Greater Shepparton City Council

Cussen Park Grey-headed Flying-fox Colony

Colony Assessment and Management Framework for Future Land-use

Question today
Imagine tomorrow
Create for the future

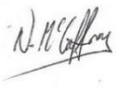
Cussen Park Grey-headed Flying-fox Colony
Colony Assessment and Management Framework for Future Land-use

Greater Shepparton City Council

WSP
Level 15, 28 Freshwater Place
Southbank VIC 3006

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
wsp.com

REV	DATE	DETAILS
A	26/01/2022	Draft report
B	11/02/2022	Technical Review and approval
C	29/03/2022	Finalisation following client review

	NAME	DATE	SIGNATURE
Prepared by:	Briony Mitchell	22/01/2022	
Reviewed by:	Rodney van der Ree	30/01/2022	
Approved by:	Nic McCaffrey	11/02/2022	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

Table of contents

List of tables

List of figures

List of appendices

Glossary

Camp	The physical location that flying-foxes occupy as a group during the day. Synonymous with roost.
Colony	The group of flying-foxes occupying a camp
Occupied camp	A camp that has been occupied by flying-foxes in more than one year and was occupied at the time of inspection.
Pup	Juvenile flying-foxes dependent on their mother
Population	Refers to the total number of flying-foxes across their geographic range
Roost	The physical location that flying-foxes occupy as a group during the day. Synonymous with camp.
Unoccupied camp	A camp that has been occupied by flying-foxes in more than one year, but was unoccupied at the time of inspection

Abbreviations

ABLV	Australian Bat Lyssavirus
ATCW	Authority to Control Wildlife permit
CaLP Act	*Catchment and Land Protection Act 1994*
CSIRO	Commonwealth Scientific Industry Research Organisation
DAWE	Department of Agriculture, Water and the Environment (Australian Government)
dB(A)	A-weighted decibels
DELWP	Department of Environment, Land, Water and Planning (Victorian Government)
DJPR	Department of Jobs, Precincts and Regions (Victorian Government)
DoT	Department of Transport
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FFG Act	*Flora and Fauna Guarantee Act 1988*
FF/s	Flying-foxes
GHFF	Grey-headed Flying-fox
Hz	Hertz
kHz	Kilohertz
LRFF	Little Red Flying-fox
m	Metre
OCR	Office of the Conservation Regulator
P&E Act	*Planning and Environment Act 1987*
VBA	Victorian Biodiversity Atlas
Wildlife Act	*Wildlife Act 1975*

Executive summary

Greater Shepparton City Council are developing a structure plan to guide the development of residential land to the north and north-west of Cussen Park in Tatura. Cussen Park has supported a colony of Grey-headed Flying-foxes *Pteropus poliocephalus* (GHFF) since at least 2017, which are protected under state and national legislation. WSP have been engaged to develop a management framework for this GHFF colony at Cussen Park to inform the implementation of the Tatura Structure Plan The aim of the framework is to ensure that the GHFF colony is protected from current and future potential land use conflict, including encroachment from urban development to the north and north-east of the colony. To inform the framework WSP ecologists undertook a site visit, a literature review, and community consultation sessions.

A colony of GHFF and periodically Little Red Flying-fox *Pteropus scapulatus* (LRFF) have been present at Cussen Park, Tatura, from 2017 and 2013, respectively. Colony numbers peak in Autumn in most years at approximately 10,000 – 12,000 flying-foxes (FFs). The evidence that WSP has collated from camps across the state, plus ongoing discussion with the managers of many camps in Victoria indicates that the Cussen Park colony is permanent and likely to continue to increase in size. This poses significant challenges for Greater Shepparton City Council (Council) in its approach to managing the colony, the public use of Cussen Park, impacts to nearby residential properties and the local town of Tatura. Potential residential developments adjacent to Cussen Park are a particular obstacle to colony management for Council.

The Tatura Structure Plan (SP) proposes a 'general residential area' north and north-east of the current FF roosting locations, with the proposed drainage basins planned adjacent to the park boundary. The Structure Plan does not incorporate land to the west of the park, over Tatura-Undera Road, but is proposed as a general residential area and a small section of this is to be investigated for industrial development. The implication of potential additional residential housing nearby the colony increases anthropogenic impacts on FF and FF-human conflict. FF also preferentially roost near water (amongst other factors) in urban and peri-urban environments, as such the addition of drainage basins adds another level of complexity to future management of the camp. Consideration of these anthropogenic impacts, as well as options to reduce noise, smell, electrocution via powerlines, and faecal matter have been investigated. Pre-planning and design of any proposed housing or industrial developments, during the urban planning process will be key to reducing FF-human conflict within Tatura.

The context of the Cussen Park camp is different to most camps experiencing FF-human conflict because most surrounding housing in proximity are yet to be built, and many of the known FF-human mitigation strategies only become relevant if the conflict can't be avoided initially at the land-use planning stage (i.e., when developing the SP). The most efficient and cost-effective approach, therefore, for the Cussen Park Camp is to develop effective camp buffers that avoid conflict from the beginning and avoids the need for often ineffective and piece-meal strategies that are applied retroactively.

As such, the proposed Framework identifies primary, secondary, and ongoing actions. Primary actions will be the most successful at initially preventing FF-human conflict from arising within new housing developments and to avoid any conflict in the future. Secondary actions are those that should be considered if adequate camp buffers cannot be implemented. Ongoing actions relate to currently implemented park management and camp monitoring actions that can be built-upon to specifically improve camp management. These actions are as follows:

Primary

— Camp Buffer Zone implementation – a minimum of a 150 m vegetation free buffer is proposed.

— Utilisation of strategic or statutory planning tools to incorporate the camp buffer in local law.

— A community education program

Secondary

— Future development provisions - such as housing design parameters or anti-FF roosting and foraging lists provided to residences.

Ongoing

— Ongoing camp monitoring - including for heat stress events

— Continued Cussen Park management – with the inclusion of an FF Management Plan.

Once the Framework is finalised with Council, several measures are proposed as next steps to establish essential colony management protocols and implementation of FF controls under statutory planning tools.

1 Introduction

1.1 Project background

A colony of Grey-headed Flying-fox *Pteropus poliocephalus* (GHFF) and periodically Little Red Flying-fox *Pteropus scapulatus* (LRFF) have been present at Cussen Park, Tatura, from 2017 and 2013, respectively. Colony numbers peak in Autumn in most years at approximately 10,000 – 12,000 flying-foxes (FF). The evidence that WSP has collated from camps across the state, plus ongoing discussion with the managers of many camps in Victoria indicates that the Cussen Park colony is permanent and likely to continue to increase in size. This poses significant challenges for Greater Shepparton City Council (Council) in its approach to managing the colony, the public use of Cussen Park, impacts to nearby residential properties and the local town of Tatura. The proposed residential developments adjacent to Cussen Park are a particular challenge to the effective management of the colony.

WSP have been engaged to develop a management framework for the GHFF colony at Cussen Park in relation to the implementation of the Tatura Precinct Structure Plan. The aim of the framework is to ensure that the GHFF colony is protected from current and future potential land use conflict, including encroachment from urban development to the north and north-east of the colony. To inform the framework WSP ecologists undertook a site visit to identify the current size and requirements of the colony and to understand its current and future needs and behaviours, as well as understanding interaction with the local community through consultations.

1.1.1 Study area

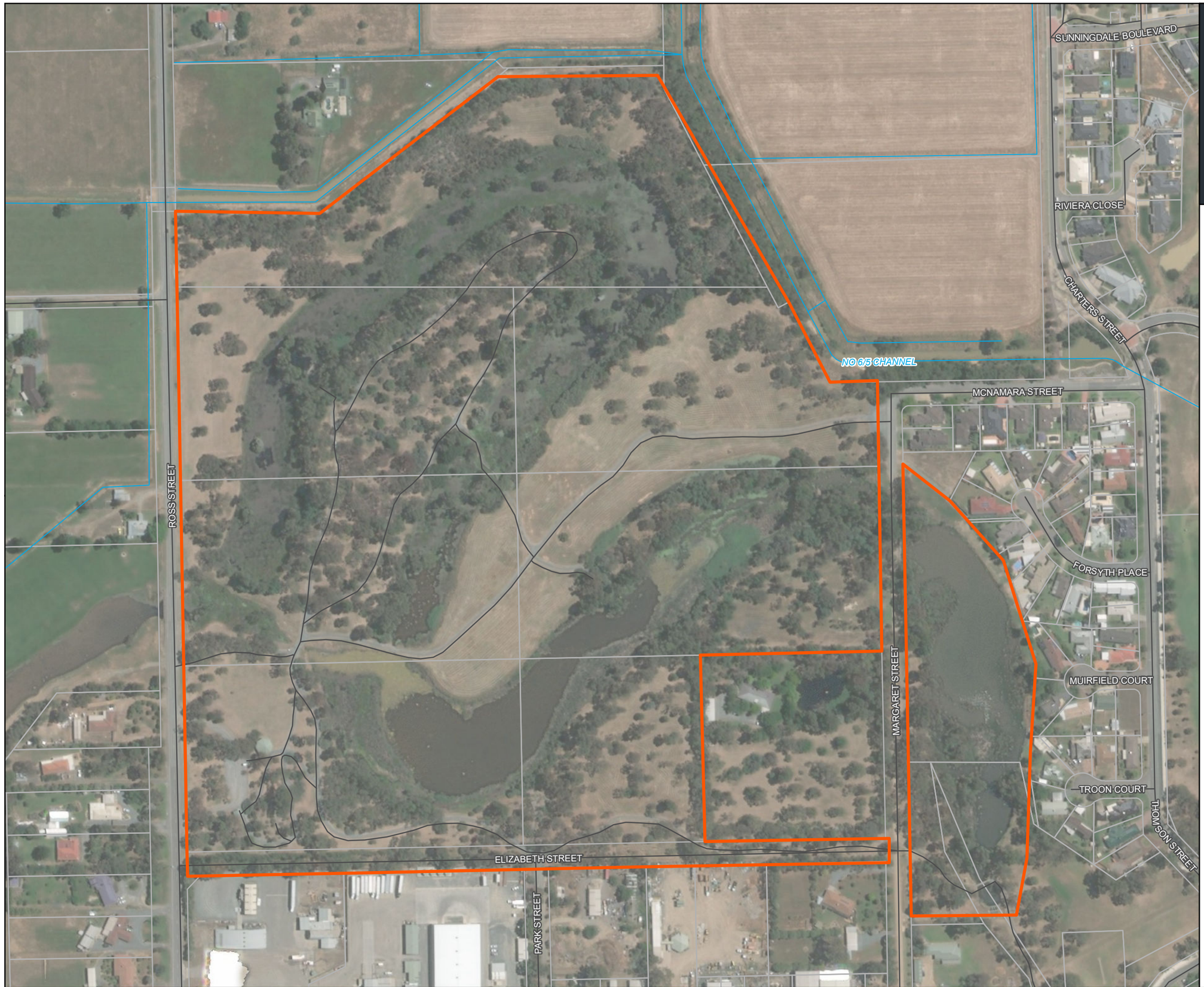
The colony is present within a local park in Tatura, called Cussen Park, approximately 180 km north of Melbourne. Cussen Park is a reclaimed area encompassing 33 hectares (ha) of wetlands, planted bushland-style woodlands and open space on the northern outskirts Tatura (Greater Shepparton City Council 2016a). Cussen Park was established in 1983, with further additions in the mid-1990s, including an old rubbish dump, BMX track and wasteland.

The Park is owned by Greater Shepparton City Council, and is surrounded by freehold industrial, residential and farmland (Figure 1.1). Cussen Park is bound by Ross Street to the west and industrial properties to the south extending to William Street, with open farmland at the northern and north-east boundary of the Park. These paddocks are proposed for development. Existing residential housing extends from Margaret Street along the eastern boundary.

The colony mainly resides to the north of the park around the waterbody, named the Loop wetland (latitude: -36.429388, longitude: 145.226800) extending to the No.6/5 Irrigation Channel (Figure 1.1). The location of the colony in Cussen Park will be discussed further in Section 3. The Loop wetland can be filled via water entitlement from the No.6/5 Irrigation Channel. The Margaret Street pond can be filled via Lake Bartlett, where a flow gate can be adjusted to control water flows into the Margaret Street pumps.

The nearest known flying-fox camps to Cussen Park includes the regularly occupied camp of LRFF at Numurkah, approximately 42 km north-east of Tatura, and the camp of GHFF at Rosalind Park, Bendigo, approximately 100 km south-west of Tatura.

The study are falls within the Goulburn Broken Catchment Management Authority (CMA) and the Victorian Riverina Bioregion.



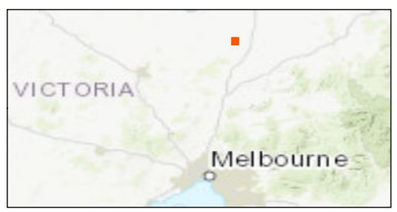
WSP

Cussen Park, Tatura

Figure 1
Study Area

Legend

- Road
- Watercourse
- Cadastre
- Cussen Park Boundary



0 30 60
Meters

Coordinate system: GDA2020 MGA Zone 55

Scale ratio correct when printed at A3

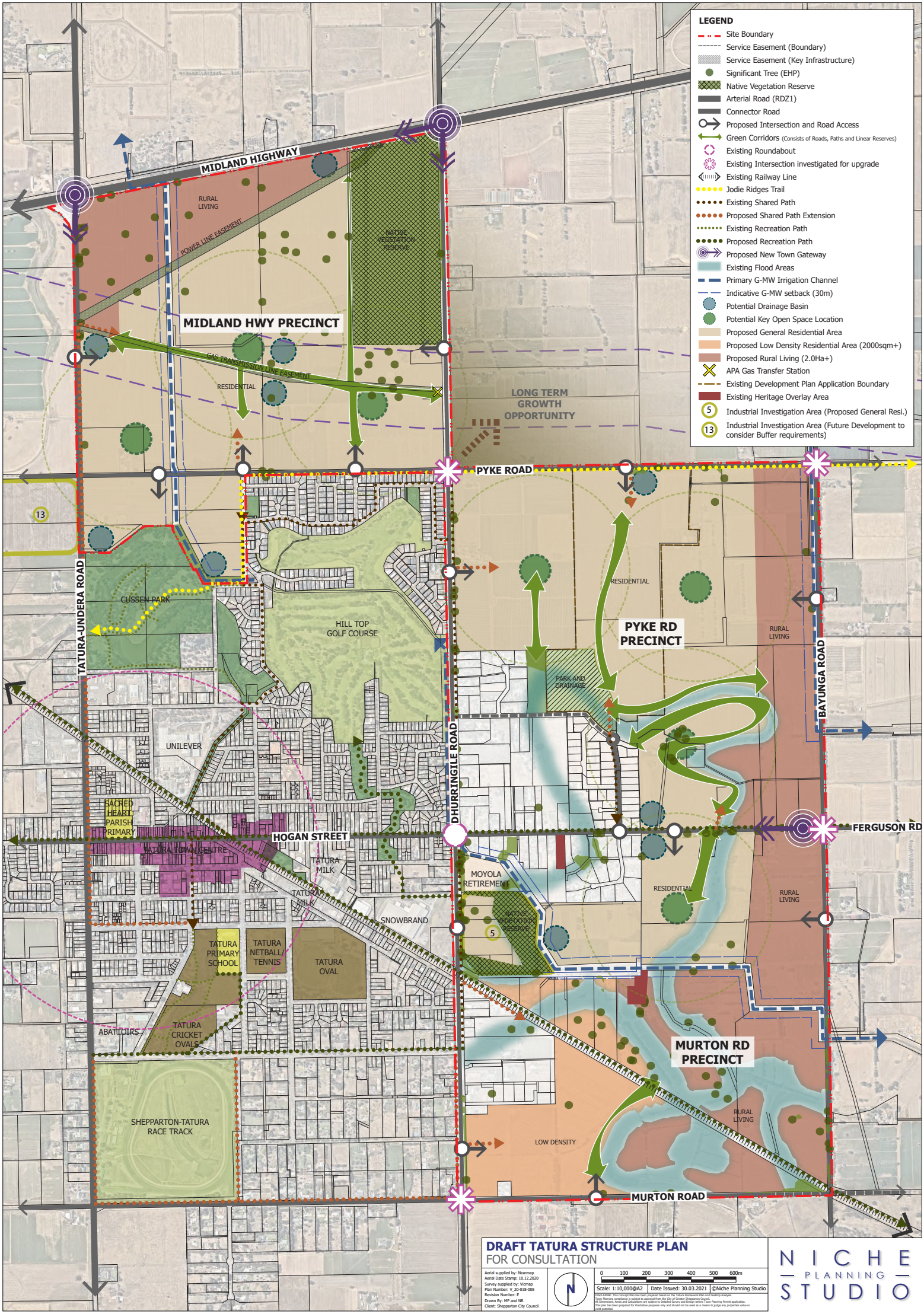
1:3,000 Date: 11-Jan-22

Data sources: DELWP 2022, WSP 2022

1.1.2 Conservation status

GHFF are protected under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the State *Flora and Fauna Guarantee Act 1988* (FFG Act). The species is listed as Vulnerable under the EPBC Act and the category of threat under the FFG Act is Vulnerable. Any management plans for the species must consider the National Recovery Plan (DAWE 2021) and Referral guidelines (DoE 2015). As such, Council has legal obligations under both pieces of legislation to manage the site and the colony to enhance conservation outcomes for the species.

At the local government level, there is no direct policy, or planning scheme ordinance in the Greater Shepperton Planning Scheme concerning the GHFF camp at Cussen Park. Council is developing the Tatura SP, which is currently in draft form (Figure 1.2). Outcomes of the GHFF management framework should be incorporated as part of the PS.


LEGEND
Site Boundary
Service Easement (Boundary)
Service Easement (Key Infrastructure)
Significant Tree (EHP)
Native Vegetation Reserve
Arterial Road (RDZ1)
Connector Road
Proposed Intersection and Road Access
Green Corridors (Consists of Roads, Paths and Linear Reserves)
Existing Roundabout
Existing Intersection investigated for upgrade
Existing Railway Line
Jodie Ridges Trail
Existing Shared Path
Proposed Shared Path Extension
Existing Recreation Path
Proposed Recreation Path
Proposed New Town Gateway
Existing Flood Areas
Primary G-MW Irrigation Channel
Indicative G-MW setback (30m)
Potential Drainage Basin
Potential Key Open Space Location
Proposed General Residential Area
Proposed Low Density Residential Area (2000sqm+)
Proposed Rural Living (2.0Ha+)
APA Gas Transfer Station
Existing Development Plan Application Boundary
Existing Heritage Overlay Area
5 Industrial Investigation Area (Proposed General Resi.)
13 Industrial Investigation Area (Future Development to consider Buffer requirements)
MIDLAND HIGHWAY
RURAL LIVING
POWER LINE EASEMENT
NATIVE VEGETATION RESERVE
MIDLAND HWY PRECINCT
GAS TRANSMISSION LINE EASEMENT
RESIDENTIAL
LONG TERM GROWTH OPPORTUNITY
PYKE ROAD
13
TATURA-UNDERA ROAD
CUSSEN PARK
HILL TOP GOLF COURSE
DHURRINGILE ROAD
RESIDENTIAL
PYKE RD PRECINCT
RURAL LIVING
PARK AND DRAINAGE
BAYUNGA ROAD
UNILEVER
SACRED HEART PARISH PRIMARY
HOGAN STREET
FERGUSON RD
TATURA TOWN CENTRE
TATURA MILK
MOYOLA RETIREMENT
RESIDENTIAL
RURAL LIVING
SNOWBRAND
NATIVE VEGETATION RESERVE
5
TATURA PRIMARY SCHOOL
TATURA NETBALL/ TENNIS
TATURA OVAL
ABATTOIRS
TATURA CRICKET OVALS
MURTON RD PRECINCT
SHEPPARTON-TATURA RACE TRACK
RURAL LIVING
LOW DENSITY
MURTON ROAD
DRAFT TATURA STRUCTURE PLAN
FOR CONSULTATION
Aerial supplied by: Nearmap
Aerial Date Stamp: 10.12.2020
Survey supplied by: Vicmap
Plan Number: V_20-018-008
Revision Number: E
Drawn By: MP and NR
Client: Shepparton City Council
0 100 200 300 400 500 600m
Scale: 1:10,000@A2
Date Issued: 30.03.2021
©Niche Planning Studio
DISCLAIMER: This Concept Plan has been prepared based on the Tatura Framework Plan and Desktop Analysis.
All Dimensions, Areas and Calculations are subject to Detailed Survey and Design before Town Planning Permit application.
This plan has been prepared for illustrative purposes only and should not be used as a means to judge any properties value or yield potential.
NICHE PLANNING STUDIO

1.2 Scope

The scope of works is to prepare a framework that can be used to assess the GHFF colony in Cussen Park, Tatura and inform the development of the Tatura Structure Plan.

The scope of deliverables include:

- Literature review and existing management plan research
- Site visit to assess colony behaviour, distribution, and current numbers.
- Report, including both the literature review and the management framework.

