Reserve and Offset Area Ecological Management Guidelines.*

The working group's determination requires that the following measures also be implemented as part of the Kama Interface (Australian Bushfire Protection Planners 2016).

1. *There shall be established and maintained a minimum 60 metre wide Inner Asset Protection Zone (IAPZ) to the north-western edge of the urban development, managed to the prescriptions as detailed in the SBMP. This IAPZ shall contain an edge road and also a gravel fire trail located adjacent to the eastern boundary of Kama and shall include stormwater treatment ponds, cycleway/pedestrian access and electrical power lines, as required.*

2. *There shall be established and maintained a six (6) metre wide fire break located inside the eastern boundary of Kama Nature Reserve.*

3. *The existing access/fire trails within Kama Nature Reserve shall be upgraded and maintained to provide access for management works and fire-fighting operations.*

Item 1 is of critical relevance to this strategy as it defines the minimum characteristics for one of the elements that must be included in the Kama Interface, the Inner Asset Protection Zone.

Items 2 and 3 will be implemented as part of the management of Kama Nature Reserve (addressed in the final version of the Kama Operational Plan).

2.6 Additional Relevant Context

2.6.2 Kama Woodland/Grassland Heritage Listing

'Kama Woodland/Grassland, Belconnen' was listed as a heritage place on the ACT Heritage Register on 18 October 2012, subject to Notifiable Instrument NI2012-541. As illustrated in Figure 5, 'Kama Woodland/Grassland, Belconnen' encompasses Blocks 1419 and 1386 (i.e. Kama Nature Reserve), together with parts of 1596 and 181 and the verge of William Hovell Drive.

The Statement of Heritage Significance assigned to the listed heritage place is –

> *The Kama Woodland/Grassland, Belconnen is significant because it includes examples of two endangered ecological communities (Yellow Box-Red Gum Grassy Woodland and Natural Temperate Grassland) together with the natural boundary (ecotone) between them. The landscape relationship between the two vegetation communities is important because it is considered to be similar to the vegetation patterns that existed prior to European settlement.*
>
> *This place is also significant because there is a high diversity of native species in the Kama Woodland/Grassland including uncommon native forbs, woodland birds and riparian species. The Kama Woodland/Grassland provides important ecological connectivity between the lower Molonglo River and The Pinnacle (south Belconnen Hills).*

In line with the above statement, 'Kama Woodland/Grassland, Belconnen' was assessed against the heritage significance criteria described under s.10 of the *Heritage Act 2004* and found to meet criteria *k* and *l*.

The extent of the land included within the 'Kama Woodland/Grassland, Belconnen' listed heritage place was defined based largely on ecological community classification and condition mapping which, as described in Section 2.4.3.1, has been superseded by more recent and accurate mapping (Umwelt 2013a). This is of key relevance to this strategy given that substantial portions of the land shown as 'partially modified Box-Gum Woodland' in 'Map 3. Kama Ecological Communities/Habitat Classification' of the listing, notably that which lies to the east of the Kama Nature Reserve boundary, was incorrectly mapped, and does not constitute Box-Gum Woodland. The extension of the 'Kama Woodland/Grassland, Belconnen' listed heritage place beyond the eastern boundary of Kama Nature Reserve is likely attributed to this incorrect mapping, and is could therefore be considered to be unjustified.

2.6.3 Contamination Site within the Future Urban Area

As identified in Figure 5, a large pit was excavated in Block 12, Molonglo, immediately east of the Kama Nature Reserve eastern boundary, for the disposal of carcasses from kangaroo culling operations completed within Kama Nature Reserve. The ACT Government Environmental Protection Authority has determined that this pit poses a contamination risk to the adjacent future urban area and, as such, the ACT Government will exhume the contents of the pit and dispose of it elsewhere.

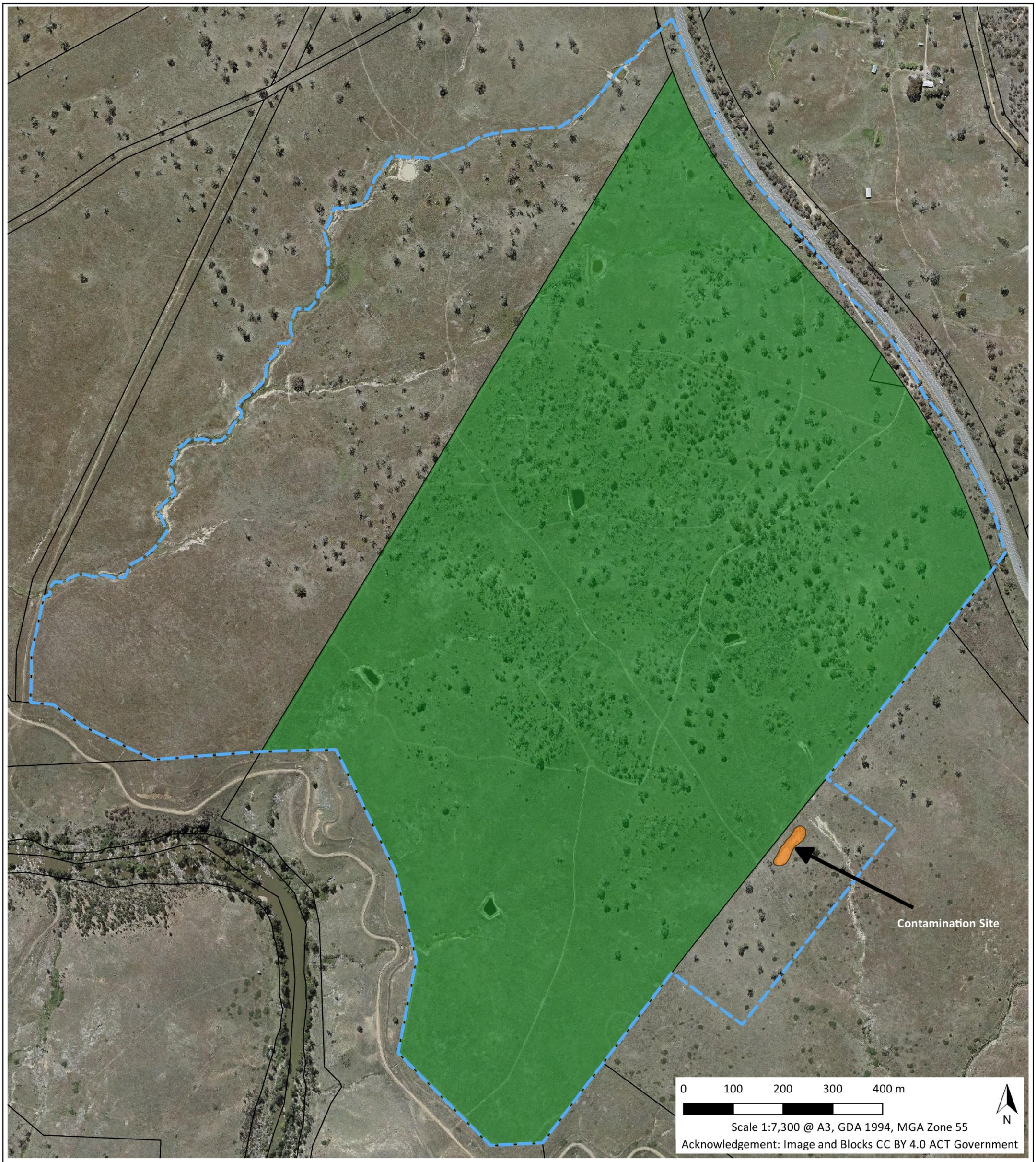

Figure 5. Kama Woodland/Grassland Heritage Listing and Contamination Site

Legend

- ACT Blocks
- Kama Nature Reserve
- Kama Woodland/Grassland Heritage Listing (NI2012—541)
- Contamination Site - Kangaroo Pit

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Date: 29 September 2016

3 Key Potential Threats from Urban Development

The key potential threats to the ecological values of Kama Nature Reserve from the development of Molonglo 3 (i.e. urban edge effects) are detailed in Table 2. Whilst these potential threats are listed discretely, as discussed in Table 2:

- they will all occur, or their degree of impact will increase, as a result of the development of Molonglo 3;
- they are all linked (directly or indirectly); and
- many of the measures recommended to address one of the threats will also influence the degree of impact of one or more of the others.

Table 3 provides a threat-sensitivity matrix outlining the degree of sensitivity each significant value is likely to have to each identified potential threat in Table 2. As shown in Table 3, the most significant threat to the MNES within Kama Nature Reserve is weed invasion. The introduction, establishment and proliferation of weeds as a result of the development of Molonglo 3, notably African Lovegrass and Chilean Needle Grass, poses a very high degree of threat to the condition and overall integrity of Box-Gum Woodland, Natural Temperate Grassland and Pink-tailed Worm-lizard habitat. The NC Act listed and/or regionally declining (significant) woodland birds of Kama Nature Reserve are likely to be the most sensitive of the values of within the reserve. As noted herein, whilst these species are not themselves currently listed as MNES, their occurrence within a patch of Box-Gum Woodland is a key indicator of the ecological integrity and overall value of the patch. The avoidance and/or mitigation of threats to these other significant woodland birds is therefore a key consideration for the design of the Kama Interface.

Table 2. Key potential threats from urban development

Threat	Description
1. Weed invasion	The incursion, establishment and proliferation of noxious weeds in Box-Gum Woodland and Natural Temperate Grassland remnants is one of the foremost threats to the conservation of these threatened ecosystems and their habitat values. Once established, noxious weeds progressively degrade natural ecosystems, often to the point that they no longer reflect the original climax community or support its constituent significant biota. Adverse impacts of noxious weeds on natural ecosystems include: • smothering and/or outcompeting characteristic native groundstorey flora species; • suppressing recruitment, establishment and development of canopy and midstorey species due to smothering, altered soil chemistry, and losses or changes in the presence of vectors necessary for dispersal; and • reducing the availability or suitability of key foraging and/or breeding resources for native fauna. Although Kama Nature Reserve contains a relatively high cover of both perennial and annual exotic grasses, thistles and other common agricultural weeds, the current occurrence of noxious weeds such as St John's Wort *Hypericum perforatum* and Blackberry *Rubus fruticosus aggregate* is limited and manageable. The noxious perennial grasses African Lovegrass *Eragrostis curvula* and Chilean Needle Grass *Nassella trichotoma* now occur extensively along most road verges and median strips throughout urban Canberra. Many such areas, William Hovell Drive being a prime example, support a near monoculture of African Lovegrass in summer-autumn (i.e. C4 warm season growing) alternating with a near monoculture of Chilean Needle Grass in winter-spring (i.e. C3 warm season growing). Both species are highly invasive, have very high seed yields and tolerate harsh climatic conditions, characteristics which allow them to outcompete native species and make them virtually impossible to eradicate once established. African Lovegrass is also adaptable to most soils types and hydrological conditions, giving it the ability to establish even in skeletal soils where weeds have not historically been a major threat. African Lovegrass and Chilean Needle Grass do not disperse via wind-borne seed and rely largely on other human introduced vectors for dispersal (i.e. vehicles, machinery, stock etc.). This is evidenced by the extent of occurrence along roadsides, often roughly aligning with the mowing extent. In this regard, mowing is undoubtedly the primary vector responsible for the spread of these noxious grasses around the urban areas of the ACT, both species being spread into new areas when mowers move from one infested area to another area with little or no consideration of vehicle hygiene. A recent inspection of over 40 woodland and grassland sites subject to mowing by ACT Government City Services observed very poor adherence to weed hygiene requirements and resulting high weed prevalence throughout mown areas (M. Mulvaney 2016, pers. comm.).

Threat	Description
2. **'Urban-adapted' native fauna**	Native bird species in Australia are classified as being 'urban-adapters' (respond positively to urbanisation) or 'urban-avoiders' (sensitive to urbanisation and often present only in reserves) as first described by Blair (1996). Urban-adapted species are likely to gain a competitive advantage from the proximity of specific resources present in urban environments such as garden plantings of exotic shrubs which produce berries in winter, garbage, changes in vegetation density etc. These species generally decrease in density with distance from the urban fringe into an adjacent reserve (Rayner *et al*. 2015). Ikin *et al.* (2014) found that in Canberra suburbs, bird assemblages were characterised by higher proportions of large-bodied species, arboreal and opportunistic nesters, and granivorous and nectarivorous foragers. In contrast, the reserve community was characterised by woodland-dependant species including small-bodied species, understorey and tree cavity/hollow nesters, and arboreal insectivores. Native bird species considered to be urban-adapted that are likely to gain a competitive advantage as a result of development of Molonglo 3 include the Pied Currawong *Strepera graculina*, Australian Magpie *Cracticus tibicen*, Noisy Miner *Manorina melanocephala* and Red Wattlebird *Anthochaera carunculata*. In addition, certain species such as the Crimson Rosella *Platycercus elegans* and Common Brushtail Possum *Trichosurus vulpecula* may increase in number on the urban fringe only (as opposed to deeper within the urban area), as they benefit from new foraging resources in the urban matrix, but require resources such as hollows which in the shorter term may only be present within Kama Nature Reserve and other nearby areas. Impacts of urban-adapted fauna, particularly upon (generally smaller) birds, may include: • increased competition for nesting space, foraging resources, and hollows; • direct harassment; and • predation of nestlings. Given the potential intensity and reach of the effects of increased density of urban-adapted species, the entirety of Kama Nature Reserve may be reduced in value for small woodland birds. Urban-adapted species may also affect other values of Kama Nature Reserve such as the Superb Parrot and Pink-tailed Worm-lizard.
3. **Proximity of urban edge on 'urban-avoiding' bird species**	The extent to which edge effects, penetrate into reserves adjoining urban areas is not well understood. However, results from a study on bird communities across Canberra woodland/urban fringes suggested that the effects of the suburban matrix penetrate into reserves for greater distances than previously thought. Some studies have found that even sites 250 m from the reserve edge were perceived as edge habitat by birds (Ikin *et al.* 2014). A study in the United States of America recommended restricting housing development within one kilometre of protected areas (Wood *et al.* 2015) and a study in the ACT detected urban proximity effects on species frequently beyond three kilometres (and up to five kilometres) from the urban boundary (Rayner *et al.* 2014). Alterations to bird community composition in a reserve following the introduction of adjacent or nearby development are to date poorly studied and are not well understood. Such alterations are likely to depend on numerous factors, however it can be expected that the proximity of the urban edge will reduce the abundance of particular urban avoiding species within Kama Nature Reserve, such as the Brown Treecreeper, and in general reduce the value of the woodland in supporting woodland-dependant species. This is an overarching threat directly contributed to by the other threats listed in this table.

Threat	Description
4. **Loss of remnant trees (east of Kama Nature Reserve)**	As illustrated in Figure 3, the area within Molonglo 3 east of Kama Nature Reserve supports 36 very old (i.e. >150 years) live eucalypts (GHD 2014), together with numerous stags (dead trees). Most of these remnant trees and stags contain numerous hollows. The groundstorey under these trees and across much of the paddock is a mixture of exotic pasture and low diversity native pasture, highly modified by past tree clearance and approximately 180 years of intensive grazing. As such, the trees are unlikely to be of high value to the MNES of relevance to Kama. Notwithstanding this, recent research indicates that such old remnant trees are of disproportionately high value to the survival of many woodland bird and mammal species in modified environments (Gibbons and Lindenmayer 2002; Goldingay 2011; Le Roux *et al.* 2014a; Le Roux *et al.* 2015). The trees themselves are of substantial aesthetic and intrinsic value and, given the age of the trees, cannot be replaced in a timely manner. In light of the above, given the values of these remnant trees, their loss should be avoided to all extent practicable through their retention as part of the Kama Interface. It is noted however that the structural integrity of very old eucalypts is often assessed as unsuitable for retention within urban development. Further, accommodating the retention of remnant trees (including each tree's 'tree protection zone' (Australian Standards 2009)) within urban development is often difficult and impractical. As such, whilst it should be the intention to retain as many of the remnant trees as possible in the Kama Interface buffer (refer Section 6.2.4) as well as within the urban development area, in reality, few of the remnant trees are likely to be retained in the urban area beyond the buffer.
5. **Decreased foraging range**	Development east of Kama Nature Reserve will lead to distinct changes in the foraging resources available to native fauna, with planted gardens which include shrubs (including non-local and exotic species), structurally non-diverse and generally exotic lawns, fewer mature trees (in the short term) and provision of unnatural food sources (garbage bins, roadkill etc.). This is likely to benefit some species (urban-adapted) and disadvantage others (urban-avoiding). It will also result in the loss of open hunting habitat for large predatory birds such as the Little Eagle and Wedge-tailed Eagle *Aquila audax*.
6. **Loss of connectivity**	Fragmentation of habitat is an ever increasing threat in Australia. At Molonglo 3, loss of connectivity for fauna including invertebrates and birds could have a significant impact upon rare groundcover flora species (reliant on pollinator populations) and upon the bird assemblage of Kama Nature Reserve. Structural connectivity in the form of habitat corridors or stepping stones of remnant vegetation or revegetated land leads to functional connectivity in flora and fauna populations (Doerr *et al*. 2010). The functional connectivity for the constituent fauna of Kama Nature Reserve, particularly woodland birds, may be impacted by the development of Molonglo 3, however the impacts are likely to be minor. As evident in the aerial image (refer Figure 4), there are presently vegetation corridors between Kama Nature reserve and high quality habitat in the Molonglo River Reserve and the habitat across William Hovell Drive (i.e. The Pinnacle Nature Reserve). These corridors, which support remnant trees less than 150 metres apart, will remain unchanged by the loss of the widely scattered remnant trees within Molonglo 3. Some loss of connectivity may occur for the Pink-tailed Work-lizard, however the habitat patches within the development area of Molonglo 3 are not of high significance to the conservation of the species in the locality. The Molonglo River Reserve is likely to remain a significant habitat corridor for the Pink-tailed Worm-lizard.

