



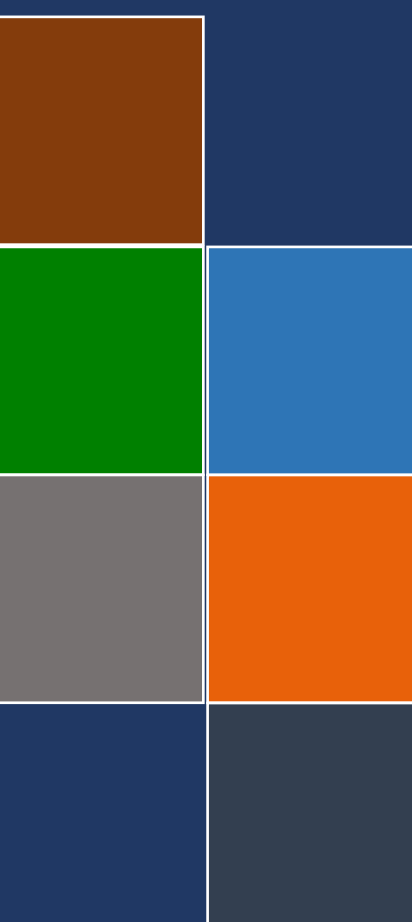
Transport for  
New South Wales

# Warrell Creek to Nambucca Heads

Interim Underpass Monitoring Report - Operational  
Phase, Year Five interim spring/summer (2022-  
2023)

Transport for New South Wales | February 2023





# **Pacific Highway upgrade: Warrell Creek to Nambucca Heads (WC2NH)**

**Underpass and Adjacent habitat  
monitoring– operational phase  
Year Five interim report  
(Spring/summer 2022/23)**

# Document Review

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# 1. Introduction

In 2015, Transport for NSW (TfNSW), in conjunction with Acciona Ferrovia Joint Venture (AFJV), commenced the upgrade of the Pacific Highway between Warrell Creek and Nambucca Heads (WC2NH). The WC2NH project was opened to traffic in two stages:

- Stage 2a - 13.5km section from Lower Warrell Creek Bridge to Nambucca Heads opened on 18 December 2017; and
- Stage 2b - 6.25km section from the southern end of the project to the Lower Warrell Creek bridge opened on 29 June 2018.

The Ministerial Conditions of Approval (MCoA) for the WC2NH upgrade included a requirement (MCoA B10) to prepare an Ecological Monitoring Program (EMP). The EMP was developed and approved in 2014 and later amended in 2018 (RMS 2018). Species and mitigation measures targeted in the EMP include koala, spotted-tailed quoll, grey-headed flying fox, yellow-bellied glider, giant barred frog, green-thighed frog breeding ponds, vegetated median, road-kill, exclusion fencing, threatened flora, and fauna underpasses.

As part of the project's approval (MCoA B1, B2, B3) fauna underpasses were installed "to maintain the viability of local terrestrial fauna populations by facilitating wildlife movement between proximate areas of habitat either side of the upgrade corridor and to accommodate use by several threatened fauna species including the spotted-tailed quoll, koala and giant barred frog" (RMS 2018). To assess the effectiveness of the fauna underpasses the EMP specified that operational phase monitoring should take place bi-annually (i.e., spring/summer and autumn/winter) for 5 years. The seasonal timing of monitoring was intended to align with the breeding and dispersal periods of targeted threatened species (i.e., koala, spotted-tailed quoll and giant barred frog).

The following report presents methods and interim results of the spring/summer year 5 operational phase underpass and adjacent habitat monitoring. The objective of fauna underpass monitoring is "to assess use of underpasses by threatened and common fauna and to assess the effect of exclusion fencing on movement of small mammals, reptiles and frogs" (RMS 2018). Effectiveness of exclusion fence is also assessed in the annual road-kill report (see Sandpiper Ecological 2022a). The results are discussed in relation to the potential indicators of success detailed in the WC2NH EMP (RMS 2018) and recommendations regarding future monitoring are provided. The potential indicators of success used to assess the performance of the WC2NH underpasses include:

1. Low rates of use of fauna underpasses and adjacent habitats by feral predators;
2. High levels of fauna underpass use by a wide variety of native fauna species;
3. No change to densities, distribution, habitat use, and movement patterns compared to baseline population data of target species;
4. Evidence of use by dispersing individuals and different age cohorts;
5. Use by cover-dependent species and species with low mobility;
6. No breaches in fauna exclusion fencing;
7. Low incidences of fauna road strike mortality.

A list of species names for fauna referred to in text and Tables is provided in Appendix A.