Utilising the framework, surveys and the literature review, the report will aim to provide a series of recommendations for the continued protection of the bat colony and their habitat from future land-use conflict.

To achieve this scope, several WSP staff from multiple disciplines worked collaboratively on this project. These staff members are presented in Table 1.1.

Table 1.1 Personnel involved on the project

STAFF MEMBER	TITLE	PROJECT ROLE
Rodney van der Ree	Technical Executive - Ecology	Specialist advice - flying-fox Site visit Technical review
Jacqui Willis	Environmental Planner	Site visit Planning - literature review (Section 7)
Briony Mitchell	Senior Ecologist	Site visit Reporting
Katie Dean	Consultant, Communications & Engagement	Community consultation questionnaire and result compilation

2 Method

2.1 Database and literature review

A database search and literature review were undertaken to provide a summary of current literature on FF management and implemented FF management plans elsewhere in Australia. Relevant and available documents were reviewed for information on options for FF colony management and what has or hasn't worked. Reports, databases, legislation, and literature reviewed included:

— The Federal EPBC Act and associated species listings and documents for FF under the Act, including the National Recovery Plan for the Grey-Headed Flying-fox *Pteropus poliocephalus (DAWE 2021)* and the Referral guideline for management actions in grey-headed and spectacled flying-fox camps (DoE 2015)

- The Victorian FFG Act
- The Victorian Wildlife Act 1975
- Survey data from the National (DAWE) Flying-fox monitoring viewer (http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf)
- Yarra Bend Park Flying-fox Campsite Management Plan 2005 (Department of Environment and Primary Industries 2015)
- Management options for flying-foxes at Cussen Park, Tatura, Victoria; Final Report May 2017 (EII 2017)
- Cussen Park Environmental Management Plan 2016 (Greater Shepparton City Council 2016b)
- The Draft Tatura Structure Plan 2021
- Material gathered during other GHFF projects WSP has completed for local and state government in Victoria, including Geelong, Bendigo, Colac, East Gippsland and DELWP
- Management plans for other camps in Victoria and nationally, especially those with high levels of conflict with the community (e.g., Batemans Bay, SE Queensland).

2.1.1 Expert advice

As part of the literature review, several experts on FF management were contacted in September 2021 to gain perspective on the use of buffer zones around FF colonies to accommodate for smell or noise emissions by FF camps. Those respondents are detailed in Table 2.1.

Additionally, Goulburn Murray Water were contacted several times from the 30 September 2021, with the aim of determining management requirements of the adjacent irrigation channel (i.e., is a vehicle access track required). However, no response was received.

Table 2.1 Experts contacted for the project

ORGANISATION	NAME
Sunshine Coast Council	Tyron de Kauwe
Department of Planning, Industry and Environment - NSW	Matthew Mo
Department of Agriculture, Water and the Environment - Federal	Tim McGrath
Ecosure	Jess Bracks

ORGANISATION	NAME
Western Sydney Council	Justin Welbergen
Flying-fox ecologist, Uni NSW	Peggy Eby

2.2 Planning

A due diligence assessment was undertaken, which included a review of the existing site conditions (including planning controls and draft documentation for the Tatura Structure Plan) surrounding Cussen Park, to:

- gain an appreciation of the Tatura Structure Plan and current information available
- identify any relevant planning policy which may assist in the implementation of the management framework

Sources reviewed included, but were not limited to:

- Greater Shepparton Planning Scheme
- Planning Practice Notes
- Victorian Planning Authority website
- Vicplan (DELWP 2021).

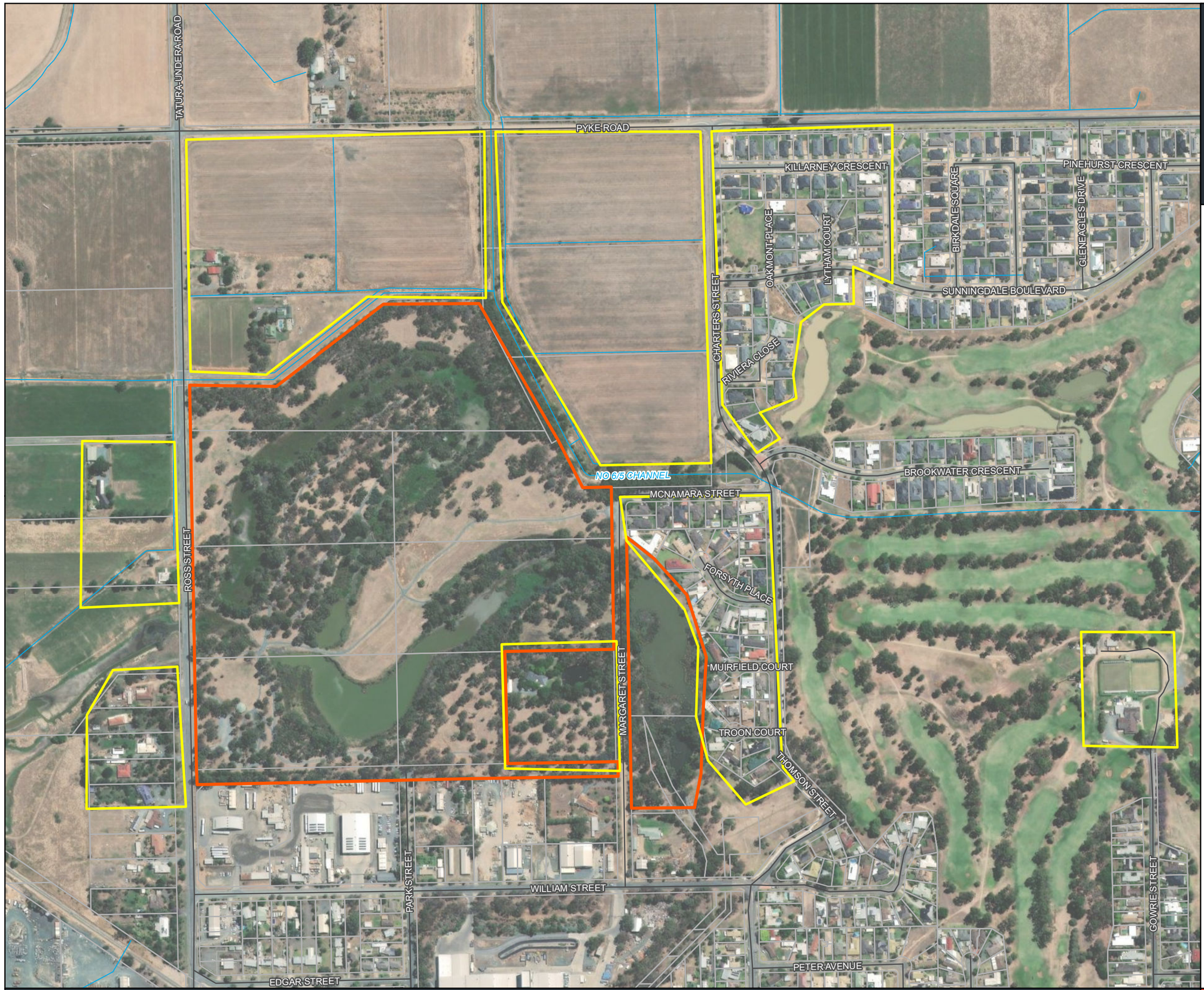
The findings of this review are detailed in Section 7.

2.3 Community consultation

A critical component of the review was to gain an understating of the community's experience with the FF colony. Due to COVID-19, WSP undertook online community consultation processes, including an online questionnaire for residents and a workshop with members of the Cussen Park Advisory Committee and Tatura Community Plan Steering Committee. The Workshop with the two local committees took place on the evening of 14th October 2021 and was an open discussion around the current management of the colony, colony numbers and camp distribution and local attitudes towards the FF.

The WSP Ecology Team, in collaboration with the WSP Communications and Engagement Team, put together a series of 16 questions that would help to understand residents experience with FF (Appendix A, Section A1.1). Residents were chosen to participate based on their proximity to the colony and Cussen Park to gain meaningful information about noise and smell extent. The general residential areas which were contacted to participate in the questionnaire can be viewed in Figure 2.1.

The questionnaire was presented online using Zoho Survey (https://www.zoho.com/survey/login.html). Respondents were invited via postal letter to respond to the online survey about the Cussen Park camp. A total of 117 properties were contacted, including the Hill Top Golf and Country Club. Responses were then reviewed and summarised by the WSP Communications and Engagement Team.



wsp

Cussen Park, Tatura

Figure 1.3
Local households contacted for community consultation

Legend

- Road
- Watercourse
- Cadastre
- Cussen Park Boundary
- Local Households Contacted

0 60 120
Meters

Coordinate system: GDA2020 MGA Zone 55

Scale ratio correct when printed at A3

1:5,000 Date: 13-Jan-22

Data sources: DELWP 2022, WSP 2022

C:\Users\Angela.Sun\WSP O365\WSP O365\AU-WKG - Geospatial - AIS - Projects\PS126517_Cussen_Park_Grey\Mxd\PS126517_ENV_F005_HouseholdsContacted_r1v1.mxd

2.4 Target species survey

2.4.1 Species ecology

GHFFs are a largely sub-tropical mammal species whose range extends from southern Queensland along the east coast and into Victoria and can be found as far west as Adelaide and as far south as Geelong (Figure 2.2). They eat fruit and nectar from native and introduced trees and shrubs. They are colonial, which means they roost in groups, ranging from a handful to 50,000 – 100,000 individuals. Colony size is influenced by the area of suitable roosting habitat and food availability around the camp and across their range (McDonald-Madden et al. 2005). An abundant food source can attract animals, and low availability of food in an area can force mass movements away from the area of food shortage (Roberts, B 2012). Colonies can form very quickly as the species is highly mobile, from zero to 10s of 1000s in a small number of weeks and disband as quickly. There is constant movement of some flying-foxes among camps, while other individuals appear to permanently reside within the one camp.

Despite GHFFs large geographic range (over 2,500 km), the species is considered a single population because of their extreme mobility and lack of genetic differentiation (Tidemann 2003; Webb & Tidemann 1996; Welbergen 2006). GHFF can travel a few hundred kilometres (km) per night between camps, travel in excess of 2,500 km annually with daily colony turnover rates approaching 20% and highly variable directions of travel (Webb & Tidemann 1996).

LRFF are more nomadic than GHFF because their diet is more focussed on blossom, which can be very sporadic and unpredictable across the continent. (Figure 2.2) (Franklin, Barnes & Prout 2017). Consequently, LRFF also tend to establish new camps and colonise existing camps much more quickly and often in larger numbers than GHFF, sometimes reaching one million individuals (Churchill 2008). Their geographic range covers a larger area of Australia than for (Welbergen 2006). GHFF, and the southern extent of their range is central Victoria. Numurkah and Tatura are as far south as LRFF are regularly recorded in Australia, although they occasionally occur in Bendigo and very rarely in Melbourne.

Figure 2.2 Example images of Grey-headed Flying Fox *Pteropus poliocephalus* (GHFF) on the left and Little Red Flying-fox *Pteropus scapulatus* (LRFF) to the right. LRFF Image © Vivien Jones.

2.4.2 Site assessment

WSP Ecology (Rodney van der Ree and Briony Mitchell) and Planning (Jacqui Willis) attended site with Council on the 20th September 2021. The site visit aimed to understand the context of the GHFF colony at Cussen Park, Tatura. Suitable GHFF habitat around Cussen Park was assessed to confirm the potential maximum boundaries of the colony to inform the size of any potentially recommended buffer zone.

2.5 Environmental legislation and policy

As relevant to the project, environmentally related legislation and policy considered included:

- EPBC Act
- FFG Act
- *Planning and Environment Act 1987* (P&E Act)
- *Catchment and Land Protection Act 1994* (CaLP Act)
- *Wildlife Act 1975* (Wildlife Act).

Relevant legislation and policy are described in detail in Appendix B, Table B.1.

3 Cussen Park camp

3.1.1 Camp history

Flying-foxes (FF) have been roosting at Cussen Park for approximately 10 years, with the first formal camp counts being undertaken in August/September 2013. At that time the camp comprised of up to a few hundred LRFF (Terry Court, personal communication). Between 2013 to 2016 camp numbers were between 200 – 400, with the largest peak in January 2014 at approximately 2000 individuals. Roosting began in section 4 around the Margaret Street waterbody, and then the camp established in its current position.

GHFF were first observed at Cussen Park in late summer to early autumn 2017, with number peaking at approximately 10,000 – 15,000 individuals. A colony of GHFF, and periodically LRFF, have now been present at Cussen Park since, with numbers peaking during autumn in most years at approximately 10,000 – 12,000 individuals. The monthly maximum counts by Terry Court and occasionally Rodney van der Ree since 2013 can be viewed in Figure 3.1. This establishment and pattern of use of Cussen Park by FF is set against a background of an ongoing increase in the size and distribution of the GHFF population in Victoria and is typical of many new GHFF camps across the state. The evidence that WSP has collated from many camps across the state, plus ongoing discussion with the managers of many camps in Victoria indicates that the Cussen Park colony is permanent and likely to continue to increase in size.

When determining if management actions may have a significant impact under the EPBC Act, a GHFF camp must be classified as a 'nationally-important' camp (DoE 2015).The Commonwealth EPBC Act Referral Guidelines define a Nationally important GHFF camp as camps that "…have contained ≥ 10,000 grey-headed flying-foxes in more than one year in the last 10 years, or have been occupied by more than 2,500 grey-headed flying-foxes permanently or seasonally every year for the last 10 years (DoE 2015)." From 2017 the Cussen Park camp has contained over 10,000 FF, and above 2,200 consistently since that year. Therefore, the camp does qualify as a nationally important camp, despite not yet being formally recognised as such on the Commonwealths Department of Agriculture, Water and Environment (DAWE) interactive flying-fox viewer. The number of FF at the Tatura camp (number 798) as detailed on the flying-fox viewer can be viewed in Figure 3.2. The viewer only contains data to 2019 and is conducted less frequently than monitoring conducted by Terry Court, and thus is not considered fully representative. Therefore, based on data available, the Tatura camp is likely to remain permanently occupied, possibly continue to increase in size and qualifies as a Nationally important camp for management purposes (Section 7.1.7).

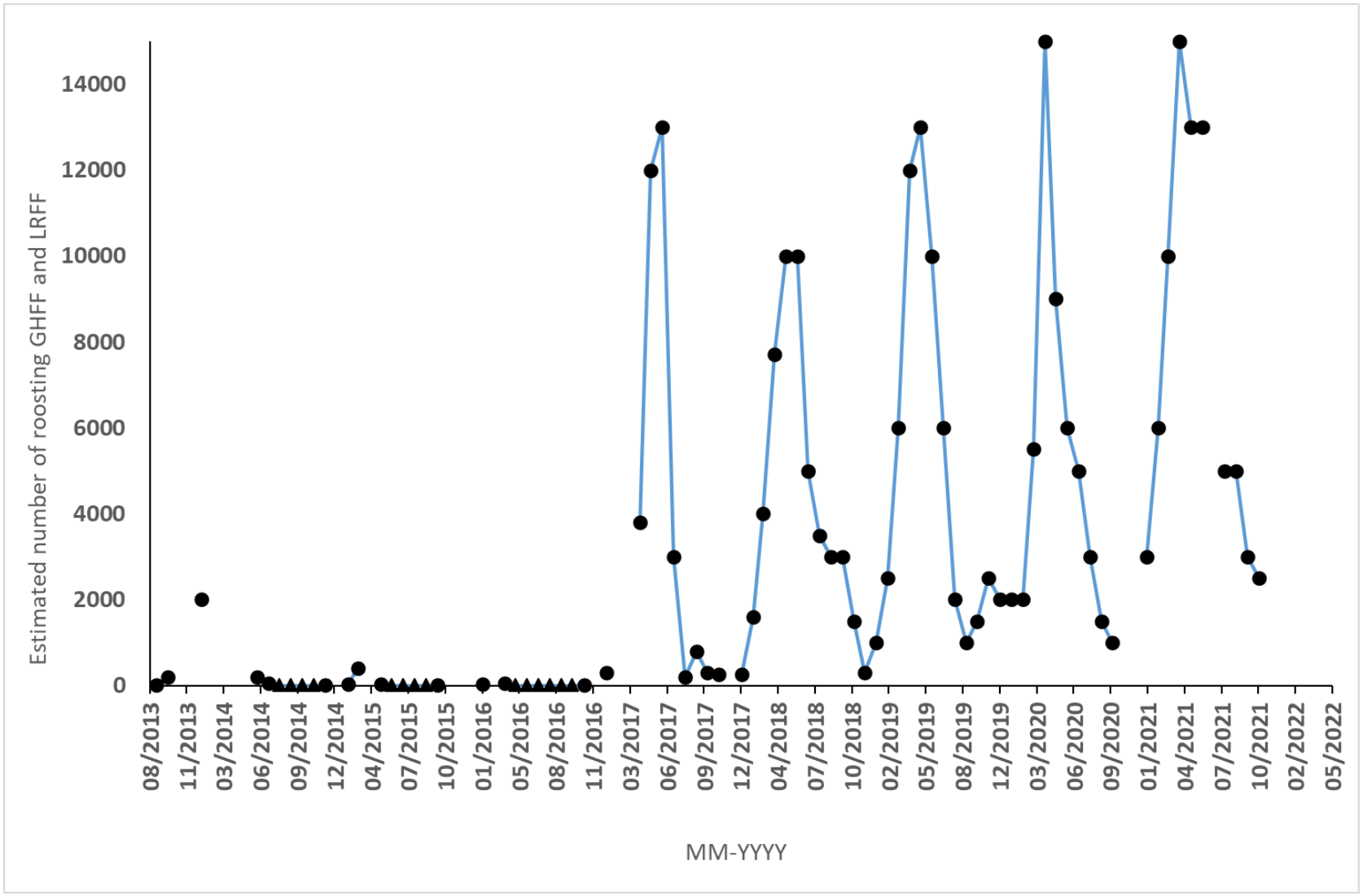


Figure 3.1 Maximum monthly camp numbers from 2013 to 2021.

Source: Weekly count data from Terry Court.

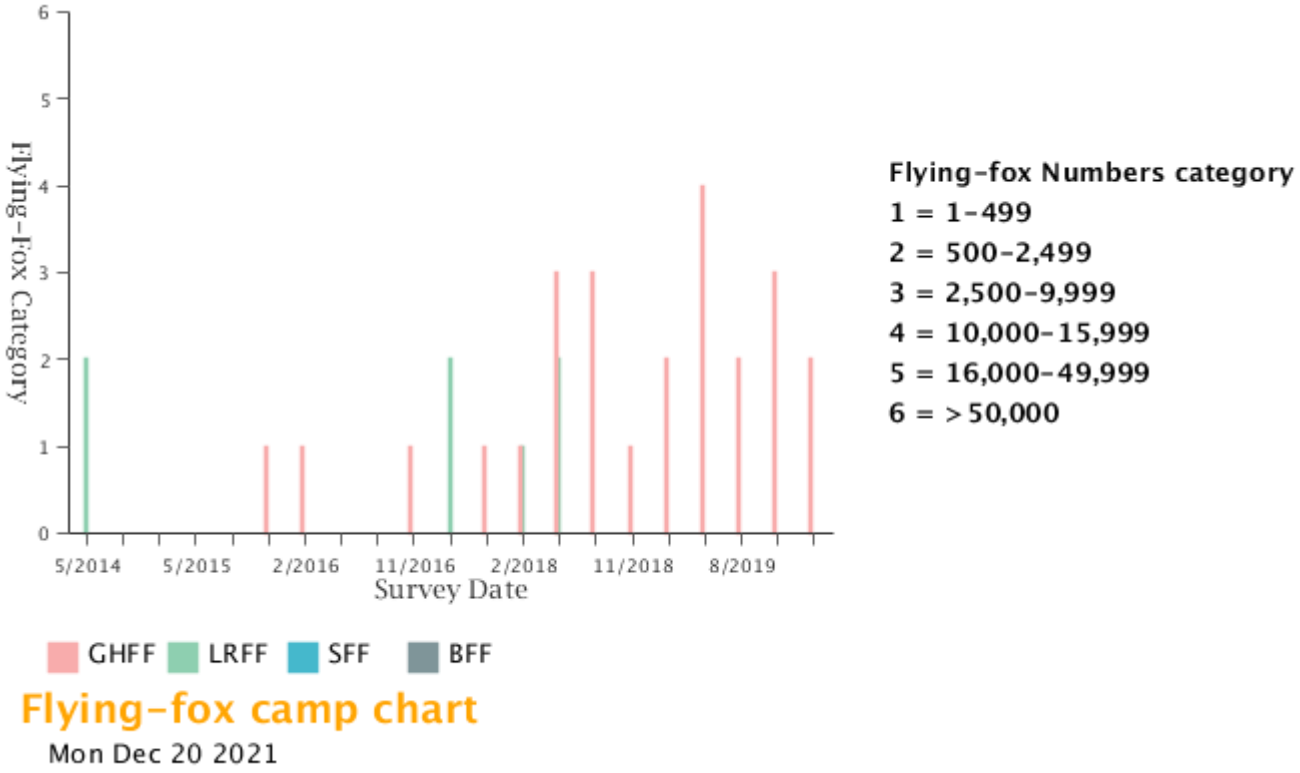


Figure 3.2 The Tatura camp (number 796), Cussen Park, camp numbers as detailed on the Commonwealths interactive flying-fox viewer (DAWE 2015).

