



# **Newcastle Inner City Bypass - Rankin Park to Jesmond**

Flora and Fauna Construction Monitoring Program

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## Revision history

Revision	Description	Date
Rev A	TfNSW review	23 September, 2021
Rev B	TfNSW review	20 October, 2021
Rev C	TfNSW review	23 November, 2021
Rev D	TfNSW review	07 December, 2021
Rev E	TfNSW review	18 January, 2022
Rev F	Updated to include baseline survey	14 April, 2022
Rev G	Update to address DPE comments	1 June, 2022

## Approval and authorisation

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<b>Date</b>	June, 2022	
<b>Version</b>	Rev G	
<b>Reference</b>	A39597294	
<b>Program reviewed by:</b>	<b>Program reviewed by:</b>	<b>Program endorsed by:</b>
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Senior Environment and Sustainability Officer		Environmental Representative
14/04/2022 [REDACTED]		14/04/2022 [REDACTED]

Term/acronym	Definition
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
CEMP	Construction Environmental Management Plan
FFCMP	Flora and Fauna Construction Monitoring Program
CoA	Condition of Approval
DAWE	Department of Agriculture, Water and the Environment
dB	Decibels, a measurement unit for sound level
DPI	Department of Primary Industries
DPE	Department of Planning and Environment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ER	The Environmental Representative for the SSI
GHFF	Grey-headed Flying Fox
Ha	Hectares
NML	Noise Management Level
NSW	New South Wales
Project Approval	The Infrastructure Approval for Newcastle Inner City Bypass, Rankin Park to Jesmond, issued by the New South Wales Government on 15 February 2019
PCT	Plant Community Type
Project boundary	The area shown in Figure 2.1
SPIR	Submissions and Preferred Infrastructure Report
SSI	State Significant Infrastructure

Study area	The study area used in the Project Biodiversity Assessments including the Biodiversity Assessment Report (GHD, 2016a), SPIR Biodiversity Assessment Report (GHD, 2018) and Modification report for additional construction compounds (Transport, 2021). The study area is shown on Figure 7.1.
TEC	Threatened Ecological Community
Transport	Transport for NSW
WONS	Weeds of National Environmental Significance

# 1 Introduction

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## 1.1 Background

Transport for NSW (Transport) is planning for the construction of the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the Project). The Project involves the construction of 3.4 kilometres of a new four lane divided road between Lookout Road, New Lambton Heights and Newcastle Road, Jesmond.

The Project is located in the Newcastle local government area, about 11 kilometres west of the Newcastle central business district and about 160 kilometres north of Sydney.

An Environmental Impact Statement (EIS) was prepared by Transport in November 2016 (Newcastle Inner City Bypass – Rankin Park to Jesmond Environmental Impact Statement (GHD, 2016b) to assess the potential impacts of the project.

The accompanying Biodiversity Assessment Report (Technical Paper 1) (Project Biodiversity Assessment) (GHD, 2016a) determined that despite measures to avoid and mitigate impacts of the Project on biodiversity, there will be the following direct impacts within the construction footprint:

- Disturbance of an overall construction footprint of about 50.1 hectares.
- Removal of about 39.2 hectares of native vegetation and associated habitat resources for threatened fauna and flora species and other native biota. Within the 39.2 hectare of native vegetation:
  - Removal of about 4.1 hectares of Lower Hunter Spotted Gum Ironbark Forest Endangered Ecological Community (EEC) listed under the *Biodiversity Conservation Act 2016* (BC Act)
  - Removal of about 4.4 hectares of Sydney Blue Gum – White Mahogany shrubby tall open forest intermittent Groundwater Dependant Ecosystem
  - Removal of about 846 clumps of *Tetratheca juncea* (Black-eyed Susan)
  - Removal of five known and about 17 potential Powerful Owl (*Ninox strenua*) roost trees
  - Removal of about 320 identified hollow-bearing trees within known Squirrel Glider (*Petaurus norfolcensis*) habitat.

The project would also result in the loss of about 39.2 hectares of known and potential habitat for threatened biota including the Squirrel Glider, Powerful Owl and Grey-headed Flying-fox (*Pteropus poliocephalus*).

Following public exhibition of the EIS, Transport prepared the Newcastle Inner City Bypass – Rankin Park to Jesmond Submissions and Preferred Infrastructure Report (SPIR) (GHD, 2018) to respond to submissions and describe Project design refinements. Approval for the Project was granted on 15 February 2019 by the Minister for Planning (application number SSI 6888) and was subject to a number of Conditions of Approval.

In May 2021, Transport requested an additional three construction compounds as a modification to the Project. A modification report was prepared to assess the potential environmental impacts associated with the proposed modification and was approved on 7 February 2022.

This Flora and Fauna Construction Monitoring Program (FFCMP) has been prepared in response to the Conditions of Approval for the Project with a focus on threatened biodiversity monitoring during construction and has been prepared by a suitably qualified ecologist.

## 2 Purpose and objectives

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### 2.1 Purpose

This FFCMP has been prepared in response to the NSW Conditions of Infrastructure Approval issued under s 5.19 of the Environmental Planning and Assessment Act 1979 (EP&A Act) (SSI 6888) and focuses on threatened biodiversity recorded as part of the Project Biodiversity Assessment (GHD, 2016a), SPIR Biodiversity Assessment (GHD, 2018) and Modification report for Additional Construction Compounds (Transport, 2021). Table 3.1 outlines the conditions of approval relevant to monitoring and how each condition has been addressed in this FFCMP.

### 2.2 Land subject to monitoring

The Project boundary identified in the latest modification is shown on Figure 2.1 with construction compounds highlighted. The monitoring locations have been positioned outside, though within close proximity to, the Project boundary (as shown on Figure 7.1). Where possible, control monitoring locations are located further from the Project boundary. Control monitoring locations have been included to assist in identifying project-related impacts and effectiveness of mitigation measures against indirect impacts.

The following project features have been excluded from this monitoring program, for reasons outlined in the following subsections:

- Peatties Road construction compound
- Rivers and streams

#### 2.2.1 Peatties Road Construction Compound

A modification to the project approval to allow for an additional three construction compound sites was approved on 7 February 2022. Of the three compounds proposed, only Peatties Road will require vegetation removal. Impacts include removal of a low condition artificially created wetland which does not align to a Threatened Ecological Community. Additionally, no hollow-bearing trees or substantial habitat features likely to support threatened species were recorded (Transport, 2021).

Prior to use, Peatties Road construction compound will be subject to pre-clearing procedures however, given the absence of substantial or threatened biodiversity, this area has been excluded from this FFCMP.

#### 2.2.2 Dark Creek Culvert

Dark Creek flows in a north-westerly direction through the northern extent of the Project boundary under the Jesmond roundabout on Newcastle Road. Dark Creek enters the culvert in Jesmond Park and exits to the north of Newcastle Road between Blue Gum Road and the Newcastle Inner City Bypass. The length of the culvert is about 250 metres.

During a structural inspection of the Dark Creek culvert on 14 May 2019, a colony of microbats was encountered roosting approximately 45 metres downstream of the inlet (Jesmond Park side), inside one of the cells of the twin cell section of culvert (each cell 1.8 metre wide by 1.45 metre high). Photos and video footage of the colony, taken by contractors undertaking the inspection showed the microbats roosting in a 50 to 75 millimetre gap between the crown units (WSP, 2021c).

A targeted survey of the culvert was undertaken in October 2019 to determine the species of microbat roosting in the culvert. Echolocation calls confirmed the presence of the Little Bent-



winged Bat (*Miniopterus australis*) and the Large Bent-winged Bat (*Miniopterus orianae oceanensis*) inside the Dark Creek culvert (SMEC, 2019). Both species are listed as Vulnerable under the NSW *Biodiversity Conservation Act 2016*. Based on the number of calls recorded, it is most likely that the colony is dominated by the Little Bent-winged Bat, but both species have similar roosting habitat requirements.

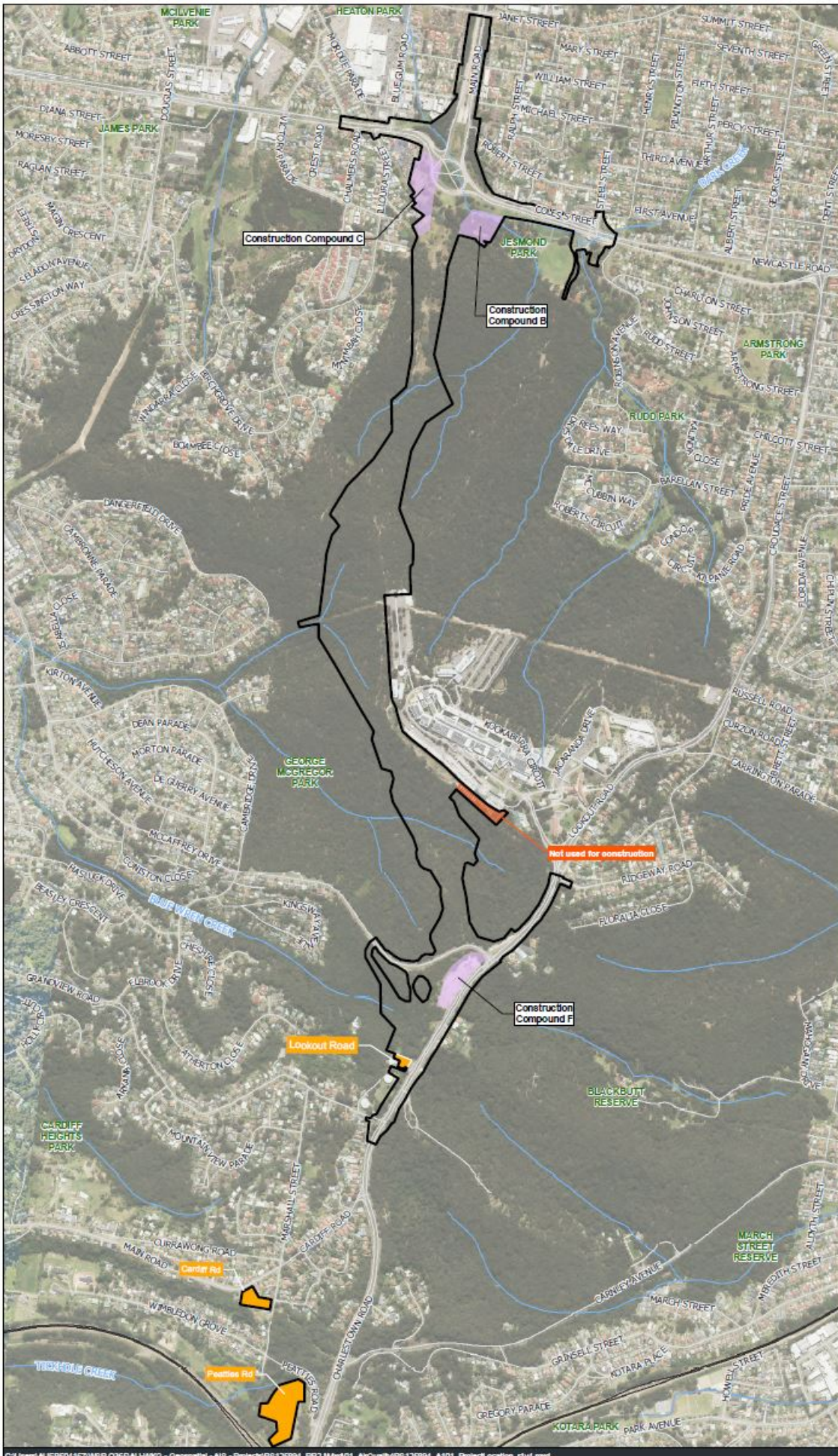
Remote camera surveys of the entire Dark Creek culvert were again undertaken for Transport in December 2020 and September 2021 with flyout surveys being undertaken in January and September 2021. The purpose of these surveys was to determine if any of the Bent-winged Bats were breeding in the culvert, or to identify if any other species of microbat were roosting in other areas of the culvert. No microbats were present during any of these inspections (WSP, 2021c).

This means Bent-winged Bats are not currently breeding in the Dark Creek culvert and would likely have returned to maternity roosts in caves to give birth. Similarly, no Southern Myotis were recorded during the 2019 targeted survey or in the recent 2021 surveys), suggesting they are unlikely to be breeding in the Dark Creek culvert (WSP, 2021c). The culvert has been determined to be non-maternity roost sites for Bent-winged Bats, the culvert does not meet the requirements of a high conservation over-winter maternity roost site.

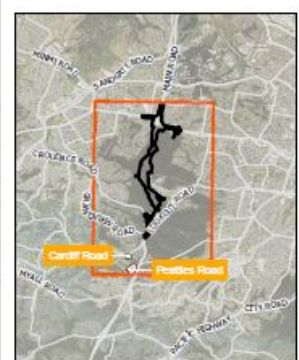
To address this uncertainty, a Microbat Management Strategy has been developed to manage potential impacts on roosting bats in the Dark Creek culvert, which includes specific monitoring requirements to determine the effectiveness of mitigations. The Microbat Management Strategy has been included as Appendix B, with its monitoring requirements being addressed in Table 7.1.