Threat	Description
7. Noise and light spill	Noise and light from residential areas have been known to impact native fauna, resulting in modified behaviours and changes in distribution and abundance. Light spill from headlights, street lights and houses adjacent to a reserve may impact the function of adjacent ecosystems, through confusing navigation, changing foraging behaviour/predator-prey interactions, or negatively affecting animals or plant physiology (Simon & Babcock 1999). Nocturnal species such as bats may be most affected (Gleeson & Gleeson 2012). Noise from vehicles, construction, music, pets etc. at Molonglo will travel into adjacent areas. Impacts from urban noise have been recorded in fauna groups worldwide and may include distinct changes in fauna assemblages, such as declines in bird diversity and abundance (Shannon *et al.* 2016). Francis *et al* (2009) showed that noise alone could reduce nesting species richness and lead to different bird communities. Dog barking can alter bird behaviour by eliciting a fear response which may be detrimental to some species more than others (Randler 2005). To date no studies have been completed that focus specifically on the impact of light pollution and/or noise on wildlife in the ACT region. As such, the precautionary principle must be followed in limiting the impact of this threat to the fullest extent practicable.

Threat	Description
8. Exotic pest animals	Exotic pest animals (feral pests) adversely impact upon natural ecosystems in numerous ways, including by: causing erosion and other direct degradation; preying upon native fauna; competing with native fauna for habitat and foraging resources; introducing disease; and introducing and/or spreading weeds. The impacts of some exotic pest animals have been listed as Key Threatening Processes under the EPBC Act, and threat abatement plans have been developed and implemented for these priority pests. Although numerous feral pests occur in the Kama Interface locality, as described below, the Red Fox *Vulpes vulpes*, Feral Cat *Felis catus* and Common Myna *Acridotheres tristis* are the species which pose the greatest threat to the biodiversity values of Kama Nature Reserve. <u>Red Fox</u> Predation by foxes is a Key Threatening Process impacting upon many native fauna groups, including woodland/grassland birds, small reptiles (including the Pink-tailed Worm-lizard) and small mammals. Foxes occur commonly throughout the rural lands surrounding Canberra, within Canberra Nature Park Reserves and adjacent suburbs. Whilst the progressive removal of sheep grazing from the Molonglo locality will reduce the associated food source for foxes, the development of suburbs in close proximity to Kama Nature Reserve has the potential to maintain or increase populations via the introduction of alternative food sources such as unsealed rubbish bins, domestic poultry (chickens, ducks etc.), aviary birds and rodents. <u>Feral Cat</u> Feral cats are a serious vertebrate pest in Australia having severe to catastrophic effects on native fauna in all regions where present (Woinarski *et al*. 2014). Predation of native species is the primary threat from feral cats, however feral cats can also compete with native fauna in some regions and are known to transmit diseases (Commonwealth of Australia 2015). Feral cats occur commonly throughout the rural lands surrounding Canberra, particularly within five kilometres of the urban edge. Many of these feral cats come from the nearby suburban areas, often as lost or discarded pets or the progeny of these. The development of Molonglo 3 has the potential to increase the number of feral cats in the Kama Interface Locality, thereby increasing the degree to which this pest impacts upon the biodiversity values of Kama Nature Reserve. <u>Common Myna</u> Listed as one of the world's worst invasive species (Lowe *et al.* 2000), the Common Myna is a highly territorial species once established and is known to disrupt many native bird species and guilds of species. Gracock *et al.* (2014) observed negative associations between Common Myna abundance and some native bird species in Canberra's urban reserves, particularly those species that nest and/or roost in tree hollows. These impacts are usually particularly pronounced within close proximity to urban development. Whilst the Common Myna is not regularly observed in Kama Nature Reserve, urbanisation associated with the development of Molonglo 3 will undoubtedly result a substantially increase in the species' presence in the locality. As has been observed with all other recently developed suburbs in Canberra and the region (i.e. Gungahlin, Jerrabomberra, Googong etc.), the Common Myna will follow human occupation, and as such, proactive and intensive control of this species will need to commence upon occupation of Molonglo 3 and be ongoing.

Threat	Description
9. Domestic animals (pets)	Domestic animals, particularly dogs and cats, can dramatically impact wildlife within reserves if permitted within. Both dogs and cats will hunt native fauna, with cats being a particular threat to small woodland-dependant birds (Holderness-Roddam & McQuillan 2014). Cats are also more likely to roam (even in 'cat containment' areas) and are harder to keep out of reserves with fences. As study of pet cats along the urban fringe found that radiotracked cats roamed up to 300 m from home (Lilith *et al*. 2008). Dogs can also have a large impact upon wildlife, even when leashed (Lenth & Knight 2008; Westgarth *et al.* 2010). A study in urban fringe woodland north of Sydney found that on-leash dog walking in woodland led to a 35% reduction in bird diversity and a 41% reduction in abundance, with no evidence for habituation (Banks & Bryant 2007).
10. Increased human use/disturbance	Human use of Kama Nature Reserve could have a variety of impacts upon the significant values of the reserve. The most significant impacts are likely to be from recreation as well as from undesirable behaviour within or adjacent to the reserve. Recreational impacts may include damage to flora and disturbance to fauna from walking. Walking dogs adjacent to the reserve may also disturb wildlife. Impacts from undesirable behaviour may include: dumping of garbage and garden waste, disturbing or collecting rocks, and harvesting flora. High human use may lead to increased weed introduction and spread, and reduction in sensitive flora and fauna.

Table 3. Threat-sensitivity matrix

Degree of threat	Very High	High	Moderate	Low

		Value					
		Box-Gum Woodland	**Natural Temperate Grassland**	**Pink-tailed Worm-Lizard**	**Superb Parrot**	**Swift Parrot**	**Other Significant Woodland Birds**
Threat	**1. Weed invasion**	May lead to severe degradation of Box Gum Woodland, including loss of characteristic flora. Whilst groundcover weed invasion does not impact overstorey species (although it may reduce recruitment in the long term), it may significantly reduce the overall value and function of the habitat.	Weed invasion can lead to severe degradation of Natural Temperate Grassland, including loss of characteristic flora.	The Pink-tailed Work-lizard is only known to occur in rocky habitat within native-dominated grassland. Weed invasion may reduce the quality of habitat for this species, possibly resulting in local extinction.	Weed invasion may reduce the quality of available foraging resources. As the impact of weed invasion upon this species is not known, the precautionary principle has been applied in categorising the threat as moderate.	Unlikely to have a significant impact upon this species, as it is a rarely visiting migrant and does not breed in the region.	Weed invasion may reduce the quality of available foraging resources for woodland birds and may change the structure of the habitat. May also benefit competing species.
	2. 'Urban-adapted' native fauna	May impact upon the functioning of the community through changes in predator-prey and competition dynamics, leading to a reduction in diversity and abundance of characteristic woodland species.	May reduce foraging by certain fauna species.	Unlikely to be a threat although may increase predation.	Urban exploiting native fauna may compete with the Superb Parrot for food or potentially for hollows and may harass birds, leading to reduction in use of Kama Nature Reserve by the species.	May lead to reduction in visitation of Kama Nature Reserve but unlikely to be a significant threat to the species.	Highly likely to compete with small woodland birds. May reduce the abundance and diversity of woodland dependant species.
	3. Proximity of urban edge on 'urban-avoiding' bird species	May impact upon the functioning of the community through changes in fauna species composition.	N/A	N/A	May reduce the frequency and duration of foraging behaviour. Likely to prevent the species from breeding in trees near to the urban fringe in future.	Species unlikely to be significantly impacted however foraging behaviour may be affected.	Overarching threat – proximity of urban development likely to permanently change the species composition within Kama Nature Reserve.
	4. Loss of remnant trees (east of Kama Nature Reserve)	Trees east of Kama Nature Reserve are valuable for fauna habitat and a proportion are likely to be cleared. These areas are already highly modified and do not represent the ecological community.	N/A	N/A	Species may be impacted by reduction in mature flowering eucalypts and grassland leading to lower breeding success in Molonglo. Over time, planted trees will mature and may eventually be utilised.	Unlikely to affect the species given the amount of foraging habitat nearby.	May lead to a reduction in abundance and diversity of woodland dependant species in Kama Nature Reserve. Some species unlikely to be affected.
	5. Decreased foraging range	N/A	N/A	N/A	Species may be impacted by reduction in mature flowering eucalypts and grassland leading to lower breeding success in Molonglo. Over time, planted trees will mature and may eventually be utilised.	Unlikely to affect the species given the amount of foraging habitat nearby.	May lead to a reduction in abundance and diversity of woodland dependant species in Kama Nature Reserve. Some species likely to be unaffected. Large predatory birds likely to be affected.

	Value					
	Box-Gum Woodland	**Natural Temperate Grassland**	**Pink-tailed Worm-Lizard**	**Superb Parrot**	**Swift Parrot**	**Other Significant Woodland Birds**
6. Loss of connectivity						
	Development is unlikely to significantly affect connectivity for characteristic flora and fauna of this community.	Development is unlikely to significantly affect connectivity for characteristic flora and fauna of this community.	Development may have some impact upon connectivity for the species through loss of potential habitat within Molonglo 3, however this is unlikely to be significant for the conservation of the species in the locality.	Development is unlikely to significantly affect connectivity for the species.	Development is unlikely to significantly affect connectivity for the species.	Development is unlikely to significantly affect connectivity for other significant woodland birds.
7. Noise and light spill						
	May have some minor impact upon the habitat values of the community.	May have some minor impact upon the habitat values of the community.	Unlikely to significantly affect the species.	May reduce the frequency and duration of foraging behaviour. Likely to prevent the species from breeding in trees near to the urban fringe in future.	May reduce the likelihood of the species foraging near the urban edge. Unlikely to have a significant impact.	Likely to reduce the frequency of foraging and nesting near the urban edge of some urban avoiding species. May impact behaviour.
8. Exotic pest animals						
	May impact upon the functioning of the community through changes in predator-prey and competition dynamics, leading to a reduction in diversity and abundance of characteristic woodland species.	May impact upon the functioning of the community through changes in predator-prey and competition dynamics.	Certain pest fauna may prey upon the species. Unlikely to be a significant threat.	Exotic pest animals may harass or compete with the Superb Parrot for foraging resources and/or hollows.	Unlikely to be a significant threat however may reduce the likelihood of the species foraging near the urban edge.	Highly likely to compete with or prey upon small woodland birds. May reduce the abundance and diversity of woodland dependant species.
9. Domestic animals (pets)						
	May cause physical disturbance, carry weeds and prey upon native fauna.	May cause physical disturbance, carry weeds and prey upon native fauna.	May prey upon the species, reducing its occurrence in Kama Nature Reserve.	May harass or predate upon foraging birds leading to greater pressure upon the population and reduction in the suitability of the habitat for the species.	May harass or predate upon foraging birds although unlikely to be significant.	Likely to prey upon small woodland birds. May prevent breeding near the urban edge.
10. Increased human use/disturbance						
	Physical disturbance may reduce abundance and diversity of sensitive native flora.	Physical disturbance may reduce abundance and diversity of sensitive native flora.	Physical disturbance of rocky habitat likely to occur. Collection of rocks and animals may impact upon population density and distribution.	Human use may prevent potential breeding of the species in Kama Nature Reserve in the future.	Unlikely to affect the species given the amount of foraging habitat nearby, however the species may be less likely to visit.	Human disturbance may reduce abundance and diversity of sensitive woodland dependant species.

4 Determination of Minimum Buffer Characteristics

A key component of the Kama Interface is the buffer to be established between Kama Nature Reserve and the adjacent urban area of Molonglo 3 (the 'buffer'). It is a pre-established requirement that the buffer contains a minimum 60 m wide IAPZ along its full length; this dictates the minimum width of the buffer at any point along the Kama Interface. The width of the buffer beyond this 60 m must be determined based on that which is required to *provide protection* (to the significant biodiversity values of Kama Nature Reserve) *against urban edge effects.* As established in Section 2.4.3, Kama Nature Reserve contains numerous biodiversity values which require protection from urban edge effects. However, the buffer width and characteristics required to provide an effective level of protection differ substantially between the subject values. In recognition of this, Table 4 lists each relevant significant biodiversity value and defines the corresponding minimum buffer width and other characteristics required. The buffer characteristics required have been determined based on the level of effectiveness where applied elsewhere in the ACT, together with information drawn from the available literature and the application of relevant ecological principles.

Table 4. Minimum buffer width and characteristics

Significant Biodiversity Value	Discussion and Rationale	Minimum Required Buffer Width and Characteristics
Box-Gum Woodland	The key threat to the Box-Gum Woodland ecological community is the invasion and proliferation of exotic weeds, notably African Lovegrass, Chilean Needle Grass, St John's Wort, and Blackberry. The management of the buffer is likely to be of greater importance to its ability to protect against this threat than its width. Indeed, a narrower buffer that incorporates effective weed control is likely to provide better protection than a larger buffer that is poorly managed (i.e. allowed to become a source of weeds etc.). A broader buffer would also be unlikely to substantially increase protection against feral animals or humans. No standard buffer width has been established for Box-Gum Woodland in the ACT, with setbacks of development from Box-Gum Woodland varying greatly, generally being defined based on other factors.	20 m A 20 m wide buffer to Box-Gum Woodland is likely to provide a sentinel zone of sufficient width to undertake targeted weed monitoring and control. This buffer can be managed as IAPZ (i.e. grazed/mown understorey with or without canopy trees) or as regeneration plantings.
Natural Temperate Grassland	The key threat to the Natural Temperate Grassland ecological community is the invasion and proliferation of exotic weeds, notably African Lovegrass, Chilean Needle Grass, St John's Wort, and Blackberry. The management of the buffer is likely to be of greater importance to its ability to protect against this threat than its width. Indeed, a narrower buffer that incorporates effective weed control is likely to provide better protection than a larger buffer that is poorly managed (i.e. allowed to become a source of weeds etc.). A broader buffer would also be unlikely to substantially increase protection against feral animals or humans. No standard buffer width has been established for Natural Temperate Grassland in the ACT, with setbacks of development from Box-Gum Woodland varying greatly, generally being defined based on other factors.	20 m A 20 m wide buffer to Natural Temperate Grassland is likely to provide a sentinel zone of sufficient width to undertake targeted weed monitoring and control. This buffer can be managed as IAPZ (i.e. grazed/mown understorey).

