MKD Architects

Wildlife Hazard Review

River Gardens Cemetery Wildlife Hazard Review

April 2021

Revision 2

AVISURE
safety | aviation | wildlife

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Abbreviations

AC	Advisory Circular
AGL	Above Ground Level
AIP	Aeronautical Information Package
ATSB	Australian Transport Safety Bureau
CASA	Civil Aviation Safety Authority
FAA	Federal Aviation Administration
IBSC	International Bird Strike Committee
ICAO	International Civil Aviation Organization
MOS	Manual of Standards
NASF	National Airports Safeguarding Framework
NOTAM	Notice to Airman
WSA	Western Sydney Airport
WSAP	Western Sydney Aerotropolis Plan
WSPP	Western Sydney Planning Partnership

1. Introduction

1.1. The Wildlife Strike Issue

The consequence of wildlife strikes with aircraft can be very serious. Wildlife strikes have caused 532 human fatalities and 614 aircraft losses since the beginning of aviation (Shaw et al, 2019). Wildlife strikes cost the commercial civil aviation industry an estimated US$1.2 billion per annum (Allan, 2002) and involve more than just the repair of damaged engines and airframes. Even apparently minor strikes which result in no obvious damage can reduce engine performance, cause concern among aircrew and add to airline operating costs.

The main factors determining the consequences of a strike are the number and size of animals struck, the combined closing speed at which the strike occurred, the phase of flight when struck and the part of the aircraft hit. Generally, the larger the animal, the greater the damage. Large animals have the ability to destroy engines and windshields and cause significant damage to airframe components and leading edges. Strikes involving more than one animal (i.e., a multiple strike) can be serious, even with relatively small wildlife, potentially disabling engines and/or resulting in major accidents. While total mass struck and impact site on the aircraft are important strike consequence considerations, final impact speed is the most significant determinant as impact force varies exponentially with the square of closing speed.

Strike risk depends on the probability of colliding with wildlife and the consequence to the aircraft if collision occurs. The probability of a wildlife strike occurring increases as the number of wildlife and aircraft operating in the same airspace increases. Strike probability also increases with airspeed. In practice, this means that the likelihood of colliding with a bird inflight increases when operating at high speed below 5000’ above ground level (AGL), which is where the majority of birds operate. Wildlife density, and therefore strike probability, increases with decreasing height above the ground. Aircraft operating at low altitudes over, or near, wildlife attracting areas will significantly increase strike probability.

In civil aviation around 93% of strikes occur at below 3500’ AGL (Dolbeer 2011), with 96% of flying-fox strikes recorded at or below 1000’ AGL (Parsons et al 2008). Consequently, management focusses largely on terminal airspace and management responsibility has typically resided with aerodrome operators. However, aircrew and air traffic controllers should be engaged in strike risk and mitigation processes, and high-risk operations consider predicted or observed wildlife movement patterns. It is also critical that external stakeholders, including wildlife authorities, local planning authorities and land users, are engaged to monitor

and mitigate wildlife hazards, and that both on- and off-aerodrome hazards are critically assessed. Consequently, it is important that surrounding land managers are aware of wildlife strike issues and that all stakeholders become involved in the process of reducing the hazard. Effective management of wildlife-attracting land uses adjacent to airports is imperative to safe aircraft operations.

1.2. Project Background

MKD Architects are designing a cemetery (River Gardens Cemetery), hereafter referred to as the cemetery, proposed for 1290 Greendale Park Road Wallacia (Lot 1 DP 776645) which is located approximately 4 km from the new Western Sydney Airport (WSA). The 73.46 ha site will include a cemetery and crematoria services, community facilities, various buildings and infrastructure, extensive landscaping and gardens, as well as water features and stormwater infrastructure. WSA have reviewed the proposal and have expressed concerns that wildlife attracted to this facility in the vicinity of the airport may compromise aviation safeguarding principles and contribute to the wildlife strike risk once the airport is operational. WSA have requested MKD Architects address these concerns, in response, MKD Architects sought advice from Avisure, wildlife hazard experts experienced in wildlife hazard management on and around airports.

1.3. Project Scope

MKD Architects engaged Avisure to review the proposed design, including landscaping and water features, comment on the potential wildlife attraction and how this may contribute to the wildlife strike risk at WSA. We cross referenced the proposed development with the National Airports Safeguarding Framework, the State Environmental Planning Policy (Western Sydney Aerotropolis) 2020, the draft planning framework developed by the Western Sydney Planning Partnership and drew on a range of industry guidance and standards relating to land use in the vicinity of airports. Avisure reviewed all available designs and documentation and delivered the Wildlife Hazard Review Report (this report) that summarises any potential wildlife hazards and presents mitigation options for consideration.

1.3.1. Limitations and assumptions

1. The airport and the surrounding Aerotropolis precincts are not constructed. Assumptions are made about wildlife species based on previous survey work on the WSA site and in its vicinity. The changing landscape during and after development will

influence wildlife populations, however the existing information of which species are currently using the site and surrounds are a reasonable guide.