3.1.2 Camp management

At present, there is no implemented management plan specific to the Cussen Park FF camp. However, Council do currently manage water levels within the Cussen Park waterbodies to provide support to the camp during the warmer months. Council utilises water entitlement from No.6/5 Irrigation Channel (usually 1-2 mL at a time) to maintain standing water in the Loop wetland when it hasn't been filled naturally by stormwater flowing through from the Margaret Street pumps. This usually happens at least once per summer, or 2 or 3 times depending on the season. Before the camp established at its current location, the Loop wetland was allowed to dry out during late summer and not managed.

A management options paper for the camp was developed in May 2017 (EII 2017). This was developed during the time when the camp first reached approximately 10,000 individuals, with the greater species proportion being GHFF. The management plan for Cussen Park was written prior to the arrival of the GHFF and they are not considered in that plan (Greater Shepparton City Council 2016a). The management plan divides the Park into management zones which can be viewed in Figure 3.3.

The Park is a Council owned asset and consequently Council has a range of roles and responsibilities with regard to the Park. Council manages annual maintenance requirements for the Park, including mowing and tree trimming. The Cussen Park Advisory Committee works with Council to manage the Park and are responsible for monitoring and providing advice to Council on Park health and to undertake strategic planning with Council.

The relevant local management plans:

— Management options for flying-foxes at Cussen Park, Tatura, Victoria; Final Report May 2017 (EII 2017)

— Cussen Park Environmental Management Plan 2016, including the Cussen Park Action Plan (Greater Shepparton City Council 2016a)

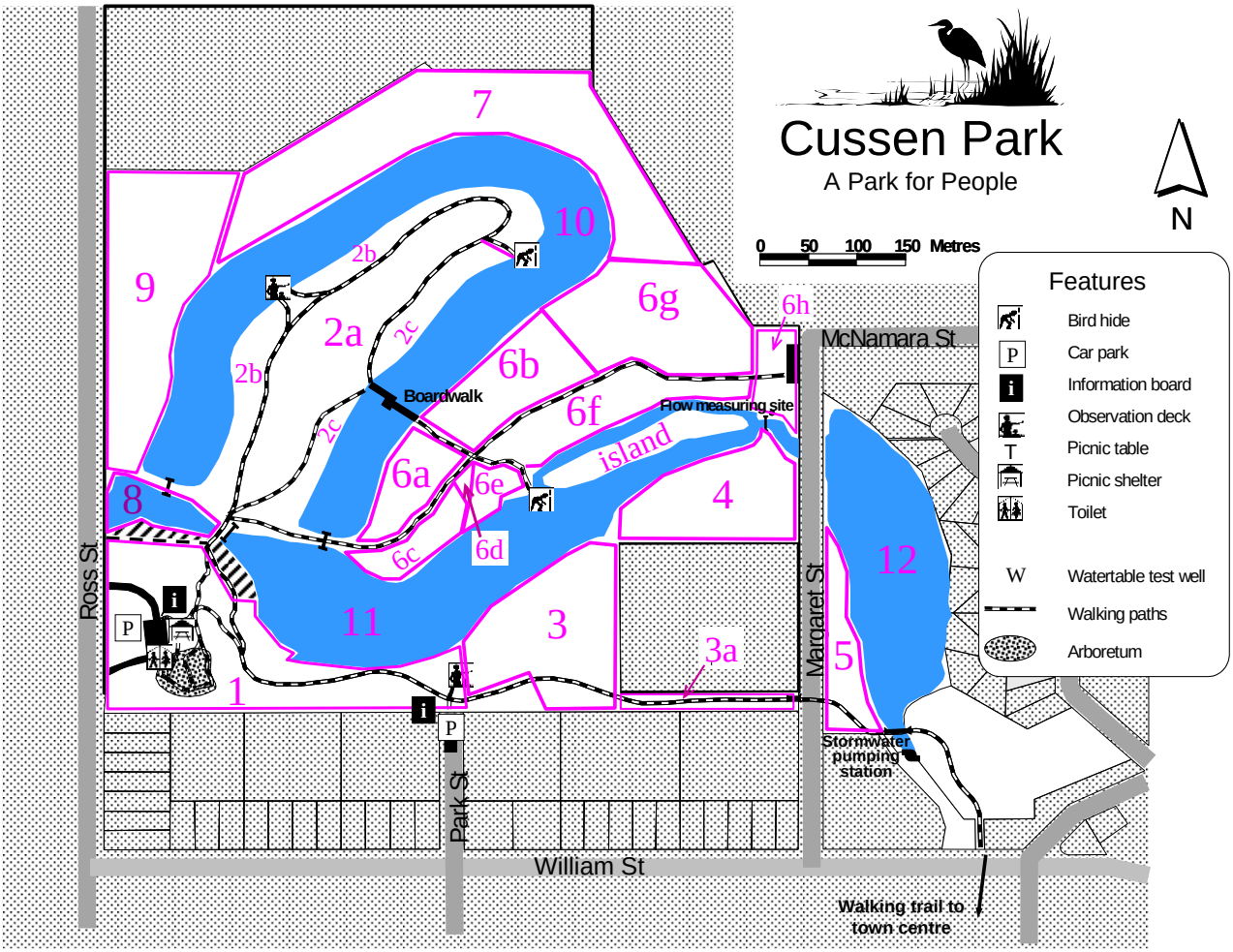


Figure 3.3 Management zones within Cussen Park. *Source:* Cussen Park Environmental Management Plan 2016, Greater Shepparton City Council (Greater Shepparton City Council 2016a).

3.1.3 Site assessment

The Cussen Park FF camp has historically roosted adjacent to the water body classified as management zone 10 and have resided mostly in management zone 2 (including sub-zones), 6g and 6b and 7 (Figure 3.4). During the site visit the camp mainly occurred within zones 7 along the irrigation channel and adjacent to the water body in zones 7 and 6g (Figure 3.5). GHFF were roosting within planted vegetation along the irrigation channel, where the canopy connects over the GMW vehicle access track to vegetation within Cussen Park (Figure 3.6). Other observation of note include:

— Heavy tree damage within the camp (Figure 3.7), and

— Evidence of a mown gap preventing FF from roosting in suitable trees in management zone 6g (Figure 3.8). The grassed gap is approximately 30 – 50 m from roosting FF.

The general camp extents depending on camp size can be viewed in Figure 3.4.

Cussen Park, Tatura

Figure 2
Flying-Fox Camp Distribution
in relation to Population Size

Legend

- Road
- Watercourse
- Cadastre

Population Size

- >~15,000
- 10,000 - 15,000
- GHFF ~2000 - 5000
- GHFF ~5000 - 10,000
- Minimum extent up to ~2000

0 30 60
Meters

Coordinate system: GDA2020 MGA Zone 55

Scale ratio correct when printed at A3

1:2,500 Date: 11-Jan-22

Data sources: DELWP 2022, WSP 2022

C:\Users\Angela.Sun\WSP O365\WSP O365\AU-WKG - Geospatial - AIS - Projects\PS126517_Cussen_Park_Grey\Mxd\PS126517_ENV_F002_FFCampDistribution_r1v1.mxd

Figure 3.5 The Cussen Park camp viewed from a bird hide facing north-east, during the site assessment. The camp resides in management zone 7.

Figure 3.6 The Cussen Park camp roosting along No. 6/5 Irrigation Channel on the 20th September 2021.

Figure 3.7 Evidence of tree damage by Grey-headed Flying-Fox roosting in planted Sugar Gums *Eucalyptus cladocalyx* on the 20th September 2021.

Figure 3.8 The mown grassed area within management zone 6g, between the Flying-Fox camp in trees to the right and the stand of trees to the left of the image.

3.1.4 Study area context

With the Cussen Park camp roosting along north-east section of the irrigation channel, the camp is adjacent to the 'proposed general residential area' of the Tatura Draft Precinct Structure Plan (Figure 1.2). The residential areas are proposed along the whole northern boundary of Cussen Park and the no. 6/5 irrigation channel. To the north-east of the Cussen Park boundary, existing residential housing is approximately 320 m from the minimum camp distribution extent (2000 individuals) (Figure 3.9). The closest existing residential housing, at Margaret Street and McNamara Street, is approximately 185 m south-east of the minimum camp distribution extent (Figure 3.10). Refer to Figure 3.4 for the camp distribution extents.

Immediately north and west (west of Ross Street) of the Park, agricultural paddocks dominate, with limited trees or suitable FF trees available. The named, 'Potential drainage basins,' within the PSP on the northern side of the Park, adjacent to the Park boundary. The existing waterbody (management zone 10) also continues, via a culvert under Ross Street, through farmland to the west of Cussen Park. Additionally, the town centre of Tatura is approximately 550 m south of the southern boundary of Cussen Park.

Local weather is also important for understanding camp behaviour and potential current and future FF-human conflict. When camp numbers are at their highest through Spring/ Summer, maximum temperatures average above 20 degrees Celsius (° C), with the highest temperatures observed in January and February at 44.8° C. Average rainfall varies between 32.3 mm and 46.7 mm, with a high of 46 mm in October. Tatura weather data (weather station number: 081049) can be viewed in Table 3.1.

Data from the local Tatura INST Sustainable AG weather station (Site number: 081049) shows that the majority of times wind typically blows from the South to South-west. This direction indicates that camp odour may be more detectable by the human nose within the town centre itself, rather than to the east or north-east where residential housing is closest to the colony. Although, the wind rose does highlight that wind direction also occurs north-east. The wind rose can be viewed in Figure 3.11.

Figure 3.9 View from Cussen Park looking north-east over the No. 6/5 Irrigation Channel towards an existing housing estate. The existing housing estate is approximately 230 metres from the irrigation channel.

Figure 3.10 On the left, the view of Margaret Street, facing north towards the junction with McNamara St. On the right, the junction of Margaret Street and McNamara St, facing south, showing the proximity of existing housing to Cussen Park to the right of the image.

Table 3.1 Average weather observations per month at the Tatura weather station

STATISTIC	MONTH												DATA PERIOD (YEARS)
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	
Mean maximum temperature (°C)	29.8	29.5	26.3	21.6	17.2	14.0	13.1	14.7	17.5	21.2	24.8	27.7	1965-2021
Highest temperature (°C)	44.8	44.8	39.6	35.0	26.3	21.5	22.5	26.0	33.7	35.6	42.1	44.0	1965-2021
Mean minimum temperature (°C)	14.3	14.5	11.9	8.4	5.7	3.7	3.1	3.8	5.4	7.6	10.3	12.4	1965-2021
Mean rainfall (mm)	33.7	32.3	34.1	34.8	44.4	43.9	47.6	46.4	42.5	46.0	39.6	34.8	1964-2021
Maximum wind gust speed (km/h)	94	85	81	85	80	100	83	94	97	76	89	94	2001-2021

Source: Bureau of Meteorology (bom.gov.au) – Tatura INST Sustainable AG weather station (Site number: 081049)

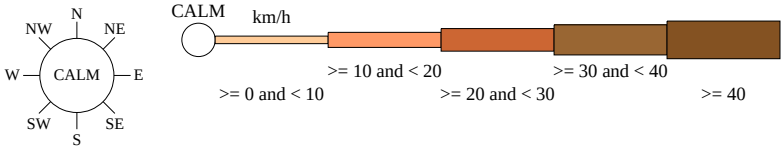
Rose of Wind direction versus Wind speed in km/h (01 Jan 1965 to 13 Aug 2021)

Custom times selected, refer to attached note for details

TATURA INST SUSTAINABLE AG

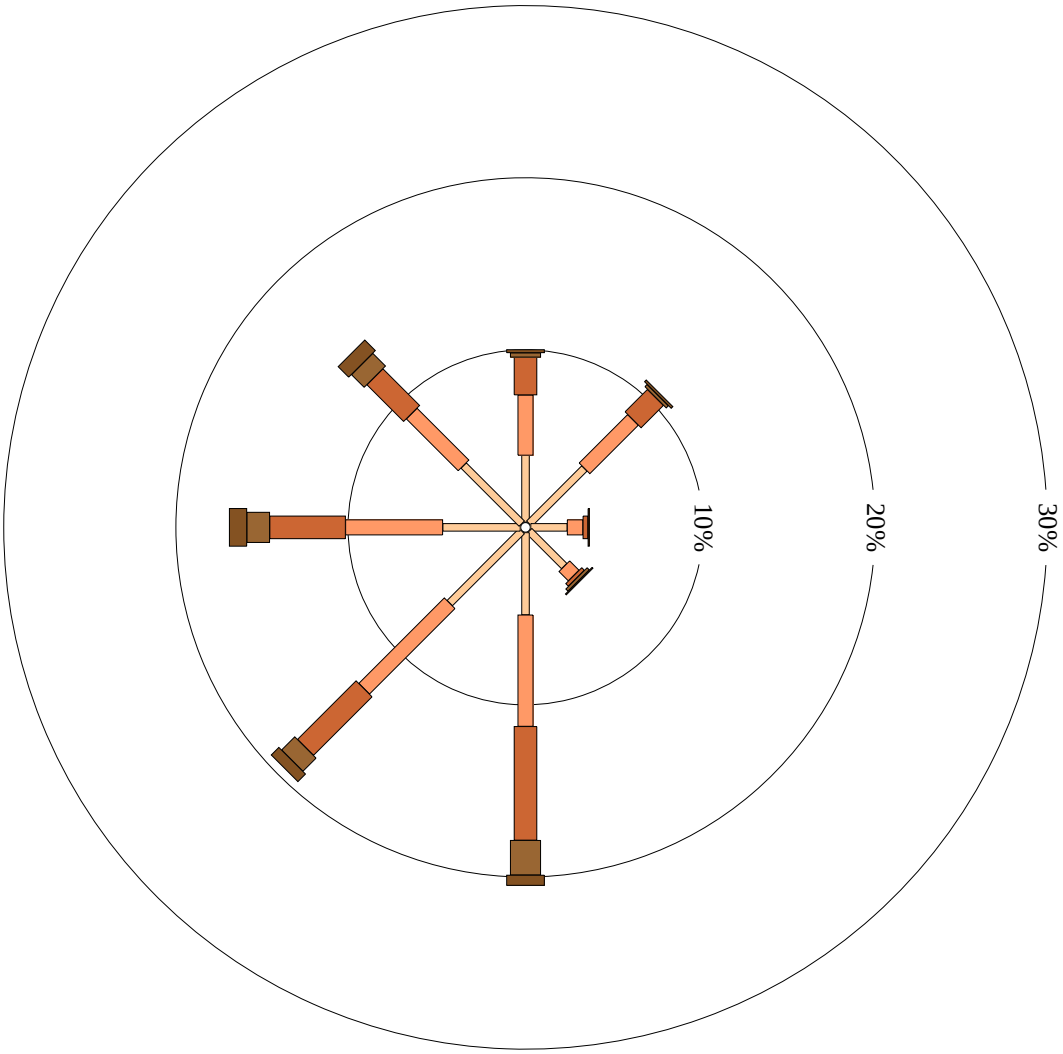
Site No: 081049 • Opened Jan 1942 • Still Open • Latitude: -36.4379° • Longitude: 145.2673° • Elevation 114m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm Nov
1447 Total Observations

Calm 1%



4 Flying-fox management considerations

4.1 Camps and fly-outs

FFs are highly adapted for activity at night with well-developed physical characteristics and senses for finding their food at night, including a strong sense of smell and large eyes particularly suited for recognising colour at night. FFs roost in 'camps/colonies' (i.e. groups of individuals) during the day to rest and leave (fly-out) the camp at dusk to forage (Welbergen 2006). GHFFs are significant contributors to forest health through long-distance seed dispersal (Timmiss et al. 2021) and pollination during their night-time foraging and when moving among camps (Eby, P. 1991; Timmiss et al. 2021). Studies have shown that they consume fruit, nectar, pollen, and other food sources from hundreds of species of plants across their range (Williams et al. 2006) and no other frugivorous or nectivorous species travel the same distances as frequently as FFs.

GHFF are vulnerable to mortality from numerous anthropogenic causes, including large-scale habitat loss, collision and entanglement with fruit tree netting, barbed wire fencing and powerlines, as well as collision with vehicles and direct persecution. An increasingly frequent cause of mortality is heat stress events. Thousands of individuals within camps and across regions can die when temperatures exceed 40–42°C (Welbergen et al. 2008), especially when these temperatures are reached on multiple consecutive days. These anthropogenic causes contribute to FF camp incursion into urban or peri-urban landscapes, where camps are often established in Parkland or Golf Courses where suitable roosting vegetation remains and where 'watering' of garden beds/vegetated areas can reduce temperatures or increase humidity (Parris & Hazell 2005; Yabsley et al. 2021). Similarly, LRFF cap site choice all correlates positively with 'greenness;' the greener the vegetation index the better, and closeness to water (Macdonald et al. 2021).

Flying-fox camps are important locations for sleeping, mating, raising young and social interactions (Connell, Munro & Torpy 2006) (SCC 2016) (DAWE 2021). Camps are typically located near food sources and waterbodies and increasingly in cities and towns. For several weeks in late spring and summer, roosts provide refuge during the day for lactating females and their young (Roberts, B 2012{Yabsley, 2021 #8456). During the night roosts are a safe refuge for flightless young while adults depart to feed. Camps vary in size seasonally and across camps numbers can vary from dozens to tens of thousands of animals (Westcott et al. 2018). The largest camp numbers in Victoria typically occur during Summer and Autumn, when FF migrate from northern Australia to find cooler weather.

GHFF roosts are highly socially structured (SCC 2016). Most roost trees are occupied by mixed-groups of adults, comprising of a single male, who scent-marks and defends a territory shared by one or more females and their dependent young. The roosting positions of individual animals are highly consistent and animals return to the same branch of a tree over many weeks or months. As such, FFs can be extremely resistant to relocation efforts. Alternatively, LRFF appear to enter camps of other FF species or establish camps transiently, including joining GHFF camps. This has been evidenced at the Cussen Park Camp where LRFF have entered the camp periodically.

4.2 Breeding season

Breeding seasons differ between GHFF and LRFF, with mating occurring between March and April for GHFF and between October and November for LRFF (DAWE 2021{O'Brien, 2003 #8465). A 'creche' period within a camp, where young are dependent on their mothers for food and care occurs between December and February (inclusive) for GHFF. During this period, FF young also learning to fly. Creche for LRFF occurs during July-September. Detailed information on critical breeding periods for both species are presented in Table 4.1.

Table 4.1 also denotes the level of risk that any management actions may have on the camp and young if implemented at a particular breeding or growth stage. Risk level has been assigned based on the likelihood of a significant impact

occurring to either species at that time. Risk level and the difference in breeding cycles between species should be considered when management measures are planned to be introduced.

For GHFF, evidence suggests that there is seasonal variation in the timing of breeding and growth stages. There may also be an overlap in the presence of flightless young being carried by their mothers, and young that are no longer carried, but still incapable of sustained flight. As such, breeding and growth stages should be monitored in real-time to inform management plans and to act accordingly.

Table 4.1 Breeding times for Flying-fox and the potential risk level if management actions are implemented

MONTH	BREEDING			
	GREY-HEADED FLYING-FOX	DISTURBANCE RISK	LITTLE RED FLYING-FOX	DISTURBANCE RISK
January	Young learning to fly	Medium		Low
February				
March				
April		Low		Medium
May				High
June				
July			Young learning to fly#	
August				Medium
September	Final trimester	Medium to high		Medium
October	Peak birthing	High		Low
November				
December	Young also learning to fly#			

Key:

BIRTH AND CARING FOR YOUNG (LACTATION)
PEAK CONCEPTION
PREGNANCY
YOUNG LEFT AT ROOST AND DEPENDENT ON MOTHER

Source:(Eco Logical Australia 2013; Ecosure 2020; SEQ Catchments 2012).

4.3 Flying-fox-human conflict issues

The main concerns associated with FF-human conflict include the following:

- Human health risk; Hendra virus, Australian Bat Lyssavirus (ABLV) or transmission of other diseases through faecal droppings
- Camp noise
- Camp odour
- Damage to vegetation: FF camps often damage roosting trees and strip them of leaves and smaller branches.

- Faecal droppings around residential housing or commercial buildings.
- The handling of injured or dead FF, particularly during heat stress events.