## 2. Methods

### 2.1 Study area

The WC2NH project covers a total length of 19.75km and extends from Warrell Creek in the south to Nambucca Heads in the north (Figure 1). The alignment bypasses the town of Macksville and the northern section traverses Nambucca State Forest. The WC2NH upgrade features 23 fauna underpasses, including 13 box culverts, three pipe culverts and seven bridges. Underpasses targeted for monitoring were specified in the WC2NH EMP and include eleven box culverts and one bridge (RMS 2018; Table 1). Eleven underpasses are situated north of the Nambucca River and one (Site 1) is situated at Upper Warrell Creek near the southern extent of the project (Figure 1). Sites four to 12 adjoin Nambucca State Forest and sites two and three adjoin remnant vegetation on private land (Figure 1). Site five includes a dual cell box culvert with one cell designated as a wet passage (for aquatic fauna) and the other as dry passage (Plate 1). The dry cell includes a concrete ledge that provides dry passage for terrestrial fauna. Sites 9/10, and 11/12 consist of corresponding culverts on either side of a vegetated median (Plate 1). Fauna underpasses were designed to target spotted-tailed quoll (*Dasyurus maculatus*), koala (*Phascolarctos cinereus*) and giant barred frog (*Mixophyes iteratus*). Giant barred frog is known to occur at site 1 (Upper Warrell Creek) only, whilst quoll and koala could occur at sites 2-12.

**Table 1:** Underpasses sampled during operational phase monitoring of the WC2NH upgrade. SQ = spotted-tailed quoll; K = koala; GBF = giant barred frog; \* sites consist of dual cells 3x3m box culverts with one cell providing wet passage for aquatic fauna; P/A = presence/absence.

Site	Chainage	Type	Structure	Dimensions	Fauna Furniture (P/A)	Substrate	SQ	K	GBF
1	42500	Combined	Bridge		A	Soil			x
2	55120	Dedicated	Box Culvert	1 x 3000 x 3000	P	Concrete	x	x	
3	56410	Combined	Box Culvert	1 x 2400 x 2400	P	Concrete	x	x	
4	57770	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
5 *	58510	Combined	Box Culvert	2 x 3000 x 3000	A	Concrete	x	x	
6	58560	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
7	59090	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
8	59550	Dedicated	Box Culvert	1 x 3000 x 3000	P	Mulch	x	x	
9	59750 NB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	
10	59760 SB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	
11	60600 NB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	
12	60610 SB	Dedicated	Box Culvert	1 x 2400 x 2400	P	Mulch	x	x	

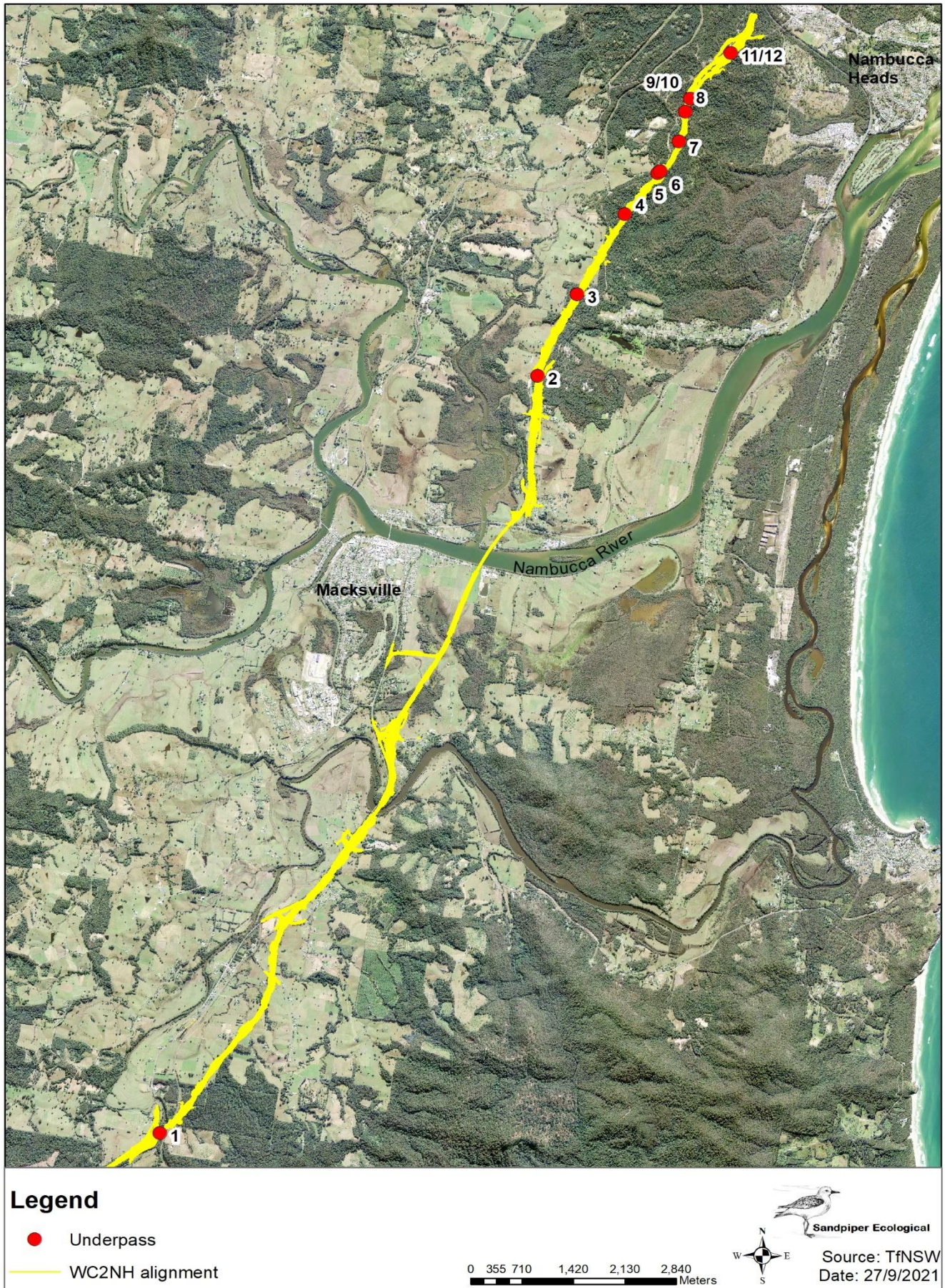


Figure 1: Underpass locations along the WC2NH alignment.