2. The cemetery is not constructed. Assumptions are made based on our understanding of the proposed facilities (which are a reference design and may change as detailed design progresses) and the nature of the site's attraction to wildlife.

3. The desktop analysis was done without a site visit or field surveys.

Despite these limitations, Avisure could reasonably evaluate the potential wildlife attraction to the cemetery and provide recommendations to mitigate any identified risk in order to help safeguard WSA once operational.

2. Method

Avisure reviewed the following literature.

Proposed site technical reports and designs:

- Travers Bushfire and Ecology, Watercourse Constraints Assessment Report (November 2020).
- SJB Planning, River Gardens Cemetery Plan of Management (Concept DA) (December 2020).
- Development Application form to Liverpool City Council (4/12/2020).
- MKD Architects, River Gardens Cemetery (Wallacia) Landscape Masterplan (November 2020).
- Travers Bushfire and Ecology, Biodiversity Assessment Report (November 2020).
- Saukutsu, 1290 Greendale Road Water Sensitive Urban Design: Stormwater Assessment (November 2020).
- Saukutsu, 1290 Greendale Road Waste Management Plan (December 2020).
- Saukutsu, 1290 Greendale Road Water and Wastewater Assessment Report (October 2020).
- Travers Bushfire and Ecology, Vegetation Management Plan (November 2020).
- MKD Architects, River Gardens Cemetery (Wallacia) Pre-DA Concept Masterplan - Architecturals (May 2020).
- GHD, Greendale Road Assessment Biodiversity Implications and Riparian Analysis (letter to Saukutsu 8th April 2020).
- SJB Planning, 1290 Greendale Road Statement of Environmental Effects for Development Application (December 2020).

Western Sydney Aerotropolis planning documents (and the associated legislative framework):

- State Environmental Planning Policy (Western Sydney Aerotropolis) 2020.
- Western Sydney Planning Partnership (WSPP) Draft Aerotropolis Precinct Plan – Draft for Public Comment (November 2020).

- WSPP Western Sydney Aerotropolis Development Control Plan – Phase 1 (September 2020).
- WSPP Western Sydney Aerotropolis Plan 1 (September 2020).
- NSW Environmental Planning and Assessment Act 1979.
- NSW Damage by Aircraft Act 1952.
- NSW Workplace Health and Safety Act 2011.

Aviation industry requirements, standards and guidance reports:

- Civil Aviation Safety Authority (CASA) Advisory Circular 139-26(0) Wildlife Hazard Management at Aerodromes.
- CASA Part 139 (Aerodromes) Manual of Standards (MOS) 2019.
- National Airports Safeguarding Framework (NASF) Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports.
- International Birdstrike Committee (IBSC) Recommended Practices No. 1 Standards for Aerodrome Bird/Wildlife Control.
- International Civil Aviation Organization (ICAO) Doc 9137 Airport Services Manual. Part 3: Wildlife Control and Reduction.
- ICAO Doc 9184 Airport Planning Manual. Part 2: Land Use and Environmental Control.
- ICAO Annex 14 to the Convention on International Civil Aviation: Aerodromes, Volume 1 Aerodrome Design and Operation.

Following on from the desktop review of the documentation, Avisure:

- Consolidated all information.
- Evaluated the potential wildlife hazard based on the design.
- Identified recommendations to mitigate potential risks.
- Compiled the Wildlife Hazard Review Report (this report).

3. Regulations, Standards and Guidance

There are a number of national and international requirements and guidance documents that indicate land use in the vicinity of an airport can contribute significantly to the wildlife hazard levels and safety of aircraft operations. Appendix A provides the detail.

4. Wildlife Hazard Review

The land use type (cemetery) is not in the NASF. The land use type is not a prohibited land use and is not listed as a relevant development under the SEPP (Western Sydney Aerotropolis) 2020.

Despite the exclusion of cemeteries from the NASF and SEPP, water bodies and other landscape features, including plantings may attract wildlife and should be carefully considered when located within 8km of an airport.

Figure 1 shows the location of the cemetery to the Western Sydney Airport (shaded blue). The 3km and 8km wildlife buffers are determined by the NASF.

The facility is located close to the departure path for aircraft departing on Runway 23 (or arriving on Runway 05 when runways are temporarily changed). At a distance of ~4 km from the runway threshold, aircraft on departure will be at approximately 3000-3500 ft AGL[1] and 500-750 ft on arrival[2]. Birds and flying-foxes using the site may contribute directly and indirectly to WSA's strike risk profile. Raptors or other birds that aerially hunt or thermal may conflict directly with aircraft. Of greater concern is if the site provides access to food and water which then contributes to sustaining or growing local populations of wildlife who use various locations in the region, including the airfield. Elevated populations of birds and flying-foxes interchangeably using different land uses close to airports can elevate strike risks. We have identified flying-foxes as a potential significant risk and our landscaping recommendations take a conservative approach in order to minimise the number of flying-fox attractants. This is because:

- There are seven known active flying-fox colonies in the Western Sydney area.
- Although six of these colonies lie outside of the 13 km wildlife buffer, they can travel 100 kilometres in a single night with a foraging radius of up to 50 kilometres from their

[1] Aircraft height during arrival and departure procedures is determined by a range of variables such aircraft size, aircraft speed, obstacles (temporary or permanent), other aircraft, weather etc. Therefore, the heights indicated here are a guide only.