Conflict between local communities and FF can arise in a myriad of situations and contexts, including:

- At the camp: Establishment of new camps or rapid expansion of existing camps in parks used for a range of public activities (e.g., walking tracks, festivals, picnics etc) creates conflicts between users and FF, including concerns about impacts on vegetation and amenities.
- At the camp boundary: Occurs when residential or other neighbours are impacted by the noise, smell, faeces, or other disturbances emanating from the camp. In residential areas: where people interact with GHFF feeding in fruit trees or other trees in backyards, along streets or in parks and gardens.
- Across their range: wherever people interact with FF and are concerned about the risk of disease transmission, including the ABLV and Hendra virus from FFs to people, pets, and livestock. In commercial orchards: where GHFF feed on fruit and damage crops, reducing profits.

The severity of these conflicts varies over space and time and is likely related to distance from the camp, the time since camp establishment, the nature of the conflict and the level of knowledge and understanding of the community towards FFs. For example, concern about the risks associated with the transmission of zoonotic disease from GHFF to people, pets and livestock appears quite variable amongst community members (Currey et al. 2018; Kung et al. 2015). With the increased movement of FF and camp residencies into urban areas, FF-human conflict is set to increase (Timmiss et al. 2021).

4.3.1 Camp odour

FFs use chemical signalling (smell) to communicate within species (Nelson 1965; Wagner 2008). Male FFs have sebaceous (oily) glands on their necks, where they rub the secretion onto tree branches within camps to establish territories, particularly during the breeding season (Nelson 1965{DECC, 2008 #8469; Wagner 2008). The glands of male GHFF enlarge in response to elevated hormone levels (mainly testosterone) corresponding to the mating season, between January and April. This gland augmentation is also suspected to occur for other FF species (Klose, Welbergen & Kalko 2009{Wagner, 2008 #8466)}. Female FFs also have scent glands on their necks. Consequently, camps emit a distinctive odour.

Olfactory odour concentration data of FF camps is limited or absent (i.e., mostly unpublished). Camp odour can be dependent on species compositions, with LRFF smelling distinctively different from GHFF (pers. comm. Peggy Eby). LRFF also roost differently from GHFF; individuals roost closer together and roost lower down in trees, which may, along with other factors, increase the extent to which humans smell camps (pers. comm. Peggy Eby). The presence of LRFF in Queensland do increase public complaints about camp smell (pers. comm. Tyron de Kauwe). Although, the presence of LRFF coincides with (pers. comm. Tyron de Kauwe):

- their breeding season when gland secretion increases
- a higher influx of numbers
- their presence during wetter months, which may aerosolise the scent.

Camp odour is usually stronger or is smelt at a greater distance from a camp during:

- wetter periods or prolonged rain, where males remark their scents continuously.
- hot and humid weather conditions, and
- times of higher camp numbers (Summer - Autumn in Victoria).

Wind direction can also affect the strength of the smell, or the extent to which is it smelt by residents (i.e., if wind direction drives odour towards a town centre or residential development). At the National Flying-fox Forum 2021, Byron Reynolds, from the Port Macquarie Hastings Council, presented on the Kooloonbung Creek FF Camp Management Plan.

For the Plan, noted that odour increased due to rain and sprinkler irrigation only helped within 15 m of the roost, and at a further distance had a negligible impact on smell and noise. At the Forum, Dr. Justin Welbergen, also mentioned that misting increased humidity, which pushed roosting FF further out to the edge of the camp extent.

It is noted that camp odour is not caused by faecal matter at the base of a camp. Faecal droppings during fly-out may smell and is hard to clean.

4.3.2 Vocalisation

Flying foxes are highly vocal and use their vocalisations to socialise during daytime roosting and in night nurseries, as well as during fly-outs and whilst feeding. GHFF calls are often broadly classified into five different call types (Christesen & Nelson 2000). GHFF calls range between 2 - 8 hertz (Hz) (noting that the original study recorded in cycles per second (kc) prior to the replacement of the international system of units)) and some peak intensities between 10 - 13 Hz (Nelson 1964). Other studies on acoustic behaviour show that their calls are in the range of 2 - 6 kilohertz (kHz), with peaks to 8 kHz (Christesen & Nelson 2000). The dominant frequency of individual male courtship calls averaged 2.88 + 0.36 kilohertz (kHz) at two rural camps and 3.01 + 0.30 kHz at two urban camps. It is important to note that these are individual call recordings, rather than an assessment of camp noise as whole. The overall 'loudness' of an FF camp is dependent on the number of individuals in the camp, species composition and distribution. LRFF are more active, more easily disturbed and more vocal than GHFF (pers. comm. Peggy Eby) than GHFF, which may increase noise levels of a camp.

Studies on measuring the noise level of camps with GHFF or LRFF are limited. Camp noise has been recorded across five GHFF camps within New South Wales (Pearson, T & Clarke 2019). Average colony soundscape loudness, at 10 m from the vocalising FF, was measured 57, 59.3, 55.4, 61.7, and 56.6 A-weighted decibels (dB(A)), from highly rural to highly urban roosts, respectively (Pearson, T & Clarke 2019). Baseline background noise levels at each camp peaked at between 43.4 - 61.5 (dB(A). A-weighted decibels (dB(A) is an expression of the relative loudness of sounds in air as perceived by the human ear. For context, the VicRoads noise reduction policy states that traffic noise levels for new or upgraded roads should be restricted to 63 (dB(A) between 6am and midnight around residential dwellings (VicRoads 2005). The Greater Shepparton Planning Scheme doesn't specify noise volumes around residential developments but do mandate the cessation of construction noise at times of the day or night. As such, the likely noise level of GHFF camps at greater than 10 m distances are expected to be less than 61.5 (dB(A), and therefore, is under the VicRoads recommended traffic noise level near residential properties. The closest residential property from the Cussen Park camp at both its smallest and largest distribution extent is approximately 150 - 200 m.

At the National Flying-fox Forum 2021, Byron Reynolds, from the Port Macquarie Hastings Council, presented on the Kooloonbung Creek FF Camp Management Plan. Observation of the camp and community consultation indicated that noise was greatest upon return to the roost at dawn (around 4 am). Noise complaints were also received at greater than 50 m from the camp.

Additionally, current typical urban noise levels do not appear to alter the calling behaviour or mask noise level of GHFF, unless there is a an 'extreme' noise impulse, like a low-flying aircraft (averaged 70.75 dBA), where the noise level exceeds that emitted by an urban roost (Pearson, T & Clarke 2019).

4.4 Housing development implications

Increased urbanisation, such as new housing developments, can increase FF-human conflict, as well as potentially impact FF colony health and mortality (Jung & Threlfall 2016; Threlfall, Law & Banks 2012). Elements of FF-human conflict which may be exacerbated are discussed in Section 4.3. The risk of disease transfer to humans may increase, with an increase in human population and reduced FF proximity to woodland habitat, associated with increased spill-over of the Hendra Virus to horses in Queensland and northern New South Wales (Walsh, Wiethoelter & Haseeb 2017). Increased human population size and population proximity/ housing density to FF camps increases the possibility of harm to FF from anthropogenic causes, such as fruit-tree netting, barbed wire, powerlines, vehicle collision, domestic animals and window strikes (Jung & Threlfall 2016) (Threlfall, Law & Banks 2012). Medical records of 532 GHFF submitted to

Healesville Sanctuary and the Royal Melbourne Zoological Gardens between 2000 and December 2014, showed that anthropogenic factors were a major cause of GHFF admission to veterinary hospitals, with entanglement in fruit netting the most significant risk for FF (Scheelings & Frith 2015). The full extent of this is unknown, as most individuals exit the camp at dusk, however crèched young that remain in the camp at night may be impacted to some degree. It is also possible that the location of the camp could shift within Cussen Park or depart Cussen Park entirely in response to nearby developments, with flow-on effects to other areas of the park or neighbours, depending on where the FF move to.

Artificial light that alters the natural patterns of light and dark in ecosystems is referred to as 'ecological light pollution' (Longcore & Rich 2004). Types of ecological light pollution include chronic or periodically increased illumination, unexpected changes in illumination, and direct glare (Longcore & Rich 2004). Bats most often show avoidance behaviour as a result of light at night, meaning they may avoid well-lit areas due to an increased risk of predation (Longcore & Rich 2004). Reduced activity levels at night are also demonstrated (Jung & Threlfall 2016). For the Common Pipistrelle *Pipistrellus pipistrellus*, considered a light-tolerant species, activity at the city-scale in France was negatively impacted when assessing ground-based light (i.e., the location of streetlights) (Pauwels et al. 2019). Light at night also reduces bat activity around water, depending on proximity to woodland and linear connectivity (Ancillotto et al. 2019; Barré et al. 2021). Many of these studies show the impacts of artificial light on insectivorous bats, whereas research on the impact of light pollution on FF is limited. Although some studies of FF, suggest that light in urban areas may attract FF camps, due to increased light helping with navigation to a camp (Tait et al. 2014). Other studies assume that increased light nearby a camp may have similar negative outcomes to those of insectivorous bats (Jung & Threlfall 2016). However, in the case of the Cussen Park camp, with the introduction of an appropriate buffer zone between the camp and housing developments, increased artificial light within housing developments is unlikely to impact the camp.

As FF preferentially roost near water (amongst other factors) in urban and peri-urban environments (see Section 4.1), planning for the drainage basins will also be important. Insectivorous bats species richness and activity levels around water have been recorded to increase when woodland was within 1 km of a waterbody and when linear connectivity, such as natural banks (vegetated) or hedgerows were included at waterbodies (Ancillotto et al. 2019). Similarly, for FF, the addition of extra waterbodies nearby the existing camp may have the potential to increase camp numbers, if the area adjacent to the new basins are treed. Camp site preferences in LRFF has been characterised by distance to the nearest watercourse and "greenness" of a site, as opposed to local tree and shrub height or cover (Macdonald et al. 2021). Although, increases in food resources is more likely to encourage GHFF range or camp expansion, rather than the addition of new waterbodies (Williams et al. 2006). Planning vegetation plantings around these potential drainage basins will need to be considered as part of the Precinct Structure Plan and any future housing developments.

4.5 FF and climate change

An overarching consideration for FF management in Victoria is climate change, which will directly and indirectly affect the species through its influence on the future distribution, extent and quality of FF habitat and the frequency, intensity and distribution of threats (Parris & Hazell 2005). The challenges of climate change for FF include (Parris & Hazell 2005):

- Increased frequency, severity, and duration of extreme weather events, including heatwaves, droughts, floods, and storms.
- Increased frequency, intensity, and extent of wildfire, affecting camps and foraging resources.
- Rising sea levels, potentially affecting habitat in coastal regions.
- Changes to freshwater flows, levels, and regimes (including wetlands and estuaries), which may affect GHFF habitat.
- Changes in the composition of plant communities and the range of important habitat species, including food and shelter trees.

- Changes to plant growing seasons, including alterations to the timing and abundance of fruiting and flowering resources.

The greatest single threat of climate change on GHFF is extreme heat events where thousands of individuals within camps and across regions can die when temperatures exceed 40–42°C (Welbergen et al. 2008). The severity of heat events is exacerbated when these temperatures are reached on multiple consecutive days, when camps contain vulnerable cohorts (e.g., juveniles in December and January and adult males in February) and in camps with low levels of shade.

5 Community consultation

5.1 Committee workshop

Overall, the Committee Workshop offered great insights into the history and ecology of the Cussen Park FF camp. The main results and comments from the Cussen Park Advisory Committee and Tatura Community Plan Steering Committee Workshop on the current FF camp are presented in Table 5.1. Attendees emphasised that public education was going to be very important for the future management of the camp.

Table 5.1 Main results of the committee workshop

TOPIC	OUTCOMES
Camp size	— Typical minimum population size is about 3000 GHFF in Winter — In the last 3 out of 4 years the FF typically fly-out towards the south-east and south-west. — Extreme maximum count at about 16,000 in Summer for one or two weeks — It is possible that food availability i9s the main factor influencing local population size.
Camp distribution	— Camp spreads out further through the park during storms — Numbers can fluctuate weekly — No other roosting locations in town — FF enter the Golf Course at night only. It is hypothesised that the camp has not expanded here as there is a lack of large trees in the Golf Course — Roosting observed along Market Street if the camp is disturbed — Committee members haven't noticed any roosting in nearby properties on extremely hot days — Predicted potential camp expansion to the west
Camp odour	— Wind from west and south-west pushes odour to Charles Street and smell can be very strong — Odour within proximity to the camp likely is strongest on extreme heat days, which could be due to FF deaths.
Camp management	— Water-level in Cussen Park actively managed by Goulburn Murray Water with input by Council — Irrigation channel is managed by Goulburn Murray Water, who undertake tree maintenance along the channel for vehicle access — No future revegetation planned within Cussen Park, outside of that detailed within the Cussen Park Environmental Management Plan. — The gap in vegetation between the camp and the next set of trees (management zones 6b and 6g) is not planned to be treed and will remain a grassed area. — Regular mowing of grassed areas disturbs the camp, but they do not move roost.

TOPIC	OUTCOMES
Heat stress	— FF drink from the open water bodies in Cussen Park on extreme heat days — Deaths begin to occur when the temperature reaches approximately 40 degrees Celsius. No mass die-offs experienced to date at Cussen Park - typically 3 - 6 may die per day. — On extreme heat days the camp stays closer to water. — The main issue is that temperatures don't cool significantly over night in Tatura, so there's no relief from the heat for FF.

5.2 Online questionnaire

Out of the 117 properties contacted, 23 properties responded, inclusive of 24 individuals as some properties had multiple respondents. Most respondents used the Park "more than once a week" and the main activities they undertook were walking and bird watching (Table 5.2) Five respondents never used the park and two responses were left blank (Table 5.2). All respondent properties were aware of camp presence within Cussen Park, with a couple of properties noticing the FF fly-out at night. When asked if they liked having FF in the Park, 11 respondents said no, with two answers left blank (Figure 5.1), resulting in 11 respondents with a positive or neutral attitude towards the camp. Of the respondents with a negative attitude towards the camp, the concern was mostly around the FF eating the fruit in people's backyards, the smell associated with faecal droppings and the droppings themselves "which carry disease" and power outages believed to be caused by bats hitting the powerlines. The main issues around faecal droppings were its presence within people's properties and not being able to clean it or remove the staining. Attitudes towards the camp in relation to camp proximity can be viewed in Figure 5.1.

There was no clear relationship between hearing or smelling the FF camp from nearby properties and proximity to the colony (Figure 5.2). Most respondents could not smell the colony from inside their home or outside within their yard. Of those that could smell the camp from the outside of their property (four residences), the majority smelt the FF more than once a week. There was a slight discrepancy in the response count, with three properties responding 'no' to smelling the FF inside and outside of their property but answering that they smelt the FF either once a week or every few weeks. Odour from the colony was noted to be more noticeable on hot days during spring and summer. However, two properties did mention the smell was apparent during cold weather and didn't appear to be seasonal or weather dependent. Three individuals also noted that they could only smell the FF once within Cussen Park nearby the camp.

Most participants could not hear the FF from inside their houses but could hear them when outside within their backyards (Figure 5.2). Most residents who could hear the FF from their property, heard the FF more than once a week and suggested that the noise was more noticeable during summer and spring or hotter weather. Although, four respondents did mention they could hear bats more in colder weather or in autumn. Another 6 mentioned noise was more noticeable in any weather (hot or cold) and during most seasons, highlighting that the FF are possible heard throughout the whole year from certain locations within Tatura. Results relating to all odour and noise questions are summarised in Table 5.3.

Thirteen respondents, recommended measures Council could implement to protect the bat colony. These recommendations included the following:

- Leaving them be
- Planting more trees
- Community education
- Relocation, as numbers are increasing and there is less bird species in the Park
- Opening the tracks in summer for the FF to acclimatise to people walking past.

- Controlling numbers.

Others supported the current measures, such as closing access to the colony during spring/summer and thought the current measures adequate. Eight respondents did acknowledge that they did change their activities to accommodate the FF camp, where the actions were mainly moving inside during dusk to avoid the FF flying-out over their properties and potentially dropping faeces, or no longer going to Cussen Park.

The Communications and Engagement Team Report on the questionnaire can be viewed in Appendix A.

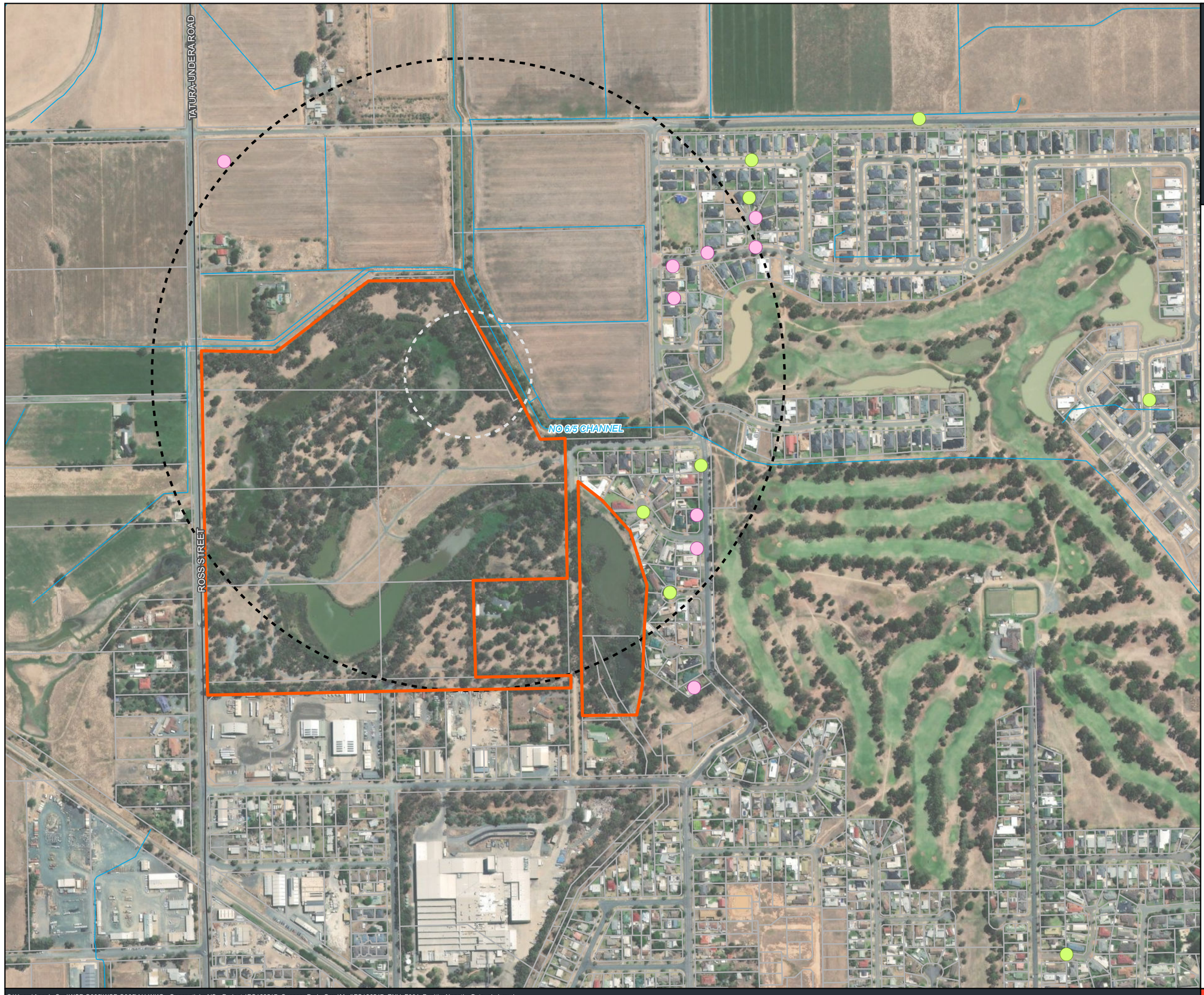
Table 5.2 Park usage of questionnaire respondents

QUESTION	RESPONSE OPTION	COUNT
How often do you go to Cussen Park?	Once a year	2
	Every few months	1
	Every few weeks	4
	Once a week	3
	More than once a week	7
	Never	5
	Blank	2

Table 5.3 Questionnaire results relating to odour and noise

QUESTION	RESULTS PER RESPONDENT
Can you hear the bats at Cussen Park when you are inside of your house?	— 9 out of the 24 individuals answered yes — 15 answered no
Can you hear the bats at Cussen Park when you are on your property outside? (For example, in your backyard)	— 14 respondents answered yes — 1 response left blank — 9 respondents answered no
How often can you hear the bats?	— Once a week: 4 — Never: 6 — Every few weeks: 2 — More than once a week: 10 — Every few months: 1
Can you smell the bats at Cussen Park when you are inside of your house?	— 21 answered no — 1 blank response — 2 responded yes
Can you smell the bats when you are on your property outside? (For example, in your backyard)	— 18 respondents answered no — 4 answered yes — 2 respondents left the question blank
How often can you smell the bats?	— Every few months: 1 — Every few weeks: 2 — Never: 13 — More than once a week: 3 — Once a week: 1

QUESTION	RESULTS PER RESPONDENT
	— Blank response: 2
Do you change your daily routine or activities when you can hear or smell the bats?	— 8 responded yes — 15 answered no — 1 blank response



wsp

Cussen Park, Tatura

Figure 1.2
Responses on whether residents have a positive or negative response towards the bats