**Plate 1:** Dual box culverts with designated wet passage at site 5 (top left). Split median box culverts at site 9 and 10 (top right). Fauna furniture entering (bottom left) and exiting site 8 (bottom right).

## 2.2 Timing and weather conditions

Year 5 spring/summer operational phase underpass and adjacent habitat surveys were conducted between 14 October 2022 to 6 February 2023. Wet conditions were a feature of early spring monitoring (October) when 300mm fell during the month. Dry conditions persisted from November with below average rainfall conditions from November – February with 175mm recorded at the Bellwood weather station. A total of 397mm of rainfall was recorded at the Bureau of Meteorology (BOM) Bellwood station (#059150) throughout the spring/summer monitoring period (BOM, 2023a). Relative humidity was high with >60% recorded on most days and air temperature ranged from 20.8 to 36.9 °C (BOM, 2023b).

**Table 2:** Summary of weather conditions recorded at Coffs Harbour Airport (station 059151) and Bellwood (station 059150) during year five spring/summer operational phase monitoring. XX = awaiting winter sample data.

Monitoring period	Total rainfall (mm)	No. rain days	Relative humidity (%)	Max temp range (°C)	Min temp range (°C)
Spring/Summer	397	55	>60% on 73% of days	20.8-36.9	6.8-24.6
Winter	XX	XX	XX	XX	XX

## 2.3 Underpass monitoring

### 2.2.1 Sand pads

Sand pads were installed on 30 January 2023 (spring/summer sample) using a 50:50 mix of brickies sand and washed beach sand. One sand pad was installed centrally in culverts, whilst at the bridge (site 1) one sand pad was installed on the northern side of Warrell Creek. Each pad was approximately 50 mm deep by 1m wide and extended for the entire culvert width, or for 3-4m at site 1. At sites with a concrete ledge the pad covered both the floor and ledge (Plate 2). The exception was site 5 where the pad covered the ledge only due to standing water over the culvert floor on the eastern end.

Sand pads were inspected on eight consecutive days across all sites. Inspections were conducted by an ecologist and included a systematic scan of each pad searching for fauna tracks. A small torch was used to illuminate the pad, if required. Information recorded included species or fauna group, number of traverses, direction of traverse and pad condition (good, fair, poor). Tracks were identified with reference to Triggs (2004) and advice from senior ecologists. Tracks that could not be identified insitu were photographed and referred to a senior ecologist for identification.



**Plate 2.** Sand pad being installed in a fauna underpass (Site 3) on the WC2NH upgrade.

## 2.2.2 Scat and track searches

Each underpass was searched by an ecologist for scats and tracks on two occasions during the spring/summer sample. The search involved a slow systematic traverse of each culvert using a hand-held spotlight (Led Lenser P14). Fauna furniture, the culvert floor, and culvert joints were targeted. Sand pads and areas of accumulated fine sediment were inspected for tracks. Tracks and scats were identified in-situ, with reference to Triggs (2004) and the ecologist's experience, or photographed and sent to colleagues for identification.

## 2.2.3 Tile checks

In autumn 2020 two roof tiles (300x200) were installed 5 m from both ends of each underpass, excluding site 1, to target small mammals, reptiles, and frogs. Tiles were inspected on eight occasions during the 2023 spring/summer sample period.

## 2.2.4 Cameras

Two motion-activated infra-red cameras (Swift 3C, Swift Enduro or Reconyx HC500) were installed centrally in each culvert. At site 1, Reconyx HC500 cameras were housed in security boxes attached to concrete posts. A single camera was installed at approximately 200 mm above ground near the water's edge on each side of Upper Warrell Creek (site 1). In total, 24 cameras were installed. In underpasses, both cameras were installed centrally, one on the fauna furniture, and one approximately 300 mm above the culvert floor. Cameras were oriented to the east except for site 1 where cameras were oriented perpendicular to the creek on the north and south banks. Cameras at site 10 were re-oriented to the west following a high incidence of false triggers caused by traffic on the southbound carriageway. Swift cameras were set to take 10 seconds of video with no delay between activation. Reconyx cameras were set on time-lapse mode to take a picture at 1-minute intervals between 8 pm and 6 am each day throughout the spring/summer period. Time-lapse mode is better suited to targeting frogs and was used successfully to monitor frog pipes on the Sapphire to Woolgoolga Pacific Highway Upgrade (Sandpiper Ecological 2017a, 2018a). Cameras were active for 24hrs each day at all sites.