[2] On occasion, airports need to temporarily change their runways (i.e., the direction aircraft land and take off), usually in response to wind speed and direction.

camp (McConkey et al. 2012) and have been recorded travelling over 500 kilometres in two days between camps (Roberts et al. 2012).

- Flying-foxes present a significant wildlife strike risk for WSA due to their strike history at Australian airports.
- In general, airports that have significant flying-fox populations close to the airport, or that have large areas of suitable foraging habitat, experience an additional strike peak during dusk and post-dusk periods as flying-foxes depart their roosts and begin their nightly foraging.

Figure 2 shows the proposed cemetery layout, provided by MKD Architects.

Where potential wildlife attractants cannot be designed out, the cemetery operator can apply retrospective mitigation, where site monitoring identifies a hazard. Section 6 lists some common options.

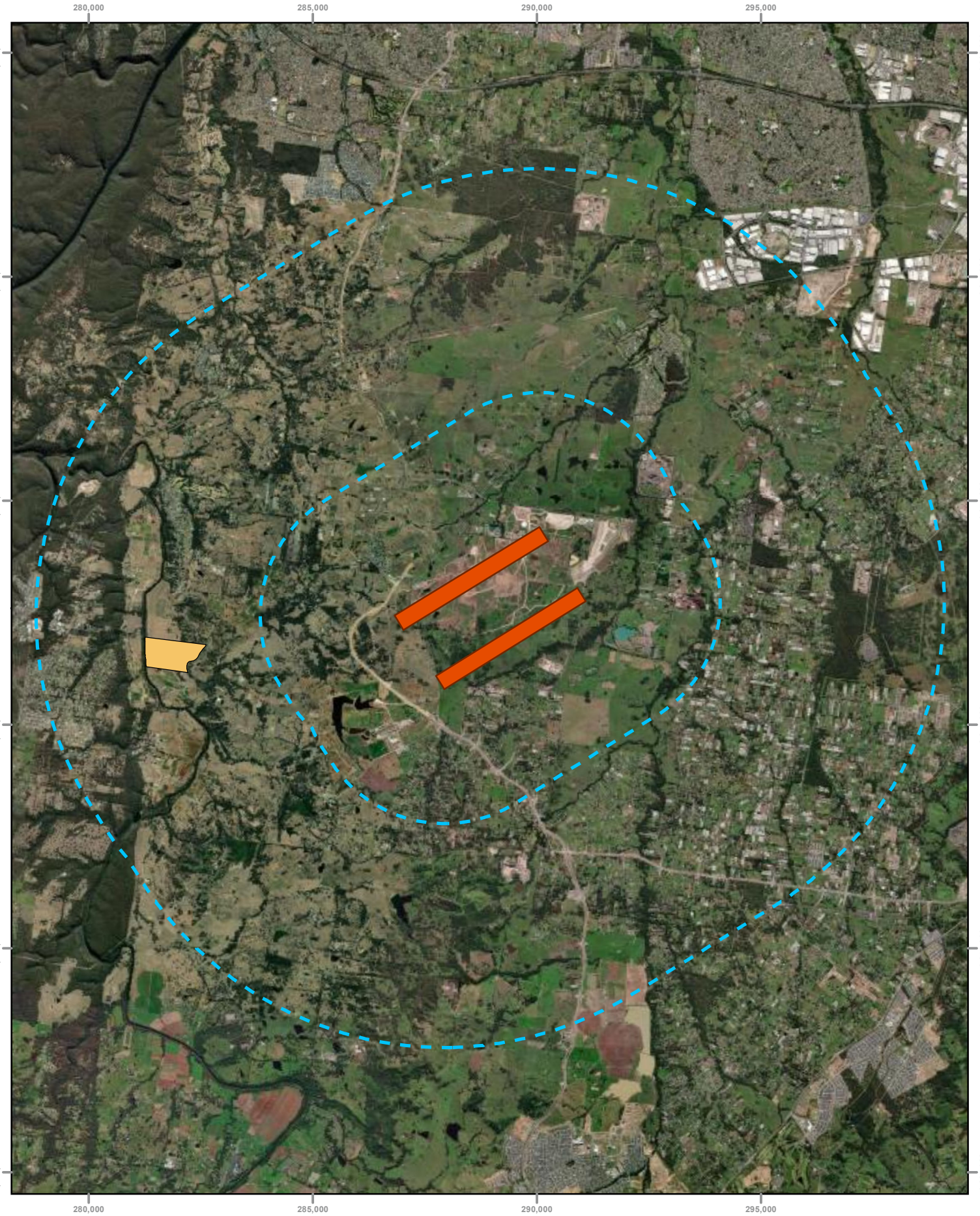

Figure 1 Location of the proposed River Gardens Cemetery relative to Western Sydney Airport