Significant Biodiversity Value	Discussion and Rationale	Minimum Required Buffer Width and Characteristics
Pink-tailed Worm-Lizard	The key threats to Pink-tailed Worm-lizard habitat in urban interface areas are the invasion and proliferation of exotic weeds and disturbance of habitat by humans. Osborne & Wong (2012) found that the areas of Mount Taylor up to approximately 100 m of residential development were significantly degraded, with no Pink-tailed Worm-lizards being recorded within this area. The key causes of this habitat degradation were noted as replacement of important native grasses by exotic weed species, grooming of loose surface rocks, and other physical disturbance (Osborne & Wong 2012). Based on their findings, Osborne & Wong (2012) recommended that a 100 m general management zone be established between residential development and Pink-tailed Worm-lizard habitat. However, where the establishment of such a broad zone is unfeasible, then protection should be achieved by implementing a higher level of management that includes: (i) rigorous protection of habitat areas; (ii) inclusion of a managed 20 m buffer that surround the habitat; and (iii) increased vigilance in managing any open areas of landscape upslope of buffer areas (Osborne & Wong 2012). It is noted that the patches of Pink-tailed Worm-lizard habitat within the Molonglo 3 area (i.e. east of the eastern boundary of Kama Nature Reserve) are included in the impact areas under the 'ecological impact budget' in the NES Plan. Accordingly, for the purposes of this strategy these patches are not considered as requiring specific protection. Notwithstanding this, to the extent that it is compatible with the other management requirements of the land (i.e. bushfire hazard mitigation), the habitat will be retained. The buffer will adjoin one patch of Pink-tailed Worm-lizard habitat within Kama Nature Reserve. A fence established along the boundary of Kama Nature Reserve with gates distant from the habitat patch would minimise human disturbance of the habitat beyond the boundary. Managing the adjoining land in line with the higher level of management recommended by Osborne & Wong (2012), notably including the 20 m managed buffer (NES Plan, ACT Government 2011), is likely to provide sufficient protection to the patch of habitat on the reserve side of the fence.	20 m A 20 m intensive management buffer is likely to provide a sentinel zone of sufficient width to undertake targeted weed monitoring and control. This buffer can be managed as IAPZ (i.e. grazed/mown understorey). The construction of a fence along the eastern boundary of Kama Nature Reserve will minimise human disturbance of the habitat protected within the reserve.

Significant Biodiversity Value	Discussion and Rationale	Minimum Required Buffer Width and Characteristics
Superb Parrot	Kama Nature Reserve provides intermittent foraging habitat for the Superb Parrot, which visits the ACT between September and March, breeding at locations in West Molonglo and North Gungahlin (Davey 2012). Although the species is not known to breed within Kama, the foraging habitat within Kama Nature Reserve is located within an easy flight distance from the recorded core breeding habitat nearby to the west (Davey 2012). As such, the habitat within Kama Nature Reserve may now, or in future, provide an important contribution towards the Superb Parrot's presence and breeding success within the Molonglo Valley. Kama Nature Reserve may also constitute a future 'bank' of habitat which may be crucial to the long-term persistence of the Superb Parrot in the ACT. Urban development and human presence appear not to adversely impact upon Superb Parrot foraging activities, rather the species is known to regularly forage in urban gardens across northern Canberra. However, the species prefers not to breed in close proximity to areas frequented by humans (Canberra Ornithological Group 2012) with birds observed to not return to previously occupied nesting trees following urban encroachment. Given the above, it is reasonable to assert that urban development within close proximity of the Superb Parrot foraging habitat within Kama Nature Reserve is unlikely to adversely impact the current foraging value of the habitat to the species. The planting of native trees in portions of the Kama Interface (including urban gardens, refer Section 6.3) may in fact increase the foraging resources present in the locality, although such additional resources may also counterproductively bolster populations of urban exploiting native and exotic birds to the detriment of the Superb Parrot and other sensitive avifauna. In addition to the above potential for impacts to current foraging habitat, as described in Section 2.4.3.3, it is important to consider the potential future value of the Box-Gum Woodland within Kama Nature Reserve as breeding habitat for the Superb Parrot. In this regard, a broad buffer (such as 200 m) is likely to be necessary for the Superb Parrot to ever utilise the Box-Gum Woodland within Kama Nature Reserve as breeding habitat.	20 m (200 m in consideration of potential future breeding habitat value) A 20 m wide buffer to the Box-Gum Woodland is likely to provide a sentinel zone of sufficient width to undertake targeted weed monitoring and control, thereby protecting the foraging value of the groundstorey of this habitat. This buffer can be managed as IAPZ (i.e. grazed/mown understorey with or without canopy trees) or as regeneration plantings. Further to the above, a buffer of 200 m to the Box-Gum Woodland is likely to be the minimum required for the Superb Parrot to ever utilise Kama Nature Reserve as breeding habitat. Subject to fire hazard mitigation requirements, planting portions of the buffer with locally native trees of foraging and/or potential future nesting value will increase the effectiveness of the buffer.

Significant Biodiversity Value	Discussion and Rationale	Minimum Required Buffer Width and Characteristics
Swift Parrot	The Swift Parrot is only an occasional non-breeding migrant to the ACT. Together with the other substantial patches of Box-Gum Woodland within the ACT region, the Box-Gum Woodland within Kama Nature Reserve provides potential transient foraging habitat for the species. Kama Nature Reserve is not known to constitute habitat of any particular importance to the Swift Parrot. With regard to the above, the proximity of urban development to foraging habitat within Kama Nature Reserve is unlikely to be of any considerable consequence to the species' utilisation of the habitat, or its broader conservation.	20 m A 20 m wide buffer to the Box-Gum Woodland is likely to provide a sentinel zone of sufficient width to undertake targeted weed monitoring and control, thereby protecting the foraging value of the groundstorey of this habitat. This buffer can be managed as IAPZ (i.e. grazed/mown understorey with or without canopy trees) or as regeneration plantings.
Other Significant Woodland Birds	The woodland/forest habitat within Kama Nature Reserve is arguably of greatest and most direct significance to the numerous NC Act 'vulnerable' listed and/or regionally declining woodland birds known to breed and/or forage within, notably including the: Brown Treecreeper, White-winged Triller, Varied Sittella and Scarlet Robin (Davey 2012; ACT Government 2014). As discussed in Section 2.4.3.3, whilst these species are not themselves currently listed as MNES, their occurrence within a patch of Box-Gum Woodland is a key indicator of the ecological integrity and overall value of the patch. These species are generally urban-avoiding species and are negatively impacted by urbanisation. A study of the impacts of urban development upon bird species in the ACT detected urban proximity effects on species frequently beyond three kilometres (and up to five kilometres) from the urban boundary (Rayner *et al.* 2014). It is therefore likely that for sensitive woodland birds, the larger the buffer (up to approximately five kilometres), the better the outcome, and that technically there is no known 'minimum' buffer width. A buffer of 200 m to the core woodland bird habitat (Box-Gum Woodland and Grassy Dry Forest, refer Figure 4) is recommended to provide effective protection to the significant woodland birds of Kama Nature Reserve. Although there is a paucity of Australian research directly relating to the effectiveness of specific buffer widths, the available international research (Martino 2001; Thorell & Gotmark 2005; Wood *et al.* 2014; Wood *et al.* 2015) suggests that 200 m is likely to greatly reduce the impact of roaming cats and dogs, human disturbance, and competition from urban-adapted species. Planting portions of the buffer with local native trees and shrubs will increase the effectiveness of the buffer, as vegetative and structural diversity is associated with a greater abundance of sensitive 'urban-avoiding' species (Ikin *et al.* 2013a).	200 m A buffer of 200 m to the core woodland bird habitat (Box-Gum Woodland and Grassy Dry Forest, refer Figure 6) is likely to be required to provide an appropriate level of protection to the significant woodland birds of Kama Nature Reserve. Subject to fire hazard mitigation requirements, planting portions of the buffer with locally native trees and shrubs will increase the effectiveness of the buffer.

5 Interface Options Evaluation

As described in Section 2.2, the overarching objective of this strategy is to provide sound, well-defined and scientifically supported advice and recommendations to the ACT Government regarding the characteristics required for the interface between Kama Nature Reserve and Molonglo 3 to achieve the NES Plan commitments. Working to achieve this objective, and with regard to each important element of the Kama Interface context (Section 2), the following process was followed to determine the most appropriate arrangements for the Kama Interface.

1. Definition and inclusion of pre-established minimum requirements

   As outlined in Section 2.5, it was determined prior to the development of this strategy that the Kama Interface must include the following bushfire hazard mitigation elements.

   a. A minimum 60 metre wide IAPZ to the north-western edge of the urban development, managed to the prescriptions as detailed in the SBMP. This IAPZ shall contain an edge road and also a gravel fire trail located adjacent to the eastern boundary of Kama and shall include stormwater treatment ponds, cycleway/pedestrian access and electrical power lines, as required.

   b. A six (6) metre wide fire break located inside the eastern boundary of Kama Nature Reserve.

↓

2. Definition of the minimum characteristics required

   Definition of the minimum characteristics required for the interface to effectively *provide protection against urban edge effects.* This was informed by a thorough review of available literature (refer References) relating to: urban edge effects; the sensitivity of the relevant values, or surrogates for those values which are not well studied; the effectiveness of various buffer widths; and the effectiveness of specific interface treatments.

↓

3. Identification and consideration of countering/controlling factors

   In general, a broader buffer between urban development and natural areas is beneficial in reducing or mitigating the impacts of edge effects. It may be that the degree of protection offered increases along a continuum from a narrow to very broad buffer. Nevertheless, the economic costs which increase with buffer width (loss of development yield, initial and ongoing management and maintenance costs etc.) necessitate that the buffer proposed is that which is required to achieve its purpose (Item 2 above), and is not excess to this.

↓

4. Development of options

   In the context of Items 1 to 3 above, several Kama Interface options were developed to broad concept level, each with varying characteristics (i.e. buffer widths, treatments etc.). The options developed are detailed in Table 5.

↓

5. Critical evaluation of options

   As detailed in Table 5, on completion of Item 4, each Kama Interface option was assessed to evaluate the degree to which it is likely to achieve its purpose, yet minimise economic costs.

The above process resulted in the identification of an interface option which, with a reasonable degree of confidence, is considered likely to achieve the purpose of the Kama Interface in a manner which is duly cognisant of economic considerations. Accordingly, this interface option has been developed in detail and is presented in Section 6 as the 'recommended interface arrangements'.

Table 5. Overview of Kama Interface options evaluation

Note: each option developed includes the pre-established minimum bushfire management requirements as outlined in Section 2.5.

Option	Key Characteristics	Likelihood of Achieving Purpose[1]	Economic Costs	Recommended Interface Option - Yes/No
1	• 60 m wide buffer along the length of the interface. • The entire buffer would be managed as IAPZ[2].	Very Low As detailed in Table 4, a 60 m wide buffer is considerably less than the minimum 200 m likely to be required.	Minimal High development yield and low establishment and maintenance costs.	No Option 1 has a very low likelihood of achieving its purpose.
2	• 230 m wide buffer along the length of the interface. • The western 200 m of the buffer would be managed as OAPZ[3], the eastern 30 m as IAPZ. • Note: although this option would not include the minimum 60 m wide IAPZ (refer point '1' above), the ACT Emergency Services Agency have advised that a 30 m wide IAPZ would suffice where it adjoins a 200 m wide OAPZ.	High A 230 m wide buffer would provide a setback in excess of the minimum 200 m likely to be required.	Very High Very high impact on development yield, together with high establishment and maintenance costs.	No The economic costs of Option 2 would not be justified.
3	• 200 m wide buffer along the length of the interface. • The western 140 m of the buffer would be managed as SFAZ[4], the eastern 60 m as IAPZ.	High The buffer would provide a setback approximately equal to the minimum 200 m likely to be required. The southern 1/3rd of the buffer would be wider than that likely to be required.	High High impact on development yield, together with high establishment and maintenance costs.	No The economic costs of Option 3 would not be justified.
4	• 200 m wide buffer along the northern 2/3rds of the interface (adjacent to Kama Nature Reserve Box-Gum Woodland), tapering back to 100 m wide for the southern 1/3rd of the interface (adjoining Kama Nature Reserve Natural Temperate Grassland and Pink-tailed Worm-lizard habitat). • The eastern 60 m would be managed as IAPZ, the balance as SFAZ.	High The buffer would provide a setback approximately equal to the minimum 200 m likely to be required. The southern 1/3rd of the buffer would provide the 100 m wide optimal buffer as recommended by Osborne & Wong (2012).	High High impact on development yield, together with high establishment and maintenance costs.	No The potential additional protection from establishing the 100 m optimal buffer would not justify the economic costs.

Option	Key Characteristics	Likelihood of Achieving Purpose[1]	Economic Costs	Recommended Interface Option - Yes/No
5	• 200 m wide buffer along the northern 2/3rds of the interface (adjacent to Kama Nature Reserve Box-Gum Woodland), tapering back to 60 m wide for the southern 1/3rd of the interface (adjoining Kama Nature Reserve Natural Temperate Grassland and Pink-tailed Worm-lizard habitat). • The eastern 60 m would be managed as IAPZ, the balance as SFAZ.	Moderate The buffer would provide a setback along the northern 2/3rds of the interface approximately equal to the minimum 200 m likely to be required. The southern 1/3rd of the buffer would provide marginally less than the 200 m to core woodland values likely to be required.	Moderate Moderate impact on development yield, together with moderate establishment and maintenance costs.	No The 60 m wide southern 1/3rd of the buffer would provide less than the minimum 200 m setback likely to be required.
6	• 200 m wide buffer along the northern 2/3rds of the interface (adjacent to Kama Nature Reserve Box-Gum Woodland), tapering back to 70 m wide for the southern 1/3rd of the interface (adjoining Kama Nature Reserve Natural Temperate Grassland and Pink-tailed Worm-lizard habitat). • The eastern 60 m would be managed as IAPZ along the northern 2/3rds, the 70 m wide buffer would be managed as IAPZ along the southern 1/3rd. The balance would be managed as SFAZ.	High The buffer would provide a setback along the northern 2/3rds of the interface approximately equal to the minimum 200 m likely to be required. The southern 1/3rd of the buffer would provide the 200 m to core woodland values likely to be required.	Moderate Moderate impact on development yield, together with moderate establishment and maintenance costs.	Yes Option 6 provides the minimum buffer width likely to be required. Accordingly, Option 6 is the recommended interface arrangement developed in detail for this strategy (refer Section 6).

[1] To provide protection to the significant biodiversity values of Kama Nature Reserve against urban edge effects.

ACT Bushfire Management Standards (ACT Government 2014c)

[2] Inner Asset Protection Zone (IAPZ)

[3] Outer Asset Protection Zone (OAPZ)

[4] Strategic Firefighting Advantage Zone (SFAZ)

6 Recommended Interface Arrangements

6.1 Kama Interface Concept and Purpose

At approximately 155 ha, Kama Nature Reserve is a relatively small reserve which supports important fauna habitat, the value of which is substantially heightened by its location as a habitat linkage (ACT Government 2015a). Although the establishment of the Molonglo River Reserve to the south will substantially increase the area of reserve land directly connected to Kama Nature Reserve, it will not significantly reduce the high edge-to-core ratio of Kama Nature Reserve itself. With a high edge-to-core ratio, small reserves have a correspondingly small area of core or interior habitat to act as a stronghold for biodiversity and provide sufficient refuge for sensitive fauna species (i.e. urban-avoiding woodland birds) (ACT Government 2015a). In this regard, in addition to effective management of Kama Nature Reserve itself, effective protection of the biodiversity values of Kama Nature Reserve will depend greatly on the characteristics and management of the land adjacent. Protection from future urban edge effects will require the combination of effective management within the reserve itself, establishment and in-perpetuity management of an appropriate buffer, together with the implementation of targeted measures within the adjoining urban area.

In recognition of the above, the arrangements for the Kama Interface recommended in this strategy are built on the concept that the Kama Nature Reserve buffer is not the entire interface, rather it is a component of the interface. Accordingly, as detailed in Section 6.2, the recommended Kama Interface arrangements address each of the interface's constituent components, namely Kama Nature Reserve, the buffer, and the urban land adjacent. Establishment and management of a Kama Interface built on this concept will most effectively achieve the interface's purpose – to *provide protection against urban edge effects.*

It is noted that the above stated purpose is logically extended to be interpreted as to *provide protection* (to the MNES of Kama Nature Reserve) *against urban edge effects.* In fact, in recognition of the significant biodiversity values of Kama Nature Reserve (as outlined in Section 2.4.3), for this strategy the purpose of the Kama Interface is considered to be to *provide protection* (to the significant biodiversity values of Kama Nature Reserve) *against urban edge effects*.