Legend

Responses on whether residents have a positive or negative response towards the bats

- Positive towards the bats
- Negative towards the bats
- Cussen Park - 100m Buffer
- Cussen Park - 500m Buffer
- Cussen Park Boundary

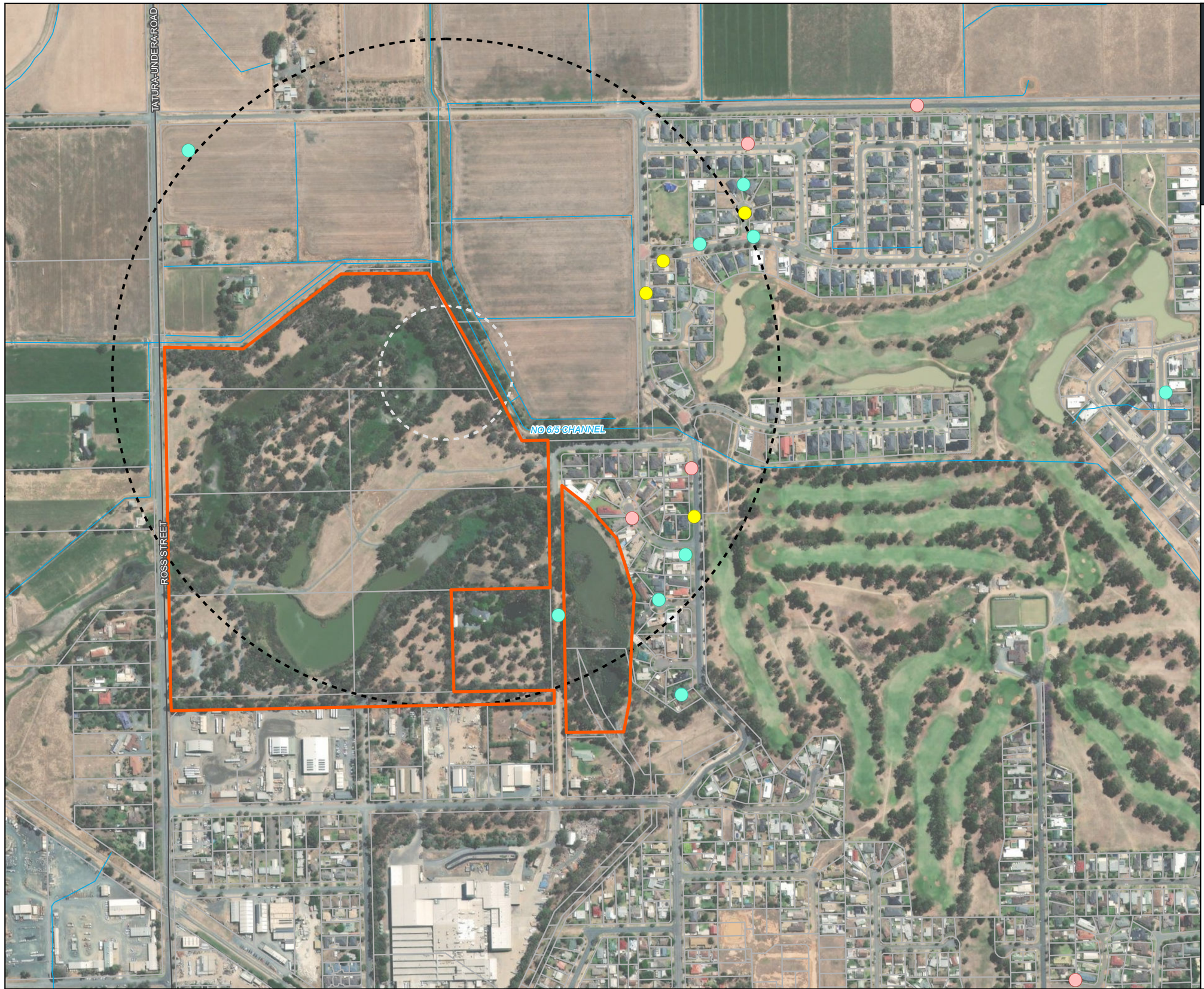
0 70 140
Meters

Coordinate system: GDA2020 MGA Zone 55

Scale ratio correct when printed at A3

1:5,800 Date: 13-Jan-22

Data sources: DELWP 2022, WSP 2022



Cussen Park, Tatura

Figure 1.1
Responses on whether residents can hear or smell the bats

Legend

Responses on whether residents can hear or smell the bats

- Can hear and smell
- Cannot hear and smell
- Can only hear
- Cussen Park - 100m Buffer
- Cussen Park - 500m Buffer
- Cussen Park Boundary

0 60 120
Meters

Coordinate system: GDA2020 MGA Zone 55

Scale ratio correct when printed at A3

1:5,500 Date: 13-Jan-22

Data sources: DELWP 2022, WSP 2022

C:\Users\Angela.Sun\WSP O365\WSP O365\AU-WKG - Geospatial - AIS - Projects\PS126517_Cussen_Park_Grey\Mxd\PS126517_ENV_F003_HearSmellBats_r1v1.mxd

6 Literature Review

Many FF management plans are now in place across Queensland, NSW and Victoria and are implemented by local Councils and other camp managers to manage the camp and mitigate FF-human conflict. The following section reviews these management plans to determine the most appropriate management framework for the Cussen Park colony.

Note that most of the strategies and options described in this section of the report have been developed and applied to situations where:

1. A camp has recently established in an area surrounded in proximity by houses, creating immediate conflict, and
2. An existing camp with relatively small numbers surrounded by houses has suddenly grown in size or extent, creating conflict.

The context of the Cussen Park camp is different to the above because most surrounding houses in close proximity are yet to be built, and many of the strategies below become relevant if the conflict can't be avoided at the land-use planning stage (i.e., developing the PSP). The most efficient and cost-effective approach, therefore, for the Cussen Park Camp is to develop effective buffers that avoid conflict from beginning and the need for these often ineffective and piece-meal strategies that are applied retroactively.

6.1 Camp buffer zones

A camp buffer is a zone or area around FF camps where specific management actions are undertaken to reduce impacts of FF to adjacent properties or land uses. The implementation of buffer zones, also called management zones, surrounding FF camps are not always possible, with FFs camps moving into established urban or peri-urban landscapes, which are already surrounded by residential housing or vegetation (Timmiss et al. 2021). Where possible, buffers have been implemented for FF camp management and are seen as one of the most useful management measures to mitigate FF-human conflict around camps (Currey et al. 2018). Buffers can reduce noise and odour levels entering residential housing and reduce negative FF-human interactions. Camp buffer zones are more often vegetation free areas surrounding FF camps, where existing vegetation is removed create a buffer, or a buffer is created via other deterrents, such as sprinklers, noise, or smoke. Successfully using deterrents to create buffer zones has been found to be rare across management plans (Currey et al. 2018). Options for creating buffer zones are presented in Table 6.1.

Table 6.1 Options to create camp buffer zones

OPTION	HOW IT WORKS	NEGATIVES
Vegetation removal (Roberts, BJ 2006)	Remove vegetation from the intended buffer area to make it unsuitable for roosting Measures can include: — Clearing the understorey or removing the lower limbs of trees, Flying-foxes (FF) may be deterred from occupying areas close to residents. — Removing trees taller than 5 m at the border between residential areas and roost sites to ensure FF will not roost within the buffer zone.	— Can increase visibility into the camp and noise issues — The removal of native vegetation may not be appropriate at all sites (i.e., where there is ecological or amenity value). In addition, under- and mid-storey vegetation should be retained in the buffer area of camps that are known or likely to be affected by heat stress events as FF can take shelter in these areas.

OPTION	HOW IT WORKS	NEGATIVES
	— Reducing the availability of suitable foraging blossom has been found to reduce FF numbers (Mo 2020).	
Vegetation planting	Plant vegetation between conflict area and the camp (i.e., low growing or spiky plants) to create a visual buffer or to make areas of the camp inaccessible to humans	— None found to be recorded or admitted
Installation of permanent/semi-permanent deterrents	A useful option for when vegetation has high ecological or amenity value. A few options include: — Visual deterrents (bags/Fluro vests/balloons) — Noise deterrents — Smell deterrents (effectiveness unproven) — Canopy mounted water sprinklers.	— The type and placement of visual and noise deterrents would need to be varied regularly to avoid habituation – noise and smell deterrents may also disrupt residents. — Visual deterrents may lead to increase rubbish in the natural environment — Canopy mounted water sprinklers can be logistically difficult and cost prohibiting. Design also needs to consider animal welfare and site features.
Noise attenuation fencing	— Useful for when camp is close to residents and can also assist with odour reduction. — Avoids the need to modify habitat values.	— Expensive to install — Visually unappealing in public settings (i.e., blocking residents views or Park views)
Attraction of the colony to an alternative roosting location (Roberts, BJ 2006)	— By planting trees and creating an understorey in areas away from surrounding residents, it may be possible to entice FF to occupy other areas, away from residents. Can include moving colony to entirely new camp or moving colony to area within same park but further from houses.	— This potentially transplants the conflict issues if the alternative roosting location is chosen poorly (i.e., a camp moves to another urban area where houses are present — Intensives works, which may not be successful

Source: (DPIE 2019)

6.1.1 Buffer size

For this section, it is important to highlight that there are limited instances where camp buffers have been implemented proactively. During the literature review, most cases found retroactively implemented camp buffers as FF-human conflict arose. The context of the Cussen Park camp is different to most camps because most surrounding housing near the camp are yet to be built. Many of the known FF-human conflict mitigation strategies only become relevant if the conflict can't be avoided initially at the land-use planning stage (i.e., when developing the PSP). Council, have, therefore, a unique opportunity to proactively put in place a camp buffer, which avoids the need for often ineffective and piece-meal secondary mitigation strategies.

A review of urban FF camp management measures found that the creation of a buffer via vegetation removal was considered the most effective action for managing camps and reducing FF-human conflict at a camp (Currey et al. 2018).

However, it is important to note, for this section, initially, that no evidence was found of the implementation of a proactive camp buffer (i.e., implementing prior to housing development), which Council has the opportunity to undertake. The research available and described below is collated from cases where buffers were introduced retroactively and were undergoing FF-human conflict. As such, Cussen Park provides an opportunity for a buffer to be as big as it needs in order to prevent FF-human conflict from starting.

The distance required to create an adequate buffer for mitigation of FF-human conflict is debated, and unlikely to eliminate conflict completely in areas with limitations on available space. The 2009 Draft National Recovery Plan for GHFF recommended that conflict be reduced through buffer zones (Department of Environment Climate Change and Water NSW 2009). Where camps were in remnant vegetation, it was recommended that they be isolated by a > 300 m wide management zone and the management zone should be included in the definition of the camp extent. The buffer zone was recommended to include the following parameters:

- Be free of habitat suitable for roosting by FF (cleared land, low shrubs, or isolated trees),
- Residential development, schools and other structures be excluded, and
- Where possible, the area of vegetation defined as a camp should be large enough to accommodate influxes of migratory animals and enable the colony to change location.

However, the Final National Recovery Plan published in 2021 does not specify buffer distances.

Multiple management plans and research have suggested that an ideal buffer between a FF camp and residential housing is at least 300 m wide (Roberts, B 2012; Roberts, BJ 2006; SEQ Catchments 2012 {DPIE, 2019 #8501). A buffer greater than 300 metres is likely to fully mitigate amenity and public conflict impacts (DPIE 2019). Although, in most cases, a 300 m wide buffer is not possible because existing land-uses prevent effective implementation of such large distance. At Coffs Harbour a buffer of 60 m has been used, and is proposed to be increased, and at the Yarra Bend Camp in Melbourne a 250 m buffer was implemented (DSE 2005; Roberts, BJ 2006). The Queensland FF Roost Management Guideline showcases FF management plan case studies utilising smaller buffers for both noise and smell reduction ranging from 10-30 m (DES 2020b). The use of several vegetation-free buffers up to 18 m wide at the Coffs Creek camp has been deemed successful at reducing FF-human conflict (Table 6.2)(Roberts, BJ 2006). Alternative measures, such as Sunshine Coast Council (SCC) mounting sprinklers at canopy height to create a buffer of around 30 m has also been successful (SCC 2016). Another Council used flood lights at a nearby school to prevent FF roosting within the grounds at night (DES 2020b). However, the usefulness of a buffer to mitigate odour and noise impacts generally declines if the camp is within 50 m of human habitation (DPIE 2019) (SEQ Catchments 2012) Research suggests that a buffer of 10 m can reduce odour impacts, but a larger buffer is required to reduce noise complaints (Pearson, TC, K. 2018) and in many cases, smaller buffers have been combined with other management measures to reduce noise or smell, such as double-glazed windows. As such, any buffer will assist in FF-human conflict and should be as wide as the site allows (DPIE 2019), and attempt to create a buffer zone of at least 100 m (Roberts, BJ 2006). Examples of other management plans using buffer zones are presented in Table 6.2.

It is generally recognised that when implementing buffers for FF the following factors should be considered (Roberts, BJ 2006; SEQ Catchments 2012):

- Variability of use of a camp site by FF within and across years. Buffers should cater for larger, seasonal influxes of FF, as these often trigger increased conflict.
- The buffer area should consist of unsuitable FF habitat, comprised of either cleared land, rivers or open space, low shrubs, or small isolated trees (< 3 m height).
- Consideration of topography and prevailing wind direction will assist with determining where compromises can be made.
- The buffer zone should be included in the definition of camp extent and the buffer zone must commence from the outer limit of the camp extent during seasonal fluctuations or influx of another species, like the LRFF.
- Residential development, schools and other structures are recommended to be excluded from buffer zones.

Another option when considering buffer zone size is the classification of camps via a risk level. Following the amendment to the *Nature Conservation (Wildlife Management) Regulation 2006*, Ipswich City Council put together a FF Roost Management Plan that identifies a 'roost risk hierarchy' (High, Medium, Low) comparing location to human conflict risk (DES 2020b; ICC). High risk roosts are considered to have high FF-human risk, with the potential to have considerable adverse implications for the local community (ICC). High risk roosts are those that are located on Council owned or managed land within 100 metres of sensitive public facilities, such as hospitals, or schools. Medium risk roosts are more than 100 m from a sensitive facility and within 50 m of residences or commercial residences, horse pastures or public facilities like toilets. Low risk roosts are those that are greater than 100 m and 50 m from the constraints. More intrusive roost management actions, such as significant vegetation removal, dispersals, or relocations, are acceptable measures for managing high risk roosts. The Plan also defines 'preferred roost locations,' where a highly preferred location for FF roost establishment in Queensland would be (ICC):

- Greater than 100 m from a sensitive facility
- Greater than 100 m from any place of residence or commercial facility
- Greater than 100 m from an area where horses commonly graze
- Greater than 100 m from public facilities such as barbeques and toilets; or
- On a Protected Area declared under the *Nature Conservation Act 1992*.

Under these criteria, the Cussen Park Colony would currently be classified as a low-risk roost, with the closest residences approximately 130 m away, the local Primary School approximately 1.5 km south of the camp and the local Medical Centre about 1 km south. Currently, it would also be considered within a 'preferred roosting location.'

Similarly, the SCC mapped the region for suitable FF roosting habitat, and determined that of the suitable roosting habitat available (SCC 2016):

- 27% was a potentially high conflict zone, being within 100 m of a building.
- 26% was a potentially medium conflict zone, within 100 – 300 m from a building
- 47% was a potentially low conflict zones, more than 300 m from a building.

Based on these results, roosting habitat was classed into zones based on its proximity to building structures, based on an understanding that 300 m was a sufficient management zone for FF. The zones were as follows (SCC 2016):

- Zone A - habitat within 100 m of a building structure
- Zone B - habitat between 100 m and 300 m of a building structure
- Zone C - habitat outside of 300 m from a building structure.

The proposed drainage basin as part of the Tatura SP presents an opportunity for inclusion of a buffer zone between future residential housing and potential camp expansion to the north and north-east of the camp within Cussen Park. Recognising that a 300 m buffer is not likely possible, with existing housing approximately 250 m and 130 m from the camp and community responses indicating conflict is present at these distances, a buffer of at least 150 m, incorporating the drainage basins is recommended. The buffer can also include proposed road widths, public open space, footpaths, and the irrigations channel.

Table 6.2 A sub-set of example Flying-fox management plans incorporating camp buffer zones

MANAGEMENT PLAN	BUFFER ZONE DISTANCE (M)	OUTCOMES
Mitchell River Revegetation Program - Bairnsdale Grey-headed Flying	— Plan to stage the replacement of existing non-native vegetation with native vegetation over several years to develop a buffer between the camp and residents.	— Staged removal limits stress levels on GHFF and allow suitable placement of the colony in surrounding vegetation.

MANAGEMENT PLAN	BUFFER ZONE DISTANCE (M)	OUTCOMES
Fox (GHFF) Roost Site	— The first stage of tree removal was to create a 50 m 'no roost opportunity' buffer between the camp and adjacent houses.	— Schedule works to occur when GHFF are absent from the roost site or when they occur in smaller populations.
Flying-fox (FF) Campsite Management Plan – Yarra Bend Park (DSE 2005)	Goal was to maintain a 250 m buffer from the closest resident, achieved through attracting the colony away from housing by using following measures: — Mass tree planting to attract the colony to specific areas. — Construction of wetlands and artificial roosts. — Selective pruning and thinning of a narrow strip of trees along the Yarra River, to create a physical buffer that stops GHFF inhabiting areas close to residents.	— Impacts, especially noise, can occur when the colony extends to within 150 m of houses. — At the Royal Botanic Gardens, the colony was about 200 m from the nearest residence and few problems with adjacent landholders were experienced.
Coffs Creek camp – Coffs Harbour Flying-fox Camps Strategic Management Plan (Eco Logical Australia 2017).	Surrounding low density residential properties neighbouring the FF camp vegetation free buffers were established, including — Zone 1: 6 m wide. — Zone 2: a moderate amount of vegetation is present within the 5 m buffer, but the easement widens to 8+m in sections. — Zone 3: a significant amount of vegetation is within the 5 m buffer but the easement extends to 15 +m in this Zone.	— These buffer sizes are considered adequate as the number of properties adjacent to the camp are not likely to have increased significantly and there has been no additional residential development within 300 m of the camp since 2007.
Ku-ring-gai Flying-fox Reserve (Larsen et al. 2002)	Planning to create at least a 50 m buffer for the Ku-ring-gai site and emphasises the need for community engagement.	— A strong trend suggests that distance from the houses to the FF colony may be an indicator for attitudes. Respondents living more than 100 m from the edge of the colony were shown to have predominantly positive attitudes to the colony and by far the biggest group of people with neutral opinions to FF. — Those living closer than 50 m to the edge of the colony reported the most negative attitudes.
Maclean Rainforest Reserve flying-fox campsite (West 2002)	— No buffer zone implemented. — Maclean Shire Council constructed two school buildings directly adjacent to and abutting the FF camp within Maclean Rainforest Reserve. — The approved Development Application made no mention of the FF camp. There	— The lack of planning and lack of a buffer zone, brought people into conflict within the FF. — Community conflict that arose in the areas surrounding the campsite for several years.

MANAGEMENT PLAN	BUFFER ZONE DISTANCE (M)	OUTCOMES
	were no planning requirements that would have allowed Maclean Shire Council to reject the application.	
Grey-headed Flying-fox Management Strategy for the Lower Hunter (GeoLINK 2013)	— Most of the areas identified for future development in the Lower Hunter Regional Strategy are further than 300 m from the nearest known GHFF camp – except for one. — For this one camp, careful vegetation management, and the implementation of a supporting buffer was recommended to be considered early during the design and planning of the development of this site, including excluding trees reaching over 3 m in height and instead landscaping with sedges and rushes.	— Looking at historical locations of FF camps can provide further information about the future risks of conflict between residents and FF. — Sites used historically as camps could be revegetated and appropriately buffered to attract FF if current and future surrounding land uses are compatible. — If land use is now incompatible with a camp, such as adjacent residential housing, development of these sites to be suitable for FF roost should not occur, or stringent vegetation control measures applied through planning controls such as Development Control Plans, such as the inclusion of Vegetation Management Plans.

6.1.2 Expert advice

Comment on appropriate buffer sizes was sought from FF experts. The consensus was to err on the side of caution with a buffer of 300 m, which had also previously been based on the view of member of the GHFF Recovery Team and camp-based results at Gordon, Coffs Creek, Maclean, Wingham, Dallis Park (pers. comm. Peggy Eby). The 300 m buffer was most often suggested when experts were asked to recommend buffers for inclusion into planning schemes (pers comm. Tyron de Kauwe). Port Macquarie Council recognised that over 100 m would be suitable for noise mitigation based on the acoustic monitoring associated with their subsidy trial (pers. comms. Tyron de Kauwe). At the National Flying-fox Forum 2021, Byron Reynolds, from the Port Macquarie Hastings Council, presented on the Kooloonbung Creek FF Camp Management Plan. For the Plan, a 100 m buffer was deemed adequate However, there was a consensus that there was not a minimum distance that would 'guarantee no conflict.' Some unpublished research showed there was no correlation between distance from roost and 'level of botheredness' by residents (pers. comms. Tyron de Kauwe).