MKD Architects

River Gardens Cemetery Wildlife Hazard Review

River Gardens Cemetery site

Runway

3 & 8 km buffers from Western Sydney Airport runways

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Job number: PR6356
Revision: 0
Author: AS
Date: 31/03/2021

0 1 2 4
Kilometers

GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Meter

PR6356_MPX_RiverGardensCemteryLocation
A4

LANDSCAPE MASTERPLAN

SITE IMAGE
Landscape Architects

mkdarchitects

River Garden Cemetery, Wallacia
Landscape Concept

Client	Saukuss Pty Ltd ATF Wallacia Trust	Issue	A
Site Image Job Number	SI20-4420	Date	25.11.2020
Location	1290 Greendale Park Road Wallacia		

Figure 2. River Gardens Cemetery landscape masterplan (source: MKD Architects).

4.1. Vegetation

We assessed the plant species nominated for use as per the Vegetation Management Plan (Restoration Species Lists on page 4) for their attractiveness to birds and flying-fox. Those known to attract birds and flying fox should be minimised (Table 1).

Of particular concern are those plant species that attract flying-foxes, which are the most frequently struck species group in Australia and regularly cause damage to aircraft. Aircraft often collide with flying-fox as they move through the airspace between off-airport camps and foraging sites. This means that there is very little the airport and its stakeholders can do to directly mitigate this risk apart from understanding the risk and implementing operational modifications to avoid flying-fox movements. Careful selection of plant species in the vicinity of WSA will help reduce this risk. We note that a number of species listed in Table 1 already exist on the site. Whilst future monitoring of the site will help understand how wildlife are using these plants, our recommendations around vegetation mostly focus on the addition of new plantings.

The WSPP have drafted a proposed plant species list and landscaping guidelines for the Western Sydney Aerotropolis. However, Avisure do not have any information as to status of this or its future availability.

Table 1. Plant species that should be minimised[3] at the cemetery development due to their attractiveness to birds and flying-fox. Other species listed in the Vegetation Management Plan are considered acceptable.

VMP Ref.	Species	Comment
PCT850	*Eucalyptus moluccana* Grey Box	Flowers are known to attract flying-foxes and nectivorous birds. Mature trees can provide extensive structural support (particularly when planted in groups) for colonial roosting/breeding species such as lorikeets and corellas.
	Eucalyptus tereticornis Forest Red Gum	
	Rubus parvifolius Native Raspberry	Fruits are known to attract a variety of frugivorous birds.

[3] There are biodiversity value controls that require the use of particular species. Long term monitoring (documented in a Wildlife Management Plan) can help detect any emerging wildlife risks.

VMP Ref.	Species	Comment
PCT835	*Casuarina cunninghamiana* River Oak	Mature trees can provide extensive structural support (particularly when planted in groups) for colonial roosting/breeding species such as lorikeets and corellas.
	Angophora subvelutina Broad-leaved Apple	Flowers are known to attract flying-foxes and nectivorous birds. Mature trees can provide extensive structural support (particularly when planted in groups) for colonial roosting/breeding species such as lorikeets and corellas.
	Eucalyptus amplifolia Cabbage Gum	
	Eucalyptus baueriana Blue Box	
	Eucalyptus tereticornis Forest Red Gum	
	Callistemon salignus Willow Bottlebrsuh	
	Melaleuca styphelioides Prickly Paperbark	
	Melaleuca linarifolia Narrow-leaved Paperbark	
PCT849	*Eucalyptus moluccana* Grey Box	Flowers are known to attract flying-foxes and nectivorous birds. Mature trees can provide extensive structural support (particularly when planted in groups) for colonial roosting/breeding species such as lorikeets and corellas.
	Eucalyptus tereticornis Forest Red Gum	
	Eucalyptus crebra Narrow-leaved Ironbark	
	Eucalyptus fibrosa Broad-leaved Ironbark	

Grass, when maintained at short lengths provide wildlife with the opportunity to forage, loaf, and establish breeding territories. Some of Australia's highest strike risk wildlife show a preference for short grass, including Masked Lapwing, Little Corella, Galah, Australian Magpie, Australian White and Straw-necked Ibis, and Feral Pigeon. As a food source, some grasses are more attractive than others, particularly when seeding. Conversely, grasslands

that are maintained at heights beyond 400 mm, can attract a suite of other hazards by providing refuge for rodents, small mammals and reptiles, which can attract raptors such as Nankeen Kestrels, Black Kites and Wedge-tailed Eagles. Maintaining grass at taller heights in a cemetery is impractical and normal mowing practices are considered reasonable.