Figure 2.1  
Project Location



- Legend**
- Roads
  - Named Watercourse
  - ▭ Project Boundary
  - ▨ Area not used for construction
  - ▨ Proposed Construction Compounds
  - ▨ Construction Compound



Coordinate system: GDA 1994 MGA Zone 56  
Scale ratio correct when printed at A3  
1:12,000 Date: 26/05/2022

Data sources: - NSWRS, TRIM, Geoscience Australia  
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### 2.2.3 Rivers and streams

The monitoring of rivers and streams recorded within and next to the Project boundary are addressed in the Construction Surface and Groundwater Monitoring Program (WSP, 2021b). The water monitoring is expected to adequately cover any ecology-related aspects which relate to water quality and structural condition of these rivers and streams and therefore these have not been included in this FFCMP.

## 2.3 Objectives

The objectives of the FFCMP have been developed in accordance with the relevant conditions of approval (refer Table 3.1) and focus on threatened biodiversity recorded for the Project Biodiversity Assessment (GHD, 2016a), SPIR Biodiversity Assessment (GHD, 2018) and Modification report for additional construction compounds (Transport, 2021).

Broad objectives of this FFCMP and the section where they are addressed is provided in Table 2.1 below.

**Table 2.1 Broad objectives of this monitoring program and section where it is addressed**

Broad objectives	Section addressed
Provision of a review and summary of baseline biodiversity data which includes data on Threatened Ecological Communities and threatened species	Section 6
Provision of the status and methods for obtaining baseline data for relevant Threatened Ecological Communities and threatened species	Table 6.1
Provision of parameters of the project to be monitored with regard to relevant threatened biodiversity matters	Table 7.1
Provision of the frequency of monitoring events for each Threatened Ecological Community and threatened species	Table 7.1
Provision of monitoring locations for relevant threatened biodiversity in maps and tables showing GPS coordinates	Section 5.2
Provision of required reporting requirements for relevant threatened biodiversity monitoring results	Table 10.1
Provision of procedures to identify and implement additional or alternative mitigation measures for occasions where results of monitoring are unsatisfactory	Table 8.1
Consultation with Transport, Newcastle City Council, Lake Macquarie City Council and DPI Fisheries in relation to the monitoring programs	Section 9

## 2.4 Related documents

The NSW conditions of approval require Construction Monitoring Programs for the following:

- Surface and Ground Water Quality
- Air Quality
- Noise and Vibration
- Flora and Fauna.

This FFCMP forms part of this suite of Construction Monitoring Programs for the project.

## **3 Compliance matrix**

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### **3.1 NSW conditions of infrastructure approval SSI 6888**

This FFCMP has been prepared in response to Part C (C9 to C15) in the conditions of infrastructure approval issued under s 5.19 of the EP&A Act (SSI 6888) (Department of Planning and Environment, 2019).

Table 3.1 outlines the conditions of approval relevant to monitoring and how each condition has been addressed in this FFCMP.

**Table 3.1 Conditions of infrastructure approval (SSI6888) – Construction Monitoring Programs**

Condition	Description	Section where this is addressed
C9	<p>The following Construction Monitoring Programs must be prepared in consultation with the relevant public authorities identified for each to compare actual performance of construction of the SSI against the performance predicted in the in the documents listed in Condition A1 or in the CEMP:</p> <p>(E) Flora and fauna,- DPI Fisheries and relevant councils (Newcastle City Council and Lake Macquarie City Council).</p>	<p>Section 9</p> <p>Section 10, Table 10.1</p> <p>Section 7.2</p>
C10	<p>Each Construction Monitoring Program must provide:</p> <p><b>A.</b> details of baseline data available;</p> <p><b>B.</b> details of baseline data to be obtained and when;</p> <p><b>C.</b> the parameters of the project to be monitored;</p> <p><b>D.</b> the frequency of monitoring to be undertaken;</p> <p><b>E.</b> the location of monitoring;</p> <p><b>F.</b> the reporting of monitoring results;</p> <p><b>G.</b> procedures to identify and implement additional or alternative mitigation measures where results of monitoring are unsatisfactory; and</p> <p><b>H.</b> any consultation to be undertaken in relation to the monitoring programs</p>	<p><b>A.</b> Section 6</p> <p><b>B.</b> Section 6</p> <p><b>C.</b> Section 5.1</p> <p><b>D.</b> Section 7</p> <p><b>E.</b> Figure 2.1, Figure 7.1</p> <p><b>F.</b> Section 10</p> <p><b>G.</b> Section 8</p> <p><b>H.</b> Section 9</p>
C11	<p>The Construction Monitoring Programs must be developed in consultation with the relevant public authorities specified in Table 4. Where an authority’s request(s) has not been included in the Monitoring Program, the Proponent must provide justification to the Planning Secretary as to why it was not included. Details of all information requested by an authority including copies of all correspondence from those authorities, must be provided with the relevant Construction Monitoring Program.</p>	<p>Section 9</p>

Condition	Description	Section where this is addressed
C12	The Construction Monitoring Programs must be endorsed by the ER and then submitted to the Planning Secretary for approval at least one (1) month before the commencement of construction.	This report will be submitted within the specified timeframe. ER endorsement of this FFCMP is included in the document controls on page 5 of this report.
C13	Construction must not commence until the Planning Secretary has approved, or as otherwise agreed by the Planning Secretary, all the required Construction Monitoring Programs, and all relevant baseline data for the specific construction activity has been collected.	This report's approval is required prior to construction activity
C14	The Construction Monitoring Programs, as approved by the Planning Secretary including any minor amendments approved by the ER must be implemented for the duration of construction and for any longer period set out in the monitoring program or specified by the Planning Secretary, whichever is the greater.	Timing and frequency of this monitoring program is outlined in section 7.
C15	The results of the Construction Monitoring Programs must be submitted to the Planning Secretary, and relevant public authorities for information, in the form of a Construction Monitoring Report at the frequency identified in the relevant Construction Monitoring Program. Where a relevant CEMP Sub-plan exists, the relevant Construction Monitoring Program may be incorporated into that CEMP Sub-plan.	Section 10

## 3.2 EPBC Conditions of Approval

Conditions of approval (2015/7550) was issued on 5 April 2019 under sections 130(1) and 133(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DEE, 2019). It should be noted that this Project was approved under a bilateral agreement whereby the EPBC and NSW conditions (section 3.1) of approval are aligned.

Table 3.2 in outlines the conditions of approval relevant to monitoring.

It should be noted that this FFCMP doesn't address all conditions outlined. The overriding Flora and Fauna Construction Environment Management Plan (CEMP) Sub-plan will be prepared to meet C4, C5 and C8 below.

**Table 3.2 EPBC Conditions of Approval (2015/7550)**

Condition	Description
C4	A Flora and Fauna Construction Environment Management Plan (CEMP) is required
C5	The CEMP Sub-plans to state how: <b>A.</b> environmental performance outcomes will be achieved; <b>B.</b> how the mitigation measures will be implemented; <b>C.</b> how the relevant terms of the NSW conditions will be complied with; and <b>D.</b> how issues requiring management during construction, as identified through ongoing environmental risk analysis, will be managed.
C8	Construction must not commence until the CEMP and all CEMP Sub-plans have been approved by the Planning Secretary



## 4 Existing Environment

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This section describes the existing biodiversity within the study area based on the information contained in the Project Biodiversity Assessment (GHD, 2016a), SPIR Biodiversity Assessment (GHD, 2018) and Modification report for Additional Construction Compounds (Transport, 2021).

The study area surrounding the current Project boundary is shown on Figure 7.1 and is comprised of the area of bushland between Newcastle Road, Jesmond Roundabout, Rankin Park, the John Hunter Hospital precinct, Lookout Road and both northern and southern sides of McCaffrey Drive.

### 4.1 Vegetation communities

The study area largely consists of remnant native vegetation surrounded by a mostly developed urban landscape. Vegetation within the study area broadly corresponds with six native vegetation types and two non-native vegetation types. The six native vegetation types identified in the Project Biodiversity Assessment (GHD, 2016a) have been reported below as the equivalent plant community types (PCTs) as recognised by the NSW BioNet Vegetation Classification. The eight vegetation types recorded include:

- Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion
- Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest of the Central Coast
- Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter (listed under the BC Act as Endangered)
- Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands
- Smooth-barked Apple – Turpentine – Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast
- Planted and parkland vegetation
- Exotic vegetation

All native vegetation zones were in moderate or good condition and are connected to other vegetation extending to the south-east and west of the site, with the exception of the low condition *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands which was recorded at Peatties Road construction compound.

#### 4.1.1 Threatened ecological communities

One of the vegetation communities recorded, Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest corresponds with a threatened ecological community (TEC):

- Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions (Endangered – BC Act).

Lower Hunter Spotted Gum Ironbark Forest TEC occurs primarily in the north of the Project boundary. The community is dominated by *Corymbia maculata* and *Eucalyptus fibrosa*, with *Eucalyptus umbra* also commonly present. In moister areas, other canopy species include *Eucalyptus propinqua* and *Eucalyptus acmenioides*, and *Eucalyptus fergusonii* was also occasionally prominent in nearby sheltered slopes.

The community was mapped as being in moderate to good condition and occupied 19.8 ha of the study area (1%).

This TEC has not been included in this FFCMP as the potential indirect impacts from the Project (i.e. weeds, inadvertent clearing) have been offset and will be managed and monitored as part of the CEMP. This is discussed further in Table 5.1.

## 4.2 Threatened flora species

Three threatened flora species were recorded within the study area during targeted surveys for the Project Biodiversity Assessment (GHD, 2016a, 2018). Threatened flora species recorded include:

- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) (Vulnerable – BC Act, Vulnerable – EPBC Act)
- *Syzygium paniculatum* (Magenta Lilly Pilly) (Endangered – BC Act and EPBC Act)
- *Tetraloche juncea* (Black-eyed Susan) (Vulnerable – BC Act and EPBC Act).

### 4.2.1 *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea)

*Grevillea parviflora* subsp. *parviflora* were found to be growing in one section of the study area in association with the Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands community. A total of 109 stems of this species was recorded.

This occurrence of this species is outside of the Project boundary and will not be directly impacted, although due to this species close proximity to the Project, it has been included in this FFCMP as a precaution.

### 4.2.2 *Tetraloche juncea* (Black-eyed Susan)

*Tetraloche juncea* was recorded as a large population comprising five sub-populations totalling 10,381 plant clumps.

Sub-populations of *Tetraloche juncea* are shown on Figure 7.1 and include:

- Sub-population 1: west of Lookout Road including Invermore Close and Dangerfield Drive reserves and bushland generally to the south and west of the John Hunter Hospital precinct (8,176 clumps)
- Sub-population 2: west of Lookout Road and north of the John Hunter Hospital precinct (4 clumps)
- Sub-population 3: Blackbutt Reserve, east of Lookout Road (5 clumps)
- Sub-population 4: Blackbutt Reserve, east of Lookout Road (2,162 clumps)
- Sub-population 5: Blackbutt Reserve, east of Lookout Road (34 clumps).

The largest sub-population within the study area (sub-population 1) meets the criteria for an 'important population' as set out by the *Environment Protection and Biodiversity Conservation*

Act 1999 referral guidelines for the vulnerable *Tetralochea juncea* (Black-eyed Susan) (Department of Sustainability Environment Water Population and Communities 2011).

This population will be impacted by the Project and is considered further in this FFCMP.

#### 4.2.3 *Syzygium paniculatum* (Magenta Lilly Pilly)

*Syzygium paniculatum* was recorded at one location on the western edge of the study area in association with Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest vegetation community along the banks of an unnamed creek. Eight stems in total were recorded, outside of the Project boundary. These plants were considered to have possibly colonised as a result of bird dispersal from nearby gardens, as this species is usually found in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas.

This species is unlikely to be impacted by the project due to its distance outside of the Project boundary. As such, this species is not considered further in this FFCMP.

### 4.3 Threatened fauna

A total of 79 fauna species were recorded within the study area (GHD, 2016a, 2018), of these six are listed under the BC Act and/or EPBC Act and are listed in Table 4.1. All threatened fauna species recorded are considered further in this FFCMP.

**Table 4.1 Threatened fauna species recorded within the study area**

Scientific name	Common name	BC Act status	EPBC Act status
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-
<i>Miniopterus australis</i>	Little Bent-winged Bat	V	-
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	V	-
<i>Ninox strenua</i>	Powerful Owl	V	-
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V

Key: V = vulnerable

## **5 Flora and Fauna Monitoring Program**

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This FFCMP outlines the surveys that would be conducted prior to and during the construction phase of the Project to assess the effectiveness of mitigation measures implemented to minimise adverse impacts to threatened biodiversity.

Flora and fauna monitoring will be implemented during the construction period and at least 12 months after completion of construction as per the frequencies identified in Table 7.1. Construction of the project is currently expected to commence in late 2022 and continue until late 2025. This FFCMP covers the eventual full construction period and post-construction monitoring requirements.

### **5.1 Target biodiversity**

The value of monitoring each threatened entity has been evaluated below to ensure this FFCMP is targeted and seeks to collect meaningful data. As such, sedentary species and those with smaller home ranges or that nest in specific locations have been included whereas species which are vagrant, nomadic or with large home ranges have not. Each threatened entity has been evaluated for inclusion in the FFCMP in Table 5.1 below.