6.2 Kama Interface Design

6.2.2 Recommended Buffer Width

With regard to the minimum buffer width and characteristics defined in Table 4, the eastern extent of the significant biodiversity values within Kama Nature Reserve is not defined by the reserve's block boundary (as illustrated in Figure 6). Indeed, along substantial sections of the interface the eastern extent of the EPBC Act Box-Gum Woodland is more than 100 m from the block boundary. Accordingly, the required buffer width should be defined in a manner that provides the minimum setback (i.e. distance from development) to the actual extent of the significant biodiversity values, rather than to an administrative boundary. For example, as illustrated in Figure 6, establishment of a buffer that provides the 200 m minimum setback to core woodland bird habitat (being a key ecological element of EPBC Act Box-Gum Woodland) does not necessitate a uniform 200 m buffer along the entire interface. Therefore, as illustrated in Figure 6, it is recommended that the buffer width be defined as that required to provide a minimum of 200 m to core woodland bird habitat. Accommodating this 200 m setback results in a 200 m buffer along the northern portion of the Kama Interface, tapering back to 70 m along the southern portion (i.e. the minimum required to provide

the 200 m setback to core woodland bird habitat). This buffer would encompass a total area of 15.82 hectares and would provide a setback equal to, or in excess of, the distances defined in Table 4 required to provide effective protection to each of the relevant significant biodiversity values.

Regarding the above, as described in Section 2.2, the purpose of this strategy is not to describe elements relevant to interface design in minute detail, nor is it to prescribe the characteristics for the recommended interface arrangements beyond a conceptual basis. It is likely that the actual width of the buffer will need to be marginally increased or reduced along portions of the interface to appropriately accommodate site-scale topographic factors and other engineering considerations. Accordingly, the precise width and other particulars of the buffer will need to be defined at a later time (i.e. during detailed design, structure planning etc.).

The recommended characteristics for the buffer (and the other Interface Management Zones) are detailed in Section 6.2.3 below.

6.2.3 Interface Management Zones

As illustrated in Figure 7 (Kama Interface Overview) and Figure 8, Figure 9 and Figure 10 (Kama Interface Detail), the recommended Kama Interface will comprise the following four Interface Management Zones (IMZs):

- **IMZ-1 Kama Nature Reserve** – comprising the land within Kama Nature Reserve;
- **IMZ-2 Interface Buffer – Woodland Regeneration** – comprising the portion of the buffer to be actively restored to Box-Gum Woodland;
- **IMZ-3 Interface Buffer – Inner Asset Protection Zone** – comprising the portion of the buffer to be managed primarily for the protection of the adjoining urban development; and
- **IMZ-4 Urban Development** – comprising the urban development land between the buffer and Deep Creek.

Table 6 provides details of the above listed IMZs, including their characteristics, primary purpose and management measures.

Table 6. Kama Interface – Interface Management Zones

Interface Management Zone	Characteristics	Primary Purpose	Management Measures
IMZ-1 **Kama Nature Reserve**	Kama Nature Reserve encompasses approx. 155 ha and shares a 1,260 m boundary with Molonglo 3. Managed as a Strategic Bushfire Advantage Zone (SFAZ). Kama Nature Reserve is a dog exclusion area.	In perpetuity conservation of biodiversity and other natural and cultural values.	IMZ-1 Kama Nature Reserve is to be managed in accordance with the *Molonglo River Reserve: Kama – Operational Plan 2014-17* (Kama Operational Plan) (ACT Government 2014) and the final *Molonglo River Reserve – Management Plan* (ACT Government, in prep - date TBD).
IMZ-2 **Interface Buffer – Woodland Regeneration**	Encompassing 8.0 ha, and managed as a SFAZ, IMZ-2 will be characterised by the following. 1. Ten remnant Blakely's Red Gum trees, retained together with stags and course woody debris. 2. A regenerating canopy throughout facilitated via the planting of local native eucalypts (notably Blakely's Red Gum and Yellow Box) (Restoration Units 1 and 2, refer Section 6.3.3). 3. Defined 'groundstorey and midstorey regeneration patches' within which these woodland strata will be restored in addition to the canopy (Restoration Unit 2 only, refer Section 6.3.3). In accordance within the management of the area as a SFAZ (*ACT Bushfire Management Standards*, ACT Government 2014c), these patches will comprise a maximum total area of 2.4 ha (i.e. 30% of 8.0 ha). The woodland regeneration works to occur within IMZ-2 are detailed in Section 6.3.3. IMZ-2 is a dog-on-leash area.	Buffer the significant biodiversity values of Kama Nature Reserve from the threats associated with the adjacent urban development.	Managed to provide an effective buffer of re-established woodland. As detailed in Sections 6.3 and 6.4, management measures include: • establishment and fencing of boundaries; • construction and maintenance of the fire trail (tanker) and public walking trails; • initial weed removal, ongoing monitoring and control; • re-establishment and encouragement of woodland vegetation (canopy throughout / canopy, groundstorey, midstorey in regeneration patches); • monitoring of woodland re-establishment, implementing alternative or additional works/management as required; • active monitoring and enforcement of dog-on-leash and cat containment laws; and • management of fuel load in line with SFAZ requirements.

Interface Management Zone	Characteristics	Primary Purpose	Management Measures
IMZ-3 **Interface Buffer – Inner Asset Protection Zone**	Encompassing 7.8 ha and managed as an Inner Asset Protection Zone (IAPZ), IMZ-3 will be characterised by the following. 1. Sixteen (16) remnant Blakely's Red Gum trees, retained together with stags (course woody debris will be removed). 2. A regenerating canopy throughout the portion of IMZ3 which would have once supported Box-Gum Woodland, facilitated via the planting of local native eucalypts (notably Blakely's Red Gum and Yellow Box) (Restoration Unit 2 only, refer Section 6.3.3). 3. Short grass/pasture throughout, as per the requirements of an IAPZ (Restoration Units 2 and 3, refer Section 6.3.3). IMZ-3 is a dog-on-leash area.	Provide effective bushfire hazard mitigation for the adjoining urban development. IMZ-3 will also provide 60 to 70 m of the 200 m required buffer width (i.e. setback to core woodland bird habitat).	Managed primarily to provide effective bushfire hazard protection to adjoining urban development. As detailed in Sections 6.3 and 6.4, management measures include: • establishment and fencing of boundaries; • construction of the retaining wall along the urban interface; • construction and maintenance of the fire trail (tanker) and public walking trails; • initial weed removal, ongoing monitoring and control; • re-establishment and encouragement of woodland vegetation (canopy only); • monitoring of woodland re-establishment, implementing alternative or additional works/management as required; • active monitoring and enforcement of dog-on-leash and cat containment laws; and • removal of course woody debris and management of fuel load in line with IAPZ requirements.
IMZ-4 **Urban Development**	Encompassing approximately 53 ha, IMZ-4 will be developed for urban purposes and will include: • residential properties; • asphalt roads; • concrete kerbs, driveways and footpaths; • planted nature strips and medians; and • ponds and other stormwater treatment infrastructure.	Provision of housing and community infrastructure for ACT residents.	Managed as urban estate. As detailed in Sections 6.3 and 6.4, management measures of relevance to the Kama Interface include: • planting of only local native species on public land; • active encouragement of residents to plant local native species on private land; • maintenance of fuel load in line with IAPZ requirements; and • active monitoring and enforcement of dog-on-leash and cat containment laws.

6.2.4 Retention of Remnant Native Trees

As illustrated in Figure 7, the recommended buffer (IMZ-2 and IMZ-3) will include, and facilitate the retention of, 26 of the 36 very old remnant Blakely's Red Gum *Eucalyptus blakelyi* in the subject area of Molonglo 3 (GHD 2014). Four of these trees were declared unsuitable for retention within residential areas, however they may be retained within the buffer. The buffer will also retain the numerous dead stag eucalypts occurring within, together with fallen trees and course woody debris within IMZ2.

Whilst the preservation of the remaining ten remnant eucalypts within the buffer would be favourable, the substantial extension of the buffer required to include these trees would be unjustified. Nevertheless, it is recommended that every practicable effort is made to retain these trees within the urban development area (IMZ-4) (i.e. in pocket parks, road verges etc.).

6.2.5 Urban Edge Road

As shown in Figure 7, a 16 metre wide road reserve will be established along the western periphery of IMZ-4 Urban Development. Within this road reserve an edge road will be constructed consisting of a two lane (i.e. a single lane each way) asphalt road. This urban edge road will include traffic slowing devices and will be designed in a manner that prevents it from becoming a major vehicular thoroughfare. The establishment of this urban edge road will provide the following.

1. Reliable and unobstructed access along the entire length of the interface between urban development and land designated for conservation and/or open space purposes (i.e. the buffer and Kama Nature Reserve beyond). This access is beneficial as it will provide effective and efficient:
    - entry and egress for residents and emergency services during a bushfire or other emergency;
    - monitoring and maintenance of the Kama Interface and the ecological values and built infrastructure; and
    - monitoring and control of weeds by ACT Government staff, contractors and others (i.e. there are no hidden or hard to access places which may be missed during weed control works).
2. A substantial separation between private properties and land designated for conservation and/or open space purposes (i.e. the buffer and Kama Nature Reserve beyond). This separation will reduce the risk of weed introduction by preventing dumping of garden waste etc. over the back fence.
3. Increased public surveillance along the Kama Interface which will reduce the incidence of illegal or antisocial activities and increase the likelihood of reporting of such activities.
4. Simplified administration and maintenance works required to appropriately maintain the interface between private land and the adjacent buffer and Kama Nature Reserve beyond.

As described in Section 6.2.2, reducing the buffer width by a few metres along small sections of the interface to accommodate part of the urban edge road would be consistent with the recommended interface concept, provided such reductions:

a. retain the 200 m setback of development to core woodland bird habitat; and
b. do not adversely affect the bushfire hazard management function of the buffer (i.e. notably IMZ3 which is the IAPZ).

6.2.6 Urban Edge Road - Buffer Verge

As shown in Figure 7, a buffer verge will be established between the urban edge road and the buffer. A concrete path will be constructed along this verge providing for pedestrian and bicycle traffic. Establishment of this verge and path will provide for and encourage people to walk dogs along the interface on the outside of the buffer rather than within it.

6.2.7 Urban Interface Retaining Wall

The majority of the Kama Interface is characterised by a moderate slope downhill to the east (i.e. from the buffer down to the urban area). It is noted that westerly winds prevail across the Molonglo Valley meaning that the detached seed and/or seed heads of weeds (e.g. Serrated Tussock, various thistles) growing in Kama Nature Reserve and further west are likely to blow east into the buffer and urban area beyond, but less likely to blow west and upslope from urban areas into Kama Nature Reserve.

The above described value of the natural topographical features along the Kama Interface in controlling weed spread will be further capitalised upon by the construction of a retaining wall along the eastern boundary of the buffer (refer Figure 7). It is envisaged that the height of the retaining wall will vary along the interface depending upon the amount of cut or fill required (and other engineering considerations), however the retaining wall should result in a minimum effective rise of one metre.

In addition to the reduction of weed spread, incorporation of this retaining wall into the interface will provide a number of benefits including:

- providing a ‘catch’ for headlight shine and vehicle noise, reducing the reach of these impacts into Kama Nature Reserve;
- making it difficult for residents to carry garden refuse (i.e. lawn clippings, prunings, unwanted plants etc.) into the buffer; and
- encouraging people to follow designated tracks into and within the buffer by only providing stepped sections which direct to tracks.

6.2.8 Fire Trail

In accordance with the agreed-upon bushfire hazard mitigation requirements for the Kama Interface (refer Section 2.5), as illustrated in Figure 7, a fire trail will be established within the buffer running along the eastern boundary of Kama Nature Reserve. The fire trail will extend around the northern and southern ends of the buffer to link with the urban edge road. The fire trail will be established to the specifications for a ‘tanker’ trail provided in the *ACT Bushfire Management Standards* (ACT Government 2014c) (i.e. having a natural grass or gravel surface, width of four (4) metres, maximum grade of 15 degrees, and corners not requiring 3-point turns by tankers).

The fire trail will also be used for horse riding, providing a link between the riding trail to be established to the north of Kama Nature Reserve and that to be established within the Molonglo River Park to the south. The interface fence and gate arrangements (refer Section 6.2.10) will need to direct horse riding to the fire trail and keep horses out of IMZ1 and the remainder of IMZ2 and IMZ3.

6.2.9 Public Walking Trails

As illustrated in Figure 8 and Figure 9, designated public walking trails will be established around the inside of the periphery of the buffer and across the buffer at a number of points. Where aligned with the fire trail the walking trail will be provided by the fire trail; all other walking trails will be established as approximately 1.5 m wide mineral earth trails.

6.2.10 Interface Fencing

6.2.10.1 Fence Type 1 - Interface buffer boundary fence

As illustrated in Figure 7, the fence to be constructed along the eastern, northern and southern boundaries of the buffer (1,488 m in length) will be standard 1.2 m high standard stock fencing with the standard mesh replaced with galvanised chain mesh which will be buried to a minimum depth of 300 mm (Fence Type 1). Two strands of standard high-tensile non-barbed wire will be strung along the top of the fence and a single strand will be strung halfway up to maintain tautness of the mesh.

Whilst the establishment of a predator proof fence (such as a Mulligans Flat Woodland Sanctuary) is not recommended along the Kama Interface, the addition of partially buried strong mesh of small aperture will reduce the incidence of domestic dogs and cats accessing Kama Nature Reserve.

The fences within the Kama Interface will not be constructed in a manner that restricts Kangaroo movement more than standard stock fencing. Fences which restrict kangaroo movement in the Kama Interface may increase incidents with dogs and would likely result in kangaroos being funnelled north towards William Hovell Drive. In this regard, fences within the Kama Interface will not incorporate barbed wire which also has the potential to injure wildlife and prevent ready movement between the IMZs.

Where running along the eastern boundary of the buffer the fence will be aligned to run along the top of the interface retaining wall.

Given the attractiveness of the buffer for trail bike riding, four-wheel-driving and other activities undesirable for the protection of ecological values within Kama Nature Reserve, Fence Type 1 will be constructed along the entire eastern boundary of the buffer, together with step-through gates (refer Section 6.2.11.3). Establishment of the fence in this manner will require those accessing for undesirable activities to cut fences or gates, such actions being indefensible when the offending parties are apprehended.

The existing stock fences in the Kama Interface locality will be maintained until their removal and replacement is required for the establishment of the interface.

6.2.10.2 Fence Type 2 - Interface buffer internal stock fence

As illustrated in Figure 8 and Figure 9, standard 1.2 m high stock fences (Fence Type 2) will be constructed along the Kama Nature Reserve boundary (1,260 m in length), between IMZ-2 and IMZ-3 and around the Restoration Unit 2 patches within IMZ2 (refer Section 6.3.3). These stock fences will be required to allow intermittent grazing of cattle within the buffer to manage herbage mass in a similar manner to that within Kama Nature Reserve (as per the Kama Operational Plan). Fence Type 2 will differ from Fence Type 1 in that the mesh will be standard Ringlock®, HingedJoint® or similar, and will not be partially buried.

6.2.11 Interface Gates

6.2.11.1 Gate Type 1 - Locked - Services Only – 4 m width

Four locked services only gates will be installed along the buffer boundary (i.e. in Fence Type 1) to provide access between the urban area (IMZ4) and the buffer (IMZ2/3), and into Kama Nature Reserve beyond. The recommended approximate locations of these gates are shown in Figure 8 and Figure 9. Consistent with Fence Type 1, Gate Type 1 will be constructed in a manner that deters passage of dogs and cats. Gate Type 1 will be locked with a Canberra Nature Park padlock, providing vehicular access to authorised services personnel only (i.e. Emergency Services Agency, Parks & Conservation Service, ActewAGL etc.).

6.2.11.2 Gate Type 2 - Public Access – 1.2 m width

Three public access gates will be installed along the buffer boundary (i.e. in Fence Type 1) next to the Gate Type 1 gates. These gates will provide the access points for public pedestrian traffic between the urban area (IMZ4) and the buffer (IMZ2/3). Whilst the public is encouraged to visit Kama Nature Reserve for low-impact recreational pursuits (i.e. bird watching, bushwalking etc.), given the requirements for stock passage between the buffer and Kama Nature Reserve, managing access to Kama Nature Reserve will be best achieved by limiting access to the buffer to three points. This will:

- limit 'bottleneck' disturbance associated with regular foot traffic to three locations, the recommended location with the shortest across-buffer distance being a point that will direct pedestrian traffic to enter Kama Nature Reserve along an existing management trail;
- increase public surveillance of the access points; and
- prevent the arbitrary establishment of new walking tracks.

Consistent with Fence Type 1, Gate Type 2 will be constructed in a manner that deters passage of unaccompanied dogs. It is envisaged that Gate Type 2 will be operate on a spring-closing mechanism. The three Gate Type 2 locations indicated in Figure 8 and Figure 9 have been located to be no more than 500 m apart, such that people cannot be more than 250 m from an egress point during a bushfire or other emergency.