4.2. Water

Figure 2 shows a significant water feature proposed as part of the primary mausoleum design as well as smaller ponds near the function and café area. In discussion with MKD Architects, the ponds are likely to be shallow (around 150mm deep) and have vertical walls. They will be filled with filtered water (chlorinated or alternatively treated) to maintain alga-free water. In principle the size of these waterbodies (especially the one associated with the mausoleum) and their association with the café indicates that they may be attractive to ducks and scavenging birds such as gulls, ibis and ravens.

Ideally ponds and other water features would be avoided or at least restricted in size. Design concepts for the pond associated with the mausoleum include a waterfall. The action of the continuous disturbed water in this instance may act to deter wildlife. Water depth, sub-surface substrate, and the slope of the edges of this water feature can also be designed in a way to limit wildlife attraction. In the event the ponds are installed, and they are significant bird attractions, retrofitting wires or nets would be an acceptable solution (see Section 6).

Rehabilitating the riparian habitat and biodiversity values of Duncan Creek, is likely to attract wildlife. Consideration should be given to developing a heath, rather than forested riparian zone if the habitat is suited to such a structure, as heath would attract smaller passerine bird species rather than larger flocking species which are attracted to forested habitats.

Stormwater and drainage, depending on design, can attract hazardous wildlife such as ducks, pelican, and a variety of other water birds. Key to managing the wildlife attraction associated with this infrastructure is the rapid (within 48hrs) drainage of detained water following rainfall.

4.3. Waste

The site will provide general waste facilities for cemetery visitors, including those associated with the cafe. These will be fully enclosed and locked. Provided that all waste receptables (i.e., including small and industrial bins) remain enclosed, this is unlikely to attract wildlife. Regular waste removal should be at a frequency that empties the bins before they overflow, whereby the exposed rubbish may attract scavenger birds such as crows and ibis.

4.4. Infrastructure

The built environment can provide a range of perching, roosting and nesting opportunities for wildlife. For example, building eaves provide nesting platforms for Fairy Martins; semi-enclosed structures provide shelter for roosting Common Starlings; light structures provide platforms for raptor nests; large open areas can provide safe loafing areas for wildlife, bridges can provide perching and nesting platforms for Feral Pigeons. Carefully considered building design can minimise, or even exclude, bird use.

5. Conclusion

Evaluating how a land use activity, which does not yet exist, contributes to a future airport's strike risk is challenging. Despite this, we are able to extrapolate from existing information the features likely to present a hazard: the availability of water and foraging resources are key, and these wildlife attractions may contribute to WSA's strike risk if not well managed.

To help safeguard WSA against the wildlife strike risk, MKD Architects can apply a range of mitigation options during the design stage, and the cemetery operator can consider a range of retrospective mitigation as required, such as those indicated in Table 2. Monitoring the site once it is operational will determine, with greater accuracy, the level of wildlife activity and its contribution to the airport's strike risk profile. An ongoing Wildlife Management Plan (detailed in Section 6), prepared prior to cemetery operation, is highly recommended and will help monitor and manage wildlife risks.

6. Wildlife Hazard Mitigation

6.1. Wildlife Management Plan

A basic Wildlife Management Plan for the site should be prepared and implemented. It should include:

- roles and responsibilities
- regular monitoring surveys (see below)
- wildlife hazard assessments by qualified ornithologists or biologists
- wildlife awareness and management training for relevant staff
- wildlife population triggers
- activities to reduce hazardous wildlife populations
- an annual review to assess implementation against performance indicators, identify gaps, and ensure currency.

The Plan should target moderate to high-risk species such as raptors, flying-fox, ibis and pelicans, and flocking species such as ducks and galahs. Ongoing monitoring and regular risk assessments will help identify high and moderate risk species. This should be regularly reviewed with reference to the species considered a high and moderate risk at the airport, once operational. Monitoring should:

- determine the level of wildlife attraction, the features that are attractive (e.g., water, food) and the behaviour of wildlife
- identify temporal variation of wildlife activity (i.e., how wildlife uses the site at different times of the day, year or climatic phase)
- identify emerging risks
- locate evidence of wildlife shelter/nesting provided by infrastructure (e.g., buildings, equipment) and/or vegetation
- validate plant species choice and landscaping structure, or other mitigation applied.

Monitoring frequency should be congruent with the level of risk, however for the first 12 months of the facilities operation, we recommend monthly monitoring. Additional monitoring may be warranted during construction if increased wildlife activity is noticed.

Monitoring procedures should:

- Establish a standard survey route around the designated site.
- Designate stopping points where areas are scanned for wildlife.
- Record wildlife data on a standardised form (electronic or paper) that has been created to capture at least the following data:
    - Date
    - Time
    - Observer
    - Weather
    - Wildlife name
    - Wildlife number
    - Wildlife behaviour (e.g., perching, foraging, transiting, etc.)
    - Wildlife habitat usage (e.g., grass, building, drain, water, etc.)