During the spring/summer sample period, cameras at sites 1-12 were installed between 14 and 21 October 2022 and were inspected during the middle of each session (i.e., after 4 weeks) to change batteries and SD cards. Cameras at sites 1-12 were retrieved on 30 December 2022 following a total sample period of 77 days (Table 3). Cameras at sites 1 (North & south), 3 (ground), 9 (ground) and 11 (ground) were reinstalled 9 January 2023 and retrieved 5/6 February 2023 following SD and camera errors during the original sample period. Two of the 24 cameras were active for less than the 60-day minimum sample period with both a result of camera malfunction/battery failure (Table 3). Overall, cameras were active for a period of 1812 days with all 12 underpasses having at least one camera active for >60 days (Table 3). The total number of camera monitoring days achieved in spring/summer year 5 (i.e., 1812) exceeded the effort required by the EMP of 1440 days.

**Table 3:** Camera survey effort during year five summer/spring operational phase monitoring. † = SD card error \* = Camera malfunction/battery failure.

Site	Camera type	Camera location	Days active
1	Reconyx	North	90*
	Reconyx	South	63*
2	Reconyx	Furniture	77
	Swift enduro	Ground	77
3	Swift enduro	Furniture	77
	Swift enduro	Ground	104†
4	Swift 3c	Ground	77
	Swift enduro	Furniture	77
5	Swift enduro	North	54*
	Swift enduro	South	77
6	Reconyx	Furniture	77
	Reconyx	Ground	77
7	Swift 3c	Ground	77
	Swift enduro	Furniture	77

Site	Camera type	Camera location	Days active
8	Swift enduro	Furniture	77
	Swift enduro	Ground	77
9	Swift 3c	Ground	33*
	Swift enduro	Furniture	77
10	Swift enduro	Furniture	77
	Swift enduro	Ground	77
11	Swift enduro	Furniture	77
	Swift enduro	Ground	82*
12	Swift enduro	Furniture	77
	Swift enduro	Ground	77

## Image review

Images were uploaded to a computer and viewed using Windows Photo Viewer ©. A senior ecologist or ecologist reviewed all images, with reference to standard field guides (i.e., Menkhorst & Knight 2004; Pizzey & Knight 2007; Van Dyck *et al.* undated).

Fauna were scored making a complete or incomplete crossing:

- A complete crossing was scored when an animal showed directional movement when detected by the centrally mounted camera.
- An incomplete crossing was scored when an animal showed no directional movement (i.e., remained stationary in front of camera) or passed the camera but returned within 10 minutes.

Crossing definitions are consistent with those used at other Pacific Highway monitoring sites (e.g., Sandpiper Ecological 2017b, 2018b, 2019) and crossing structure research programs (e.g., Soanes *et al.* 2015). Further, it represents a conservative approach to identification of complete crossings. Data recorded for fauna records included movement direction (i.e., east, west or no-directional movement - NDM) and a tally of crossing types (i.e., complete or incomplete). A hierarchical approach was adopted to species identification that included: species, genus, or group. Microbats were recorded as presence only.

## Data analysis and interpretation

To adequately assess “use of underpasses” as per the monitoring aim, complete crossings were used as the standard of measure for fauna activity as it encompasses the purpose of fauna underpasses (i.e., A structure that allows fauna to access habitat that has been fragmented by construction of a road or highway). To account for variations in survey effort between sites complete crossings/week and complete crossings/week/underpass were adopted. Survey effort and complete crossings at underpasses 5/6 (close proximity), 9/10 (split median) and 11/12 (split median) were combined during data analysis as they function as a single site and lack independence if treated separately. This same approach has been applied to data from previous monitoring years. Birds and microbats were excluded from analysis as they do not require underpasses for thoroughfare.

As seen in dot point five in the potential indicators of success (see introduction), fauna with low mobility was not defined within the EMP. As such, fauna with low mobility has been assumed to include animals whose movement is generally limited by their size or behaviour. Hence, fauna that exhibit low mobility/cover dependence has been interpreted as frogs, small reptiles (excluding goanna and water dragon), rodents and bandicoots. Rodent species were considered to be “undefined” in relation to whether they were introduced or native given the presence of several rodent species in the adjacent habitat including black rat, bush rat, swamp rat, house mouse and fauna-footed melomys.

## 2.3 Adjacent habitat survey

### 2.3.1 Survey design

A total of 18 sites were sampled at the 12 underpasses as part of adjacent habitat survey. Sample sites were established on each side of an underpass or underpass pair in the case of sites 5/6, 9/10 and 11/12. Adjacent habitat at sites 5 and 6 was sampled as one site as the underpass entrances were located within 50 m of each other. Survey effort was reduced at site 3 due to concern about disturbing neighbours. No spotlighting occurred at site 3 and no arboreal Elliott trapping occurred on the west

side at site 3 to limit disturbance of nearby private residence. The diurnal active search was restricted to a small (100m x 30m) triangular shaped remnant of vegetation in the road reserve.

### 2.3.2 Trapping

Trapping methods applied during the survey included: cage traps, ground Elliott traps (Type A), arboreal Elliott traps (Type B), pitfall traps, and hair funnels. Trapping occurred within a 1 ha area immediately adjacent to each culvert entrance and was conducted over three nights at each site. All sites were sampled concurrently, with trapping occurring between 30 January 2023 and 3 February 2023.