**Table 5.1 Evaluation of monitoring threatened biodiversity recorded within the Project Boundary**

Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
Threatened ecological communities (TEC)				
<i>Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions</i>	Low	<p>The main potential indirect impacts of the Project were identified in the Biodiversity Assessment as edge effects. To address this potential impact, a 10-metre disturbance buffer was added to the Project boundary, resulting in an additional one hectare that was included in the direct impact offset calculations for this TEC (GHD, 2016a). Additionally, the project boundary represents the worst-case clearing footprint and was offset accordingly, however the actual clearing area will be reduced through detailed design. Therefore any changes to the integrity of surrounding retained occurrences of this TEC as a result of the project have been conservatively addressed through the calculation of biodiversity credits.</p> <p>The CEMP will also detail mitigation measures to address potential impacts on retained vegetation, including hygiene and clearing protocols and requirements for monitoring of clearing limits and weed introduction/spread.</p> <p>The minimum 10-metre distance from the defined conservative construction boundary, in which Lower Hunter Spotted Gum Ironbark Forest will still be retained, is not considered to warrant specific monitoring as any change is likely to be outside of the construction timeframe of the project.</p> <p>Therefore, monitoring the occurrence of this TEC that will be retained adjacent to the Project boundary is unlikely to provide meaningful data.</p>	No, as the Lower Hunter Spotted Gum Ironbark Forest outside of construction footprint will be retained and condition is not likely to change (and any such changes are considered more likely to occur over long periods of time).	
Threatened flora				

Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
<i>Tetradlea juncea</i>	Black-eyed Susan	High	<p>Potential indirect impacts of the Project on <i>Tetradlea juncea</i> can be assessed through comparing data collected in sub-populations near the Project during the construction phase and comparing it to both the data collected prior to construction (baseline data) and data collected at a control location unlikely to be impacted by the Project (shown on Figure 7.1). Monitoring this species would provide valuable data on the effectiveness of the Projects mitigation measures to prevent impacts during the construction phase. Relevant mitigation measures include:</p> <ul style="list-style-type: none"> <li>— Hygiene protocols for invasion and spread of weeds and pathogens</li> <li>— Pre-clearing procedures and exclusion zones.</li> </ul> <p>Sub-populations of this species are distributed across the Project boundary. Monitoring high density patches of this species in areas adjoining the Project boundary and at a control site would include collecting data on:</p> <ul style="list-style-type: none"> <li>— Population density</li> <li>— Population extent</li> <li>— Observation on health of individuals including disease and dieback.</li> </ul>	Yes, monitoring of known populations can provide meaningful numeric data
<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	High	<p>A population of <i>Grevillea parviflora subsp. parviflora</i> was recorded within close proximity to the Project boundary. Monitoring this species would provide valuable data on the Projects impacts during the construction phase. Relevant mitigation measures include:</p> <ul style="list-style-type: none"> <li>— Hygiene protocols for invasion and spread of weeds and pathogens</li> <li>— Pre-clearing procedures and exclusion zones.</li> </ul> <p>Data collected would include:</p> <ul style="list-style-type: none"> <li>— Population density</li> </ul>	Yes, monitoring of known populations can provide meaningful numeric data



Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
			<p>— Observation on health of individuals including disease and dieback</p> <p>As only one population was recorded, no control location has been added for this species.</p>	
<i>Syzygium paniculatum</i>	Magenta Lily Pilly	Low	<p><i>Syzygium paniculatum</i> was recorded approximately 340 metres South-West of the Project boundary. It is considered highly unlikely these individuals will be subject to any impact from the Project and it has therefore has not been considered further or included in the FFCMP for monitoring.</p>	No, the nearest <i>Syzygium paniculatum</i> population is >350 metres from the Project
Threatened Fauna				
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox (GHFF)	High	<p>This species is a highly mobile blossom nomad and utilises a broad range of vegetation in irregular patterns. GHFF are capable of flying up to 50km from their roost for foraging (DAWE, 2021). As such, recording presence/absence of individuals foraging within vegetation surrounding the Project boundary would not provide meaningful data. However, a nationally recognised GHFF camp is located within Blackbutt Reserve which is approximately 200 metres South-East of the southern extent of the Project boundary.</p> <p>Indirect impacts from the Project were not identified by the Biodiversity Assessment (GHD, 2016a) as an issue for the Blackbutt Reserve camp. Therefore, no mitigation measures have been recommended relating specifically to managing potential noise impacts on biodiversity. However construction activities have the potential increase noise levels in the surrounding landscape, which may disturb individuals in this camp. Considering the distance of this camp from the Project boundary and the existing noise levels, this impact itself is likely to be minor.</p>	Yes

Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
			<p>Noise levels within close proximity to the camp will be monitored through the Construction Noise and Vibration Monitoring Program (WSP, 2021a). This data will be assessed as part of the monitoring program and further noise monitoring at the camp in response to exceeded noise thresholds during the construction phase would provide valuable data on potential Project impacts to camp. If noise levels at the GHFF camp exceed thresholds, monitoring surveys to determine impact will be undertaken.</p> <p>Additionally, monitoring of GHFF camp size occurs annually as part of the National Flying-fox Monitoring Program is a Commonwealth (DAWE) funded program which is collaboration between state governments, the CSIRO, local government and volunteers to collect and collate data. Although this monitoring only provides a high-level estimate of camp size, the data will also be reviewed as part of the knowledge base surrounding this camp.</p>	
<i>Miniopterus australis</i>	Little Bent-winged Bat	Low	The potential of the Dark Creek culvert as breeding habitat for this species was recently investigated, with bats found to be absent (see section 2.2.2). Foraging habitat for this species is broad and abundant within the proximity to the Project boundary. Further monitoring of this species is not likely to provide informative data in relation to construction impacts so has not been included in this FFCMP.	Yes - management of this species is detailed in the Microbat Management Strategy (see Appendix B)
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Low	The potential of the Dark Creek culvert as breeding habitat for this species was recently investigated, with bats found to be absent (see section 2.2.2). Foraging habitat for this species is broad and abundant within the proximity to the Project boundary. Further monitoring of this species is not likely to provide informative data in relation to construction impacts so has not been included in this FFCMP.	Yes - management of this species is detailed in the Microbat Management Strategy (see Appendix B)



Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
<i>Glossopsitta pusilla</i>	Little Lorikeet	Low	<p>The Little Lorikeet is considered to be a nomadic species and utilises an abundance of broad forest habitats for foraging. Irregular large or small influxes of individuals can occur at any time of year, apparently related to food availability (ie flowering trees and shrubs). A pair of Little Lorikeets was identified flying over the Project during targeted surveys undertaken as part of the Biodiversity Assessment (GHD, 2016a). It is unknown if the pair of birds recorded were inhabiting the Project study area at the time, or just passing through. The Biodiversity Assessment (GHD, 2016a) states that habitat in the Project area is likely to provide, seasonal foraging resources and potential breeding hollows for this species. As such, the species was assessed as an ecosystem-credit species in the calculation of offsets. The calculation of ecosystem credits included a buffer on the Project's boundary to allow for flexibility in the final clearing boundary and account for a range of potential indirect impacts. As such clearing calculation were conservative. Any residual impacts (following offsetting) to the presence of the Little Lorikeet are considered to be negligible and therefore did not result in the development of specific mitigation measures (other than staged clearing requirements for hollow-bearing trees).</p> <p>The value of monitoring this species has been considered based on its ecology and the potential impacts from the project. Considering the wide-ranging nomadic ecology of the Little Lorikeet, including the irregular seasonal flowering exhibited by a primary foraging resource in the area, Spotted Gum (<i>Eucalyptus maculata</i>), monitoring of this species is considered unfeasible and of low value.</p> <p>As such, the Little Lorikeet has not been included in this FFCMP.</p>	No
<i>Ninox strenua</i>	Powerful Owl	High	A nest tree was recorded approximately 38 metres to the West of the Project boundary. The primary potential impact to this species will be	Yes

Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
			disturbance from construction activities. While there are no specific mitigation measures relating to managing indirect impacts on the Powerful Owl nest tree, monitoring of occupation and any evidence of breeding prior to and during the construction phase of the Project would provide informative data on Project impacts.	
<i>Petaurus norfolcensis</i>	Squirrel Glider	Low	<p>The Squirrel Glider is widely yet sparsely distributed through the Project boundary and surrounding study area. The primary impacts to this species as a result of the Project are clearing of foraging habitat, loss of hollow-bearing trees and fragmentation of habitat connectivity. Foraging habitat for this species occurs in abundance within proximity to the Project boundary, and direct impacts are addressed through biodiversity offsets.</p> <p>Loss of hollow resources will be addressed by monitoring of replacement habitat as per Section 7.3 of this program. This data will contribute to the growing understanding of the effectiveness of artificial hollow technology.</p> <p>Mitigation measures outlined in the Biodiversity Assessment (GHD, 2016a) to address connectivity impacts state that opportunities to retain trees in construction compound A (see Figure 2.1) will be investigated to provide an arboreal crossing for the Squirrel Glider and other arboreal fauna species. Impacts to habitat connectivity will primarily be addressed by the development and implementation of Connectivity Strategy, however monitoring of connectivity structures is not considered necessary.</p> <p>Transport has over ten years of monitoring data (in addition to published literature) which demonstrates the effectiveness of properly constructed and positioned connectivity structures for the Squirrel Glider (eg rope crossing and glide poles).</p> <p>Therefore, monitoring the use of crossing structures by this species as part of this FFCMP would not provide informative data, monitoring of crossing</p>	No

Scientific name	Common name	Value for monitoring	Justification	Included in FFCMP
			<p>structures would only be valuable if new technology is being trialled, or new species currently undocumented using a structure type is being targeted.</p> <p>Any broader uncertain impacts on the local population (eg disturbance during construction) is addressed by the Project's conservative clearing boundary and additional 10-metre buffer used to determine offset requirements. Identifying indirect impacts on the local population further away from the Project would require a comprehensive mark-recapture program to effectively identify Project-related changes in activity levels. This is not considered feasible or necessary.</p> <p>It is therefore considered that the primary Project impacts on the Squirrel Glider will be addressed through the Project's offset requirements, connectivity measures and replacement habitat as per Section 7.3 of this monitoring program. As such, the Squirrel Glider has not been included in this FFCMP.</p>	

## **5.2 Monitoring methods**

Methods proposed to collect monitoring data for each threatened entity targeted in this FFCMP are outlined in this section. Baseline data requirements are addressed in Section 6.

### **5.2.1 Monitoring locations**

Monitoring locations described in this section and shown in Figure 7.1 are subject to the Project designs ongoing refinements. Further review of monitoring locations will occur prior to construction beginning and annually as part of the reporting requirements outlined in Section 10.

### **5.2.2 Threatened flora**

Threatened flora surveys will be conducted to collect baseline biodiversity data (see section 6) and during construction at monitoring locations outlined in Table 5.2. Each monitoring location is shown on Figure 7.1.

**Table 5.2 Threatened flora monitoring locations**

Scientific name	Common name	Monitoring point	Easting	Northing	Orientation (°)	Justification
<i>Tetratheca juncea</i>	Black-eyed Susan	T1	377619	6355752	280	This patch of <i>Tetratheca juncea</i> is encompassed by the Project boundary and most at risk to Project impact.
		T2	377679	6356052	220	Patches of <i>Tetratheca juncea</i> which are high density and within close proximity to the Project boundary have been chosen as monitoring locations. These patches will be able to be monitored through density quadrants and population extent surveys. These sub-populations are likely to be relatively resilient as they are large in extent and extend into bushland areas.
		T3	377420	6356649	190	
		T4	377295	6357073	80	
		T5	377608	6357066	338	
		TC	376999	6357131	80	
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	G1	377327	6356817	150	Northern and southern sub-population of <i>Grevillea</i> was used as monitoring location whereby population density quadrants count individual stems. No control location was available.
		G2	377349	6356726	65	

### 5.2.2.1 Density quadrats and population extent survey

#### Density quadrats (parallel traverses)

Density quadrats will be established at monitoring locations outlined in Table 5.2 and shown on Figure 7.1 to monitor *Tetratheca juncea* and *Grevillea parviflora subsp. parviflora*.

Density quadrats will be fixed at monitoring locations using star pickets/wooden pegs at each of the four corners of a 20 by 20 metre (400 square metre) quadrat with location recorded using a GPS (see Table 5.2). Population estimates will be recorded within the 400 square metre density quadrat using parallel field traverses at one metre intervals where threatened species are marked using survey flagging pins. This method has been developed in general accordance with the NSW Surveying threatened plants and their habitats guidelines (Department of Planning, Industry and Environment, 2011).

*Tetratheca juncea* individuals are measured by clumps. A clump is defined as a group of stems separated from an adjacent group by greater than 30 centimetres. *Tetratheca juncea* grows in clumps of single or multiple stems arising from a single rootstock and it is therefore difficult to determine whether adjacent plants are joined or are separate without removing them from the soil (Department of Sustainability, Environment, Water, Population and Communities, 2011). *Grevillea parviflora subsp. parviflora* individuals can be counted using stem counts.

Each clump of *Tetratheca juncea* and stem of *Grevillea parviflora subsp. parviflora* must be marked using survey flagging pins. Flagging pins are to be installed during baseline surveys. Flagging pins must remain in place during the entire life of the monitoring program to ensure accurate and repeatable population counts and mitigate potential trampling.

Surveys for *Tetratheca juncea* and *Grevillea parviflora subsp. parviflora* will be conducted once annually during peak flowering period for both species, between September and October.

#### Population extent survey

Population extent surveys are proposed for *Tetratheca juncea* only. Surveys involve an ecologist walking to and marking (using flagging tape or similar) the most northerly and southerly point of the patch of *Tetratheca juncea* surrounding monitoring location T2 to T5 within a 50 metre corridor from the Project boundary. A GPS will be carried to define population extent. Observations regarding population health (i.e. senescence, presence of juveniles) will be made. T1 patch is surrounded by the Project boundary and the entire population extent will be surveyed and marked.