6.2.11.3 Gate Type 3 - Stock, Services and Public Access – 4 m width

Gate Type 3 will be installed in the stock fences (i.e. in Fence Type 2) at numerous locations along the boundary between Kama Nature Reserve and IMZ2/IMZ-3, and between IMZ2 and IMZ3, with a minimum distance of 300 m between gates. Gate Type 3 will also be installed in the Fence Type 2 around the Restoration Unit 2 patches within IMZ2 (refer Section 6.3.3). Gate Type 3 is the standard stock gate with a 'step through' for pedestrian access. Gate Type 3 will be locked with a Canberra Nature Park padlock when closed.

Indicative locations for Gate Type 3 are shown in Figure 8 and Figure 9, however it is envisaged that actual gate locations will be determined during detailed design.

6.2.12 Underground 132kV Powerline Easement

As indicated in Figure 7, it is recommended that the existing 132 kV overhead powerlines be terminated at a new overhead-to-underground power pole installed within IMZ-3, immediately east of the Kama Nature Reserve boundary. At this point the powerline will be installed underground within a 10 m wide easement for approximately 755 m north to William Hovell Drive.

The establishment of a 45 to 60 m wide cleared easement along this alignment, as would be required for a new overhead powerline, would adversely impact upon the effectiveness of the

recommended interface arrangements in meeting the stated objective. Should the recommended undergrounding of the 132 kV powerline be untenable, then the overhead easement should be aligned to run north within IMZ-3 immediately adjoining the urban interface.

6.2.13 Artificial Light and Noise Control

The impacts of artificial light and noise on native fauna in and adjacent to urban areas are not currently well understood. Nevertheless, it is reasonable to assume that the foraging behaviour and potentially breeding behaviour of insectivorous or omnivorous nocturnal vertebrate fauna (i.e. owls, frogmouths, nightjars, microbats, Sugar Gliders etc.) would be influenced by both artificial light itself and the changes to invertebrate activity associated with the light sources. Although at present none of the nocturnal vertebrate species occurring in the lowland areas of the ACT are listed as threatened in the ACT, a number of the microbats listed as vulnerable in NSW occur in Canberra's urban reserves, including Kama Nature Reserve. Whilst not MNES themselves, the persistence of each component of this fauna group is important to the ecosystem function of Box-Gum Woodland.

In light of the above, the following measures will be incorporated into the Kama Interface to protect the biodiversity values of Kama Nature reserve from artificial light and noise from Molonglo 3.

1. As detailed in Section 6.2.7, a retaining wall with a minimum effective rise of one (1) metre will be constructed along the eastern boundary of the buffer. This retaining wall will provide a 'catch' for headlight shine and vehicle noise, reducing the reach of these impacts into Kama Nature Reserve.

2. All street lights along the urban edge road will include a shield which limits the light arc to 180°, directed towards the urban area and away from the buffer and Kama Nature Reserve.

3. The number of roads which run perpendicular to the buffer (and therefore direct headlight shine and exhaust noise into the buffer and Kama Nature Reserve) will be limited to the minimum number practicable.

4. The urban edge road will include traffic slowing devices and will be designed in a manner that prevents it from becoming a major thoroughfare or desirable road for 'noisy' vehicular activities.

6.2.14 Signage

A permanent sign will be installed at the three public pedestrian entry points to the Kama Interface buffer (refer Figure 9). This sign will provide information regarding:

- Kama Nature Reserve and its significant natural and cultural values;
- the activities which are permitted within Kama Nature Reserve and those that are prohibited (notably that Kama Nature Reserve is a dog exclusion area and the buffer is a dog-on-leash area);
- the entity responsible for the management of Kama Nature Reserve and the buffer;
- contact details for the party whom members of the public should contact should they observe illegal or degrading activities being conducted within Kama Nature Reserve or the buffer; and
- contact details for active community conservation ('friends of') groups which interested people can join, together with the ACT Government Access Canberra contact details for general information.

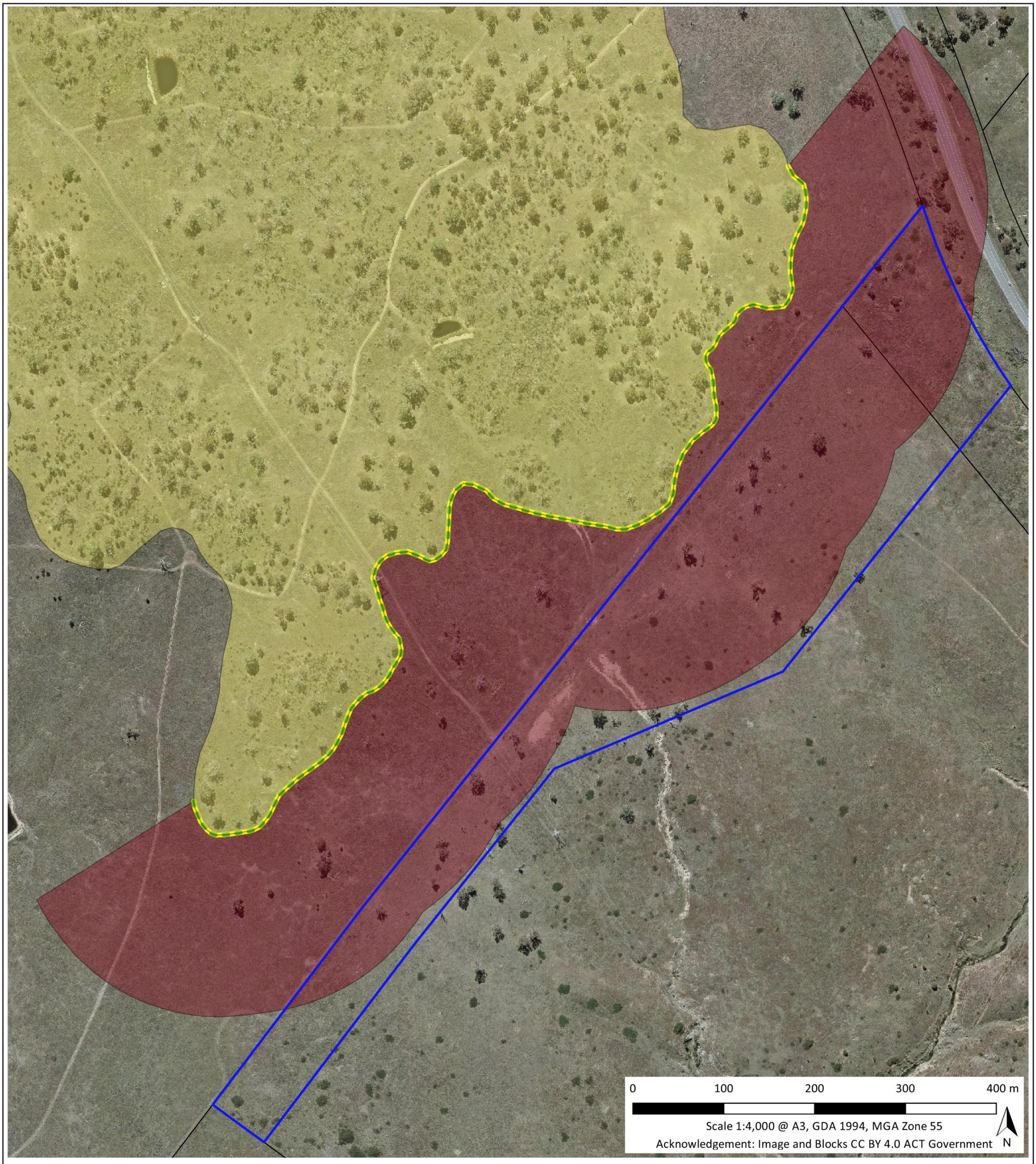

Figure 6. Kama Interface Arrangements – Buffer Width

Legend

- ACT Blocks
- Kama NR - Core Woodland Bird Habitat
- Eastern Extent of Core Woodland Bird Habitat
- 200m Buffer to Eastern Extent of Core Woodland Bird Habitat Values
- Recommended Buffer Boundary

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Date: 29 September 2016

0 100 200 300 400 m

Scale 1:3,400 @ A3, GDA 1994, MGA Zone 55

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N

Figure 7. Recommended Kama Interface Arrangements – Overview

Legend

- ACT Blocks
- Pink-tailed Worm-lizard Habitat (ACT Gov)

Tree Assessment

- Remnant Tree
- Tree Assessment - Removal Recommended

Recommended Interface Arragements

- Interface Management Zone 1 - Kama NR
- Interface Management Zone 2 - Woodland Regeneration
- Interface Management Zone 3 - IAPZ (60m - 70m width)
- Interface Management Zone 4 - Urban Development
- IMZ2 & IMZ3 - Restoration Unit 1 - Restored Woodland Canopy
- IMZ2- Restoration Unit 2 - Restored Woodland - All Strata
- Fence Type 1 - Interface Buffer Boundary Fence
- Fence Type 2 - Interface Buffer Internal Stock Fence
- Gate Type 1 (Locked - Services Only - 4m width)
- Gate Type 2 (Public Access - 1.2m width)
- Gate Type 3 (Stock, Services and Public Access - 4m width)
- Fire Trail - Tanker (4m width)
- Public Walking Trail
- Development Interface Retaining Wall
- Urban Edge Road (16m)
- Urban Edge Road - Buffer Verge
- Concrete Path (Walking & Riding)
- Current 132kV Power Line Easement (45m) - Eastern Termination
- Underground 132kV Poweline Easement (10m width)
- 132kV Overhead-to-Underground Pole

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Date: 24 December 2016

0 25 50 75 100 m

Scale 1:1,300 @ A3, GDA 1994, MGA Zone 55

N

Figure 8. Recommended Kama Interface Arrangements – Detail North

Legend

- ACT Blocks
- Pink-tailed Worm-lizard Habitat (ACT Gov)

Tree Assessment

- Remnant Tree
- Tree Assessment - Removal Recommended

Recommended Interface Arragements

- Interface Management Zone 1 - Kama NR
- Interface Management Zone 2 - Woodland Regeneration
- Interface Management Zone 3 - IAPZ (60m - 70m width)
- Interface Management Zone 4 - Urban Development
- IMZ2 & IMZ3 - Restoration Unit 1 - Restored Woodland Canopy
- IMZ2- Restoration Unit 2 - Restored Woodland - All Strata
- Fence Type 1 - Interface Buffer Boundary Fence
- Fence Type 2 - Interface Buffer Internal Stock Fence
- Gate Type 1 (Locked - Services Only - 4m width)
- Gate Type 2 (Public Access - 1.2m width)
- Gate Type 3 (Stock, Services and Public Access - 4m width)
- Fire Trail - Tanker (4m width)
- Development Interface Retaining Wall
- Urban Edge Road - Buffer Verge
- Concrete Path (Walking & Riding)
- Urban Edge Road (16m)
- Underground 132kV Poweline Easement (10m width)

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0 25 50 75 100 m

Scale 1:1,300 @ A3, GDA 1994, MGA Zone 55

N

Figure 9. Recommended Kama Interface Arrangements – Detail Centre

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Legend

ACT Blocks

Tree Assessment

Remnant Tree

Tree Assessment - Removal Recommended

Recommended Interface Arragements

Interface Management Zone 1 - Kama NR

Interface Management Zone 2 - Woodland Regeneration

Interface Management Zone 3 - IAPZ (60m - 70m width)

Interface Management Zone 4 - Urban Development

IMZ2 & IMZ3 - Restoration Unit 1 - Restored Woodland Canopy

IMZ2- Restoration Unit 2 - Restored Woodland - All Strata

Fence Type 1 - Interface Buffer Boundary Fence

Fence Type 2 - Interface Buffer Internal Stock Fence

Gate Type 2 (Public Access - 1.2m width)

Gate Type 1 (Locked - Services Only - 4m width)

Gate Type 3 (Stock, Services and Public Access - 4m width)

Fire Trail - Tanker (4m width)

Public Walking Trail

Development Interface Retaining Wall

Urban Edge Road - Buffer Verge

Concrete Path (Walking & Riding)

Urban Edge Road (16m)

Current 132kV Power Line Easement (45m) - Eastern Termination

Underground 132kV Poweline Easement (10m width)

132kV Overhead-to-Underground Pole

0 25 50 75 100 m

Scale 1:1,300 @ A3, GDA 1994, MGA Zone 55

N

Figure 10. Recommended Kama Interface Arrangements – Detail South

Legend

- ACT Blocks
- Pink-tailed Worm-lizard Habitat (ACT Gov)

Tree Assessment

- Remnant Tree

Recommended Buffer Arragements

- Interface Management Zone 1 - Kama NR
- Interface Management Zone 3 - IAPZ (60m - 70m width)
- Interface Management Zone 4 - Urban Development
- IMZ3-IAPZ - Restoration Unit 1 - Restored Woodland Canopy
- Fence Type 1 - Interface Buffer Boundary Fence
- Fence Type 2 - Interface Buffer Internal Stock Fence
- Gate Type 1 (Locked - Services Only - 4m width)
- Gate Type 2 (Public Access - 1.2m width)
- Gate Type 3 (Stock, Services and Public Access - 4m width)
- Fire Trail - Tanker (4m width)
- Public Walking Trail
- Development Interface Retaining Wall

capital ecology

Capital Ecology Project No: 2717
Drawn by: R. Speirs
Date: 24 December 2016

6.3 Interface Establishment and Initial Restoration

6.3.2 Buffer Initial Weed Control

As described in Table 2, the incursion, establishment and proliferation of noxious weeds in Box-Gum Woodland and Natural Temperate Grassland remnants is undoubtedly one of the foremost threats to the conservation of these threatened ecosystems and the habitat that they provide for many threatened flora and fauna species. Once established, noxious weeds progressively degrade natural ecosystems, often to the point that they no longer reflect the original climax community or support its constituent significant biota.

In the context of the above, one of the key purposes of the buffer is to provide the primary sentinel zone for Kama Nature Reserve. Accordingly, proactive monitoring for and uncompromising control of noxious weeds throughout the buffer is of critical importance to the protection of the MNES within Kama Nature Reserve. Several noxious weeds are currently present within the buffer and rural land to the east (R. Speirs 2016, pers. obs.), however the current infestations are of a scale such that they are likely to be effectively controlled via the implementation of a program of targeted and intensive weed control measures.

In order to direct and facilitate the necessary initial weed control within the buffer, a dedicated Initial Weed Control Plan will be developed for the buffer, including but not limited to:

- fine scale survey and mapping of the noxious weeds within the buffer, prepared not more than six months prior to commencement of development in the vicinity of the Kama Interface;
- a program of works detailing the scope, methods, timing, and cost estimate of all required works required to control the current noxious weed infestations within the buffer;
- a realistic assessment of the likelihood that each weed control measure will fully achieve its objective;
- a contingency plan detailing the scope, methods, timing, and cost estimate of all additional works required to address any weed control objectives not fully met; and
- the stipulation that all weed control works must be undertaken by suitably qualified and experienced operators.

The Initial Weed Control Plan will be subject to the review and approval of a senior ACT Government weed control officer. Funding will be allocated for the development of the Initial Weed Control Plan and the full scope of works (including potential contingency works).

6.3.3 Buffer Restoration Planting

As detailed in Section 6.2.3 and illustrated in Figure 8, Figure 9 and Figure 10, the buffer will comprise two Interface Management Zones (IMZs), each with a defined primary purpose and each subject to restrictions on vegetation, imposed to meet bushfire hazard mitigation requirements. Accordingly, the requirements for restoration planting differ substantially between the IMZs. Table 7 and Table 8 detail the restoration planting that will be undertaken in each IMZ.

Table 7. Buffer restoration planting – IMZ-2 Interface Buffer – Woodland Regeneration

IMZ-2 Interface Buffer – Woodland Regeneration	
Purpose	IMZ-2 will be established to: • create habitat with woodland characteristics which will shield the Box-Gum Woodland and core woodland bird habitat within Kama Nature Reserve from the adjacent urban development; • provide a component of the minimum setback from urban development to core woodland bird habitat, as determined during the development of this strategy; • 'soften' the urban edge, an element of urban interface design identified to reduce impacts upon sensitive woodland birds (Hodgson *et al*. 2007); and • improve connectivity for woodland birds between Kama Nature Reserve and similar habitat north of William Hovell Drive.
Total Area	8.0 ha
Restoration Units Refer Figure 7	**Restoration Unit 1 – Restored woodland canopy** Restoration Unit 1 will involve the following. • The Box-Gum Woodland canopy will be restored throughout via the planting of local native eucalypts (primarily Blakely's Red Gum and Yellow Box), grown from seed of local provenance. • All remnant eucalypts will be retained with new trees planted in a manner that, when mature, will augment the canopy cover that these provide. • Planting density will be in accordance with the canopy separation requirements stipulated in the *ACT Bushfire Management Standards* (ACT Government 2014c) for an SFAZ. • No midstorey/shrubstorey will be established. • The groundstorey will be managed in line with SFAZ requirements (i.e. generally maintained via periodic grazing).  **Plate 1. Indicative photograph of the objective for Restoration Unit 1.** Photograph of Schwarz Place park on the southwest slope of Mt Rogers, Flynn, ACT. Example of Blakely's Red Gum and Yellow Box trees planted during the establishment of Flynn circa 1975 (i.e. approx. 40 year old trees). Note: appropriate canopy separation, absent midstorey/shrubstorey and maintained (periodically mown) groundstorey. Photograph: August 2016.