Traps were set in an “X” formation with five ground and five arboreal traps set at 20 m intervals on one axis and two cage traps and two hair funnels set at 50 m spacing on the other axis (Plate 3). A line of three pitfall traps with drift fence was set at the intersection of both lines (Plate 3). Pitfall traps typically followed the contour and were set near fallen logs and dense ground cover. Pitfall traps at sites 1, 4 and 2 east were closed due to rising groundwater that filled the buckets. Trap effort is summarised in Table 4.



**Plate 3:** Example of a pitfall trap line installed during adjacent habitat surveys (L). Setting up traps in adjacent habitat at site 1 (R).

Arboreal traps and ground Elliott traps were baited with a peanut butter, honey and oats mixture. Arboreal traps were installed 1.8 m above ground and attached to a bracket. Honey water was sprayed on the trunk above each arboreal trap, and bait was replaced as required. A plastic bag was placed over the end of each trap to provide cover, and a small amount of leaf litter was placed inside the trap. In spring/summer, arboreal traps were set on the western side of trees to provide shelter from the morning sun. Cage traps were set in a sheltered location and baited with sardines. A tuna oil and water mix was sprayed around the entrance to cage traps baited with sardines. All traps were checked within four hours of sunrise. In spring/summer, cage and Elliott traps were closed following the morning inspection and re-opened in the late afternoon. Pitfall traps were checked in the morning and again in mid-afternoon.

Captured fauna were identified to species or genus, and, where possible, sexed and weighed. Fauna were identified with reference to standard field guides (Van Dyck *et al.* 2013; Menkhorst & Knight 2004; Wilson & Swan 2010). Fauna were not marked as the aim of sampling was to determine species richness in adjacent habitat rather than abundance.

### 2.3.3 Diurnal active search

Diurnal active searches were conducted by one or two ecologists and involved a meandering traverse of habitat within 100 m of the underpass entrance at each sample site. Surveys involved searching leaf litter, rolling logs, observing reptile habitat (i.e., log piles, rocks, dense leaf litter) and looking for fauna signs such as scats and tracks. Each site was sampled twice during each sample period for a minimum of 30 person minutes/sample. Diurnal active searches were conducted between 1 and 3 February 2023 for a total of 1080 person minutes (Table 4).

### 2.3.4 Nocturnal active search

Nocturnal surveys were conducted on each side of each underpass on two non-consecutive nights during the spring/summer and winter sample periods. One or two ecologists conducted spotlight surveys for 60 person minutes per underpass side/sample period, divided into two 30-person minute samples on non-consecutive nights (Table 4). Surveys were conducted using hand-held Led Lenser P14 spotlights and involved a meandering traverse of habitat within 200m of the culvert entrance. Fauna were detected by sight and call and identified to species or genus where possible. Nocturnal surveys were conducted between 1 and 7 February 2023 for a total of 1080 person minutes (Table 4).

### 2.3.5 Opportunistic records

Opportunistic observations of fauna near culvert entrances made whilst doing other monitoring activities such as koala, giant barred frog and yellow-bellied glider monitoring were recorded. All fauna observed whilst setting up equipment, with exception of birds, were also recorded.

**Table 4:** Survey effort for sampling adjacent habitat on the WC2NH upgrade. \* Pitfall traps at sites 1, 4 and 2 east were packed down on February 1 due to the water table rising and filling up the buckets.

Component	Method / culvert side	No Samples	Total effort
<b>Arboreal Elliott traps</b>	5 x traps @ 20m spacing	3 nights/site	510 trap nights
<b>Ground Elliott traps</b>	5 x Type A Elliott traps @ 20m spacing	3 nights/site	540 trap nights
<b>Cage traps</b>	2 @ 50m spacing	3 nights/site	216 trap nights
<b>Pitfall traps</b>	1 x line of 3 pits with drift fence	3 nights/site*	324 trap nights
<b>Hair funnels</b>	2 @ 50m spacing	14 nights/site	504 trap nights
<b>Active diurnal search</b>	30 person minute search at UP entrance	2 sample/site	1080 person minutes
<b>Active nocturnal search</b>	30 person minute search at UP entrance	2 samples/site	1080 person minutes

## 2.4 Exclusion fence

Exclusion fence monitoring is to be conducted in winter 2023.

## 3. Results

### 3.1 Underpasses

#### 3.1.1 Camera monitoring

##### *Year 5 spring/summer species diversity and native fauna use*

Seventeen species, one unique genus (brown antechinus) and six fauna groups were confirmed making complete crossings of underpasses during year five spring/summer camera monitoring (Table 5). Of the fauna recorded, fourteen were native species with an additional six native fauna groups (Table 5). Native fauna diversity was highest at site 2 with thirteen species/groups,

followed by site 11/12 (twelve species/groups), site 4 (eleven species/groups) and site 8 and 9/10 (nine species/groups). Native fauna diversity was lowest at site 1 (three species - *Antechinus* spp., lace monitor and swamp wallaby) (Table 5). Remaining sites including 3, 5/6 and 7 all recorded eight native fauna species/groups (Table 5). Four introduced species were also recorded including cat, wild dog, red fox and black rat (Table 5).