Population extent surveys are proposed for baseline data collection only and are detailed in section 6. Annual population extent surveys are not required provided density quadrats do not record a 25% reduction of population density.

In the event that a 25% reduction in population density at any one monitoring location is recorded. Population extent survey are required at each monitoring location. Whilst ecologist is walking through the sub-population to record extent, observation regarding population health, signs of disturbance, changes in vegetation structure and microclimate etc..

#### Supplementary data

Supplementary data to be collected at each monitoring and control location is listed below. This data wont be directly analysed for a threshold, but may help in understanding any changes recorded. Supplementary data includes:

- Photograph at each of the photo points shown on Figure 7.1
- Record exotic species present and assign cover using the Braun-Blanquet scale (see Table 5.3)



- Comments of any disturbance i.e. dumped rubbish, tree dieback or recruitment, clearing etc..
- Comments of population health, peak flowering, maturity of plants/clumps, senescence etc.

**Table 5.3 Braun-Blanquet cover scale**

Scale	Range of cover
r	Very few individuals forming <5% of plant foliage cover
+	Few individuals forming <5% of plant foliage cover
1	Numerous individuals forming <5%
2	Any number of individuals forming 5-25% of plant foliage cover
3	Any number of individuals forming 25-50% of plant foliage cover
4	Any number of individuals forming 50-75% of plant foliage cover
5	Any number of individuals forming 75-100% of plant foliage cover

**Table 5.4 Aims and objectives of data collected at each threatened flora monitoring location**

Data collected	Aim	Objective	Threshold
Density quadrats	Monitoring the population density through sampling	Assess for decrease in population density	25% reduction from baseline at any one monitoring location (not including the control site) would trigger surveys in population extent
Population extent	Mark population extent within 50m corridor from the Project boundary, make comments on health of subpopulation, signs of disturbance, conditions (i.e. vegetation structure, microclimate)	Provide baseline monitoring to be reviewed if threshold for population density surveys are exceeded	If population extent surveys record that both northern and southern population boundaries have reduced at 1 or more monitoring location, an adaptive management response is triggered.

## 5.2.3 Threatened fauna

### 5.2.3.1 Grey-headed Flying-fox camp

The Grey-headed Flying-fox camp in Blackbutt Reserve is a locally important population, known to support breeding females and is the only continuously occupied camp in the Lower Hunter region (GHD, 2016a).

Since the Biodiversity Assessment (GHD, 2016a) was published, the Blackbutt Reserve camp has been listed as nationally important by the Department of Agriculture, Water and the Environment and included in the National Flying-fox Monitoring Program (Department of the Environment, 2015). The Blackbutt Reserve camp would not be directly impacted by the Project, however considering it is located around 200 metres from the southern extent of the Project, there is potential that construction works may increase noise and vibration above existing levels. However, due to the distance of the camp from the project boundary, the scope of works that would be undertaken around the boundary (i.e no major earthworks or clearing) and the existing level of noise and vibration caused by traffic along Lookout Road, the potential for this impact is considered to be negligible.

Regardless, some degree of monitoring is recommended to ensure GHFF do not abandon the existing camp. As such, baseline data was collected prior to the commencement of construction and included photographs, presence/absence of camp and extent of individuals. A summary of this baseline data has been included as Appendix A.

Since noise and vibration is the only potential impact, this will be the focus of monitoring. The Noise and Vibration Construction Monitoring Program (WSP, 2021a) determined that noise and vibration risks from the Project are unlikely given existing noise sources in the area and distance of camp from Project boundary. To be certain of this impact, Project Noise Management Levels (NML's) in Noise Catchment Area 13 (NCA13) will be monitored as per the Construction Noise and Vibration Monitoring Program (WSP, 2021a) and shown on Figure 7.1c. NCA13 is located on Lookout Road and is the closest NCA to the GHFF camp and Project, approximately 400 metres from GHFF camp in Blackbutt Reserve. Where construction noise levels exceed the project NCA 13 NML by 10 dBA LAeq during the daytime period over a 15-minute monitoring period (i.e. not a spike in otherwise stable noise levels), further noise monitoring will be carried out at the Blackbutt Reserve Camp. If noise levels attributable to construction work on the project exceed the NCA13 daytime NML by 10 dBA at the Blackbutt Reserve Camp, additional surveys of the camp will be triggered. Surveys would include recording the same data as the baseline surveys previously conducted. Additional information could be used to identify elevated stress level indicators, such as high numbers of flying individuals or orphaned pups on the ground. GHFF camp monitoring would occur daily (or as otherwise determined appropriate on an ongoing sense) to ensure that the population in the camp remains visually unaffected until the daytime noise returns to lower than benchmark levels at the camp. Stressed individuals or a decrease in population size in response to noise levels will require an adaptive management response agreed to by an appropriately qualified ecologist. Further details on the adaptive management response can be seen in Table 8.1.

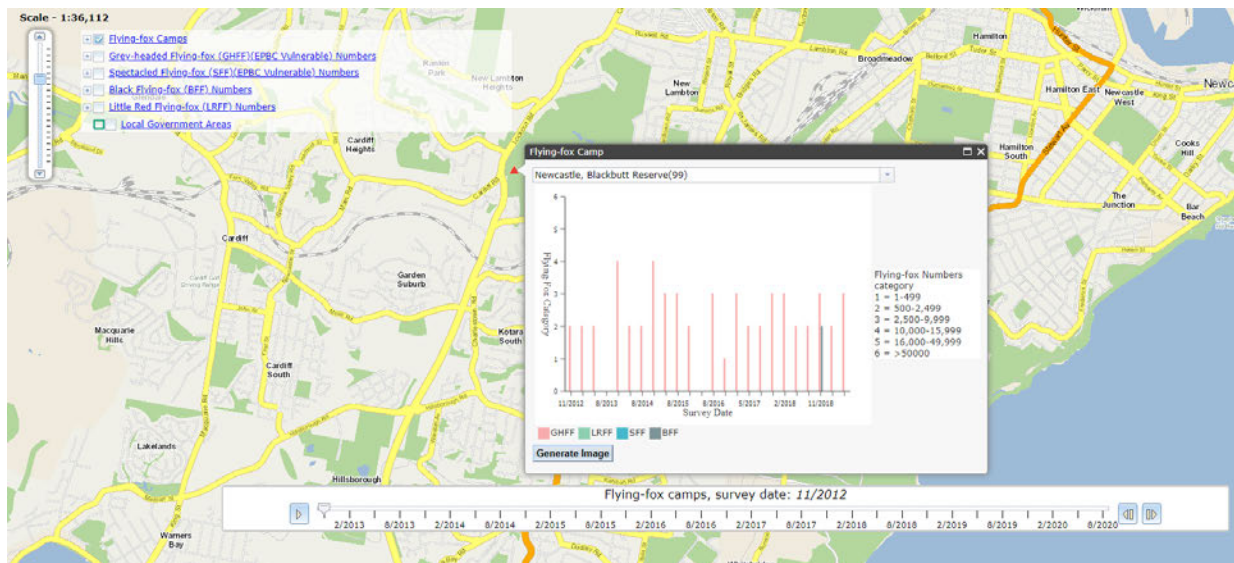
Daytime-only monitoring has been selected as this is when the GHFF are at the camp and more susceptible to noise impacts. Night-time construction will usually be quieter due to sensitivities of nearby residents. Night-time is also the time when the GHFF will usually have left to forage in the surrounding region, therefore noise and vibration impacts on the camp at night do not need to be considered.

### **Supplementary data**

Monitoring of this camp as part of the National Flying-fox Monitoring Program occurs during November/December and February when the greatest proportion of the population are found in camps, each year. The program estimates population size and distribution (CSIRO, 2011) and has been monitoring the Blackbutt Reserve camp since 2012 (see Photo 5.1).

Survey results from this program and future surveys during the construction period of the Project will be requested from DAWE and contribute to the knowledge base around the Blackbutt Reserve camp. Trends and seasonal variation in population at the camp will be taken into consideration. It is acknowledged that the population size estimates are reported in categories, which fluctuate year to year between 499 and 15,999 individuals (see Photo 5.1). Therefore, this data will be supplementary to achieving the program objectives.





**Photo 5.1 National Flying-fox Web viewer showing population census data from 2012-2019 (DAWE, 2021b)**

### 5.2.3.2 Powerful Owl

Survey methods detailed in this section for monitoring Powerful Owls are consistent with those previously used by Parsons Brinckerhoff (2015b).

The nest tree identified in the Project Biodiversity Assessment (GHD, 2016a) and any others identified for monitoring during the pre-clearing surveys, would be stag watched and inspected for the presence of Powerful Owl pellets, evidence of discarded prey items and whitewash. The nest tree monitoring location is outlined in Table 5.5 and shown on Figure 7.1. This location is subject to change in the event that a more suitable nest/roost trees for Powerful Owls is identified either by an ecologist pre-clearance survey or through consultation with the Hunter Bird Observers Club.

Stag watching will be carried out over a 90-minute period (30 minutes before sunset and 60 minutes following sunset) during the breeding season to determine if the hollows are being utilised by breeding Powerful Owls. Surveys will be carried out over three consecutive nights or until Powerful Owl presence is confirmed and will record Powerful Owl calls (including duets between male and females) and sightings of adults/juveniles. Call playback is not to be used as a survey technique for nest tree use surveys during the breeding season to avoid disturbance to resident individuals.

Surveys will be conducted twice a year throughout the breeding season, once in July and one in August at monitoring locations outlined in Table 5.5. If Powerful Owl presence is confirmed during July surveys, August surveys are not required.

As per the Threatened Biodiversity Data Collection (EES, 2021) endorsed by the Biodiversity Assessment Method 2020, Powerful Owl presence includes:

- The presence of male and female in or near the nest tree
- Male and female duetting in or near the nest tree
- Presence of juvenile Powerful Owl in or near the nest tree

If no Powerful Owls are identified after the two surveys, additional surveys of the surrounding vegetation will be required. Broader surveys may include the use of call playback to determine if the resident pair is still present in the vicinity. This will attempt to locate the breeding pair if they have moved to another nest tree.

**Table 5.5 Threatened fauna species monitoring locations**

Scientific name	Common name	Monitoring point	Location	Easting	Northing
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Grey-headed Flying-fox Camp	The camp is location in Blackbutt Reserve below the New Lambton Heights Lookout. Access is via the Blackbutt Reserve carpark. 230m South-East of the Project	377601	6355127
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Noise Monitoring Location in NCA13	Lookout Road	377421	6355146
<i>Ninox strenua</i>	Powerful Owl	Nest Tree (NT1)	The Nest Tree is located approximately 38 metres to the West of the Project Boundary	377501	6356411

**Table 5.6 Aims and objectives of data collected at threatened fauna monitoring locations**

Data collected	Aim	Objective	Threshold
<b>Grey-headed Flying Fox</b>			
Noise monitoring at NCA13	Monitor the ambient noise levels at NCA13	Identify an exceedance in noise levels during the daytime period that may increase noise levels at the GHFF camp	Further noise monitoring is triggered at the GHFF camp when the Construction Noise and Vibration Monitoring measures 10dB more than the project noise management levels at NCA13, during the daytime
Noise monitoring at NCA13 and GHFF camp	Monitor the ambient noise levels at the GHFF camp during the daytime	Identify an exceedance in noise levels that may affect the GHFF camp at Blackbutt Reserve during the daytime	Monitoring of the GHFF camp is triggered when the noise monitoring at the GHFF camp measures 10dB more than the project noise management levels during daytime

Data collected	Aim	Objective	Threshold
Presence/absence, extent survey and photo monitoring of GHFF	Monitor population for presence/absence during the daytime in response to noise level thresholds being exceeded at the GHFF camp.	Determine if noise levels are impacting population of GHFF at existing camp during the daytime through population extent surveys and presence/absence of GHFF individuals.	Reduction in population extent compared to baseline data and absence or mass exodus of GHFF individuals
Review of National Flying-fox Monitoring Program annual census data (requested from DAWE)	To determine if population size and extent is remaining stable or fluctuating beyond normal trends	To inform knowledge base and contribute to the understanding of potential Project construction impacts	This census data varies widely from 499 to 15,999 individuals being recorded at one time. Whilst there are no thresholds for this data, seasonal trends can be determined.
<b>Powerful Owl</b>			
Stag watch	Monitor the use of nest tree (NT1) by Powerful Owls	Determine if nest tree NT1 (or any others identified) continue to be used during the Project construction period	Powerful Owl individuals or evidence of presence isn't recorded during July or August surveys, will trigger additional surveys of the surrounding habitats to attempt to find the breeding pair.

## 6 Baseline biodiversity data

Baseline data is the most up to date survey results used to inform the monitoring program. Baseline data must be collected before construction works commence and will be used to draw comparison to construction phase survey data throughout the monitoring program. Baseline survey data results will be stored in an excel database and reported in the Flora and Fauna Construction Monitoring Baseline Report.

To ensure a complete set of baseline data is collected, each targeted threatened species and their baseline biodiversity data requirements are outlined in Table 6.1.

All baseline data will be collected prior to the commencement of construction.