Monitoring should also note any nesting activity, unusual bird activity, effectiveness of mitigation devices.

6.2. Mitigation Options

Managing features that attract wildlife ideally involves exclusion with physical barriers such as nets over water. There are also a variety of design options that, if incorporated well, can provide effective long-term solutions for deterring wildlife (Table 2).

Table 2. Mitigation options for MKD Architects to manage potential wildlife hazards at the proposed River Gardens Cemetery. Some of these options could be addressed retrospectively, if after regular monitoring, it is established that a bird attraction has eventuated.

Area of Mitigation	Recommendation / mitigation option	
Built environment	At the design stage, assess and evaluate building and infrastructure design to identify ways to proactively reduce the wildlife attraction (e.g. reduce eave size or remove altogether, if possible, to reduce nesting opportunity). This can minimise any retrospective efforts required to reduce the attraction by installing exclusionary devices or retrofitting structures.	
	Where perching, roosting or nesting activity is detected on structures, install exclusionary devices such as netting or anti-perching spikes. Carefully evaluate any retrospective installation of exclusionary devices to ensure they are effective.	
Waste management	Enclose waste receptacle areas or use blade walls. This can provide an extra barrier to prevent or deter bird access.	 4

4 Source: www.urbanshed.ca

Area of Mitigation	Recommendation / mitigation option
	Ensure all waste bins are lidded and kept closed. This restricts access to opportunistic urban forages such as Feral Pigeon and Australian White Ibis.
	Ensure waste collection is at a suitable frequency to ensure bins do not overflow. Restricts access to opportunistic urban forages such as Feral Pigeon and Australian White Ibis. 
Landscaping	The plant species listed in Table 1 should be minimised in landscape plans except where required for biodiversity value requirements. There is also a numbers of ways landscaping and vegetation use can be applied to reduce the wildlife attraction. These have been included in Appendix B. *Note - aligns with the same landscaping principles recommended to the WSPP for inclusion in their Aerotropolis planning framework. However, this a guide and MKD Architects should review all proposed site-specific landscaping schedules and species selection at the design stage*
Ponds and Stormwater management facilities (includes drains and	Detention areas should fully drain within 24-48 hours.
	Ponding should, ideally, not exceed 100m^2 of open water.

Area of Mitigation	Recommendation / mitigation option
detention/retention areas)	If the surface area exceeds 100m^2 wires or nets can be fitted over the waterbody to reduce the attractiveness to larger birds.  
	Drains and culverts can provide an ideal nesting habitat for species such as Fairy Martins and Welcome Swallows. Drains should be completely circular, free of 90° angles, including at the central join. This will prevent stable foundations for nest building. To limit access by birds drains, including circular drains, can be fitted with exclusion devices to prevent access for birds and vertebrate pests.
	Use underground drains and water storage where possible to reduce the availability of water to wildlife.
Nest Removal	Establish protocols to detect and remove bird nests under a Licence to Harm Protected Animal under the *NSW Biodiversity Conservation Act 2016* issued by the Department of Planning, Industry and Environment (Environment, Energy and Science). Protocols should consider the health and safety of personnel completing the works.

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Appendices

A. Summary of regulations, standards and guidance for managing wildlife hazards around airports.

B. Landscaping guidelines to minimise the wildlife attraction

Appendix A: Regulations, Standards and Guidance

There are a number of national (Table A1) and international (Table A2) requirements and guidance documents that indicate land use in the vicinity of an airport can contribute significantly to the wildlife hazard levels and safety of aircraft operations.

Table A1. Summary of national requirements and recommendations for managing wildlife hazards in the vicinity of airports.

Instrument	Summary
National Airport Safeguarding Framework	Guideline C of the NASF, *Managing the Risk of Wildlife Strikes in the Vicinity of Airports*, provides guidelines to land users and planners regarding the management of wildlife hazards. Adhering to the ICAO guidelines relating to radial distances from airports (3km, 8km and 13km), the NASF allocates risk categories to land uses from very low to high and recommends actions for both existing and proposed developments (i.e. incompatible, mitigate, monitor, no action). The NASF encourages a coordinated approach between airport operators and land use planning authorities to mitigate risks, and where risks are identified for new developments, the NASF recommends: • developing a management program • establishing management performance standards • allowing for design changes and/or operating procedures where the land use is likely to increase the strike risk • establishing appropriate habitat management • creating performance bonds should obligations not be met • monitoring by airport authorities • reporting wildlife events as per ATSB requirements.
State Environmental Planning Policy (Western	An environmental planning instrument that establishes planning controls for land use in the Western Sydney Aerotropolis. Includes controls for a range of overlays