6.2 Faecal droppings

Reducing the amenity impacts of faecal drops is constrained by the location of existing land uses, especially if houses or parkland is within the fly-out flight path of the FF at night. It is also hard to mitigate if food sources are present throughout the town and the FF are feeding in people's backyards. Identification of the affected property owners (as evidenced within the community consultation) is vital to ensuring reduced conflict, as it identifies properties that require physical modifications (Eco Logical Australia 2013). Considering local public concerns relating to faecal matter, a component of any community education plan should focus on this topic, as well as Council offering nearby property owners' options for structural modifications. Modifications commonly proposed within management plans include (Eco Logical Australia 2013, 2017; Ecosure 2016):

- Carports over vehicles

- Shade cloth or pergolas in areas affected by faecal drop, such as over outdoor sitting areas or barbeques.
- Double-glazed or laminated windows for ease of cleaning.
- Coating surfaces to allow easier cleaning.
- Pool covers.
- Provision of a gurney for regular cleaning.
- Food-tree removal from yards.
- Clotheslines covers.
- Landscaping vouchers to create anti-FF roosting gardens.

There is limited quantification on the success of these measures, but used in combination with other measures, can reduce FF-human conflict. Similar modifications can also be applied within Cussen Park. Additionally, FF-friendly fruit trees netting should be offered where residents do not want to remove potential foraging trees. It is important to note that these are secondary mitigation measures and may to be required if adequate camp buffer zones are implemented.

6.3 Power outages

Power outages can result from foraging FF being electrocuted, and power outages were noted as a concern during community consultation. At the National Flying-fox Forum 2021, Linda Collins from the Fauna Rescue of South Australia Inc., presented research on electrocutions by FF in Adelaide, noting that juvenile FF were particularly susceptible to electrocution by powerlines. The National Recovery Plan highlights powerline electrocution (Recovery Objective 9) as an important consideration when managing FF, recommending consideration of undergrounding powerlines or increasing spacing between cables during the planning stage of new developments (DAWE 2021). However, effective powerline mitigation measures are more understood for bird species, over FF, with perching and collision deterrents, such as flagging, considered highly effective (T-PVS / Inf 2003).

General measures to reduce FF electrocutions include have been presented in the Batemans Bay FF Assessment (Ecosure 2016) and include:

- Bundling aerial cables
- Increasing spacing between cables
- Converting overhead cables to underground
- Re-routing cables away from high-risk areas
- Managing foraging resources and restricting access to water sources around powerlines to reduce localised flying-fox activity
- increasing visibility of powerlines with flagging or similar.

Design of powerlines and their location should be considered during the design phase of any housing developments proposed near Cussen Park.

6.4 Other odour and noise mitigation

Alternative mitigation measures for noise or smell can include physical modification of buildings. For instance, the following modifications are often recommended:

- Acoustic/ thermal batts for sound proofing
- Closed widows and provision of air conditioning for preventing odour entering

- Window double-glazing and noise proofing, such as lamination
- Vegetation barriers, such as hedging, or berms, as noise barriers
- Smell neutralizers.

At the National Flying-fox Forum 2021, Byron Reynolds, from the Port Macquarie Hastings Council, presented on the Kooloonbung Creek FF Camp Management Plan. Byron highlighted that window glazing and noise proofing of windows was successful for mitigation noise, but an Acoustics Assessment of the camp was critical to informing the extent of glazing or noise proofing required. The Council also offered subsidies for increases in water and electricity bills associated with extra cleaning or increased use of air conditioning. Around $50-$100 subsidies were provided, which saw no long-term change in attitudes towards the FF camp. It was suspected that the subsidy offer was too small to have a meaningful impact to bill costs, noting that some people were offended by the offer. At the Forum, Lindsay Delzoppo from the Department of Environment and Science in Queensland, discussed the establishment of an FF management grant program with Councils, which would help to pay for direct to the public mitigation measures such as these. It is recommended that housing already 130 m or 250 m away from the camp are at a sufficient distance not to require subsidies, and if the new buffer can be implemented appropriately subsidies aren't likely to be required.

At the National Flying-fox Forum 2021, an FF Odour Neutralising Trial was also presented. In 2018, Ecosure assisted Eurobodalla Shire Council in developing the Eurobodalla Flying-fox Management Plan and part of the plan was to trial the use of odour neutralising systems as potential tools for helping address public odour concerns for houses that backed onto the colony. It also evaluated feasibility relating to financial affordability and practicality. The proposed odour neutralising system was found to be financially feasible, but community acceptance was not guaranteed. The trial the neutralising systems comprised of testing:

- An indoor system – small, inexpensive Hostogel™ pots with a gel-based neutralising formula to neutralise flying-fox odour.
- An outdoor system – misted or vapourised neutralising formula (QuickAir™0900V diffused via a Vapourgard™ unit).

It was found that the main issue for the community and determining the success of the systems was the smell of the neutralisers themselves, where the smell mixed with camp odour and created another layer of artificial odour itself.

6.5 Housing development design

Proposed future housing developments near Cussen Park can design and plan for reduced FF-human conflict. The proactive design of new housing to avoid FF conflict with residents within the Tatura PSP, has the potential to completely avoid conflict from the start of PSP implementation, rather than waiting for conflict to arrives in the future. Implementation of both a camp buffer and FF housing standards, can also minimise future costs for Council.

In addition to measures listed in Section 6.2, 6.3 and 6.4 that should be considered during the design phase of housing developments in Tatura, potential mitigation measures that can be implemented for newly developed housing can include (Roberts, BJ 2006):

- All new homes have acoustic batts installed in the walls. This material is relatively cheap to install and are frequently used in houses to reduce highway and aircraft noise.
- If an adequate buffer cannot be created, consider constructing a sound barrier around the camp. An acoustic assessment at the camp would be required, but other research suggests that simply constructed plywood or a similar material would be effective. Suitable height for FF is not known, but wall height could follow general noise wall height recommendations used for highways. This will have ongoing maintenance costs and has aesthetic and visual issues and is not recommended as a first option.
- For public amenity, paving or concreting in areas that are used frequently make flying-fox droppings easy to remove by hosing down. Councils should undertake regular cleaning of communal areas.

- Financial contributions by the developer could be an option to cover the cost of implementation of Management Plans or cleaning.

Signage within Cussen Park and nearby housing development will also help to improve attitudes towards FF. At the National Flying-fox Forum 2021, Hugh Pitty from the Friends of Glebe Wetlands in Bega, highlighted that signage was very important in improving FF-human relations. Signage and other information should be provided at Cussen Park to accurately explain the real health risks and advise what steps need to be taken if dead/injured flying-foxes are found and what to do in the case of getting bitten or scratched. The wording should not be alarmist and should be part of an overall education and engagement package that also includes information about their important ecological role and fascinating facts about their ecology and biology.

A summary of options for design considerations and physical building modifications, presented throughout this literature review are presented in Table 6.3.

Table 6.3 Options to reduce FF-human conflict when considering housing development design

TYPE	EXAMPLES
Design features for new housing or physical modifications to existing housing	Shade cloth and pergolas. Choice of lighting features or design of buildings to reduce light emission, particularly at night. Acoustic/ thermal batts in walls. Window double-glazing and noise proofing, such as lamination. Vegetation barriers, such as hedging, or berms, as noise barriers. Indoor smell neutralizers. Carports over vehicles. Coating surfaces to allow easier cleaning. Planting of screening plants between camp and residents. Powerline modifications, such as bundling aerial cables, increasing spacing between cables, converting overhead cables underground or re-routing cables away from high-risk areas. Managing foraging resources and restricting access to water sources around powerlines to reduce localised flying-fox activity. Increasing visibility of powerlines with flagging. Modifying light structures (height, placement, shielding etc) to reduce spill over from artificial light at night to the camp. Use of lighting within high-conflict and residential areas to discourage GHFF from using them. Closed widows and use of air conditioning for preventing odour entering. Educational signage Planning anti-FF foraging vegetation plantings around the potential drainage as part of the Precinct Structure Plan and any future waterbodies within proposed housing developments.

TYPE	EXAMPLES
Community incentives - recommended only if an adequate buffer cannot be implemented and maintained	Landscaping vouchers to create anti-FF roosting gardens. Electricity and water bill subsidies. Community grant programs to modify existing housing. Provision of physical modifications, such as pool or clothesline covers, free of charge to identified high risk residences. Council providing exotic tree removal services (i.e., removal of suitable GHFF vegetation within yards). Provision of a high-pressure water cleaning for regular cleaning. Giving the community control over mitigation measures, such as turning off lights. Community education programs.

7 Planning Schemes as an instrument for implementing Flying-fox management actions

Research has identified the need for linking FF camp management controls through local government (Eby, P & Lunney 2002; Larsen et al. 2002; West 2002). Whilst legislation surrounding FF management and framework implementation has increased over the past two decades, there is still a need to legitimise management through more transparent law making (Thiriet 2010). For example, the camp extents, including buffer zones, could be zoned for environmental protection using the local Planning Scheme. The implementation of land use controls may restrict development surrounding FF camps. It has also been recognised that buffers zone may be more effective when implemented through Planning controls, as it also helps to alleviate public conflict (Eby, P & Lunney 2002; West 2002). The example of the Maclean Rainforest Reserve flying-fox campsite highlights how poor planning and lack of provision in local laws for a proposed housing development nearby a FF camp, resulted in escalated conflict (West 2002).

There are limited examples of FF management actions being included in local government Planning Schemes. One example was found within NSW, with Councils around Gosford, nearby the Ku-ring-gai Flying-fox Reserve, having included FF management actions into Section 149 Planning Certificates (Larsen et al. 2002; Roberts, BJ 2006).Section 149 Planning Certificates are issued in accordance with the state *Environmental Planning and Assessment Act 1979*, where the Certificates provide information about the zoning of a property, the relevant state, regional and local planning controls and other property pretentions, such as land contamination and road widening. The Planning Certificates issued in relation to the FF camps included restrictions around the proximity of properties being built to the FF camps (Larsen et al. 2002; Roberts, BJ 2006). WSP does not have access to these Certificates to obtain what distances were used purchasing access of the Certificates is required through from NSW Planning. Council may be able to purchase the Certificates through regulatory planning portals.

Other examples for implementing camp management actions into the local Planning Scheme within Victoria are summarised below.

7.1.1 Incorporated document - Flying Fox Campsite, Yarra Bend Park, December 2004

Potentially like the Planning Certificates issued in NSW are the Incorporated Documents in Victoria. Locally, planning authorities can incorporate their own documents into the Planning Scheme in the form of Incorporated Documents, which can be, for example, development guidelines, incorporated plans, or restructure plans. An Incorporated Document carries the same weight as other parts of the scheme and as it is a part of the Planning Scheme, the planning authority can only change an incorporated document through a planning scheme amendment.

The Flying Fox Campsite Yarra Bend Park is a current Incorporated Document into both the Boroondara (Clause 72.04) and Yarra Planning Schemes (Clause 72.04). Under both Schemes the Incorporated Document is also listed under the Specific Controls Overlay – Schedule 6 (SCO6) under Clause 45.12. Published in December 2004, the Document relates to specific Crown Allotments, which, because of the Incorporated Document, may be developed and used without a permit for a GHFF flying fox campsite. The Incorporated document does specify that a Flying Fox Campsite management plan must first be endorsed by the Minister for Planning prior to implementation of the Documents, and that any works must be "generally in accordance" with the management plan. The Document also notes what should be within a management plan at the least and includes a map of the Flying-fox Management Area but does not set specific actions around the Yarra Bend camp. Although, the management plan that was developed as part of the Incorporated Document, does include specific management actions to be implemented for the GHFF camp, including revegetation and weed control (DSE 2005). It does not specify a buffer zone or mitigation for noise or smell.

Similarly, in 2002, an Incorporated Document was included into the Banyule Planning Scheme, relating to developing a new proposed GHFF roosting location at Horseshoe Bend in Ivanhoe (NRE 2002). It is incorporated into the Banyule Planning Scheme under Clauses 45.12 and 72.04.

7.1.2 Clause 13.07-1S – Land Use Compatibility

The objective of Clause 13.07-1S of the Victorian Planning Provisions – Land use compatibility is to protect community amenity, human health and safety while facilitating appropriate commercial, industrial, infrastructure or other uses with potential adverse off-site impacts.

The following strategies of Clause 13.07-1S are of potential relevance to implementing a management framework for the Cussen Park Grey-headed Flying-fox Colony.

— Ensure that use or development of land is compatible with adjoining and nearby land uses.

— Avoid or otherwise minimise adverse off-site impacts from commercial, industrial, and other uses through land use separation, siting, building design and operational measures.

7.1.3 Clause 44.08 – Buffer Area Overlay

Clause 44.08 of the Victorian Planning Provisions – Buffer Area Overlay (BAO) exists to.

— identify buffer areas where there is potential for off-site impacts on human health or safety, or significant off-site impacts on amenity, from industry, warehouse, infrastructure, or other uses.

— ensure that use and development within buffer areas is compatible with potential off-site impacts.

Application of the BAO to land uses must be based on evidence – demonstrating the types of potential impacts, the spatial extent of those impacts (the buffer area) and appropriate requirements for land use and development within the buffer area. The use must have potential for unintended off-site impacts on safety or human health. For the purposes of applying the BAO, potential impacts on safety or human health can be interpreted broadly. Off-site impacts on human health can sometimes occur due to emissions typically considered to have amenity impacts, such as odour, dust, and noise, depending on several factors. The Cussen Park FF Colony could be considered to have noise and odour amenity impacts on surrounding sensitive land uses, warranting the application of the BAO. The spatial extent of the buffer area would be determined through a site-specific assessment, considering variables including prevailing weather conditions and topography.

The BAO is designed to address:

— Human health, safety, or significant amenity impacts

— Off-site impacts

— Unintended impacts.

In a similar manner, there is potential for a BAO to be utilised to encompass the Cussen Park distribution extent and camp buffer, to protect both huma health and safety and camp health and safety. Alternatively, an Environmental Significant Overlay (ESO) could be used, incorporating distribution extent and the camp buffer, to automatically indicate the presence of ecologically important values at that location.

7.1.4 Planning Practice Note 92: Managing buffers for land use compatibility (March 2021)

Planning Practice Note 92: Managing buffers for land use compatibility (March 2021) provides guidance on planning for land use compatibility and the Planning Policy Framework. The practice note was prepared to support the application of the BAO and provides information for avoiding land use conflicts in the context of strategic planning projects. Specifically, the practice note provides the following advice for precinct structure plans.

— ‘Industries and other uses with potential off-site impacts should be clearly identified so they can be considered early in strategic planning processes and in the development of precinct structure plans… This should be outlined in precinct structure plans.’

7.1.5 Greater Shepparton Planning Scheme

Planning Scheme Amendment V10, gazetted on 1 March 2021 inserted the Buffer Area Overlay (BAO) into the Victoria Planning Provisions (VPP) at Clause 44.08. The amendment only changed the VPP. It did not apply the BAO to any land or introduce it to local planning schemes. As such to date there are no examples where the Buffer Area Overlay has been applied to land in Greater Shepparton.

If the BAO is introduced into the Greater Shepparton Planning Scheme, Council may reasonably expect that they would experience an increase in the number of planning permit applications received and related resource and administrative costs.

7.1.6 Examples outside of local planning scheme

As of December 2021, there is one example of a draft Planning Scheme Amendment that proposes to introduce and apply the Buffer Area Overlay to land, draft Amendment C407melb. It is noted that the buffer area proposed in C407melb is for industry and would surround an existing asphalt plant.

7.1.7 Other legislation mechanisms

Following amendments to the *Nature Conservation (Wildlife Management) Regulation 2006* in 2013, the Queensland Government have authority to local governments to manage FF roosts in defined urban areas, or Urban Flying-Fox Management Area (UFFMA) (DES 2020b). This authority includes the ability to actively disperse a flying-fox roost or conduct other non-lethal management actions without a Permit (DES 2020b). Although, all management actions must comply with the Code of Practice for flying-fox roosts and other relevant legislation, including the EPBC Act (DES 2020a). In doing so, the state Government recognised the important role local governments continue to play in managing issues around FF in urban areas, where higher FF-human conflict occurs. Since, local governments have developed local policies and management plans showing the management actions or intended measures to be implemented for FF camps within municipalities (ICC).

Within NSW, the Coffs Creek FF camp in Coffs Harbour occurs on a mixture of tenured land; residential, easement and Public Reserve (Eco Logical Australia 2017). Under local government the camp is covered by Low Density Residential (R2) zone, an Environmental Conservation (E2) zone and a Public Recreation (RE1) zone under the Coffs Harbour *Local Environmental Plan 2013 (Eco Logical Australia 2017)*.

8 Framework for Cussen Park camp management

The Framework was developed by considering the outcomes of the literature review, public concerns, and the existing proposed management options for Cussen Park FF camp {EII, 2017 #8452}. The measures presented below must be adaptive to breeding seasons, any changes in camp numbers, extent, and behaviour, and consider, on an ongoing basis, other relevant state, and Commonwealth legislation, including potential significant impacts under the EPBC Act. The Framework specifically speaks to measures that will be essential to consider for the implementation of the Tatura Precinct Structure Plan. As such, camp dispersal options have not been discussed within this document, particularly when considering the growing number of unsuccessful camp dispersal attempts across Australia (Mo 2020). The Management Framework for the Cussen Park FF camp is presented in Table 8.1.

The preferred management option of state and Federal Government is to manage FF colonies in-situ. This means leaving the colony more-or-less in the location that it chooses and managing the site and/or public expectations to achieve this goal. As such, the Framework takes into consideration the Cussen Park FF camp is a permanent one is considered a Nationally-important camp (DoE 2015). Planning by Council should assume that LRFF and/or GHFF will remain at or LRFF return to Cussen Park and that other camps will form within the greater Shepparton area.

The overall objective of the Framework is to reduce conflict with existing neighbouring residential properties and potential future development adjacent to the Park within proposed ‘general residential areas’ of the Tatura Precinct Structure Plan. The preferred roost location is within the centre of Cussen Park, the bird hides at management zone 10. Historic camp extents, as well as continued implementation of current management measures, indicate that the camp is likely to remain at this roost location.

Within the Framework we prioritise actions (primary and secondary) in order of which will be the most successful at initially preventing FF-human conflict from arising within new housing developments and to avoid any conflict in the future. The most efficient and cost-effective approach for the Cussen Park Camp is to develop effective buffers that avoid conflict from the very start. Secondary actions are those that should be considered if adequate camp buffers cannot be implemented. Recommendations to build upon currently ongoing Park management and camp monitoring actions that should be included in the Framework are presented in Table 8.2.

Following finalisation of the framework, next steps, including Management Plans, are proposed to implement the framework through statutory planning tools.

Table 8.1 Cussen Park Flying-fox camp management framework

PRIORITY	ACTION	DETAILS	NEXT STEPS
Primary			
1a	Camp Buffer Zone	A buffer zone of at least 150 m should be implemented between the camp and any new development to the west, north and north-east of the camp, where housing developments are not currently present. The buffer should be created through the exclusion of suitable roosting and foraging vegetation. Particularly, to the north and north-east of the camp, the buffer should extend from the irrigation channel and include the proposed drainage basins. Recommended vegetation parameters within buffer zones should include: — grassland or low shrubs — Small, isolated tre**es** up to 5 – 6 m in height — Tall trees, including exotic species or fruit trees, should be removed, and not planted. Recent observation of FF roosting along the irrigation channel, highlight an opportunity to increase buffer size if trees are removed or pruned along the irrigation channel. Consultation with Goulburn Murray Water would be required. The gap in vegetation between the camp and the next set of trees (management zones 6b and 6g) should remained grassed and be labelled as another buffer zone within Management Plans or legislation. Regular mowing of this area should continue. Vegetation within the Golf Course should also remain as is (low shrubs, lack of trees) to prevent FF roosting within there. Incursion of FF into the Golf Course is likely to substantially increase conflict with the public.	— All buffer zones (150 m buffer along north/north-east extent, gap between management zones 6b & g) should be included in any mapping of camp extent, and the map should be included in the PSP and any planning mechanisms implemented as part of the Framework. — Consultation with Goulburn Murray Water would be required. — The Hill Top Golf Course should be included into any FF Management Plan, where planting parameters are prescribed.
1b	Utilisation of statutory planning tools for sound and transparent FF management	The tools and provisions within this Framework should be incorporated into the Tatura Structure Plan. This will be particularly important for adherence to proposed camp buffer zones, where we recommend an additional planning tool, such as either a Buffer Area Overlay or Ecological Significance Overlay is incorporated to protect camp extent and reduce FF-human conflict.	— Any FF-related prescriptions included within the PSP should be reviewed by an FF specialist. — Any Development Applications and proposed design modification should be reviewed by a Flying-fox

PRIORITY	ACTION	DETAILS	NEXT STEPS
		The Structure Plan should include FF-sensitive provisions surrounding the design of future housing or industrial developments, such as vegetation prescriptions and new housing design and modification of existing building requirements. The Structure Plan should refer to an FF Management Plan, where all FF camp management measures proposed in the Structure Plan are to be followed in accordance with an FF Management Plan.	(FF) specialist to ensure measures are suitable to reduce FF-conflict. — Camp extent, including buffer zones, should be included in a map within the Structure Plan documents — Develop an FF Management Plan.
2	Community awareness and education	Council, in conjunction with local community groups, should provide information through a variety of means (e.g., Council website, leaflets, community information 'walk and talk', local newspapers, signage), focussing on the role and importance of flying-foxes and the natural fluctuation in numbers. Signage and other information should be provided at Cussen Park and housing developments, to accurately explain the real health risks and advise what steps need to be taken if dead/ injured FF are found and what to do in the case of getting bitten or scratched. The wording should not be alarmist and should be part of an overall education and engagement package that also includes information about their important ecological role and fascinating facts about their ecology and biology.	— Develop an Education Program.
Secondary			
3	Future development provisions	Physical modification and design of any future housing development within the General Residential Area of the proposed Tatura Structure Plan , to the north and north-east of the camp, should include parameters to reduce noise and odour impacts. These should include: — Implementation of a 150 m buffer between the camp and any proposed development. The buffer can include grasslands, walking trails, drainage ponds, roads, and front yards. — Anti-FF vegetation parameters to apply within the development boundaries to deter FF roosting and foraging. — A suitable backyard planting list for residents to reduce FF visitation	— Any Development Applications and proposed design modification should be reviewed by a Flying-fox (FF) specialist to ensure measures are suitable to reduce FF-conflict. — These future development provision actions should be included within the chosen Planning mechanism.