Complete crossings by native species were recorded at all sites at an overall rate of  $3.05 \pm 0.52$  cc/week/underpass (Figure 2, Figure 3, Figure 5). Sites 2, 4 and 7 featured the highest use by native fauna with a total of 4.18cc/week, 5.59cc/week and 3.91cc/week respectively (Figure 2). Sites 1 and 5/6 exhibited the lowest use by native fauna recording 0.50cc/week and 1.30cc/week respectively (Figure 2). Native fauna use was higher than that of feral predators at all sites and introduced/undefined rodents across most sites (Figure 2). Native species exhibited use of fauna furniture in all underpasses, with preferential furniture use demonstrated by *Antechinus* spp., lizard spp. and *Trichosurus* spp. (Table 5).

Short-eared brushtail possum was the most frequently recorded native species with a total of 13.54cc/week across all sites (Table 5). This was followed by bandicoot species (including long-nosed and northern brown) with 9.77cc/week, swamp wallaby (including wallaby species records) with 8.66cc/week and lace monitor with 5.92cc/week (Table 5).

Koala was the only threatened species recorded, with one complete crossing using the culvert floor at site 4 (Table 5, Plate 4).

### ***Use by cover dependent species with low mobility***

Cover dependent fauna with low mobility (see classification in methods) were recorded at all sites (Table 5). In order of use, rodent species recorded a total of 24.05 cc/week, bandicoots 9.77 cc/week, and *Antechinus* spp. 3.62 cc/week (see total Table 5). Confirmed rodent species were black rat (underpasses 2,4,5,7,8,9/10, 11/12), bush rat (sites 2, 4, 7, 11/12) and water rat (site 5/6) (Table 5). Other cover dependent species included eastern blue-tongue lizard using the culvert floor at sites 2 and 11/12 (Table 5). Lizard species were also identified using the fauna furniture at sites 2, 9/10 and 11/12, these individuals are considered probable *Egernia mcpheii*. No frogs were recorded using underpasses during camera monitoring.

### ***Feral predator activity***

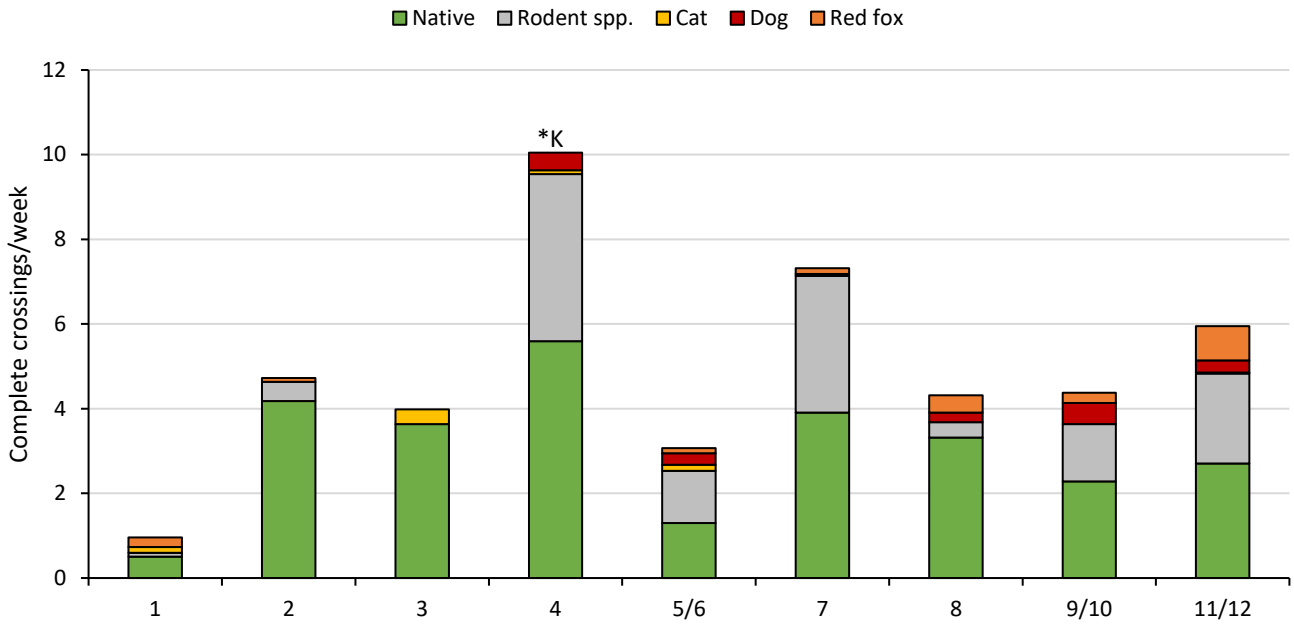
Feral predators including wild dog, red fox and cat were recorded at all sites during the spring/summer monitoring period 2023 (Table 5, Figure 2). Feral predator records accounted for 14% of all complete crossings excluding rodents (Figure 3). Cat activity was recorded across five of nine sites at an average rate of 0.097 cc/week/underpass with the highest activity (combined total of 0.61 cc/week) occurring at site 3 (Table 5, Figure 2 and Figure 3). Fox activity was recorded at seven of the nine sites at an average rate of  $0.24 \pm 0.2$  cc/week/underpass and no records at sites 3 and 4 (Table 5, Figure 2). Wild dog activity was recorded at six of the nine sites, with the highest activity at site 9 with 1.21 cc/week, and an average of  $0.22 \pm 0.07$  cc/wk/site and a total of 3.22 cc/week. Sites 1, 2 and 3 saw no activity on the cameras of wild dogs (Table 5, Figure 2). Feral predator activity since year 4 has fluctuated, with cat crossings decreasing by 0.43 cc/wk and dog increasing from 0.0015 cc/wk/site to  $0.22 \pm 0.07$  cc/wk/site (Figure 4). Complete crossings by feral predators were lowest at sites 2 (0.09cc/wk; 4.18 cc/wk), 4 (0.5 cc/wk; 5.59cc/wk) and 7 (0.18cc/wk; 3.9cc/wk) (Table 5, Figure 2). Overall, red foxes were the most prominent feral predator utilising the underpasses, with a combined total of 3.60 cc/week (Table 5).