**Table 6.1 Targeted threatened species and baseline biodiversity data requirements**

Scientific name	Common name	Baseline biodiversity data
<i>Tetratheca juncea</i>	Black-eyed Susan	Surveys were undertaken of threatened flora population on the 27 <sup>th</sup> and 28 <sup>th</sup> of October 2021 to investigate population density and population extent. Survey methods included: Population density quadrats at T1-5 and TC and population extent surveys at T1-T5.
<i>Grevillea parviflora</i> <i>subsp. parviflora</i>	Small-flower Grevillea	Surveys were undertaken of threatened flora population on the 27 <sup>th</sup> and 28 <sup>th</sup> of October 2021 to investigate population density. Survey methods include: Population density quadrats at G1-G2.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Presence/absence surveys, camp extent and photos of the Camp were undertaken on the 27 <sup>th</sup> and 28 <sup>th</sup> of October 2021.
<i>Ninox strenua</i>	Powerful Owl	Nest tree baseline monitoring is scheduled to occur in July/August 2022 prior to construction. The results of this survey will be included as part of the initial Flora and Fauna Annual Report.

## **7 Monitoring approach**

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### **7.1 Flora and fauna monitoring program summary**

A summary of the monitoring approach for each threatened entity is outlined in Table 7.1 with monitoring locations shown in Figure 7.1.

**Table 7.1 Flora and Fauna Monitoring Program approach**

Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Method	Data to be collected
Population density	<i>Tetradthea juncea</i>	Monitoring locations identified on Figure 7.1	During peak flowering between Sep – Oct	Annually; September/October until one year post-construction	Density quadrats 20x20m (with 1m parallel transects), count clumps of <i>Tetradthea juncea</i>	Population density at T1-T5 and TC, photos at photo points, supplementary data including observations on populations health, weediness, dieback etc..
	<i>Grevillea parviflora subsp. parviflora</i>	Monitoring locations identified on Figure 7.1	During peak flowering between Aug-Oct	Annually; September/October until one year post-construction	Density quadrats 20x20m (with 1m parallel transects), count stems of <i>Grevillea parviflora subsp. parviflora</i>	Population density at G1 and G2, photos at photo points, supplementary data including observations on populations health, weediness, dieback etc..
Population extent	<i>Tetradthea juncea</i>	T2-T5 within 50m corridor from the Project boundary and entire population within the Project Boundary at T1	During peak flowering between Sep – Oct	In response to a 25% reduction in population density at any one monitoring location until one year post-construction	Mark population extent north and south of monitoring location T2-T5 within 50m corridor from the Project boundary within the Project Boundary at T1	Population extent, comments on dieback/health at T1-T5



Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Method	Data to be collected
Review of Noise monitoring results at NCA13	Ambient noise levels (Grey-headed Flying-fox)	Measuring noise levels in Noise Catchment Area 13	Anytime throughout the year	Monitoring will occur monthly as part of the Construction Noise and Vibration Monitoring Program (WSP, 2021a)	As per the methodology outlined in the Construction Noise and Vibration Monitoring Program (WSP, 2021a)	Noise levels at NCA13
Review of Noise monitoring results at GHFF camp	Ambient noise levels during daytime (Grey-headed Flying-fox)	Noise levels at the GHFF camp during daytime	Anytime throughout the year	In response to noise levels at NCA13 measuring 10dB above project noise management levels during the daytime period	As per the methodology outlined in the Construction Noise and Vibration Monitoring Program (WSP, 2021a)	Noise levels at GHFF camp, if 10dB above project noise management levels is recorded during daytime, Site Environmental Representative will be notified to engage ecologist <sup>1</sup> to undertake surveys at GHFF camp. The survey is to be conducted as soon as practicable.

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<sup>1</sup> A Project Ecologist will be engaged by the contractor for the construction duration

Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Method	Data to be collected
Grey-headed Flying-fox camp	Grey-headed Flying-fox (GHFF)	GHFF camp in Blackbutt Reserve	Anytime throughout the year	In response to project noise management levels exceeding threshold (10dB increase) at the GHFF camp during daytime. Repeated daily until project noise management levels return to below benchmark levels	Observations of presence/absence of GHFF population, extent of camp using GPS recording tracks	Photograph, presence/absence, observations of stress level indicators (ie large numbers of flying individuals or orphaned pups on the ground), extent of camp using GPS, signs of disturbance of the GHFF population, air temperature, notes on audible construction noises and other potential disturbances
Review of census data	Grey-headed Flying-fox (GHFF)	GHFF camp in Blackbutt Reserve	-	Census data in collected annually during November/December and January (CSIRO, 2011) and will be requested from DAWE	Review of National Flying-fox Monitoring Program annual census data	Data on population size and seasonal trends is collected



Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Method	Data to be collected
Stag watches	Powerful Owl	Nest tree (NT1) identified on Figure 7.1	During breeding season (1 July - 31 Aug) over 3 consecutive nights	Maximum of twice a year; Initial surveys in July, if not recorded, surveys are repeated in August	Observing NT1 and any other suitable nest/roost trees identified during pre-clearing surveys, for 90-minutes (30 minutes before sunset and 60 minutes) following sunset over 3 consecutive nights.	Powerful Owl calls (duetting of male and female) and/or sightings at Nest Tree (NT1) (or any other identified)
Habitat replacement	Opportunistic sightings and fauna utilisation	Replacement habitat	Monitoring would coincide with nesting season for hollow-dwelling target species (July – September)	Monitoring the utilisation of all replacement habitat annually for the first two years after installation, skip third year and monitor again in fourth year	Replacement habitat would be monitored via a camera on the end of a pole	As per Section 7.3, including: <ul style="list-style-type: none"> <li>• Nest box/ replacement habitat identification</li> <li>• Weather</li> <li>• Assessment of replacement habitat condition</li> <li>• Evidence of fauna activity</li> <li>• Presence of any pest species</li> <li>• Presence of any Threatened Species</li> </ul>

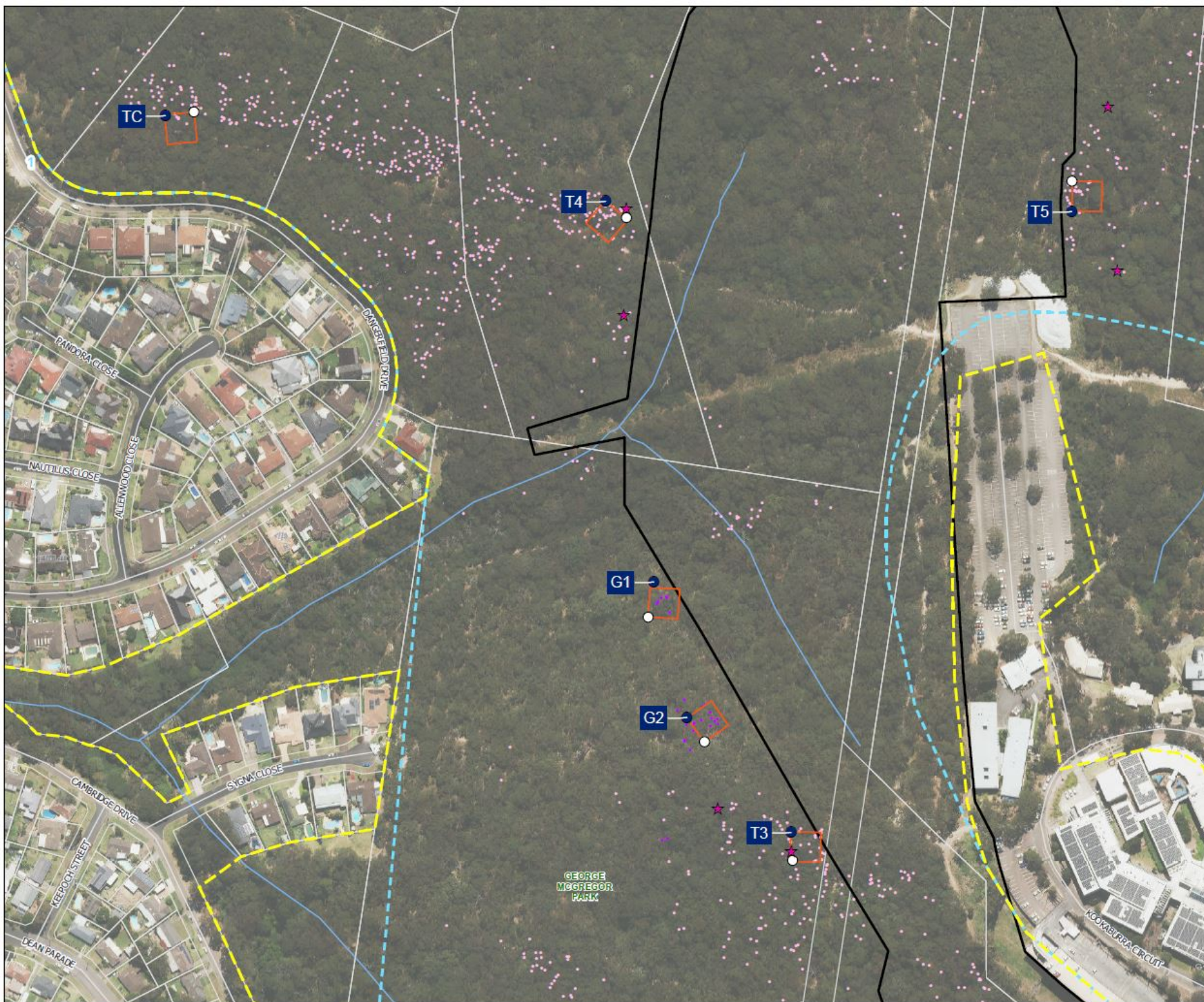
Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Method	Data to be collected
Emergence	Microbats	Dark Creek Culvert	Anytime throughout the year (higher likelihood of presence during winter)	Evening prior to grouting works occurring within the Dark Creek Culvert	Visual, thermal, ultrasonic and Anabat survey as deemed appropriate during the dusk period. Surveys to be conducted from both openings of the culvert.	Presence/absence, estimated population size and species present.
Remote camera survey	Microbats	Dark Creek Culvert	-	During each morning of grouting works as per the Microbat Management Strategy	Survey of the Dark Creek Culvert using a remote camera	Video, presence/absence
Post-completion of Dark Creek culvert	Microbats	Dark Creek Culvert	Daytime between March and November	Monthly for up to 24 months post completion of the new culvert <sup>2</sup>	remote camera surveys to be reviewed by the ecologist.	Presence/absence. Confirmation new roosting habitat in the culvert is being utilised.

<sup>2</sup> Monitoring would cease if microbats are recorded in the new Dark Creek culvert

Survey type	Monitoring target	Location	Seasonal restrictions	Timing and frequency	Method	Data to be collected
Post-completion of Dark Creek culvert	Microbats	Dark Creek Culvert	Daytime between March and November	As soon as practicable after detection of microbats during remote camera survey carried out post-completion of the new culvert	Emergence surveys, thermal, ultrasonic recordings as deemed appropriate by the ecologist.	Estimated population size and species present

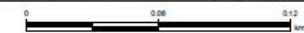
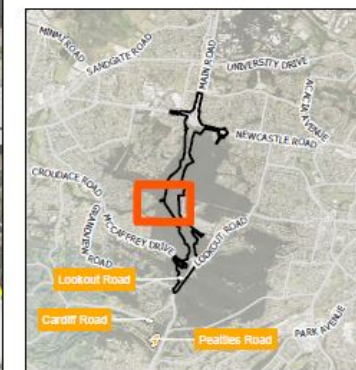


Figure 7.1a (north)  
Baseline Biodiversity Surveys



**Legend**

- Environmental Monitoring Sites
- Photo Point
- Named Watercourse
- Monitoring Quadrat (20x20m)
- ▭ Project Boundary
- Proposed Construction Compounds
- ▭ Biodiversity Assessment Study Area
- Threatened Flora Species**
  - *Tetratheca juncea*
  - *Grevillea parviflora*
  - ▭ Subpopulations of *Tetratheca juncea*
  - ★ *Tetratheca juncea* population extent
  - ★ Grey Headed Flying Fox Camp



Coordinate system: GDA 1994 MGA Zone 56  
 Scale ratio correct when printed at A3  
 1:2,500 Date: 17/05/2022