PRIORITY	ACTION	DETAILS	NEXT STEPS
		— Pre-planning of powerline locations and design within the development boundaries. — Provision of housing design elements for all new housing, such as: **A** Double-glazed windows and laminating of surfaces to make cleaning faecal matter easier. **B** Acoustic batts installed in the walls. — Signage for public education of FF within Cussen Park and near the camp.	

Table 8.2 Ongoing Cussen Park and FF camp management actions to be included in the Framework

ACTION	DETAILS	NEXT STEPS
Cussen Park Management	This action recognises that there is currently no Management Plan (MP) for the Cussen Park camp. It is recommended that a Management Plan is created and implemented in conjunction with the Cussen Park Environmental Management Plan. The MP should incorporate existing measures to help the colony, including: — Continued closure of tracks under the camp in Summer — Water level control of management zone 10 during heat stress events — Regular mowing of grassed areas within Cussen Park to restrain roosting extent The MP should also focus on developing responses to heat stress events, vegetation management protocols, buffer zones and further management controls to influence roosting distribution within the Park. For instance, management of existing wetlands to increase FF-suitability and management of the proposed drainage basins to retain anti-FF roosting habitat.	— Consult with Goulburn Murray Water regarding management requirements of the irrigation channel. — Consult Cussen Park Advisory Committee and Tatura Community Plan Steering Committee — Develop site specific heat stress protocols (Bishop 2019) — Develop the Cussen Park FF MP using this document and the Management Options Report (EII 2017) as starting points.

ACTION	DETAILS	NEXT STEPS
Camp monitoring	Camp monitoring in the form of the current weekly counts should continue. If weekly cannot occur, monthly counts should be enacted. Extent mapping of camp distribution should also occur every season to inform camp management. Counts are recommended to occur every month and extent mapping every season. Camp numbers and distribution information are critical to informing adaptive management plans. Monthly counts are often done by local volunteers and facilitated through local Committees or as in the case of the Yarra Bend Camp, through the government department that manages the land the camp is on. Camp monitoring should also include monitoring of heat stress events and heat stress protocols.	— Establish a volunteer network or program to monitor FF and support management. — Apply to register the camp as Nationally significant.

9 References

Ancillotto, L, Bosso, L, Salinas-Ramos, V & Russo, D (2019), 'The importance of ponds for the conservation of bats in urban landscapes', *Landscape and Urban Planning*, vol. 190, p. 103607.

Barré, K, Spoelstra, K, Bas, Y, Challéat, S, Kiri Ing, R, Azam, C, Zissis, G, Lapostolle, D, Kerbiriou, C & Le Viol, I (2021), 'Artificial light may change flight patterns of bats near bridges along urban waterways', *Animal Conservation*, vol. 24, no. 2, pp. 259-67.

Bishop, T, Pearson, T., and Lyons, R., 2019, *Flying-fox Heat Event Response Guidelines* Queensland.

Christesen, L & Nelson, J (2000), 'Vocal communication in the Grey-headed Flying-fox Pteropus poliocephalus (Chiroptera: Pteropodidae)', *Australian Zoologist*, vol. 31, no. 3, pp. 447-57.

Churchill, S (2008), *Australian Bats*, 2nd edn, Allen & Unwin, Sydney.

Connell, K, Munro, U & Torpy, F (2006), 'Daytime behaviour of the grey-headed flying fox Pteropus poliocephalus Temminck (Pteropodidae: Megachiroptera) at an autumn/winter roost', *Australian Mammalogy*, vol. 28, no. 1, pp. 7-14.

Currey, K, Kendal, D, Van der Ree, R & Lentini, PE (2018), 'Land manager perspectives on conflict mitigation strategies for urban flying-fox camps', *Diversity*, vol. 10, no. 2, p. 39.

DAWE 2015, *National Flying-Fox monitoring viewer*, Australian Government2022, <https://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf>.

—— (2021), *National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus.*,Commonwealth of Australia.

DELWP 2017, *Guidelines for the removal. destruction or lopping of native vegetation*, Department of Environment Land Water and Planning.

—— 2021, *Planning Property Report - 8 Dunlop Court Bayswater*, Department of Environment, Land, Water and Planning, East Melbourne.

Department of Environment and Primary Industries 2015, *Victorian Biodiversity Atlas*, <https://vba.dse.vic.gov.au/vba/>.

Department of Environment Climate Change and Water NSW 2009, *Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus* Department of Environment Climate Change and Water NSW, Sydney.

DES (2020a), *Code of Practice: Ecologically sustainable managementof flying-fox roosts Nature Conservation Act 1992*,Queensland Government.

—— (2020b), *Flying-fox roost management guideline*,Queensland Government.

DoE (2015), *Referral guideline for management actions in grey-headed and spectacled flying-fox camps*,Commonwealth of Australia.

DPIE (2019), *Flying-fox Camp Management Plan Template*,NSW Government.

DSE (2005), *Flying Flying-fox Campsite Management Plan Yarra Bend Park*,Victorian Government.

Eby, P (1991), 'Seasonal movements of Grey-headed Flying-foxes, *Pteropus poliocephalus* (Chiroptera : Pteropodidae), from two maternity camps in northern New South Wales', *Wildlife Research*, vol. 18, no. 5, pp. 547 - 59.

Eby, P & Lunney 2002, *Using New South Wales planning instruments to improve conservation and management of Grey-headed Flying-fox camps* Royal Zoological Society of New South Wales, Mosman NSW.

Eco Logical Australia (2013), *Kareela Flying Fox Camp Plan of Management*,Sutherland Shire Council.

—— (2017), *Coffs Harbour Flying-fox Camps Strategic Management Plan*,Coffs Harbour City Council.

Ecosure (2016), *Batemans Bay Flying-fox Camp Assessment*,Eurobodalla Shire Council.

—— (2020), *Commonwealth Park Grey Headed Flying-fox Camp Management Plan*,National Captial Authority.

EII 2017, *Management options for flying-foxes at Cussen Park, Tatura, Victoria* Ecology and Infrastructure International Wantirna, Victoria.

Franklin, DC, Barnes, TA & Prout, K (2017), 'Large, temporary camps of the Little Red Flying-fox at Herberton', *North Queensland Naturalist*, vol. 47, pp. 32-42.

GeoLINK (2013), *Grey-headed Flying-fox Management Strategy for the Lower Hunter*,Department of Sustainability, Environment, Water, Population and Communities.

Greater Shepparton City Council (2016a), *Cussen Park Enviornmental Management Plan*,Greater Shepparton City Council.

—— (2016b), *Cussen Park Environmental Management Plan 2016*,Greater Shepparton City Council.

ICC *Ipswich Flying-Fox Roost Management Plan* Ipswich City Council.

Jung, K & Threlfall, CG 2016, 'Urbanisation and its effects on bats—a global meta-analysis', in *Bats in the Anthropocene: conservation of bats in a changing world*, Springer, Cham, pp. 13-33.

Klose, SM, Welbergen, JA & Kalko, EK (2009), 'Testosterone is associated with harem maintenance ability in free-ranging grey-headed flying-foxes, Pteropus poliocephalus', *Biology Letters*, vol. 5, no. 6, pp. 758-61.

Kung, NY, Field, HE, McLaughlin, A, Edson, D & Taylor, M (2015), 'Flying-foxes in the Australian urban environment—community attitudes and opinions', *One Health*, vol. 1, pp. 24-30.

Larsen, E, Beck, M, Hartnell, E & Creenaune, M 2002, 'Neighbours of Ku-ring-gai Flying-fox Reserve: community attitudes survey 2001', in pp. 225-39, DOI 10.7882/FS.2002.055.

Longcore, T & Rich, C (2004), 'Ecological Light Pollution', *Frontiers in Ecology and the Environment*, vol. 2, no. 4, pp. 191-8.

Macdonald, SL, Bradford, M, McKeown, A, Vanderduys, E, Hoskins, A & Westcott, D (2021), 'Camp site habitat preferences of the little red flying-fox (Pteropus scapulatus) in Queensland', *Australian Journal of Zoology*.

McDonald-Madden, E, Schreiber, ESG, Forsyth, DM, Choquenot, D & Clancy, T (2005), 'Factors affecting Grey-headed Flying-fox (Pteropus poliocephalus: Pteropodidae) foraging in the Melbourne metropolitan area, Australia', *Austral Ecology*, vol. 30, no. 5, pp. 600-8.

Mo, M, Roache, Mike, Williams, Rebecca, Drinnan, Ian N and Noël, Beth, (2020), 'From cleared buffers to camp dispersal: mitigating impacts of the Kareela flying-fox camp on adjacent residents and schools', *Australian Zoologist*, vol. 41, no. 1, pp. 19-41.

Nelson, JE (1964), 'Vocal communication in Australian flying foxes (Pteropodidae; Megachiroptera)', *Zeitschrift für Tierpsychologie*, vol. 21, no. 7, pp. 857-70.

—— (1965), 'Behaviour of Australian pteropodidae (Megacheroptera)', *Animal Behaviour*, vol. 13, no. 4, pp. 544-57.

NRE (2002), *Horseshoe Bend Management Plan - Development of an alternative roosting site for the Grey-headed Flying-fox at Ivanhoe, Victoria*,Victorian Government.

Parris, KM & Hazell, DL (2005), 'Biotic effects of climate change in urban environments: the case of the grey-headed flying-fox (Pteropus poliocephalus) in Melbourne, Australia', *Biological Conservation*, vol. 124, no. 2, pp. 267-76.

Pauwels, J, Le Viol, I, Azam, C, Valet, N, Julien, J-F, Bas, Y, Lemarchand, C, de Miguel, AS & Kerbiriou, C (2019), 'Accounting for artificial light impact on bat activity for a biodiversity-friendly urban planning', *Landscape and Urban Planning*, vol. 183, pp. 12-25.

Pearson, T & Clarke, JA (2019), 'Urban noise and grey-headed flying-fox vocalisations: evidence of the silentium effect', *Urban Ecosystems*, vol. 22, no. 2, pp. 271-80.

Pearson, TC, K. 2018, *It's not just noise…*, Department of Biological Sciences, Macquarie University, NSW.

Roberts, B 2012, 'The ecology and management of the grey-headed flying-fox Pteropus poliocephalus', Ph. D. Thesis, Griffith University, Brisbane, Australia.

Roberts, BJ 2006, *Management of Urban Flying-fox Camps: Issues of Relevance to Camps in the Lower Clarence, NSW.* , Valley Watch Inc., Maclean, NSW.

SCC (2016), *Regional Flying-Fox Management Plan*,Sunshine Coast Council.

Scheelings, TF & Frith, SE (2015), 'Anthropogenic Factors Are the Major Cause of Hospital Admission of a Threatened Species, the Grey-Headed Flying Fox (Pteropus poliocephalus), in Victoria, Australia', *PLoS ONE*, vol. 10, no. 7, p. e0133638.

SEQ Catchments (2012), *Management and Restoration of flying-fox Camps: Guidelines and Recommendations* South East Queensland Catchments.

T-PVS / Inf 2003, *15 Protecting birds from power lines: a practical guide to minimising the risks to birds from electricity transmission facilities*, Council of Europe Publishing, <https://rm.coe.int/090000168074657f>.

Tait, J, Perotto-Baldivieso, HL, McKeown, A & Westcott, DA (2014), 'Are flying-foxes coming to town? Urbanisation of the spectacled flying-fox (Pteropus conspicillatus) in Australia', *PLoS ONE*, vol. 9, no. 10, p. e109810.

Thiriet, D (2010), 'Flying fox conservation laws, policies and practices in Australia: A case study in conserving unpopular species', *Australasian Journal of Natural Resources Law and Policy*, vol. 13, no. 2, pp. 161-94.

Threlfall, CG, Law, B & Banks, PB (2012), 'Sensitivity of insectivorous bats to urbanization: Implications for suburban conservation planning', *Biological Conservation*, vol. 146, no. 1, pp. 41-52.

Tidemann, CR (2003), 'Displacement of a Flying-fox camp using sound', *Ecological Management & Restoration*, vol. 4, no. 3, pp. 224-6.

Timmiss, LA, Martin, JM, Murray, NJ, Welbergen, JA, Westcott, D, McKeown, A & Kingsford, RT (2021), 'Threatened but not conserved: flying-fox roosting and foraging habitat in Australia', *Australian Journal of Zoology*.

VicRoads (2005), *Traffic Noise Reduction Policy*.

Wagner, J (2008), 'Glandular Secretions of Male Pteropus (Flying Foxes): Preliminary Chemical Comparisons Among Species', *Independent Study Project (ISP) Collection*, vol. 559.

Walsh, MG, Wiethoelter, A & Haseeb, M (2017), 'The impact of human population pressure on flying fox niches and the potential consequences for Hendra virus spillover', *Scientific Reports*, vol. 7, no. 1, pp. 1-13.

Webb, NJ & Tidemann, CR (1996), 'Mobility of Australian flying-foxes, *Pteropus spp*. (Megachiroptera): evidence from genetic variation', *Proceeding of the Royal Society London Series B*, vol. 263, pp. 497-502.

Welbergen, JA (2006), 'Timing of the evening emergence from day roosts of the grey-headed flying fox, Pteropus poliocephalus: the effects of predation risk, foraging needs, and social context', *Behavioral Ecology and Sociobiology*, vol. 60, no. 3, pp. 311-22.

Welbergen, JA, Klose, SM, Markus, N & Eby, P (2008), 'Climate change and the effects of temperature extremes on Australian flying-foxes', *Proceedings of the Royal Society B: Biological Sciences*, vol. 275, no. 1633, pp. 419-25.

West, C (2002), 'Contemporary issues in managing flying-fox camps: a publicly-documented conflict from Maclean on the north coast of NSW', *Managing the Grey-headed Flying-fox as a Threatened Species in NSW*, pp. 176-95.

Westcott, DA, Caley, P, Heersink, DK & McKeown, A (2018), 'A state-space modelling approach to wildlife monitoring with application to flying-fox abundance', *Scientific Reports*, vol. 8, no. 1, pp. 1-9.

Williams, NS, Mcdonnell, MJ, Phelan, GK, Keim, LD & Van Der Ree, R (2006), 'Range expansion due to urbanization: Increased food resources attract Grey-headed Flying-foxes (Pteropus poliocephalus) to Melbourne', *Austral Ecology*, vol. 31, no. 2, pp. 190-8.

Yabsley, SH, Meade, J, Martin, JM & Welbergen, JA (2021), 'Human-modified landscapes provide key foraging areas for a threatened flying mammal: The grey-headed flying-fox', *PLoS ONE*, vol. 16, no. 11, p. e0259395.

Appendix A

Community Consultation – Online Questionnaire and Results

A1.1 Online Questionnaire

1 CUSSEN PARK GREY-HEADED FLYING FOX ASSESSMENT - SURVEY

Thank you for taking part in this survey. It should take around 5 minutes to complete.

This survey is for residents who live near Cussen Park in Tatura to gather information on the colony of the bats (Grey-headed Flying-foxes) that live within an area of the park.

Greater Shepparton City Council is in the process of developing the Tatura Structure Plan to guide the growth of residential development around Cussen Park. Council is creating a framework that will be used to ensure conservation outcomes and enforce protection for the colony of bats, which will influence the outcomes of the Tatura Structure Plan.

The Grey-headed Flying-fox species are protected under national and state laws, which means Council needs to ensure the habitat and the animals themselves are protected from effects of residential development.

This survey aims to understand your interactions with the bats, and any frequent behaviours of the bats that you have observed since you have lived at your property. All feedback gathered will be considered and will provide Council with an overview of key priorities, concerns, and opportunities to inform how we plan and further develop the framework to guide the Tatura Structure Plan and ensure the protection of the bats.

Disclaimer: Your responses to this survey will be kept confidential and not shared publicly. It is strictly forbidden for Council and/or contracted consultants to release the below personal information to any third party without written consent from the responder.

1. Please enter your property address here:

2. Are you aware that there are a colony of bats (Grey-headed Flying-foxes) that live in Cussen Park?
☐ **Yes**
☐ **No**
☐ **Other (please specify)**

3. If so, can you hear the bats at Cussen Park when you are inside of your house?
☐ Yes
☐ No

4. Can you hear the bats at Cussen Park when you are on your property outside? (For example, in your backyard)
☐ Yes
☐ No

5. How often can you hear the bats? (Please select one)
☐ Never
☐ Once a year
☐ Every few months
☐ Every few weeks
☐ Once a week
☐ More than once a week

6. When do you most noticeably hear the bats from your house or outdoors on your property? (Please select all that apply)
☐ Never
☐ In summer
☐ In autumn
☐ In winter
☐ In spring

☐ In hot weather
☐ In cold weather
Please give more details below if possible (for example, during windy conditions, during humid conditions, shortly after rainfall):

7. Can you smell the bats at Cussen Park when you are inside of your house?
☐ Yes
☐ No

8. Can you smell the bats at Cussen Park when you are on your property outside? (For example, in your backyard)
☐ Yes
☐ No

9. How often can you smell the bats? (Please select one)
☐ Never
☐ Once a year
☐ Every few months
☐ Every few weeks
☐ Once a week
☐ More than once a week

10. When do you most noticeably smell the bats from your house or outdoors on your property? (Please select all that apply)
☐ Never
☐ In summer
☐ In autumn
☐ In winter
☐ In spring
☐ In hot weather
☐ In cold weather
Please give more details below if possible (for example, during windy conditions, during humid conditions, shortly after rainfall):

11. Do you change your daily routine or activities when you can hear or smell the bats?
☐ Yes
☐ No
If yes, please describe how your activities change:

12. Do you enjoy having the bats at Cussen Park?
☐ Yes
☐ No
If not, please let us know why:

13. How often do you go to Cussen Park?
☐ Never
☐ Once a year

☐ Every few months
☐ Every few weeks
☐ Once a week
☐ More than once a week

14. What activity do you undertake the most at the park? (For example, walking, picnics, bird watching)

15. Do you think that Council should help protect the bat colony at Cussen Park?
☐ Yes
☐ No
If yes, please give more detail if you can on why and/or how Council should protect the colony:

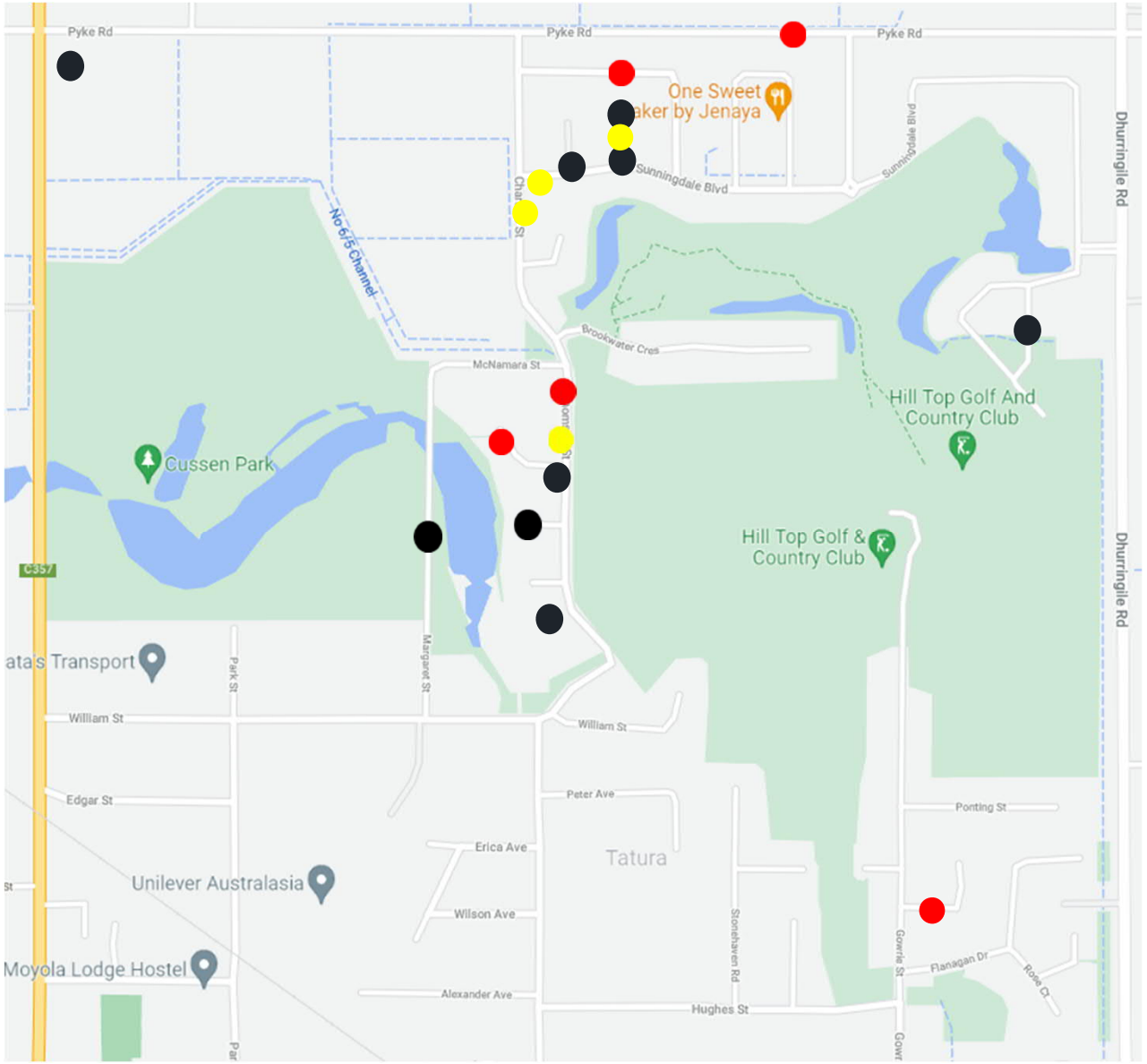
16. Would you be happy for us to contact you following the survey if we have any further questions?
☐ Yes
☐ No
Please add your email address or phone number below:

Survey end - Thank you for completing our feedback survey.