IMZ-2 Interface Buffer – Woodland Regeneration	
	Restoration Unit 2 – Restored woodland – all strata Restoration Unit 2 will involve the following. • The Box-Gum Woodland canopy will be restored throughout via the planting of local native eucalypts (primarily Blakely's Red Gum and Yellow Box), grown from seed of local provenance. • All remnant eucalypts will be retained with new trees planted in a manner that, when mature, will augment the canopy cover that these provide. • Tree planting density will be that required to re-establish the natural Box-Gum Woodland canopy. • The midstorey/shrubstorey of Box-Gum Woodland will be established via the planting of midstorey/shrubstorey species chosen from the list provided in Appendix 1. • The native proportion and overall condition and habitat value of the groundstorey will be improved via the planting of hardy native grasses and forbs chosen from the listed provided in Appendix 1. • The groundstorey will be managed for ecological conservation purposes, generally consistent with that applied for the high value portions of Kama Nature Reserve (Kama Operational Plan, ACT Government 2014). • Fence Type 2 (refer Section 6.2.10.2) will be constructed around each patch to restrict cattle access. Gates in these fences will be opened if cattle grazing is desirable for conservation purposes. In accordance within the management of the area as a SFAZ (*ACT Bushfire Management Standards*, ACT Government 2014c), patches of Restoration Unit 2 will comprise a maximum total area of 2.4 ha (i.e. 30% of 8.0 ha). This area of IMZ-2 is indicated in Figure 8, comprising three patches. It is recommended that the patches are established generally in the configuration shown in Figure 8. Working within the 30% total area restriction, this configuration will: • maximise the proportion of the interface shielded by Restoration Unit 2, whilst providing gaps between patches to allow for walking tracks and emergency vehicle passage; • minimise the distance within IMZ-2 to points of midstorey/shrubstorey refuge for small woodland birds; and • include most of the remnant eucalypts, notably the three recommended for removal due to structural instability (GHD 2014).  **Plate 2. Indicative photograph of the objective for Restoration Unit 2.** Photograph of replanted Box-Gum Woodland on the southern slope of Mt Rogers, Flynn, ACT. Example of Blakely's Red Gum and Yellow Box trees planted during the establishment of revegetation of Mt Rogers circa 1975 (i.e. approx. 40 year old trees). Note: characteristic woodland canopy, planted and now naturally regenerating midstorey/shrubstorey, and groundstorey of native and exotic grass and forbs. Photograph: August 2016.

Table 8. Buffer restoration planting – IMZ-3 Interface Buffer – Inner Asset Protection Zone

IMZ-3 Interface Buffer – Inner Asset Protection Zone	
Purpose	IMZ-3 will be established to: • provide effective bushfire hazard mitigation for the adjoining urban development; • provide a component of the minimum setback from urban development to core woodland bird habitat, as determined during the development of this strategy; • create habitat with woodland characteristics (canopy only) which will shield the Box-Gum Woodland and core woodland bird habitat within Kama Nature Reserve from the adjacent urban development; and • 'soften' the urban edge, an element of urban interface design identified to reduce impacts upon sensitive woodland birds (Hodgson *et al*. 2007).
Total Area	7.8 ha
Restoration Units Refer Figure 7	**Restoration Unit 1 – Restored woodland canopy** Consistent with the areas to which it applies within IMZ-2, Restoration Unit 1 will involve the following. • The Box-Gum Woodland canopy will be restored throughout via the planting of local native eucalypts (primarily Blakely's Red Gum and Yellow Box), grown from seed of local provenance. • All remnant eucalypts will be retained with new trees planted in a manner that, when mature, will augment the canopy cover that these provide. • Planting density will be in accordance with the canopy separation requirements stipulated in the *ACT Bushfire Management Standards* (ACT Government 2014c) for an IAPZ. • No midstorey/shrubstorey will be established. • The groundstorey will be managed in line with IAPZ requirements (i.e. generally maintained via periodic grazing and/or slashing).
	Restoration Unit 3 – Managed mixed native and exotic grassland Restoration Unit 3 will involve the following. • Consistent with the natural grassland (i.e. treeless) climax community of the area, no trees or midstorey/shrubstorey vegetation will be planted. • The groundstorey will be managed in line with IAPZ requirements (i.e. generally maintained via periodic grazing and slashing only when grazing is insufficient). • The patches of rocky habitat (i.e. mapped Pink-tailed Worm-lizard habitat) will be maintained as rocky native grassland if this is compatible with IAPZ requirements. Note: Restoration Unit 3 encompasses the southern portion of IMZ-3 not included in Restoration Unit 1 (refer Figure 7 and Figure 10).

6.3.4 Native Plants for Streetscape and Urban Open Space

Numerous published local studies have demonstrated the benefits of a predominance of native plant species within the urban area to sensitive fauna groups within adjacent or nearby reserves (Ikin *et al.* 2012; Ikin *et al.* 2013b; Ikin *et al.* 2013c; Le Roux *et al.* 2014b; Manning *et al.* 2006; Rayner *et al.* 2015). Ikin *et al.* (2013b) found that the establishment and retention of native suburban streetscapes in Canberra is an important management strategy for improved bird conservation, and reported that native streetscapes increase bird richness and diversity in adjacent woodland and dry forest reserves. Native street trees were found to provide foraging resources for birds that would be reduced or absent in exotic streetscapes (Ikin *et al.* 2013b). Eucalypts planted in urban areas provide particularly diverse and valuable foraging resources for birds, via foliage, flowers, flaking bark, leaf litter, woody debris, and the tendency of some species to support Mistletoe (McElhinny *et al.* 2006).

Studies have found that the diversity of birds present in an urban area is higher where a variety of eucalypt species are planted (McElhinny *et al.* 2006; Ikin *et al.* 2013b), however this tends not to be reflected in the diversity of 'urban avoiders'. Urban avoiders, which include most of the significant woodland birds of Kama Nature Reserve, appear to be less influenced by the proportion of native street trees. Suburbs with more leaf litter and shrub cover, and with less grass and impervious surface cover provide refuge and alternative foraging and nesting resources, which tends to support urban avoiders both within an urban area and in adjacent reserves (Ikin *et al.* 2013b). Ikin *et al.* (2012) described the four high-priority actions to maintain the current bird community in the Molonglo Valley development zone as: (i) river restoration; (ii) maintenance of a shrubstorey; (iii) preservation of grassland areas within public open spaces; and (iv) promotion of vegetation heterogeneity across the urban landscape.

As described above, the retention of native vegetation (notably remnant trees) and predominance of native plant species (across all strata) in the urban area is likely to have a significant positive influence on the conservation of native fauna of Kama Nature Reserve, particularly with regard to significant woodland birds. Accordingly, the following specifications will apply to IMZ-4 Urban Development (i.e. west of Deep Creek).

1. Only native plant species will be planted on public land. Chosen from the species list provided in Appendix 1, these species will predominantly consist of species representative of Box-Gum Woodland, being the climax community of the land. Species of other local woodland or dry forest communities (e.g. Red Box *Eucalyptus polyanthemos*, Red Stringybark *E. macrorhyncha*) and non-local native species (e.g. Mugga Ironbark *E. sideroxylon*, Argle Apple *E. cinerea*) may also be planted given their particularly high value as foraging resources and suitability as street trees.

2. Patches of native shrubs will be established within urban parks and in other locations on public land. Species will be chosen from the list provided in Appendix 1, with a preference for dense, thorny native shrubs (e.g. Bushy Needlewood *Hakea decurrens*, Native Blackthorn *Busaria spinosa*) which will provide important 'cat resistant' refuge points for small birds.

3. Residents will be encouraged to plant native plants on their private land. To this effect, information will be provided to residents regarding the conservation benefits of planting native plants. Information will also be provided regarding the most suitable species to plant in specific locations. Residents will be encouraged not to plant native species with excessive nectar yields (e.g. Rosemary Grevillea *Grevillea rosmarinifolia*, nursery cultivars etc.) which bolster populations of large honeyeaters (i.e. Red Wattlebird, Noisy Miner) known to drive out smaller woodland birds (Rayner *et al.* 2015).

4. Residents will be informed that the exotic weed species in the 'prohibited species list' provided in Appendix 1 must not be planted on their land. It will be of particular importance that winter seed bearing exotic plants are not planted due to their propensity to prevent winter mortality of first year Pied Currawongs, thereby bolster populations of this species during the spring nesting season of small woodland birds.

6.3.5 Staging of Interface Establishment

A significant challenge in urban planning is to undertake proactive conservation action, and mitigate negative effects of urbanisation on native fauna communities before development begins (Ikin *et al*. 2012). Nevertheless, it is critical to the effectiveness of many of the measures proposed as part of the recommended interface arrangements that they are established and substantially developed

prior to the development and occupation of Molonglo 3. The protections that the buffer and other interface elements will provide must be in place and functioning prior to the introduction of development related threats to the locality. In this regard, the broad staging described in Table 9 is recommended for the establishment of the Kama Interface. As it is unlikely to be practicable to delay the development of Molonglo 3 to allow for the buffer restoration plantings to develop, it will be important to commence Stage 4 as soon as can be facilitated.

Table 9. Staging of interface establishment

Stage	Actions/Measures	Recommended Timing
Stage 1 **Commitment to the interface arrangement**	Consensus between all relevant agencies and commitment to a final interface arrangement.	As soon as possible.
Stage 2 **Establishment of interface boundaries**	On ground delineation and fencing of the boundaries of the interface (notably the IMZs of the buffer).	As soon as possible following Stage 1.
Stage 3 **Initial weed control**	Program of initial weed control works as detailed in Section 6.3.2.	Commences immediately following Stage 2.
Stage 4 **Restoration planting**	Buffer restoration planting as detailed in Section 6.3.3.	Commences upon confirmation from ACT Government ecologists that the outcomes of Stage 3 have been sufficiently achieved.
Recommended minimum buffer development period of five (5) years between Stage 4 and Stage 5.		
Stage 5 **Urban development**	Urban development commences beyond the buffer (within IMZ-4). IMZ4 will continue to be managed as rural grazing land until Stage 5.	Development will commence as per land release schedule.

6.4 Interface Management and Maintenance

6.4.2 Buffer Ongoing Weed Monitoring and Control

As described in Table 2, noxious weeds pose one of the foremost threats to the conservation of the significant biodiversity values of Kama Nature Reserve. The Initial Weed Control Plan described in Section 6.3.2 will be implemented to identify, define and control (eradicate if possible) the current noxious weed infestations within the buffer, however the buffer must also function as the primary sentinel zone for Kama Nature Reserve in perpetuity.

The dominant topography of the interface, together with the recommended retaining wall, urban edge road and other design elements, will reduce the risk of new weed incursions into the buffer. Notwithstanding this, many of the most effective vectors for weed introduction and spread are in fact associated (directly or indirectly) with management of the land. Indeed, without conscientious attention to weed hygiene, vehicles, stock, and pedestrian traffic are very effective vectors for many noxious weed species. In light of the above, commencing immediately following establishment of the buffer, the following measures/controls will be implemented on an ongoing basis.

1. Only authorised vehicles will be permitted to access the buffer or Kama Nature Reserve. This access will be restricted via the fences and locked gates detailed in Sections 6.2.10 and 6.2.11.

2. Only dedicated nature reserve (Parks and Conservation Service) machinery and slashing equipment will be used within the buffer or Kama Nature Reserve. The effectiveness of this restriction is evident in Canberra's nature reserves where firebreaks etc. are mown by equipment which is only used in nature reserves. Strict conformance to this is critical as a single mowing event using equipment laden with African Lovegrass and/or Chilean Needle Grass seed is likely to be sufficient to establish these species throughout the buffer.

3. A wash down facility will be built at a point along the urban edge road (i.e. on the down side of the retaining wall). Water from the wash down will flow immediately to underground stormwater or sewer. All vehicles used within the buffer or Kama Nature Reserve will be thoroughly cleaned of all mud, soil and other material which may contain weed seed or propagules.

4. Any stock grazed within the buffer will be subject to the same weed hygiene measures applied to those grazed within Kama Nature Reserve.

5. A dedicated Weed Monitoring and Management Plan will be developed for the buffer, including, but not limited to:

    - biannual monitoring and fine scale mapping of noxious weeds within the buffer, specifically including a review of all previously treated weed infestations to determine requirements for additional treatment;

    - biannual intensive treatment of all newly mapped noxious weeds and any identified as requiring retreatment;

    - a risk assessment for each weed species, updated following each monitoring or control event;

- a contingency plan for each weed species, detailing the scope, methods, and timing of all works likely to be required to address any weed control objectives not fully met; and
- the stipulation that all weed control works must be undertaken by suitably qualified and experienced operators.

The Weed Monitoring and Management Plan will be subject to review by, and approval of, a senior ACT Government weed control officer. Funding will be allocated for the development and periodic revision of the Weed Monitoring and Management Plan, together with the annual costs of implementing the full scope of weed monitoring and treatment works (including potential contingency works).

6. Information will be conveyed to the public (refer Section 6.4.5), providing:
    - descriptions of the relevant noxious weeds, including photographs and other relevant information;
    - details regarding how to prevent introduction and spread of the relevant weeds;
    - an outline of the weed monitoring and control measures implemented in the buffer; and
    - details regarding how members of the public can assist with weed control and associated conservation activities.

The success of the buffer in providing this sentinel zone function will hinge upon the full implementation of, and uncompromising compliance with, the measures described above.

6.4.3 Domestic Animal Control

The following measures will be implemented to protect the significant values of Kama Nature Reserve from domestic animals.

1. As detailed in Section 6.2.10.1, Fence Type 1 (fence with partially buried strong mesh of small aperture) will be constructed along the Kama Interface buffer boundary to reduce the incidence of domestic dogs accessing the reserve.
2. Molonglo 3 will be a designated cat containment area, the enforcement of which will be facilitated by the ACT Government.
3. Kama Nature Reserve is a designated dog exclusion area and the buffer will be a designated dog-on-leash area. These designations will be clearly conveyed to the public via signage and other community education (refer Section 6.4.6). Active enforcement of these designations will be facilitated by the ACT Government.

6.4.4 Feral Animal Control

As detailed in Table 2, the Red Fox, Feral Cat and Common Myna are the feral animal species which pose the greatest threat to the biodiversity values of Kama Nature Reserve. The recommended management of these species is detailed below.

Red Fox and Feral Cat

The construction of Fence Type 1 along the eastern boundary of the Kama Interface buffer (refer Section 6.2.10.1) is unlikely to provide a substantial impediment to foxes and feral cats moving across the Kama Interface; a fox will jump the recommended fence with ease and a cat will climb over. Foxes and feral cats can also readily enter Kama Nature Reserve from rural land to the north-west and south.

In light of the above, fox and feral cat populations in the locality will be managed most effectively by the existing and ongoing 'integrated feral animal control program' undertaken within Kama Nature Reserve by the ACT Government in accordance with the *ACT Pest Animal Management Strategy 2012 – 2022* (ACT Government 2012). This program will be extended to apply to the buffer once established.

Common Myna

The Common Myna is known to prefer urban areas with low woody vegetation cover, particularly where a high proportion of this vegetation is exotic (Gracock *et al.* 2014). The species has been observed to be far less prevalent in woodland and dry forest with a more intact canopy and midstorey (Gracock *et al.* 2014), indicating that dense planting of native species in reserves and buffers can reduce the reach and prevalence of the Common Myna in these areas. A number of over-abundant native species, such as the Noisy Miner and Red Wattlebird, have also been observed to be less prevalent in more intact woodland environs (Lindenmayer *et al.* 2010). In this regard, the recommended restoration of the buffer (refer Section 6.3.3) is likely to be a useful measure in reducing the impacts of the Common Myna within the core woodland bird habitat within Kama Nature Reserve beyond.