No instances of predation were recorded occurring within the underpasses during year five spring/summer operational monitoring. However, there were several instances of feral predators carrying prey through the underpasses (see fox Plate 4).

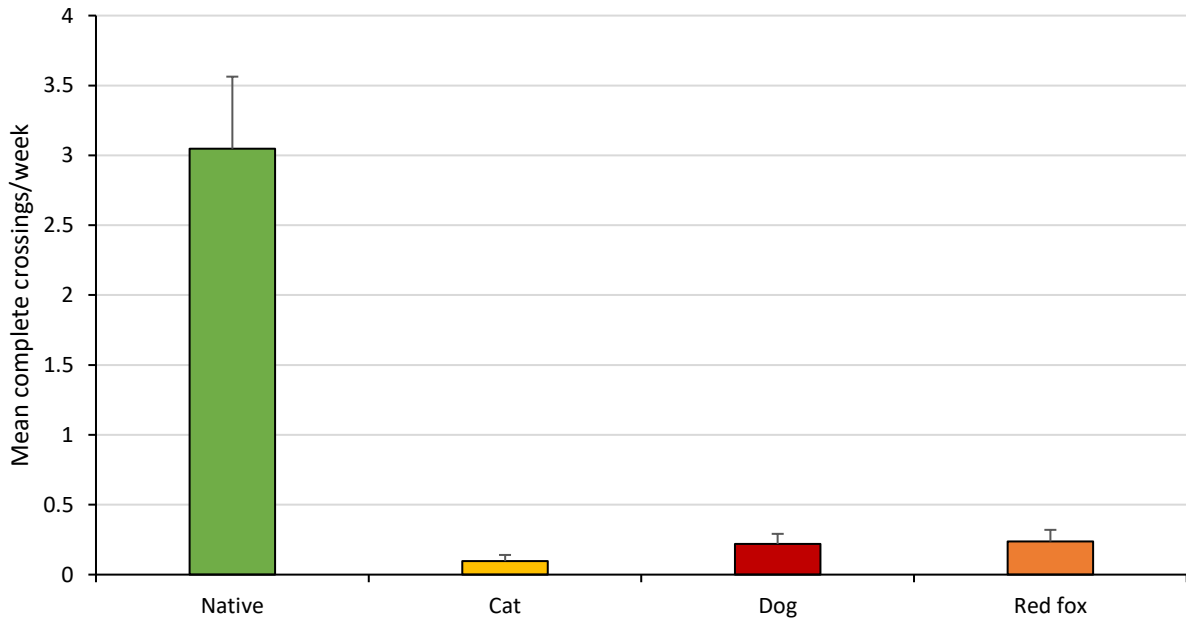
**Table 5:** Total complete crossings/week/underpass made by each species/group at 12 underpass structures monitored on the WC2NH upgrade during year 5 spring/summer monitoring. FF= fauna furniture and G= ground (culvert floor), N = north, S = south. Sites 1 and 5 did not contain fauna furniture. Total number of native species/groups recorded per site (9/10 and 11/12 split median) in bold. Species in bold denote threatened species, ^=Cover dependent species and \* = introduced species. See appendix B, Table B1 for all data.