Instrument	Summary
Sydney Aerotropolis) 2020	including a Wildlife Buffer Zone that places restrictions on land use types within 3 and 8k of Western Sydney Airport in order to adhere to airport safeguarding principles against wildlife hazards.
NSW Environmental Planning and Assessment Act 1979	The *Environment Planning and Assessment Act* institutes the state's planning system and describes the Ministerial Directions under Section 9.1. that relate to safeguarding aviation and the Western Sydney Aerotropolis.
NSW Damage by Aircraft Act 1952	The *Damage by Aircraft Act* describes 'unlimited liability' to aircraft operators in the event of property damage/destruction or personal injury/loss of life by an aircraft or part thereof. In worst case situations following a significant strike, aircraft operators will likely seek to clarify if aerodrome operators, and even land users in the vicinity of airports, showed adequate due diligence in their responsibility to safeguard operations against wildlife strikes.
NSW Workplace Health and Safety Act 2011	The *Work Health and Safety Act* requires appropriate duty of care to employees and contractors to maintain a safe working environment. Although not directly linked to aviation and wildlife strike management, the presence of wildlife in workplaces can create health issues for workers. Therefore, managing land use activities that are attracting wildlife, particularly where birds are nesting or roosting, not only contributes to airport safeguarding but maintains a safe work environment.
Civil Aviation Safety Authority (CASA) Part 139 (Aerodromes) Manual of Standards 2019	The Part 139 MOS prescribes the aerodrome requirements. Sections relevant to wildlife hazard management focus on: bird hazard information for the Aeronautical Information Package (AIP), drainage and drains in the runway strip, requirements for serviceability inspections, Notice to Airman (NOTAM) requirements for bird hazards, Reporting Officer responsibilities, animal hazard management requirements,

Instrument	Summary
	and standing water on paved surfaces. It also considers off-airport land use and their contribution to the wildlife strike risk

Table A2. Summary of international requirements and recommendations for managing wildlife hazards in the vicinity of airports.

Instrument	Summary
International Civil Aviation Organization ICAO Annex 14, Volume 1 (Aerodrome Design and Operation)	As a member state to the ICAO, Australia is required to adhere to the rules and regulations stipulated by ICAO, including those relating to wildlife hazard management on and around airports. There are also series of guidance documents and best practice standards airports can refer to assist with wildlife hazard management. ICAO Annex 14, Volume 1 (Aerodrome Design and Operation) establishes requirements for the management of wildlife strikes, including the requirement for authorities to take actions to reduce the number and types of wildlife-attracting sites in the vicinity of airports.
ICAO Airport Services Manual Doc. 9184: Part 2 Land Use and Environmental Control	Provides airport personnel with guidance on land use planning within the vicinity of aerodromes, and the need for good planning and control measures. It focusses on how the airport impacts on its surroundings, and vice versa, with regard to people, flora, fauna, the atmosphere, water courses, air quality, soil pollution, rural areas, and the environment in general. It frequently discusses the significance of how some land use in the vicinity of airports, such as landfills, can influence an airport's strike risk profile. Appendix 2, Land-use Guidelines for the Avoidance of Bird Hazards, is particularly useful however it does remind readers that "*Any land use that had the potential to attract birds in the airport vicinity should be subject of a study to determine the likelihood of bird strikes to aircraft using the airport*".
World Bird Strike Association	The World Birdstrike Association (International Bird Strike Committee (IBSC)) provides a series of standards relevant to

Instrument	Summary
	all aspects of integrated wildlife hazard management programs.
Federal Aviation Administration	The United States FAA has no jurisdiction over Australian aerodromes; however, they provide critical and useful guidance on water body management in AC 150/5200-33B, with particular reference to new storm water management facilities.

Appendix B: Landscaping Guidelines to Reduce the Wildlife Attraction

Table B1 describes Avisure's planting and landscaping guidelines developed to reduce the wildlife attraction on and in the vicinity of airports to help minimise the wildlife strike risk. It is recognised that elements of these guidelines contradict the landscaping objectives and principles of the cemetery. In response, we recommend they are applied wherever possible. Where landscape structure (i.e., the number of trees) cannot be compromised, species selection should be prioritised (i.e., select species that are consider low wildlife attractants).

Table B1. Planting guidelines and recommendations to reduce the wildlife attraction.

Area	Recommendation	Comment for application
Landscape and Vegetation Management Plan	Develop a plan that provides planting and species guidelines, identifies acceptable and unacceptable species, and provides guidance for landscaping to reduce the overall wildlife attraction.	Fully applicable.
Assessment and evaluation	For proposed landscaping works that do not meet approved guidelines, request an evaluation and assessment from a suitably qualified aviation ecologist.	Fully applicable.
Species selection	Select landscape plants that minimise the attraction of birds and flying-foxes.	Applicable and highly recommended. Specific guidelines should be developed for species selection.
	Do not plant trees and shrubs which bear edible berries, fruits, seeds or nuts, or flower profusely.	Applicable and highly recommended. Whilst all plants bear berries, fruits, seeds, nuts or flowers, this principle suggests excluding or