The Canberra Indian Myna Action Group Inc. (CIMAG) is group which undertakes control activities and provides advice to the public regarding effective Common Myna control measures and their implementation. In addition to the recommended interface design measures, working in cooperation with the CIMAG, the ACT Government will develop and implement a Common Myna control plan for Molonglo 3. It is envisaged that this control plan will involve trapping programs, education for residents, together with other actions to minimise the impacts of the Common Myna on the biodiversity values of Kama Nature Reserve.

6.4.5 Community Education and Involvement

Effective reserve management relies upon the support of local residents through the provision of public surveillance, assistance with restoration and weed control works, and support for public expenditure on conservation-related infrastructure and activities. As people tend to appreciate and value what they understand, involving and educating the community is key to gaining this support. The following measures will be implemented to educate and involve the community regarding the Kama Interface and its function in protecting the significant biodiversity values of Kama Nature Reserve.

1. Pre-purchase information. Pre-purchase information provided as part of marketing and sales for Molonglo 3 will contain information regarding Kama Reserve and the Kama Interface, notably outlining:

    - the significant biodiversity values of Kama Nature Reserve;

- the infrastructure and management measures established as part of the development of Molonglo 3;
- the laws/regulations that residents must abide by, such as access provision, cat containment, dog-on-leash requirements, prohibited weeds etc.;
- who the public should contact should they observe illegal or damaging activities being conducted within Kama Nature Reserve or the buffer;
- the active community conservation ('friends of') groups which interested people can join; and
- ACT Government Access Canberra contact details (phone number and website) for general information.

2. As detailed in Section 6.2.14, a permanent sign will be installed at the single public pedestrian entry point to Kama Nature Reserve (refer Figure 8) and each designated entry point from the urban area into the buffer. This sign will provide information to educate and involve the public regarding the Kama Interface.

3. In cooperation with the Australian National Botanic Gardens, Australian Native Plant Society and/or other similar organisations, the ACT Government will make local native plants available to residents of Molonglo 3. This may be achieved via 'weed-for-plant' swaps or similar events. Information will also be provided regarding the most suitable species to plant in specific locations.

6.4.6 Access Provision and Management

Whilst it is important restrict access to nature reserves for intensive and potentially degrading activities (i.e. bike riding, dog walking, horse riding etc.), it is equally as important to facilitate and encourage access for low-impact recreational activities such as bushwalking, jogging, birdwatching etc.

The recommended interface design has been developed with the specific objective of creating an interface which facilitates and encourages desirable public use of the buffer and Kama Nature Reserve, whilst minimising the degree of ongoing government supervision. To this affect, the recommended locations and characteristics for the fences, gates, retaining wall and walking tracks have all been developed to maximise the effectiveness of this infrastructure in encouraging desirable access and activities.

In addition to the above, as is applicable to all Canberra Nature Park reserves, persons undertaking illegal activities within the buffer or Kama Nature Reserve will be investigated and prosecuted under the provisions of relevant legislation.

6.5 Matters for Determination

The recommended interface arrangements detailed in this strategy have been developed to the concept level on the basis that the precise layout of the Kama Interface will not be determined until future detailed design of Molonglo 3. There are various engineering and design requirements that will need to be appropriately accommodated in the final Kama Interface. These are likely to necessitate fine scale alterations to the recommended interface, however provided they do not entail major changes, these alterations are unlikely to significantly reduce the effectiveness of the recommended interface. The following important interface design matters were identified during the development of this strategy and will require further determination.

1. As described in Section 6.2.12, it is recommended that the existing 132kV overhead powerlines be installed underground within the buffer north to William Hovell Drive as an overhead alternative would substantially adversely impact upon the effectiveness of the recommended interface arrangements in meeting the stated objective. In this regard, it will need to be determined whether the recommended undergrounding of the powerline is feasible.

2. It is understood that stormwater management for Molonglo 3 will require the establishment of stormwater management devices (e.g. retention ponds, drainage swales etc.) within the buffer. The position and design specifications of these should be consistent with the purpose of the buffer and its constituent IMZs.

3. The urban edge road described in Section 6.2.5, and illustrated in Figure 7, is indicative only. The actual location and design specifications for this road will need to be determined, considering relevant engineering requirements whilst ensuring that it will achieve its stated purposes.

6.6 Threat Mitigation Assessment Matrix

Even the best mitigation measures often only result in a reduction in the impact of the applicable threat, they rarely entirely remove the threat or impact. This concept is a key element in the approach to environmental impact management recommended by the Commonwealth Government (Commonwealth of Australia 2012) and ACT Government (ACT Government 2015b), being to avoid → minimise → mitigate, and where there is a significant residual impact, offset.

In applying the above concept, Table 10 provides an assessment of the degree to which each identified potential threat from urban development is likely to be mitigated by the measures included in the recommended interface arrangements. A key outcome of this assessment is the identification and definition of the residual threats associated with the recommended interface arrangements.

Table 10. Threat Mitigation Assessment Matrix

Degree of threat	Very High	High	Moderate	Low

Threat	Key Mitigation Measures	Threat to MNES Without Mitigation	Assessment of Mitigation Efficacy	Residual Threat
11. Weed invasion	Interface Design • Buffer as sentinel zone. • Interface retaining wall. Management • Initial weed control. • Ongoing weed monitoring and control. • Community education and involvement. • Prohibition on planting of weed species.		→ → Moderate → →	
			Effective protection of the biodiversity values of Kama Nature Reserve will require the full and uncompromising implementation of the recommended interface arrangements and all recommended weed management measures (as detailed herein). Adoption of this approach is likely to provide a high level of protection, substantially reducing the impact of weeds within Kama Nature Reserve.	The implementation of intensive weed monitoring and control in the Kama Interface is likely to substantially reduce the impact of weeds. Notwithstanding this, the degree of threat from weeds will remain high given the prevalence of weeds in the broader locality.
12. 'Urban-adapted' native fauna	Interface Design • Buffer that provides a minimum 200 m setback from urban development to core woodland bird habitat. • Buffer restoration planting. Management • Community education and involvement.		→ → Moderate → →	
			The development of Kama Interface as recommended is likely to provide a moderate level of protection to the 'urban avoiding' woodland birds within Kama Nature Reserve.	The proposed measures will likely reduce but not entirely mitigate the impacts of urban-adapted fauna on sensitive woodland birds within Kama Nature Reserve.
13. Proximity of urban edge on 'urban avoiding' bird species	Interface Design • Buffer that provides a minimum 200 m setback from urban development to core woodland bird habitat. • Buffer restoration planting. • Native streetscape planting. Management • Domestic animal control. • Feral animal control. • Access provision and management. • Community education and involvement.		→ → Moderate → →	
			The development of Kama Interface as recommended, together with the implementation of the recommended management measures, is likely to provide a moderate level of protection to the 'urban avoiding' woodland birds within Kama Nature Reserve.	As described herein, some of the impacts of the urban edge are felt up to five kilometres from the urban edge and, as such, the proposed measures will not entirely mitigate the impacts of the urban edge on sensitive woodland birds within Kama Nature Reserve.
14. Loss of remnant trees (east of Kama Nature Reserve)	Interface Design • Retention of 26 of the 36 remnant trees. • Buffer restoration planting. • Native streetscape planting.		→ → High → →	
			The recommended interface arrangements will retain the majority of the remnant trees east of Kama Nature Reserve within the buffer. The trees within the urban area will be retained where practicable.	The retained trees, particularly those within the urban area, will be subject to pressures associated with proximity to urban development (i.e. altered hydrology etc.). These trees are also all very old and will have limited longevity.
15. Decreased foraging range	Interface Design • Buffer that provides a minimum 200 m area within which habitat can be retained and improved. • Retention of 26 of the 36 remnant trees. • Buffer restoration planting. • Native streetscape planting. Management • Community education and involvement, notably encouragement to plant native species on private land.		→ → High → →	
			The recommended interface arrangements will retain the majority of the remnant trees east of Kama Nature Reserve within the buffer, these being the foraging habitat of value to the significant woodland birds of Kama Nature Reserve (i.e. the relevant species do not generally forage in open paddocks). In addition, the proposed buffer restoration planting and native plantings in the urban area will provide new foraging habitat.	The residual threat from reduced foraging range will be negligible.

Threat	Key Mitigation Measures	Threat to MNES Without Mitigation	Assessment of Mitigation Efficacy	Residual Threat
16. **Loss of connectivity**	Interface Design • Buffer that provides a minimum 200 m area within which habitat can be retained and improved. • Retention of 26 of the 36 remnant trees. • Buffer restoration planting. • Native streetscape planting.		→ → High → →	
			With the incorporation of the recommended interface arrangements, the development of Molonglo 3 is unlikely to substantially impact upon native fauna connectivity in the locality. In fact, the proposed restoration of the buffer may improve connectivity between Kama Nature Reserve and similar habitat to the north of William Hovell Drive.	The residual threat from impacts to connectivity is likely to be low.
17. **Noise and light spill**	Interface Design • Buffer that provides a minimum 200 m setback between urban development and core woodland bird habitat. • Buffer restoration planting. • Urban edge road design. • Shielding of street lights. Management. • Access provision and management • Community education and involvement.		→ → High → →	
			The development of Kama Interface as recommended, together with the implementation of the recommended management measures, is likely to greatly reduce the impact of artificial noise and light spill on the native fauna of Kama Nature Reserve.	The residual threat from noise and light spill is likely to be low.
18. **Exotic pest animals**	Interface Design • Buffer that provides a minimum 200 m setback between urban development and core woodland bird habitat. • Buffer restoration planting. • Fence Type 1 along eastern, northern and southern boundaries of the buffer. Management • Feral animal management, notably control of the Common Myna • Community education and involvement.		→ → Moderate → →	
			The development of Kama Interface as recommended, together with the implementation of the recommended management measures, is likely to be moderately effective in reducing the impacts of exotic pest fauna.	Incursions of exotic pest animals into Kama Nature Reserve will likely be reduced, however impacts from the Common Myna and other disruptive species can occur kilometres from the urban edge. Ongoing control of this and other pest fauna species will be required to manage impacts, however it is unlikely that impacts can be entirely mitigated.
19. **Domestic animals (pets)**	Interface Design • Buffer that provides a minimum 200 m setback between urban development and core woodland bird habitat. • Buffer restoration planting. • Fence Type 1 along eastern, northern and southern boundaries of the buffer. Management • Cat containment. • Dog exclusion enforced for Kama Nature Reserve and dog-on-leash enforced for buffer. • Community education and involvement.		→ → High → →	
			The development of Kama Interface as recommended, together with the implementation of the recommended management measures, is likely to greatly reduce the impact of domestic animals on the biodiversity values of Kama Nature Reserve.	Whilst the recommended design and management measures will likely be effective in avoiding or minimising impacts from domestic animals, the threat will be ever-present with the introduction of human occupation to the locality.
20. **Increased human use/disturbance**	Interface Design • Interface retaining wall. • Urban edge road. • Fence Type 1 along eastern, northern and southern boundaries of the buffer. • Designated public walking trails. • Limited public access points to Kama Nature Reserve (i.e. Gate Type 2). Management • Access provision and management. • Community education and involvement.		→ → High → →	
			The development of Kama Interface as recommended, together with the implementation of the recommended management measures, is likely to avoid or substantially minimise the negative impacts of increased human presence in the area.	Whilst the recommended design and management measures will likely be effective in avoiding or minimising impacts from human presence, the threat from human impacts will be ever-present with the introduction of development to the locality.

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Appendices

Appendix 1. Permitted and Prohibited Plants

Table A1. 1. Permitted Plant Species for Kama Interface

Note: The list of permitted plant species has been developed to provide suitable species for each stratum (i.e. canopy, midstorey, shrubstorey and groundstorey), based on the objective of augmenting or recreating the strata of Box-Gum Woodland.

It is noted that many of the species listed (notably groundstorey species) are not readily available from local suppliers, particularly during certain seasons. Accordingly, whilst the objective of the list is to ensure that only suitable species are planted in the Kama Interface, it is also important to maximise the species options. Therefore, whilst not exhaustive, Table A1. 1 provides an extensive list of suitable species of which a sufficient diversity should be available.

Scientific Name	Common Name
Canopy	
Brachychiton populneus	Kurrajong
Eucalyptus blakelyi	**Blakely's Red Gum**
Eucalyptus bridgesiana	Apple Box
Eucalyptus dives	Broad-leaved Peppermint
Eucalyptus goniocalyx	Bundy
Eucalyptus macrorhyncha	Red Stringybark
Eucalyptus mannifera	Brittle Gum
Eucalyptus melliodora	**Yellow Box**
Eucalyptus nortonii	Mealy Bundy
Eucalyptus polyanthemos	Red Box
Eucalyptus rossii	Scribbly Gum
Eucalyptus rubida	Candlebark
Midstorey	
Acacia decurrens	Black Wattle
Acacia falcata	Sickle Wattle
Acacia implexa	Hickory
Acacia mearnsii	Late Black Wattle
Acacia melanoxylon	Blackwood
Allocasuarina verticillata	Drooping Sheoak
Eucalyptus pauciflora	Snow Gum
Eucalyptus stellulata	Black Sallee
Exocarpos cupressiformis	Cherry Ballart
Shrubstorey	
Acacia buxiflora	Box-leaf Wattle
Acacia dealbata	Silver Wattle

Scientific Name	Common Name
Acacia falciformis	Hickory
Acacia floribunda	White Sallow Wattle
Acacia genistifolia	Early Wattle
Acacia gunnii	Ploughshare Wattle
Acacia rubida	Red-stem Wattle
Acacia siculiformis	Dagger Wattle
Acacia ulicifolia	Prickly Moses
Banksia marginata	Silver Banksia
Bursaria spinosa subsp. lasiophylla	Native Blackthorn
Cassinia aculeata	Common Cassinia
Cassinia longifolia	Cauliflower Bush
Cassinia quinquefaria	Rosemary Cassinia
Dodonaea viscosa	Hopbush
Hakea decurrens	Bushy Needlewood
Hakea microcarpa	Small-fruited Hakea
Indigofera australis	Austral Indigo
Kunzea ericoides	Burgan
Kunzea parviflora	Violet Kunzea
Leptospermum brevipes	Slender Tea-tree
Leptospermum continentale	Prickly Teatree
Leptospermum lanigerum	Woolly Tea-tree
Leptospermum multicaule	Silver Teatree
Leptospermum myrtifolium	Swamp Teatree
Leptospermum obovatum	River Tea-tree
Lomatia myricoides	Long-leaf Lomatia
Melaleuca paludicola	River Bottlebrush
Pomaderris pallida	Pale Pomaderris
Rubus parvifolius	Native Raspberry
Styphelia triflora	Pink Five-corners
Groundstorey	
Shrub	
Bossiaea buxifolia	Box-leaved Bitter-pea
Bossiaea prostrata	Creeping Bossiaea
Brachyloma daphnoides	Daphne Heath
Correa reflexa	Common Correa
Cryptandra amara	Bitter Cryptandra

Scientific Name	Common Name
Daviesia genistifolia	Broom Bitter-pea
Daviesia latifolia	Hop Bitter-pea
Daviesia leptophylla	Narrow-leaf Bitter-pea
Daviesia mimosoides	Narrow-leaf Bitter-pea
Daviesia ulicifolia	Gorse Bitter-pea
Dillwynia cinerascens	Grey Parrot-pea
Dillwynia glaucula	Michelago Parrot-pea
Dillwynia prostrata	Matted Parrot-pea
Dillwynia retorta	Heathy Parrot-pea
Dillwynia sericea	Showy Parrot-pea
Hardenbergia violacea	False Sarsparilla
Hibbertia obtusifolia	Grey Guinea-flower
Hibbertia riparia	Stream Guinea-flower
Leucopogon fletcheri	Pendant Beard Heath
Leucopogon fraseri	Beard Heath
Leucopogon virgatus	Common Beard Heath
Lissanthe strigosa	Peach Heath
Melichrus urceolatus	Urn Heath
Pultenaea procumbens	Heathy Bush-pea
Sedge, Rush	
Carex appressa	Tall Sedge
Carex inversa	Knob Sedge
Isolepis cernua	Nodding Club-rush
Isolepis hookeriana	Grassy Club-sedge
Isolepis inundata	Swamp Club-sedge
Juncus australis	Austral Rush
Juncus subsecundus	Finger Rush
Lepidosperma laterale	Sword Sedge
Lomandra bracteata	Mat-rush
Lomandra filiformis	Wattle Mat-rush
Lomandra longifolia	Spiny-headed Mat-rush
Lomandra multiflora	Many-flowered Matrush
Grass	
Aristida ramosa	Purple Wiregrass
Austrostipa bigeniculata	Tall Speargrass
Austrostipa densiflora	Dense Spear-grass