Data source: - DNRM, TMR, Translink, Geoscience Australia  
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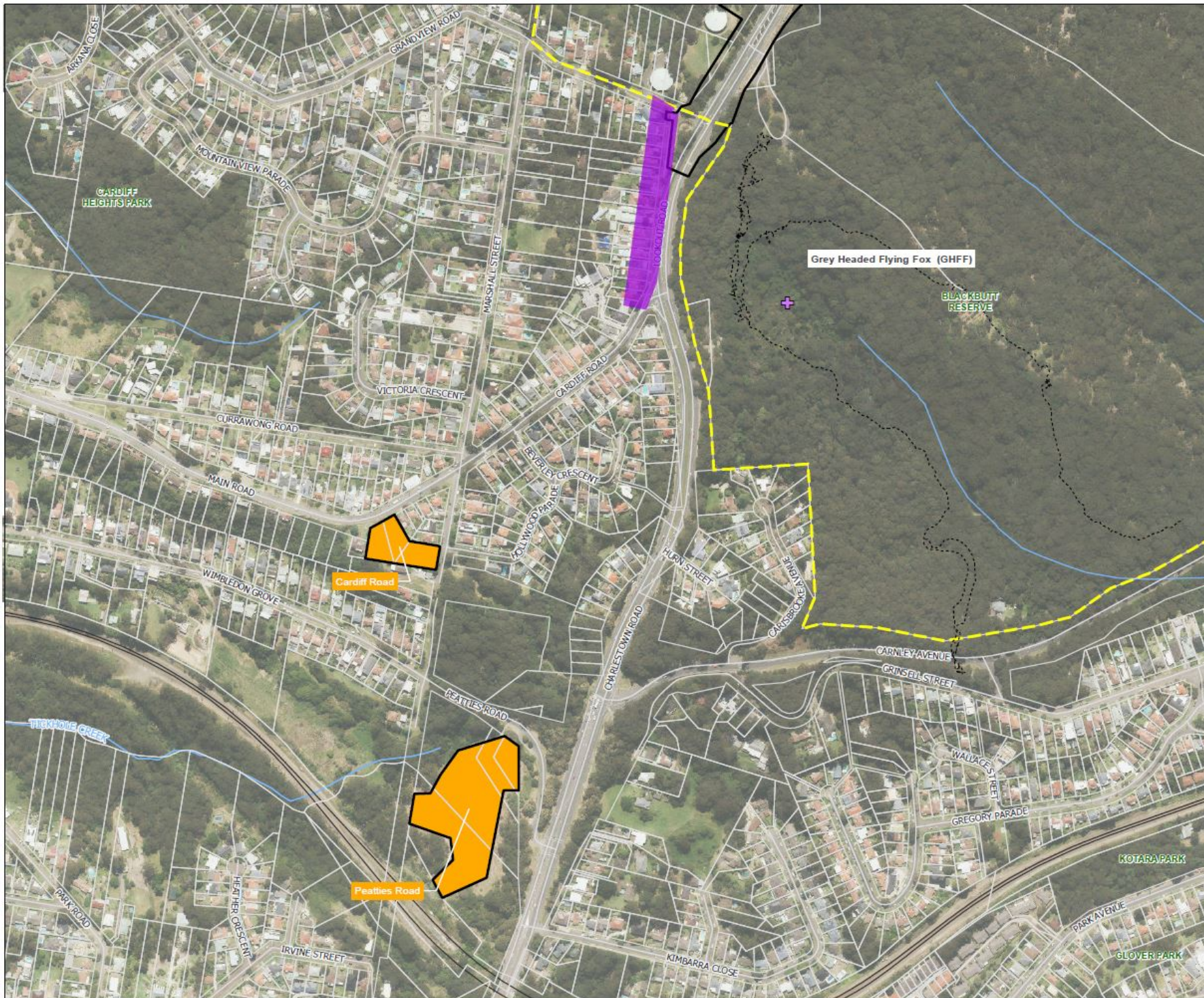


**RANKIN PARK TO JESMOND  
CONSTRUCTION MONITORING**

Figure 7.1c  
Grey Headed Flying Fox

**Legend**

- Named Watercourse
- Project Boundary
- Proposed Construction Compounds
- Indicative noise monitoring location
- Biodiversity Assessment Study
- Grey Headed Flying Fox Camp
- Grey Headed Flying Fox Survey Tracks



Coordinate system: GDA 1994 MGA Zone 56  
Scale ratio correct when printed at A3  
1:5,000 Date: 14/06/2022

Data sources - DNRME, TMR, Translink, Geoscience Australia

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## 7.2 Data analysis

Data analysis is required after every year of monitoring to determine trends and inform adaptive management.

Baseline data (see section 6) and control monitoring locations for *Tetratheca juncea* will be used to determine if thresholds are exceeded as well as data from previous monitoring events. Clear comparisons and trends will be presented in the Flora and Fauna Construction Monitoring Annual Report. Comparison of monitoring data against the relevant surveys undertaken within the EIS and SPIR will be undertaken to inform trends in the data collected. Table 8.1 outlines thresholds for each monitoring target which would be evaluated at the end of each monitoring year.

Data analysis would include a review of:

- Number of individuals recorded in Population density quadrats (T1-5 and TC) for *Tetratheca juncea*
- Number of individuals recorded in Population density quadrats (G1-2) for *Grevillea parviflora subsp. parviflora*
- Review of supplementary data include weediness of populations density quadrants and observations of threatened species habitat and individual plant health i.e. maturity, senescence, recruitment
- Population extent of *Tetratheca juncea* if survey are undertaken at T1-T5 (survey are triggered if threshold for population density quadrats are met or exceeded)
- Noise levels at Noise Monitoring Location 5 during daytime
- Noise levels at GHFF camp if required, during daytime
- Review of population extent surveys of the Blackbutt Reserve GHFF camp if required during the monitoring year
- Review of National Flying-fox Monitoring Program annual census of Blackbutt Reserve Grey-headed Flying-fox camp population and extent
- Presence/absence of Powerful Owls at Nest trees
- Observations made during monitoring e.g. bushfire, drought conditions, extreme weather events which may influence fauna presence

## 7.3 Replacement habitat strategy

A Replacement Habitat Strategy will be developed as part of the Project commitment to no net biodiversity loss. This is achieved through:

- The reuse hollows salvaged by the project
- Introduction of carved/artificial hollows
- Installation of nest boxes.

Monitoring of these types of supplementary habitat will occur in accordance with the RMS Biodiversity guidelines (RTA, 2011) and will include:

- Monitoring the utilisation of all replacement habitat annually for the first two years, skip third year and check again in fourth year
- Replacement habitat should be monitored via a camera on the end of a pole
- Monitoring should coincide with nesting season for hollow-dwelling target species
- Data collected will include:
  - Name of ecologist undertaking inspections
  - Date
  - Nest box/ habitat replacement identification
  - Prevailing weather conditions
  - Assessment of replacement habitat condition (rot in nest boxes, termite activity, loosening of fastenings etc.)
  - Evidence of fauna activity
  - Presence of any pest species such as the European Honey Bee (*Apis mellifera*), Common Myna (*Acridotheres tristis*), ants, termites etc.
  - Presence of any species including Threatened Species

### **7.3.1 Microbat Habitat**

Long term compensatory microbat habitat will be included in the new Dark Creek Culvert as identified by the Microbat Management Strategy (Appendix B).

## 8 Adaptive management

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It is expected that the threatened entities to be monitored will remain stable during construction.

Where it becomes evident that this is not the case based on the thresholds outlined in section 5, further analysis and an adaptive management response may be required.

If required, adaptive management actions to address and manage the issue/s will be implemented in accordance with consultation with the relevant parties as determined by Transport.

A summary for adaptive management thresholds is provided in Table 8.1 below.

**Table 8.1 Monitoring thresholds and adaptive management requirements**

Monitoring target	Data collected	Data analysis	Threshold	Adaptive management response	Detail
<i>Tetratheca juncea</i>	Population density quadrats (T1-5, TC) and supplementary data	Comparison of population density baseline data and data collected at the Control location (TC)	25% reduction compared to baseline data at any one monitoring location taking into consideration factors such as bushfire, weediness, drought conditions ect.	Yes	Population extent surveys carried out at T2-T5 including observations on populations health, signs of disturbance and changes in vegetation structure including weed presence ect. If population extent has decreased at 1 or more monitoring location an adaptive management response is required.
<i>Grevillea parviflora subsp. parviflora</i>	Population density quadrats (G1-2) and supplementary data	Comparison of population density baseline data	25% reduction compared to baseline data at any one monitoring location	Yes	Observations surrounding this species habitat including bushfire, weediness, drought conditions, signs of disturbance and changes in vegetation structure will be analysed.

Monitoring target	Data collected	Data analysis	Threshold	Adaptive management response	Detail
Grey-headed Flying-fox	Predicted noise levels	Comparison of predicted noise level for works within 300m of camp against threshold.	Predicted level exceeds NML +10 dBA LAeq (15 min) for works within 300m of the GHFF camp.	Yes	<p>Desktop review of noise assessment prior to any new construction activity occurring during standard hours within a 300m buffer of the GHFF camp. Adaptive management measures will be considered when operating within the buffer zone, including:</p> <ul style="list-style-type: none"> <li>- The provision of noise and vibration respite</li> <li>- Positioning plant and equipment further away from the camp</li> <li>- Shielding noise sources</li> <li>- Considering quieter methods of construction i.e., avoiding tonal or impulsive equipment</li> </ul>
Grey-headed Flying-fox	Noise levels at NCA13	Noise levels at NCA13 will be monitored as part of the Construction Noise and Vibration Monitoring Program (WSP, 2021a) and compared to Project noise management level	Noise monitoring in NCA13 exceeds NML +10 dB LAeq (15 min)during the day period as per Section 5.2.3.1	Yes	Monitoring of GHFF camp will occur daily to ensure that the population in the camp is remaining stable and is not impacted by the increased noise levels until the noise returns to low benchmark levels.

Monitoring target	Data collected	Data analysis	Threshold	Adaptive management response	Detail
Grey-headed Flying-fox	Noise levels at GHFF camp	Noise levels at the GHFF compared to Project noise management level during daytime	Construction Noise and Vibration Monitoring in Noise Catchment Area 13 (Noise Monitoring Location 5) measures 10 dB more than the Project Noise Management Level during daytime.	Yes	Monitoring of GHFF camp will occur daily to ensure that the population in the camp is remaining stable and is not impacted by the increased noise levels until the noise at the camp returns to below benchmark levels.
Grey-headed Flying-fox	Camp populations extent, presence/absence	Comparison of population extent and presence/absence recorded during baseline surveys	Camp is abandoned during construction, individuals observed leaving the camp (mass exodus)	Yes	Review of noise mitigation and management levels and possibly a stop work order if abandonment can be demonstrated to have occurred as a result of project construction
Grey-headed Flying-fox	Review of National Flying-fox Monitoring Program annual census data	Comparison of National Flying-fox Monitoring Program data across monitoring years (2012-present) and prior to construction	There is no threshold due to large variation in the population size at the GHFF camp	No	Review of National Flying-fox Monitoring Program annual census data to identify trends and seasonal variation in camp population



Monitoring target	Data collected	Data analysis	Threshold	Adaptive management response	Detail
Powerful Owl	Occupation of nest tree (NT1)	Presence/absence of Powerful Owls	The presence of male and female Powerful Owl in/near the nest tree, male and female duetting or presence of juvenile Powerful Owl in/near the nest tree isn't recorded during July or August surveys	Yes	Broader surveys to determine if resident pair are still present in the vicinity include call playback. This will attempt to locate the breeding pair if they have moved to another nest tree.

## 9 Consultation with agencies

In accordance with CoA C9 and CoA C11, this FFCMP has been prepared in consultation with:

- DPI Fisheries
- City of Newcastle
- Lake Macquarie City Council

A copy of the draft program was provided to the above groups on 23 February 2022 for review and comment. Table 9.1 provides a summary of issues raised and where in this monitoring program they have been addressed, where relevant.

**Table 9.1 Consultation summary**

Issue no.	Summary of issue	Where addressed in report
<b>DPI Fisheries</b>		
1	<i>No issues raised during agency review</i>	<i>N/A</i>
<b>City of Newcastle</b>		
1	<i>No issues raised during agency review</i>	<i>N/A</i>
<b>Lake Macquarie City Council</b>		
1	<i>No issues raised during agency review</i>	<i>N/A</i>

# 10 Reporting

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## 10.1 Annual reporting, review and improvement

A Flora and Fauna Construction Monitoring Baseline Report and Flora and Fauna Construction Monitoring Annual Report will be completed for all monitoring surveys outlined in this monitoring program. A monitoring database must also be maintained to store all baseline and construction monitoring data.

These reports will be provided for information to DPI Fisheries, City of Newcastle, Lake Macquarie City Council and any other relevant persons as otherwise agreed by these agencies annually. The results of this monitoring program will be presented at the regular Environmental Review Group (ERG) meetings and submitted to the Planning Secretary as per CoA C15 on an annual basis.

Event based Clearing Reports will also be prepared by the contractor which will be provided at monthly ERG meetings.

Table 10.1 outlines the reporting requirements for the Flora and Fauna Construction Monitoring Baseline Report and Flora and Fauna Construction Monitoring Annual Report.

## 10.2 Microbat Reporting

In accordance with the Microbat Management Strategy (Appendix B) an evaluation report will be completed after grouting works within the Dark Creek Culvert have concluded. The Microbat Management Evaluation Report will be provided to Biodiversity Conservation Division at the completion of exclusion process.

Any incidences of microbats recorded are to be uploaded to BioNet by the responsible consultant per the reporting requirements of the Scientific Licence provided by the NSW Biodiversity Conservation Act 2016.