Area	Recommendation	Comment for application
		minimising those species identified as significantly attractive to wildlife.
	Avoid species from the Proteaceae family. Commonly used landscaping species include, *Banksia* spp, *Grevillea* spp, *Hakea* spp. The nectar produced by these species can attract flying-foxes and various nectar feeding (nectivorous) birds such as lorikeets.	Applicable and highly recommended. This principle recommends replacing this group of plants with species that are less attractive.
	Avoid species from the Myrtaceae family. Commonly used landscaping species include *Callistemon* spp, *Corymbia*, *Eucalyptus* spp, *Lophostemon* spp, *Melaleuca* spp, *Syzygium* spp, *Xanthostemon* spp. Many species in this family produce large volumes of nectar that can be highly attractive to flying-foxes and various nectivorous birds. Studies at other airports have shown significant response to flowering Melaleuca by flying-foxes that have created severe strike risks.	Applicable and highly recommended. This principle recommends replacing this group of plants with species that are less attractive.
	Avoid species from the Moraceae family. Commonly used landscaping species include *Ficus* spp (Figs) due to their decorative and aesthetic appeal. Fig fruits are highly attractive to flying-fox and other fruit eating (frugivorous) birds.	Applicable and highly recommended. This principle recommends replacing this group of plants with species that are less attractive.
	Avoid palm species. These extend across a range of families and should only be used when a strict documented regime of regular fruit/flower cluster removal occurs.	Applicable and highly recommended. This principle recommends replacing this group of plants with species that are less attractive.

Area	Recommendation	Comment for application
	Where the aforementioned species already exist in landscaped areas, replace them with more suitable species. In some circumstances it may be possible to regularly remove clusters of fruits and flowers (depends on species).	Applicable and highly recommended if monitoring determines an unacceptable level of wildlife attraction relative to the airport.
Design recommendations • Trees (mature height >5m) • Shrubs (mature height 300mm-5m)	Avoid clumps of trees and shrubs because they provide more shelter and more concentrated feeding areas than individual or small groups of plants.	Applicable and highly recommended.
	Apply the following conditions when planting trees along access and other roads to the airport: • Maximum mature height of any tree: 10m. • No more than 5 trees planted in any one group. • Average interval between tree groups not less than 200m. • Minimum interval between tree groups is 100m. • Single trees are planted >50m to any other single tree or tree groups. • Trees constitute no more than 5% of total tree/shrub plantings.	Restricted. It is recognised that this principle contradicts the proposed planting objectives. We recommend applying wherever possible. For those areas where applying this principle is not possible, plant species should be carefully selected to reduce the wildlife attraction.
	Apply the following conditions to shrub plantings: • Shrubs do not exceed 5m mature height.	Restricted. It is recognised that this principle contradicts the proposed planting objectives. We recommend applying wherever possible.

Area	Recommendation	Comment for application
	• Shrubs which produce nectar, fruits or seed (e.g. Banksia, Grevillea, Hakea) are not planted in groups of more than 5 per group and such groups are not planted <50m to specimens of the same species or groups of any species which may similarly attract birds or flying-fox at the same time of the year.	For those areas where applying this principle is not possible, plant species should be carefully selected to reduce the wildlife attraction.
Ground Cover (mature height <300mm)	Use low prostrate ground cover plants, avoiding profusely fruiting or seeding species. Use ground cover species rather than grasses to reduce the wildlife attraction and minimise ongoing maintenance costs.	Restricted. Should be applied where possible.
	Avoid grasses that produce a lot of seed for rough grass or soil stabilisation.	Applicable and highly recommended. This principle recommends replacing this group of plants with species that are less attractive.
	Avoid grassed areas in gardens that require regular irrigation. Minimise the use of sprinklers and ensure taps do not drip.	Applicable if monitoring identifies significant wildlife hazards.
Maintenance	If practical, remove trees and other plants and replace with species that are more appropriate. Lopping and pruning to alter the structure of trees and shrubs can reduce food and perches and make the plants unsuitable for roosting or nesting. It can, however, be difficult if not impossible, to lop or prune some species of trees such as palms to the extent necessary to prevent birds from roosting or nesting. In such cases, the only effective way	Applicable if monitoring identifies significant wildlife hazards.

Area	Recommendation	Comment for application
	of removing the bird problem may be to remove the trees. Therefore, use palms sparingly, or not at all, in landscaping.	
	Regularly prune and lop trees and shrubs to improve their health and vigour and prevent the establishment of communal roosts and nesting colonies which, if allowed to establish, can be difficult to remove.	Applicable if monitoring identifies significant wildlife hazards.
Landscaping works when airport is operational	Tube stock planting, hydro mulching, or the establishment of other vegetation close to airports should be carefully monitored to determine any increase in wildlife activity. Management (e.g., wildlife dispersal) may be required if wildlife activity is elevating the strike risk at the airport.	Applicable if monitoring identifies significant wildlife hazards.

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