Scientific Name	Common Name
Austrostipa scabra	Corkscrew
Bothriochloa macra	Red-leg Grass
Chloris truncata	Windmill Grass
Cymbopogon refractus	Barbed Wire Grass
Dichelachne crinita	Longhair Plumegrass
Dichelachne hirtella	Slender Plumegrass
Dichelachne inaequiglumis	Plume Grass
Dichelachne micrantha	Short-hair Plumegrass
Dichelachne parva	Plume Grass
Dichelachne rara	Plume Grass
Elymus scaber	Wheat Grass
Microlaena stipoides	Weeping Grass
Panicum effusum	Hairy Panic
Poa labillardierei	Tussock Grass
Poa sieberiana	Snow Grass
Rytidosperma bipartita	Wallaby Grass
Rytidosperma caespitosa	Ringed Wallaby-grass
Rytidosperma carphoides	Short Wallaby-grass
Rytidosperma laevis	Wallaby Grass
Rytidosperma monticola	Small-flower Wallaby Grass
Rytidosperma pallidum	Red-anther Wallaby Grass
Rytidosperma racemosa	Slender Wallaby Grass
Sorghum leiocladum	Wild Sorghum
Themeda triandra	Kangaroo Grass
Forb, Lily, Orchid	
Acaena novae-zelandiae	Bidgee-widgee
Acaena ovina	Sheep's Burr
Ajuga australis	Austral Bugle
Alternanthera nana	Hairy Joyweed
Arthropodium milleflorum	Vanilla-lily
Arthropodium minus	Small Vanilla Lily
Asperula conferta	Common Woodruff
Asperula scoparia	Prickly Woodruff
Brachyscome aculeata	Hill Daisy
Brachyscome decipiens	Field Daisy
Brachyscome diversifolia	Large-headed Daisy

Scientific Name	Common Name
Brachyscome graminea	Grass Dairy
Brachyscome heterodonta	Lobe-seed Daisy
Brachyscome multifida	Cut-leaved Daisy
Brachyscome rigidula	Leafy Daisy
Brachyscome scapigera	Tufted Daisy
Brachyscome spathulata	Spoon Daisy
Brunoniella australis	Blue Trumpet
Bulbine bulbosa	Bulbine Lily
Bulbine glauca	Rock Lily
Burchardia umbellata	Milkmaids
Caesia calliantha	Blue Grass-Lily
Calocephalus citreus	Lemon Beauty-heads
Calotis cuneifolia	Purple Burr-daisy
Calotis glandulosa	Mauve Burr-daisy
Calotis lappulacea	Yellow Burr-daisy
Calotis scabiosifolia	Rough Burr-daisy
Chamaesyce drummondii	Caustic-weed
Cheilanthes austrotenuifolia	Rock Fern
Chrysocephalum apiculatum	Common Everlasting
Chrysocephalum semipapposum	Clustered Everlasting
Clematis microphylla	Small-leaved Clematis
Convolvulus erubescens	Australian Bindweed
Cotula australis	Common Cotula
Craspedia variabilis	Billy Buttons
Cullen microcephalum	Dusky Scurfpea
Cymbonotus lawsonianus	Austral Bears-ear
Cynoglossum australe	Australian Hound's-tongue
Cynoglossum suaveolens	Sweet Hound's-tongue
Daucus glochidiatus	Native Carrot
Derwentia perfoliata	Digger's Speedwell
Desmodium brachypodum	Large Tick-trefoil
Desmodium varians	Slender Tick-trefoil
Dianella longifolia	Smooth Flax Lily
Dianella revoluta	Black-anther Flax-lily
Dichondra repens	Kidney Weed
Dichopogon fimbriatus	Nodding Chocolate Lily

Scientific Name	Common Name
Dichopogon strictus	Chocolate Lily
Dipodium punctatum	Hyacinth Orchid
Diuris aequalis	Buttercup Doubletail
Diuris behrii	Golden Cowslips
Diuris chryseopsis	Common Golden Moths
Diuris dendrobioides	Long-tail Purple Diuris
Diuris maculata	Leopard Orchid
Diuris ochroma	Pale Golden Moths
Diuris pedunculata	Small Snake Orchid
Diuris punctata	Purple Donkey-orchid
Diuris semilunulata	Donkey-ears
Diuris sulphurea	Tiger Orchid
Drosera peltata	Pale Sundew
Drosera pygmaea	Pigmy Sundew
Eriochilus cucullatus	Parson's Bands
Erodium crinitum	Native Crowfoot
Eryngium ovinum	Blue Devil
Galium gaudichaudii	Rough Bedstraw
Geranium antrorsum	Antrorse Geranium
Geranium retrorsum	Common Cranes-bill
Geranium solanderi	Native Geranium
Glossodia major	Wax-lip Orchid
Glycine clandestina	Twining Glycine
Glycine tabacina	Glycine Pea
Gonocarpus tetragynus	Raspwort
Goodenia hederacea	Ivy Goodenia
Goodenia pinnatifida	Scrambled Eggs
Helichrysum scorpioides	Button Everlasting
Hovea linearis	Creeping Hovea
Hydrocotyle laxiflora	Stinking Pennywort
Hypericum gramineum	Small St John's Wort
Isotoma axillaris	Rock Isotome
Leptorhynchos squamatus	Scaly Buttons
Leucochrysum albicans var. tricolor	Hoary Sunray
Lotus australis	Austral Trefoil
Luzula densiflora	Woodrush

Scientific Name	Common Name
Luzula meridionalis	Common Woodrush
Lythrum salicaria	Purple Loosestrife
Microseris lanceolata	Yam Daisy
Microtis parviflora	Slender Onion-orchid
Microtis unifolia	Common Onion Orchid
Opercularia diphylla	Stinkweed
Ophioglossum lusitanicum	Adder's Tongue
Oreomyrrhis eriopoda	Australian Carraway
Oxalis perennans	Perrenial Oxalis
Pelargonium australe	Native Storks-bill
Pimelea curviflora	Curved Rice-flower
Plantago varia	Variable Plantain
Podolepis hieracioides	Tall Copper-wire Daisy
Podolepis jaceoides	Showy Copper-wire Daisy
Polygala japonica	Dwarf Milkwort
Ranunculus lappaceus	Common Buttercup
Rumex brownii	Swamp Dock
Rutidosis leiolepis	Monaro Golden Daisy
Rutidosis leptorhynchoides	Button Wrinklewort
Schoenus apogon	Common Bog Sedge
Solenogyne dominii	Smooth Solenogyne
Solenogyne gunnii	Hairy Solenogyne
Stackhousia monogyna	Creamy Candles
Stellaria angustifolia	Swamp Starwort
Stellaria filiformis	Thread Starwort
Stellaria pungens	Prickly Starwort
Stylidium despectum	Dwarf Triggerplant
Stylidium graminifolium	Grass Triggerplant
Stypandra glauca	Nodding Blue Lily
Swainsona behriana	Behr's Swainson-pea
Swainsona monticola	Moutain Swainson-pea
Swainsona recta	Small Purple-pea
Swainsona sericea	Silky Swainson-pea
Thelymitra ixioides	Spotted Sun-orchid
Thelymitra malvina	Mauve-tuft Sun-orchid
Thelymitra pauciflora	Slender Sun-orchid

Scientific Name	Common Name
Thesium australe	Austral toadflax
Thysanotus patersonii	Twining Fringe-lily
Thysanotus tuberosus	Common Fringe-lily
Tricoryne elatior	Yellow Rush-lily
Triptilodiscus pygmaeus	Common Sunray
Velleia paradoxa	Spur Velleia
Viola betonicifolia	Arrowhead Violet
Viola hederacea	Native Violet
Vittadinia cuneata	Fuzzweed
Vittadinia gracilis	Woolly New Holland Daisy
Vittadinia muelleri	Narrow-leaved New Holland Daisy
Wahlenbergia communis	Tufted Bluebell
Wahlenbergia gracilis	Australian Bluebell
Wahlenbergia stricta	Tall Bluebell
Wurmbea dioica	Early Nancy
Xerochrysum viscosum	Sticky Everlasting Daisy

Table A1.2. Prohibited Plant Species

Note: Whilst non-exhaustive, the list of prohibited plant species includes all species listed as pest plants in the ACT in the ACT *Pest Plants and Animals (Pest Plants) Declaration 2015 (No1)*, together with other weed species which occur in the surrounding region of NSW or have the potential to become significant pests if introduced to the Molonglo locality. Those which are also Weeds of National Significance are indicated in the table.

Scientific Name	Common Name	Weed of National Significance WoNS	ACT Declaration			
			Notifiable 1	Must be suppressed 2	Must be contained 3	Prohibited 4
Acacia karroo	Karoo Thorn					
Acacia paradoxa	Kangaroo Thorn					
Acacia baileyana	Cootamundra Wattle					X
Acer negundo	Box Elder					X
Achillea millefolium	Yarrow					
Achnatherum caudatum	Broad-kernel Espartillo		X			X
Ailanthus altissima	Tree of Heaven					X
Alnus gluttnosa	Black Adder					X
Alternanthera philoxeroides	Alligator Weed	X	X			X
Andropogon gayanus	Gamba Grass	X	X	X		X
Annona glabra	Pond Apple	X				X
Anredera cordifolia	Madeira Vine	X	X	X		X
Asparagus aethiopicus	Ground Asparagus Fern	X		X		X
Asparagus africanus	Climbing Asparagus Fern	X		X		X
Asparagus asparagoides	Bridal Creeper	X				X
Asparagus asparagoides Western Cape Form	Bridal Creeper – Western Cape Form	X		X		X

Scientific Name	Common Name	Weed of National Significance WoNS	ACT Declaration			
			Notifiable 1	Must be suppressed 2	Must be contained 3	Prohibited 4
Asparagus declinatus	Bridal Veil	X		X		X
Asparagus plumosa	Climbing Asparagus Fern	X		X		X
Asparagus scandens	Asparagus Fern	X		X		X
Austrocylindropuntia (all species)	Coral Cacti	X	X	X		X
Billardiera heterophylla	WA Bluebell Creeper					
Cabomba caroliniana	Cabomba		X			X
Cannabis sativa	Indian Hemp					
Carduus nutans	Nodding Thistle			X		
Carduus pycnocephalus	Slender Thistle				X	
Carduus tenuiflorus	Slender Thistle				X	
Carthamus lanatus	Saffron Thistle				X	
Cassinia arctuata	Sifton Brush					
Celtis australis	Nettle Tree					X
Cenchrus longispinus	Spiny Burr Grass					
Centaurea maculosa	Spotted Knapweed		X			X
Centaurea calcitrapa	Star Thistle					
Cestrum pargui	Green Cestrum					
Chromolaena ordorata	Siam Weed					
Chrysanthemoides monilifera	Bitou Bush / Boneseed					X
Cirsium vulgare	Spear Thistle					

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Conium maculatum	Hemlock					
Cortaderia jubata	Pampus Grass					X
Cortaderia selloana	Pampus Grass					X
Cotoneaster franchetti	Cotoneaster					X
Cotoneaster glaucophyllus	Cotoneaster					X
Cotoneaster pannosus	Cotoneaster					X
Cotoneaster salicifolius	Willow-leaf Cotoneaster					X
Cotoneaster simonsii	Cotoneaster					X
Crataegus monogyna	Hawthorn				X	X
Cryptostegia grandiflora	Rubber Vine					X
Cuscuta campestris	Golden Dodder					
Cylindropuntia (all species)	Pear Cacti	X	X	X		X
Cyperus eragrostis	Umbrella Sedge					
Cytisus (all species)	Broom species			X		X
Cytisus scoparius	Scotch Broom	X		X		X
Echium plantagineum	Paterson's Curse				X	
Echium vulgare	Vipers Bugloss				X	
Eichornia crassipes	Water Hyacinth	X				X
Equisetum species	Horsetails		X			X
Eragrostis curvula	African Lovegrass				X	

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Erythroxylum coca	Coca Leaf					
Foeniculum vulgare	Fennel					
Genista (all species)	Broom species	X (*G. linifolia* and *G. monspessulana* only)		X		X
Genista monspessulana	Montpellier Heliotrope	X		X		X
Gymnocoronis spilanthoides	Senegal Tea Plant		X			X
Hedera helix	English Ivy					X
Heliotropium europaeum	Common Heliotrope					
Hieracium aurantiacum	Orange Hawkweed		X	X		X
Hieracium pilosella	Mouse-ear Hawkweed		X	X		X
Hymenachne amplexicaulis	Hymenachne	X				X
Hypericum perforatum	St John's Wort				X	
Jatropha gossypiifolia	Bellyache Bush	X	X	X		X
Kochia scoparia	Kochia		X			X
Lagarosiphon major	Lagarosiphon		X			X
Lantana camara	Lantana					X
Ligustrum lucidum	Privet					X
Ligustrum sinense	Small-leaved Privet					X
Lonicera japonica	Japanese Honeysuckle					X
Lycium ferocissimum	Africa Boxthorn	X		X		X
Macfadyena unguis-cati	Cat's Claw Creeper	X		X		X

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Marrubium vulgare	Horehound					
Mimosa pigra	Mimosa	X				X
Miscanthus sinensis (all varieties)	Chinese Fairy Grass		X	X		X
Myriophyllum aquaticum	Parrot's Feather		X			X
Nasella tenuissima	Mexican Feather Grass		X			X
Nassella charruana	Lobed Needlegrass		X			X
Nassella neesiana	Chilean Needlegrass	X			X	X
Nassella trichotoma	Serrated Tussock	X			X	X
Onopordum acanthium	Scotch Thistle				X	
Onopordum illyricum	Illyrian Thistle				X	
Opuntia (all species)	Prickly Pears	X		X		X
Orobanche minor	Lesser Broomrape					
Papaver somniferum	Opium Poppy					
Parkinsonia aculeata	Parkinsonia	X				X
Parthenium hysterophorus	Parthenium Weed	X	X			X
Pennisetum setaceum	African Fountain Grass		X			X
Phyllostachys aurea	Yellow Bamboo					X
Pinus radiata	Radiata Pine				X	
Pistia stratiotes	Water Lettuce		X			X
Populus alba	White Poplar					X

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Populus nigra "Italica"	Lombardy Poplar					X
Prosopis spp.	Mesquite	X				X
Prunus cerasifera	Cherry Plum					
Prunus serotina	Black Cherry					
Pyracantha angustifolia	Firethorn					X
Pyracantha coccinea	Scarlet Firethorn					X
Pyracantha fortuneana	Firethorn					X
Robinia pseudoacacia	False Acacia					X
Rosa rubiginosa	Briar Rose			X		X
Rubus fruticosus	Blackberry (certain cultivars may be acceptable)	X			X	X
Salix ALL species of willow, except for the permitted species: Salix babylonica, Salix x calodendron, and Salix x reichardtii	All Willows except for Weeping Willow, Pussy Willow, and Sterile Pussy Willow	X		X		X
Salix alba var. vitellina	Golden Upright Willow	X		X		X
Salix caprea	Goat Willow	X		X		X
Salix cinerea	Grey Sallow	X		X		X
Salix fragilis	Crack Willow	X		X		X
Salix glaucophylloides	Willow	X		X		X
Salix matsudana "Pendula"	Matsudana Willow	X		X		X
Salix matsudana "Tortuosa"	Tortured Willows	X		X		X

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Salix matsudana XS alba (all clones)	Matsudana Hybrid Willows	X		X		X
Salix nigra	Black Willow	X		X		X
Salix purpurea	Purple Osier	X		X		X
Salix viminalis	Common Osier	X		X		X
Salix X rubens (S. alba XS S.fragilis)	Golden Crack Willow	X		X		X
Salvinia molesta	Salvinia	X	X			X
Senecio madagascariensis	Fireweed	X	X	X		X
Solanum elaeagnifolium	Silverleaf Nightshade	X	X	X		X
Solanum linnaeanum	Apple of Sodom					
Sorbus domestica	Service Tree					X
Spartium junceum	Spanish Broom					X
Tamarix aphylla	Athel Pine	X				X
Toxicodendron succedaneum	Rhus Tree		X			X
Tradescantia fluminensis	Wandering Jew					
Ulex europaeus	Gorse	X		X		X
Vachellia nilotica	Prickly Acacia	X				X
Verbascum thapsus	Great Mullein					
Vinca major	Periwinkle					X
Xanthium occidentale	Noogoora burr			X		
Xanthium spinosum	Bathurst Burr			X		