**Table 10.1 Reporting requirements**

Section	Details	Construction Flora and Fauna Baseline Monitoring Report	Construction Flora and Fauna Annual Monitoring Report
Introduction	Background description of the monitoring session.	✓	✓
Project update	An outline of Project status in relation to biodiversity e.g. clearing progress and updates, installation of fauna structures, unexpected finds etc.	✓	✓
Methods	Description of methods undertaken to survey targeted threatened species including specific monitoring locations and survey details.	✓	✓
Results and discussion	Outline and description of monitoring results.	✓	✓
Data analysis	Comparison of results with baseline data and assessment of results against thresholds. Results will be compared against baseline data records, including those taken from the EIS and further monitoring required as part of this monitoring program.		✓
Recommendations	Suggestion of adaptive responses and contingency measures potentially required based on the results of the monitoring session such as the modification of monitoring timing, frequency or methodology and any corrective actions.		✓
Appendix A: Monitoring database	Spreadsheet database that contains all monitoring data related to the FFCMP	✓	✓

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---

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## Appendix A – Summary of Baseline Biodiversity Data

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Scientific Name	Common Name	Monitoring Date	Monitoring Plot	Population Density	Weed Percentage (Braun-Blanquet Scale)	Exotic Species Recorded	Notes
<i>Tetratheca juncea</i>	Black-eyed Susan	October 2021	TC	72	0	-	Healthy population, new growth observed, seeding observed, not in peak flowering
			T1	115	1	<i>Nephrolepis cordifolia</i> var. <i>tambourinensis</i> , <i>Cinnamomum camphora</i> , <i>Ochna serrulata</i>	Healthy population, new growth observed, seeding observed, not in peak flowering, weed is restricted to areas close to track
			T2	7	0	-	Low <i>Tetratheca</i> numbers in this area, past peak flowering
			T3	5	1	<i>Asparagus aethiopicus</i>	Low <i>Tetratheca</i> numbers in this area, past peak flowering,
			T4	45	0	-	Recruitment of native pioneer species dense, plot is close to track
			T5	51	0	-	Healthy population, Large and mature clumps, seeding observed
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	October 2021	G1	28	0	-	Seedlings observed
			G2	11	0	-	Few <i>Grevilleas</i> recorded
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	October 2021	-	0	-	No GHFF individuals recorded at camp.	Discussions with Blackbutt Reserve staff revealed that GHFF had left the camp at time of survey for this report.
<i>Ninox strenua</i>	Powerful Owl	July/ August 2022	N/A	N/A	N/A	Surveys will be conducted in July/August 2022 and be included within the initial Flora and Fauna Annual Report.	N/A

## **Appendix B – Microbat Management Strategy**

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Transport for NSW

NOVEMBER 2021

FOR INTERNAL USE

# Newcastle Inner City Bypass: Rankin Park to Jesmond

## Microbat Management Strategy

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# Question today *Imagine tomorrow* Create for the future

## Newcastle Inner City Bypass: Rankin Park to Jesmond Microbat Management Strategy

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Reviewed by:	[REDACTED]	1 November 2021	[REDACTED]
Approved by:	[REDACTED]	1 November 2021	[REDACTED]

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We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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# 1 Project Background

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## 1.1 Purpose of this Microbat Management Strategy

The purpose of this Microbat Management Strategy (MMS) is to provide safeguards to minimise potential impacts during each construction phase for threatened microbats that have been recorded, or that have a high likelihood of occurring within the project area.

Six threatened microbat species have been recorded or are predicted to occur within the project area including:

- Eastern Free-tail bat (*Mormopterus norfolkensis*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
- Southern Myotis (*Myotis macropus*).

In May 2019 during a daytime structural inspection of the Dark Creek culvert, a colony of microbats was observed roosting in a 50–75-millimetre gap between the crown units of the existing culvert. The microbats were unable to be identified to species level from the video footage.

To confirm the microbat species roosting within the Dark Creek culvert, a targeted survey of the culvert was undertaken in October 2019. The survey confirmed that the Little Bent-winged Bat and the Large Bent-winged Bat were roosting inside the Dark Creek culvert (SMEC, 2019). Both species are listed as Vulnerable under the NSW *Biodiversity Conservation Act 2016*. Based on the number of calls recorded, it is most likely that the colony was dominated at the time by the Little Bent-winged Bat, but both species have similar roosting habitat requirements.

The safeguards and mitigation measures proposed as part of this strategy would be incorporated into the project's Construction Environmental Management Plan (CEMP) and project design.

This is required by the project's Conditions of Approval (E10) where *'before the removal or clearing of any vegetation, or the demolition of structure identified as potential roosting sites for microbats, commences, pre-clearing/demolition inspections for the threatened species must be undertaken. The inspections, and any subsequent relocation of fauna and associated management/offset measures, must be undertaken under the guidance of a suitably qualified and experienced ecologist. Survey and relocation methodologies and management/offset measures must be included in the Construction Flora and Fauna Management Sub-plan required under Condition C4'* (DPIE, 2019).

Pre-clearing surveys and other industry standard mitigation measures for hollow-tree dependent microbats (Eastern Free-tail bat, Yellow-bellied Sheath-tail-bat and the Greater Broad-nosed Bat) would be included in the CEMP Construction Flora and Fauna Management Sub-plan.

The main focus of this Microbat Management Strategy is to minimise potential impacts on cave-dwelling microbats (Little Bent-winged Bat, Large Bent-winged Bat and Southern Myotis) during construction, especially within the Dark Creek Culvert and its vicinity.

---

## 1.2 Description of works

The Rankin Park to Jesmond Project (RP2J) is the fifth section of the Newcastle Inner City Bypass (NICB), which will be approximately 3.4 kilometres between Lookout Road at New Lambton Heights and Newcastle Road at Jesmond, to the west of the John Hunter Hospital. The project is funded by the NSW State Government. A concept design has been completed for the Project and Environmental approvals were received in early 2019.

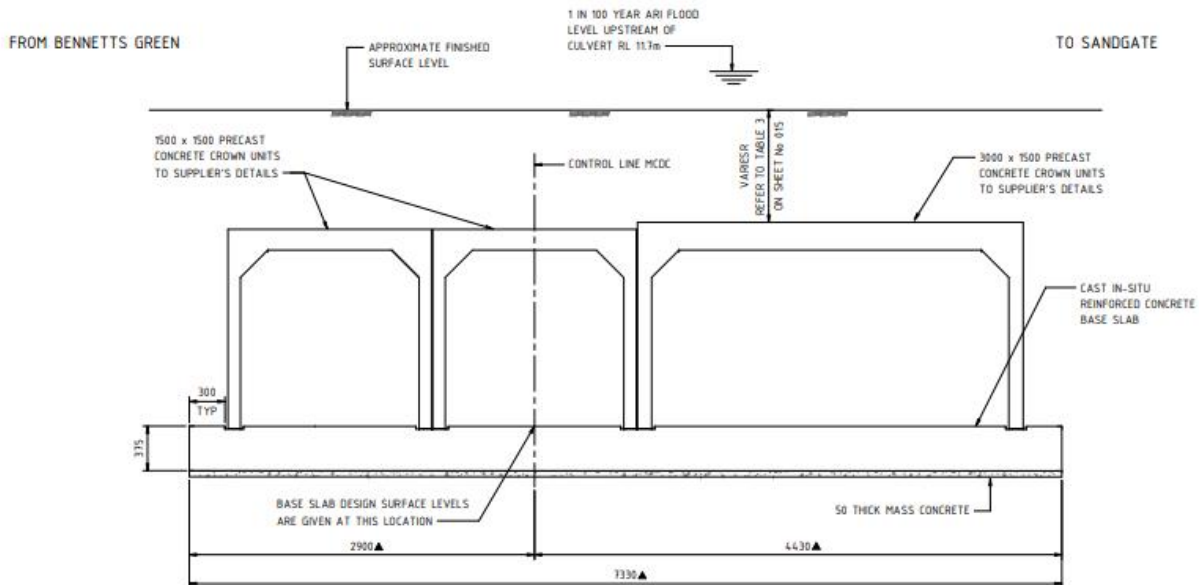
Stage 2 of the project requires the demolition of the existing sub-surface drainage structure and construction of a new channel and culvert as part of the diversion of Dark Creek. The Detailed Design report for the Dark Creek culvert (Aurecon, 2020) outlines that the existing culvert is proposed to be abandoned and a new alignment is proposed to the west with the inlet near the existing culvert inlet. The new proposed culvert structure will consist of three cells of two different sizes – two 1500 mm x 1500 mm cells and one 3000 mm x 1500 mm cell (internal dimensions of the precast crown units) (see Figure 1.1 below)

### 1.2.1 Provision of microbat roost habitat within the new Dark Creek culvert

The Project has also committed to providing long-term compensatory threatened microbat habitat into the new Dark Creek culvert. While the design is subject to change, any new design would incorporate the following:

- leaving the transport/lift holes in the new culvert unsealed and roughened internally to a 1-2mm thickness
- where possible, habitat in the form of horizontal or longitudinal recesses
- applying coarse cement render (aggregate) and/or silicon on the roof of the culvert.

Figure 1.1 Detailed design drawing of the proposed Dark Creek culverts (Aurecon, 2020)



## 2 Microbat population status

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### 2.1 Microbat species likely to occur in project area

#### 2.1.1 Hollow-bearing tree dependent microbats

The following three (3) threatened hollow-bearing tree dependent microbats have potential roosting and foraging habitat within the vegetated sections of the project area, especially where hollow-bearing trees area present:

- Eastern Free-tail bat (*Mormopterus norfolkensis*), listed as Vulnerable on the BC Act
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*), listed as Vulnerable on the BC Act
- Greater Broad-nosed Bat (*Scoteanax rueppellii*), listed as vulnerable on the BC Act.

None of the above-mentioned microbats are listed under the EPBC Act.

##### 2.1.1.1 Eastern Free-tail bat (*Mormopterus norfolkensis*)

The Eastern Free-tail bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill, 2008). Potential habitat was recorded in the study area. This species has previously been recorded within the project area by Umwelt (2006).

##### 2.1.1.2 Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)

The Yellow-bellied Sheath-tail Bat is widespread through tropical Australia and migrates to southern Australia in summer. Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally, a solitary species but sometimes found in colonies of up to ten. It roosts and breeds in tree hollows but has also been recorded roosting under exfoliating bark, in burrows of terrestrial mammals, in soil cracks and under slabs of rock and in the nests of bird and sugar gliders (Churchill, 2008). Potential habitat was recorded in the Project area. This species has previously been recorded within the project area by Umwelt (2006).

##### 2.1.1.3 Greater Broad-nosed Bat (*Scoteanax rueppellii*)

The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3–6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings (Churchill, 2008). Potential habitat was recorded in the study area. This species has previously been recorded within the project area by Umwelt (2006).

#### 2.1.2 Cave-dwelling microbats

The following three (3) threatened cave-dwelling microchiropteran bats have potential foraging habitat within the project area, and potential artificial roosting habitat within the project area especially within the Dark Creek Culvert and its vicinity:

- Little Bent-winged Bat (*Miniopterus australis*), listed as Vulnerable on the BC Act
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*), listed as Vulnerable on the BC Act
- Southern Myotis (*Myotis macropus*), listed as vulnerable on the BC Act.

None of the above-mentioned microbats are listed under the EPBC Act.

### 2.1.2.1 Little Bent-winged Bat (*Miniopterus australis*)

The Little Bent-winged Bat is listed as Vulnerable under the BC Act. The Little Bent-winged Bat is distributed between northern Queensland to southern New South Wales, along the Great Dividing Range. The Little Bent-winged Bat utilises moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and *Banksia* scrub for foraging.

The species is generally found in well-timbered areas.

Little Bent-winged Bats roost over winter in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings or tree hollows during the day, and at night forage in densely vegetated habitats.

In late spring, pregnant females disperse from the east coast and migrate to maternity roosts in caves (Dwyer 1968) where the species congregates in the thousands with Large Bent-winged Bats in a single known maternity cave in NSW to breed over summer, showing high maternity roost fidelity (Churchill 2008). They give birth in the maternity caves and raise young over summer before returning east in autumn (Dwyer 1963; Hoye and Spence 2004).

### 2.1.2.2 Large Bent-winged Bat (*Miniopterus orianae oceanensis*)

The Large Bent-winged Bat is listed as Vulnerable under the BC Act. The Large Bent-winged Bat is distributed from southern Queensland to northern Victoria, along the Great Dividing Range (with a small number of scattered recordings outside this range). Large Bent-winged Bats utilises moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* swamps, dense coastal forests and *Banksia* scrub for foraging. The species is generally found in well-timbered areas. Over winter, Large Bent-winged Bats will use caves, culverts, bridges, abandoned mines and tunnels as hibernation / winter roosts (Churchill 2008). At night they forage in densely vegetated habitats.

Individuals use a network of roosts throughout the year. In late spring, pregnant females disperse from the east coast and migrate to one of three known maternity roosts in caves in New South Wales (NSW), where they give birth and raise young over summer before returning east in autumn (Dwyer 1963; Hoye and Spence, 2004).

They congregate in the thousands in a small number of caves in NSW, often shared with Little Bent-winged Bats, to breed over summer. The species use the same maternity roost year after year. Females disperse to maternity roosts in limestone caves in late spring/early summer and return to coastal roots in March/April (Dwyer 1963; Hoye and Spence, 2004; White, 2011).

### 2.1.2.3 Southern Myotis (*Myotis macropus*)

The Southern Myotis is listed as Vulnerable under the BC Act. The Southern Myotis is patchily distributed in a broad coastal band in northern and eastern Australia and is closely associated with waterways (Churchill 2008, Gorecki, 2020). The project occurs in the core of their distribution but the closest Southern Myotis maternity roost to the Dark Creek culvert is the bridge over Ironbark Creek near Hexham approximately seven kilometres away.

The Southern Myotis utilises habitat near water, generally roosting in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Roosting habitat is often used across years and occupied year-round, but each colony will have a network of roosts within foraging range (Churchill 2008). Southern Myotis show high maternity roost fidelity however, situated usually over or within 100 m from water (Campbell 2009).

Southern Myotis forage over streams and pools catching insects and small fish by raking their feet across the water surface. The species' close association with waterways reflects this highly specialised foraging behaviour (Thompson and Fenton 1982).

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## 2.2 Potential Impacts

### 2.2.1 *Hollow-bearing tree dependent microbats*

Potential impacts to hollow-bearing tree dependent microbats from construction of the project include:

- removal of approximately 50.9 hectares of vegetation comprising about 39.2 hectares of native vegetation and associated habitat for roosting and foraging habitat
- removal of about 320 hollow-bearing trees within the construction area
- injury and mortality during construction when vegetation and habitat is being removed, machinery and plant during construction, and from operational traffic.