A1.2 Communication and Engagement Team Report

MAP 1.1

RESPONSES ON WHETHER RESIDENTS CAN HEAR/SMELL THE BATS



KEY

CAN HEAR AND SMELL:

CANNOT HEAR OR SMELL:

CAN ONLY HEAR:

Please note there are two residents who responded to the survey whose properties are outside of the map area. They could not hear/smell the bats and the sentiment of both was positive. One resident has a PO BOX listed and can hear the bats, but not smell.

OVERALL RESPONSES

CAN HEAR AND SMELL: 4

CANNOT HEAR OR SMELL: 7

CAN ONLY HEAR: 9

**(INCLUDING THOSE COUNTED OUTSIDE THE MAP AREA)

COMMENTS

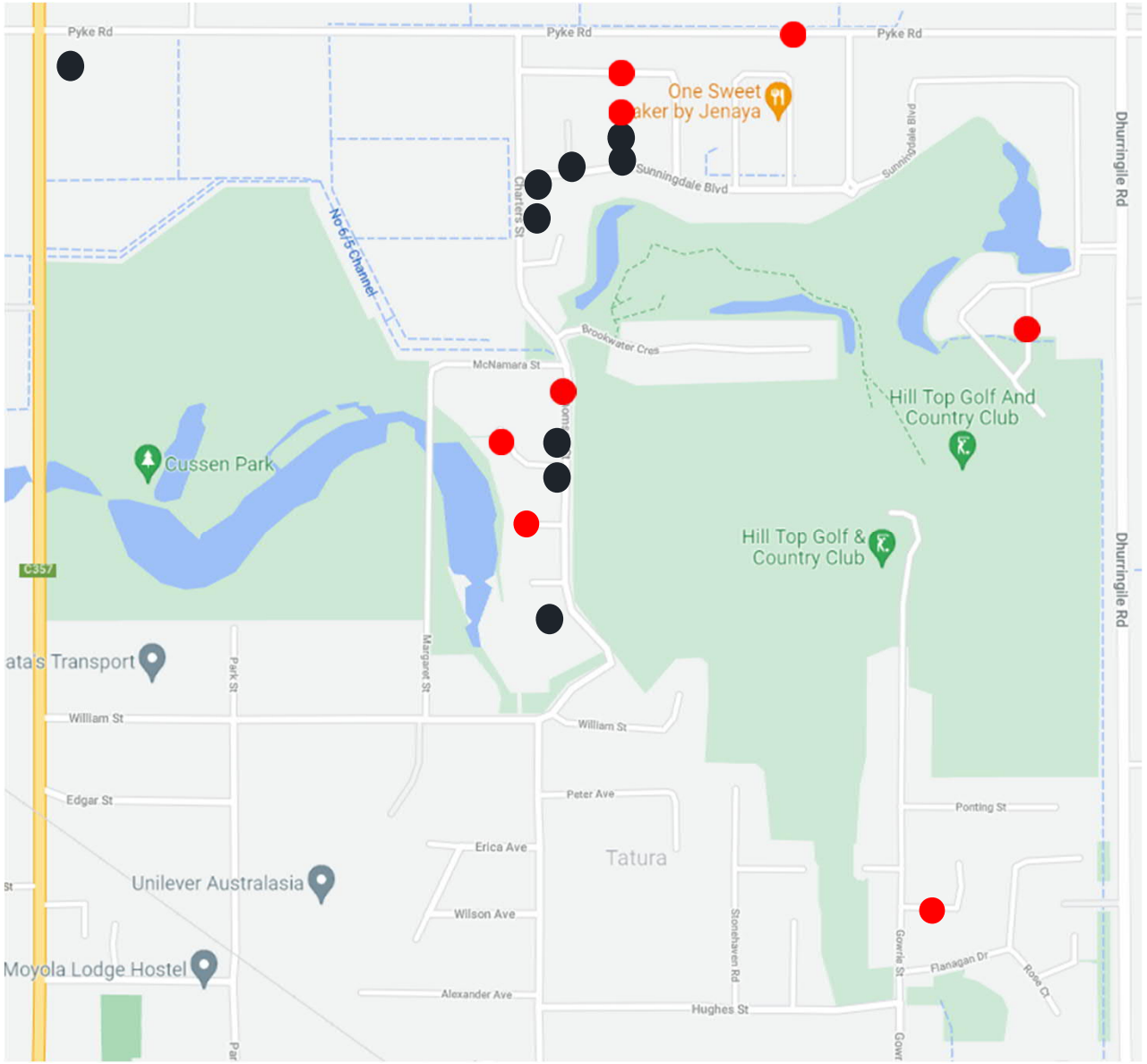
"I hardly hear them and we live a stone throw away. We actually make a point to watch the bats fly over often. They are incredible to watch. They only make noise for a short while in the evening when they are about to leave the trees for the night."

"When they fly over at dusk we move indoors. Also, we park our cars under cover. Our actions are to evade faeces. I am also aware of zoonoses, e.g. the Hendra and Nipah viruses."

"We find that you don't really start hearing the bats until you're well and truly inside the park itself. Our property backs right onto the lagoon and we never hear them unless they're flying overhead."

MAP 1.1

RESPONSES ON WHETHER RESIDENTS CAN HEAR/SMELL THE BATS



KEY

POSITIVE TOWARDS THE BATS:

NEGATIVE TOWARDS THE BATS:

Please note there are two residents who responded to the survey whose properties are outside of the map area. They could not hear/smell the bats and the sentiment of both was positive. One resident has a PO BOX listed and can hear the bats, but not smell.

OVERALL RESPONSES

POSITIVE TOWARDS THE BATS: 10

NEGATIVE TOWARDS THE BATS: 10

**(INCLUDING THOSE COUNTED OUTSIDE THE MAP AREA)

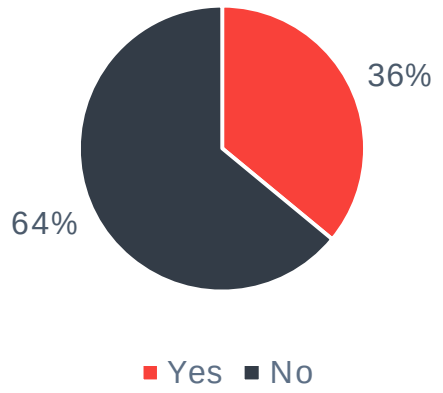
COMMENTS

"We don't particularly find them cute and cuddly. I think they are disease carriers. Plus we have had two major power outages from the bats hitting the lines – a major inconvenience to over 800 homes."

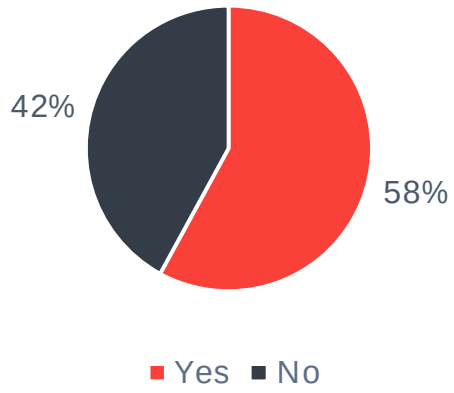
"I can always smell the faeces from the bats. It is all over our concrete and furnishings in the front and back yard."

"They (the bats) are amazing. We moved here from Deniliquin via Mooroopna, and both towns would give anything to have a natural resource like the bats (and the park).

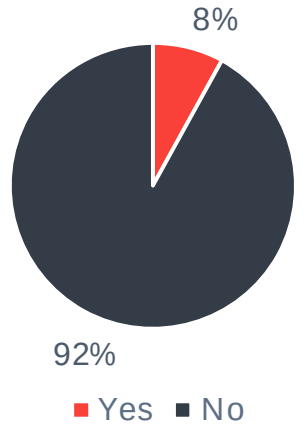
Hear GHFF inside



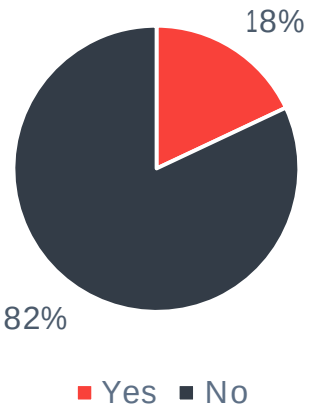
Hear GHFF outside



Smell GHFF inside



Smell GFHH outside



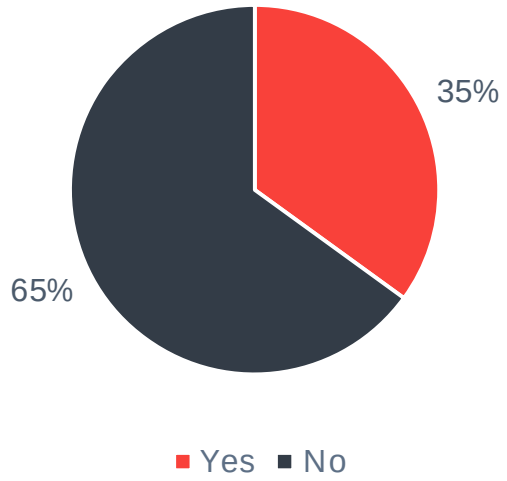
Further insights on hearing the GHFF

- Almost 50% of respondents could hear the bats more than once a week
- Almost 30% of respondents could never hear the bats
- Around 20% of respondents heard them between every few weeks/months
- Respondents had vastly different answers on what season/weather they heard the bats. The most likely was in the evening, and during summer
- “Most noticeable in the evenings and tend to swarm and feast on my fig fruit trees during fruiting season December – March.”

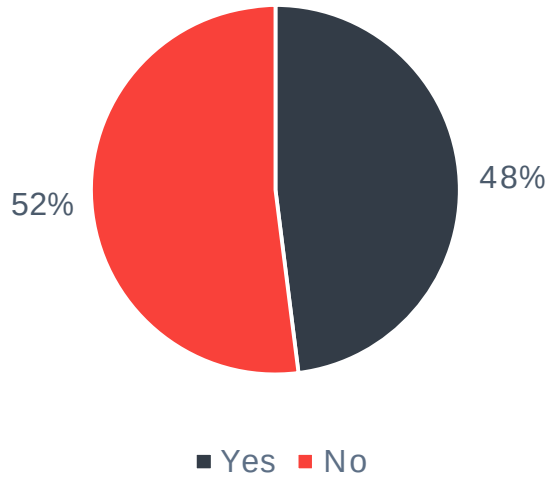
Further insights on the smell of the GHFF

- Almost 70% of respondents could never smell the bats
- Around 15% of respondents could smell them more than once a week
- Around 15% of respondents could smell the bats every few weeks/months
- Most respondents could not smell the bats, but those who could usually could smell them only in Cussen Park, or could smell the faeces in their backyard
- “You can’t smell the bats until you’re standing under them when they’re hanging in the trees, and even then it’s only subtle.”

Routine changes due to GHFF



Enjoy having GFHH at Cussen Park



Further insights

- The respondents who didn't need to change their routine and/or enjoyed having the GHFF at Cussen Park had similar responses that they believe the GHFF are important for the ecosystem and natural environment, and they enjoy taking their children to watch the GHFF flying at night.
- The respondents who needed to change their routine and/or didn't enjoy having the GHFF at Cussen Park had similar responses that the faeces of the GHFF in their backyard/on their property was an inconvenience and repellent, and that closing the walking tracks in Cussen Park near the GHFF was frustrating and unnecessary.
- Approximately 30% of respondents frequently go to Cussen Park, approximately 40% of respondents occasionally go to Cussen Park and approximately 30% of respondents never go to Cussen Park. Most respondents go to Cussen Park to exercise (e.g. walk, ride bikes, running) but some also go to watch the birds and GHFF.

FINAL OPINIONS

TATURA RESIDENTS ON WHAT THEY WOULD LIKE TO SEE REGARDING THE FUTURE OF THE GHFF COLONY

- “Continued enlightenment of the public.”
- “The bats are a living community that have incentives that we can never truly understand, and any strategy to influence their environment will have unforeseen consequences which will most likely be negative in nature.”
- “Leave them be. They will leave if they wish to, just like they arrived. It’s not rocket science!”
- “Cussen Park is a “Park for the People”. The bats have certainly done some damage to some of the trees they roost in. Open up the tracks and let the bats acclimatise to the people moving below.”
- “Don’t waste our ratepayers money. If the bats want to stay there they will, and if there is not enough food to sustain them they will leave. Let nature look after itself!”
- “Move them! Over summer the number of bats there is ridiculous. Since they have been growing in numbers you don’t see as many native birds there anymore.”

Appendix B

Summary of legislation relevant to the project

This section provides a brief overview of relevant legislation which should be considered as part of the management of the colony. A summary of each legislation or policy is provided in Table B.1.

Table B.1 Project relevant legislation considered for the project

POLICY/ LEGISLATION	DESCRIPTION	ASSESSMENT PROCESS RELEVANT TO THE PROJECT
Commonwealth		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	The EPBC Act is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places defined in the Act as Matters of National Environmental Significance (MNES). There are nine MNES to which the EPBC Act applies, these are: — World heritage sites — National heritage places — Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed) — Nationally threatened species and ecological communities — Migratory species — Commonwealth marine areas — The Great Barrier Reef Marine Park — Nuclear actions — A water resource, in relation to coal seam gas development and large coal mining development. If a project is likely to have a significant impact on one of the nine MNES, the action or proposal must be referred to the Commonwealth DAWE. This 'referral' is then released to the public for comment.	Grey-headed Flying Fox (GHFF) are listed as a threatened species under the Act, and therefore fall under one of the MNES. Any management actions undertaken for the colony must consider the Act and assess the likelihood of the action having a significant impact on the species.
STATE		

Flora and Fauna Guarantee Act 1988 (FFG Act)	The Victorian FFG Act was established to provide a legal framework for enabling and promoting the conservation of all Victoria's native flora and fauna, and to enable management of potentially threatening processes. One of the main features of the Act is the listing process whereby native species and communities of flora and fauna, and the processes that threaten native flora and fauna, are listed in the schedules of the Act. This assists in identifying those species and communities that require management to survive and identifies the processes that require management to minimise the threat to native flora and fauna species and communities within Victoria. The FFG Act Amendment Act 2019 came into effect on 1 June 2020. As part of the amendments, all taxa of flora and fauna listed under the FFG Act, along with all taxa on the DELWP Advisory lists (except those that are 'poorly known' or 'near threatened') and any taxa nominated by public submissions, were re-assessed in accordance with the common assessment method by a Scientific Advisory Committee overseen by DELWP. The new threatened species listings were completed with the gazetting of a new list in May 2021, which was published by DELWP in June 2021, with listings (categories of threat) subsequently within the VBA in July 2021. The FFG Act Amendment Act 2019 also introduces changes to the categories of protected flora and the way they are regulated, including introducing two categories: 'restricted use protected flora' and 'generally protected flora'. Restricted use protected flora are exclusively threatened by take for commercial/personal use, and the taking of these species incidental to clearing for development works, will not require a permit to take. Generally protected flora is threatened by take for reasons other than or additional to commercial/personal use (e.g., development clearing) and will require a permit to take for any purpose. The protected flora list is currently being reviewed by DELWP, but for now, all protected flora is classified as generally protected flora. A permit from DELWP is required to 'take' flora species that are listed as protected flora from public land. A permit is not required under the FFG Act for private land, unless listed aquatic species are present and the land is declared 'critical habitat' for the species. It	Under the FFG Act, public authorities have a duty of care to consider potential biodiversity impacts when exercising their functions, including giving proper attention to the objectives of the FFG Act. GHFF are listed as vulnerable under the FFG Act. When management actions are implemented, the impact of these actions on the species and colony must be assessment prior to implementation. This includes any vegetation management that may remove threatened or Protected flora under the Act.

POLICY/ LEGISLATION	DESCRIPTION	ASSESSMENT PROCESS RELEVANT TO THE PROJECT
Planning and Environment Act 1987 (P&E Act)	The P&E Act establishes the framework for planning the use, development, and protection of land in Victoria. The Act sets out procedures for preparing and amending the Victoria Planning Provisions and planning schemes. It also sets out the process for obtaining permits under schemes, settling disputes, enforcing compliance with planning schemes and permits, and other administrative procedures. *Guidelines for the removal, destruction or lopping of native vegetation* (the Guidelines) are implemented under Clause 52.17 of the Planning Scheme (DELWP 2017). The planning permit assessment process and offset requirements for impacts to native vegetation associated with Clause 52.17 (Native vegetation) of the planning scheme are undertaken in accordance with the Guidelines for the removal, destruction or lopping of native vegetation. The Guidelines guide how impacts on biodiversity should be considered, including whether a permit should be granted when assessing a planning permit application.	The finalised Precinct Structure Plan will be incorporated into the Greater Shepparton Planning Scheme and, therefore, be implemented under local law. Any vegetation removal in Cussen Park will need to consider the Guidelines.
Wildlife Act 1975 (Wildlife Act)	The *Wildlife Act 1975* is the primary legislation in Victoria for the protection of wildlife. The Act requires that wildlife research (E.g., fauna salvage and translocation) is regulated through a permit system, which is managed by DELWP. Authorisation for habitat removal must be obtained under the *Wildlife Act 1975* through a licence granted by DELWP. Any persons involved in fauna removal, salvage capture or relocation of fauna during mitigation measures must hold a current Management Authorisation under the Act.	In future, if relocation of the colony is proposed, a Management Authorisation under the Act may be required from the Department of Environment, Land, Water and Planning (DELWP). Any persons engaged to relocate or otherwise handle wildlife will need to hold the appropriate authorisation under the Wildlife Act.

POLICY/ LEGISLATION	DESCRIPTION	ASSESSMENT PROCESS RELEVANT TO THE PROJECT
Catchment and Land Protection Act 1994 (CaLP Act)	Under this Act, species of plants and animals can be declared as noxious weeds and pest animals if they have or might have the potential to become a serious threat to: — primary production — Crown land — the environment — community health. All landowners are legally required to manage declared noxious weeds and pest animals on their land. This means landowners must take all reasonable steps to: — eradicate regionally prohibited weeds — prevent the growth and spread of regionally controlled weeds — prevent the spread of — and as far as possible eradicate — established pest animals on their land.	Management of the colony and Cussen Park, particularly when undertaking revegetation or vegetation maintenance works, should endeavour to take all reasonable steps to remove or reduce the presence of CaLP Act weeds or animal species.