Unavoidable impacts to hollow-bearing tree dependent microbats were assessed and quantified in accordance with the NSW FBA (OEH, 2014) in the Environment Impact Statement for the project (GHD, 2016).

In accordance with the project Conditions of Approval (E10), pre-clearing inspections for threatened species must be undertaken and included in the CEMP (DPIE, 2019).

Minimising the removal of native vegetation and mature trees, undertaking pre-clearing surveys and implementing other industry standard construction mitigation measures for hollow-tree dependent microbats (Eastern Free-tail bat, Yellow-bellied Sheath-tail-bat and the Greater Broad-nosed Bat) are not a focus of this Microbat Management Strategy, but would be included in the CEMP Construction Flora and Fauna Management Sub-plan.

To minimise potential impacts to hollow-bearing tree dependent microbats, it is recommended the Construction Flora and Fauna Management Sub-plan of the CEMP includes industry-standard measures such as those outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity on TfNSW projects* (Transport for NSW, 2011).

### 2.2.2 *Cave-dwelling dependent microbats*

Potential impacts to cave-dwelling microbats from construction of the project include:

- removal of approximately 50.9 hectares of vegetation, of which, only a small proportion would be suitable foraging habitat
- temporary removal of occasional roosting habitat at the Dark Creek culvert (for Little Bent-winged Bat and Large Bent-winged Bat).

In accordance with S7.3 of the BC Act, significance assessments were undertaken for the three cave-dwelling microbats (WSP, 2021). The assessments concluded that the project is unlikely to have a significant impact, provided the mitigation measures outlined in the low impact work procedure in Section 3 of this Microbat Management Strategy are implemented.

Works on Dark Creek culvert can only be undertaken when no microbats are present.

If microbats return to Dark Creek culvert during construction, works must be rescheduled for when the bats are absent (usually absent in December to February when they are at maternity caves).

## 2.3 Importance of microbat habitat at Dark Creek culvert

There have been no threatened microbats (Little Bent-winged Bats or Large Bent-winged Bats) recorded roosting in the Dark Creek culvert since December 2020 when pregnant females would have migrated to maternity caves to give birth (see Table 2.1 below).

Table 2.1 Summary of survey results for the Dark Creek culvert from 2019-2021.

DATE	SURVEY TYPE	RESULTS
May 2019	Remote camera survey during structural inspection	Approximately 200-300 Little Bentwing Bats roosting in a 50-75 millimetre gap between the crown units of the culvert.
October 2019	Evening flyout survey and Anabat survey of culvert (SMEC)	Emergence of Little Bent-winged and the Large Bent-winged Bat. The majority of calls recorded on Anabat were attributed to the Little Bent-winged Bat.
December 2020	Remote camera survey	No microbats were present during this inspection.
January 2021	Evening flyout survey and Anabat survey of culvert (WSP)	No microbats were observed exiting the culvert and none were recorded on the Anabat call recording devices, placed at either ends of the culvert.
September 2021	Consecutive evening flyout survey and Anabat survey of culvert (WSP)	No microbats were observed exiting the culvert and none were recorded on the Anabat call recording devices, placed at either ends of the culvert.
September 2021	Remote camera survey	No microbats were present during this inspection.

Gonslaves and Law (2018) demonstrated that fidelity to roost sites varies by individual and is closely linked to the availability of foraging habitat (such as large, open spaces with artificial lighting). White (2011) also recorded *Miniopterus orianae oceanensis* shuffling between artificial roosts (disused military tunnels and underground bunkers) in association with changes in weather conditions.

Prior to December 2020, the Dark Creek culvert was used opportunistically as an over-wintering non-maternity roost site for Little Bent-winged Bats and a small number of Large Bent-winged Bats. The carrying capacity of the 50-75 millimetre gap between the crown units of the Dark Creek culvert is relatively small and as such does not meet the requirements of a high conservation over-winter roost site (unlike other sites such as Balickera and Brookfield Tunnels that have carrying capacities in the thousands).

The Southern Myotis was not recorded roosting/breeding in Dark Creek culvert or foraging in the vicinity of the culvert.



## 3 Infilling/sealing of microbat habitat

The infilling/sealing of gaps (low impact works) which may be known or potential microbat roosting habitat in Dark Creek can only be undertaken when threatened microbats are not present. If microbats return to Dark Creek culvert during construction, works must be rescheduled for when the bats are absent (usually absent December to February when they are at maternity caves).

The infilling/sealing of gaps whilst threatened microbats are not present in the culvert has been committed to by TfNSW as a mitigation measure to minimise any potentially significant impacts to threatened microbats, in particular the Little Bent-winged Bat (WSP, 2021) and must be implemented.

The infilling/sealing of gaps between the culvert crown units in Dark Creek culvert while microbats are absent from the culvert is considerably less of an impact compared with implementing potentially disruptive exclusion measures when an entire colony of threatened microbats may be present within the culvert.

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### 3.1 Prior to works

A suitably qualified project ecologist would be appointed prior to works to ensure the Microbat Management Strategy, in particular, the infilling/sealing of gaps procedure in Section 3.2 is implemented successfully.

A suitably qualified ecologist is considered to be an individual with:

- a minimum of five years of experience in microbat ecology and management.
- experience undertaking microbat surveys, especially roost site searches for Little and Large Bent-winged Bats and the Southern Myotis
- experience in emergence surveys, ultrasonic recording and thermal camera recording.

The project ecologist must also hold a current NPWS S132 Scientific Licence and a relevant Animal Research Authority issued by an approved Animal Care and Ethics Committee.

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### 3.2 Infilling/sealing procedure

It is recommended the following infilling/sealing procedure is implemented by the contractor/contractor's representative.

- 1 A pre-clearing evening flyout/emergence survey of the Dark Creek culvert would be undertaken by a suitably qualified ecologist prior to any works commencing. An evening flyout/emergence and Anabat survey of the culvert should be done the evening before works are proposed to start.
- 2 A diurnal remote camera survey should be undertaken on the morning works are proposed to start to ensure microbats are not present.
- 3 A suitably qualified ecologist must be on site to determine if microbats are present during the remote camera pre-clearing survey.
- 4 (*Hold point*) Ecologist to sign pre-clearing checklist that microbats are not present and sealing works of the gaps can commence.
- 5 The gaps would be sealed with a smooth grout product. If expandable foam is used to infill the gaps, it would need to be covered with thin plywood or similar to remove roughened surface, microbats may grip onto.
- 6 The preferred product is a smooth concrete grout or similar as it reduces the likelihood of microbats gripping onto infilled surfaces.
- 7 Once infilled, the surface must be smoothed and contain no edges/divots that the microbats may be able to grip onto. Painting over the surface with a glossy paint may achieve this.
- 8 The contractor should commence filling in gaps closest to where the microbats have been recorded roosting previously, approximately 45 metres downstream of the inlet (from Jesmond Park side).

- 9 If works continue over consecutive days, a pre-clearing survey is required each morning prior to any sealing works commencing.
- 10 Following sealing works and construction of the new culvert/s, provision of long-term compensatory microbat habitat into the new Dark Creek culvert would be provided including:
  - Leaving the transport/lift holes in the new culvert unsealed and roughened internally to a 1-2mm thickness.
  - Where possible, habitat in the form of horizontal or longitudinal recesses
  - Applying coarse cement render (aggregate) and/or silicon on the roof of the culvert.
  - Monitoring of the new roosting habitat for use by threatened microbats.

This procedure is summarised in Table 3.1.

Table 3.1 Infilling/sealing of gaps at Dark Creek culvert procedure

Management measure	Timing	Details	Responsibility
Engage suitably qualified project ecologist	Pre-construction	Engage a suitably qualified project ecologist as outlined in Section 3.1.	Contractor
Emergence survey of Dark Creek culvert	Construction	Undertake a pre-clearing survey/ evening flyout (emergence survey) and Anabat survey of the Dark Creek culvert the evening before works are proposed to start.	Project Ecologist
Remote camera survey	Construction	Undertake a pre-clearing survey/ remote camera survey the morning works are proposed to start to <u>ensure microbats are not present</u> .  <i>(Hold point)</i> Ecologist to sign pre-clearing checklist that <u>microbats are not present</u> and sealing works of the gaps can commence.	Contractor's or TfNSW tunnel inspection specialist Project Ecologist
Seal gaps/microbat habitat in culvert	Construction	Infill/ seal gaps and holes/cracks with a smooth grout product.  Use a smooth concrete grout or similar to reduce the likelihood of microbats gripping onto infilled surfaces. If expandable foam is used, cover it with thin plywood or similar.  Smooth the surface and ensure it contain no edges/divots that the microbats may be able to grip onto.	Contractor
	Construction	Seal gaps starting closest to where the microbats have been recorded previously, approximately 45 metres downstream of the inlet (Jesmond Park side).	Contractor
	Construction	If infilling/sealing gaps occurs over consecutive days, undertake a pre-clearing survey remote camera survey each morning of works to ensure no microbats have moved in overnight.  <i>(Hold point)</i> Ecologist to sign pre-clearing checklist that <u>microbats are not present</u> and sealing works of the gaps can commence.	Contractor's or TfNSW tunnel inspection specialist Project Ecologist

Management measure	Timing	Details	Responsibility
Recreation of roosting habitat in new culvert/s	Construction	<p>Recreate long-term compensatory microbat habitat into the new Dark Creek culvert/s by: leaving the transport/lift holes in the new culvert unsealed and roughened internally to a 1-2mm thickness.</p> <p>Where possible, providing habitat in the form of horizontal or longitudinal recesses</p> <p>Applying coarse cement render (aggregate) and/or silicon on the roof of the culvert</p> <p>Installing microbat habitat approximately 45-60 metres downstream of the inlets on the Jesmond Park side)</p>	Contractor
Monitoring of Dark Creek culvert and long-term compensatory microbat habitat	Construction/ Post-construction	Engage a suitably qualified ecologist as outlined in Section 3.1 to monitor the new roosting habitat for use by threatened microbats.	TfNSW
	Post-construction	<p>1. After construction is complete, undertake monthly daytime remote camera surveys (<u>between March and November</u>) of the new Dark Creek culverts and new roosting habitat.</p> <p>2. Ecologist to review monthly remote camera video footage for threatened microbats:</p> <ul style="list-style-type: none"> <li>- If microbats are detected on remote camera video footage, ecologist to undertake survey to obtain information on the microbat population in the culvert/s and potential use of the new roosting habitat. Surveys may include emergence surveys, ultrasonic recordings and thermal camera recording.</li> <li>- If no microbats are found, monthly daytime remote camera surveys should be undertaken <u>between March and November for 24 months</u> after construction is complete, or until threatened microbats are recorded.</li> </ul> <p>If no threatened microbats are detected after 24 months of monthly daytime remote camera surveys between March and November, then monitoring of the new Dark Creek culverts and new roosting habitat can be discontinued.</p>	TfNSW tunnel inspection specialist Ecologist
	Post-construction	Submit a report to TfNSW documenting the findings of the remote camera and/or microbat population surveys.	Ecologist

# 4 Conclusion

The purpose of this Microbat Management Strategy is to provide safeguards to minimise potential impacts during each construction phase for threatened microbats that have been recorded, or that have a high likelihood of occurring within the project area.

Six threatened microbat species have been recorded or are predicted to occur within the project area including:

- Eastern Free-tail bat (*Mormopterus norfolkensis*)
- Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Little Bent-winged Bat (*Miniopterus australis*)
- Large Bent-winged Bat (*Miniopterus oriana oceanensis*)
- Southern Myotis (*Myotis macropus*).

The main focus of this Microbat Management Strategy is to minimise potential impacts on cave-dwelling microbats (Little Bent-winged Bat, Large Bent-winged Bat and Southern Myotis) during construction, especially within the Dark Creek Culvert and its vicinity.

Section 3 provides a procedure for the infilling/sealing of gaps in Dark Creek that can be implemented when threatened microbats are not present.

The Contractor would recreate long-term compensatory microbat habitat into the new Dark Creek culvert/s including:

- leaving the transport/lift holes in the new culvert unsealed and roughened internally to a 1-2mm thickness.
- where possible, providing habitat in the form of horizontal or longitudinal recesses
- applying coarse cement render (aggregate) and/or silicon on the roof of the culvert
- installing microbat habitat approximately 45-60 metres downstream of the inlets on the Jesmond Park side)

After construction is complete, undertake monthly daytime remote camera surveys (between March and November) of the new Dark Creek culverts and new roosting habitat. Monthly daytime remote camera surveys should be undertaken between March and November for 24 months after construction is complete.

The Ecologist would review monthly remote camera video footage for threatened microbats.

If microbats are detected on remote camera video footage, ecologist to undertake survey to obtain information on the microbat population in the culvert/s and potential use of the new roosting habitat. Surveys may include emergence surveys, ultrasonic recordings and thermal camera recording.

If no microbats are found, monthly daytime remote camera surveys should be undertaken between March and November for 24 months after construction is complete, or until threatened microbats are recorded.

If no threatened microbats are detected after 24 months of monthly daytime remote camera surveys between March and November, then monitoring of the new Dark Creek culverts and new roosting habitat can be discontinued.

A report would be submitted to TfNSW by the microbat ecologist documenting the findings of the remote camera and/or microbat population surveys.

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