Species/fauna groups	Site and camera location																		Total cc/week/spp.
	1		2		3		4		5/6		7		8		9/10		11/12		
	N	S	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	
<b>Mammals</b>																			
Short-beaked echidna	-	-	-	0.09	-	-	-	0.09	-	-	-	-	-	-	-	-	-	-	0.18
Antechinus spp.	0.08	-	2.82	0.09	0.09	-	-	-	0.36	0.03	-	-	0.18	-	0.05	-	-	-	3.62
Long-nosed bandicoot	-	-	-	3.18	-	-	-	1.18	-	0.40	-	0.36	-	0.09	-	0.57	-	0.18	5.97
Northern brown bandicoot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.31	0.31
Bandicoot spp.	-	-	-	0.09	-	-	-	0.45	-	0.07	-	0.36	-	0.82	-	0.64	-	1.06	3.49
<b>Koala</b>																			
Brushtail possum spp.	-	-	-	-	0.64	-	-	1.91	-	-	-	-	0.55	0.09	0.23	0.06	0.32	-	3.79
Short-eared brushtail possum	-	-	-	0.18	3.55	-	1.55	0.09	-	-	5.09	-	0.36	0.18	0.14	-	2.36	0.04	13.54
Eastern grey kangaroo	-	-	-	-	-	0.67	-	-	-	-	-	-	-	-	-	-	-	-	0.67
Red-necked wallaby	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	0.04	0.11
Swamp wallaby	0.54	0.11	-	0.45	-	-	-	1.45	-	0.40	-	0.18	-	1.27	-	-	-	0.18	3.94
Wallaby spp.	-	-	-	0.27	-	0.47	-	1.18	-	0.03	-	0.45	-	1.82	-	0.45	-	0.04	4.72
Macropod spp.	-	-	-	0.00	-	1.21	-	-	-	-	-	-	-	-	-	-	-	-	1.21
Water rat	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-	-	-	0.07
Bush rat	-	-	0.09	-	-	-	0.36	-	-	-	0.36	-	-	-	-	-	0.59	-	1.41
<b>Rodent spp.</b>																			
Black rat*	0.08	-	-	0.45	-	-	0.73	0.09	-	0.03	0.36	0.73	0.18	-	0.14	0.25	0.09	0.04	3.10
Rattus spp.	-	0.11	0.18	0.27	-	-	7.09	-	4.36	0.03	4.91	0.45	0.45	0.09	1.95	0.06	4.18	-	24.05
<b>Feral predators</b>																			
Red fox*	0.39	-	-	0.18	-	-	-	-	-	0.17	-	0.27	-	0.82	-	0.57	-	1.58	3.60
Wild dog*	-	-	-	-	-	-	-	0.82	-	0.37	-	0.09	-	0.45	-	1.21	-	0.57	3.52
Cat*	0.08	0.22	-	-	-	0.61	-	0.18	-	0.20	-	-	-	-	-	-	-	0.04	1.03
<b>Reptiles</b>																			
Blue-tongue lizard	-	-	-	0.18	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04	0.23
Eastern water dragon	-	-	-	0.09	0.36	-	-	0.09	-	0.03	-	-	-	-	-	-	-	-	0.58
Lace monitor	0.08	-	-	0.09	0.09	0.47	0.64	2.09	-	0.61	0.64	0.18	-	0.64	-	0.25	-	0.22	5.92
Lizard spp.	-	-	0.55	0.18	-	-	-	-	-	-	0.18	-	0.64	-	2.00	0.06	-	0.04	3.65
<b>Total no. species/groups</b>	<b>6</b>	<b>3</b>	<b>4</b>	<b>15</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>13</b>	<b>2</b>	<b>13</b>	<b>6</b>	<b>9</b>	<b>6</b>	<b>10</b>	<b>6</b>	<b>11</b>	<b>5</b>	<b>14</b>	<b>88.81</b>

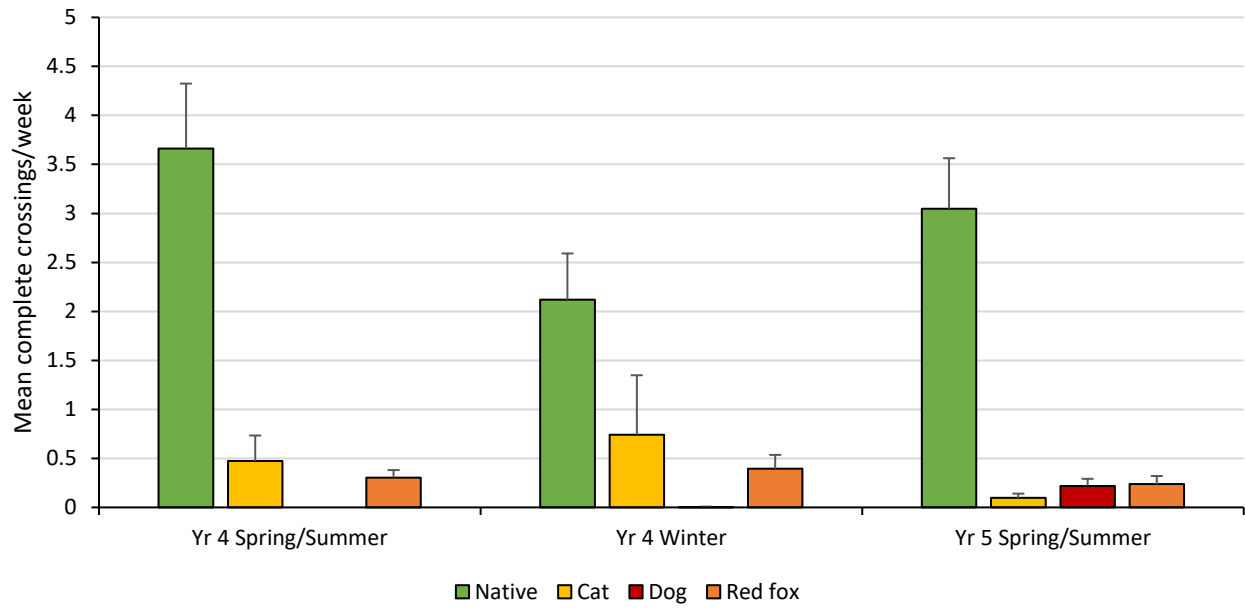




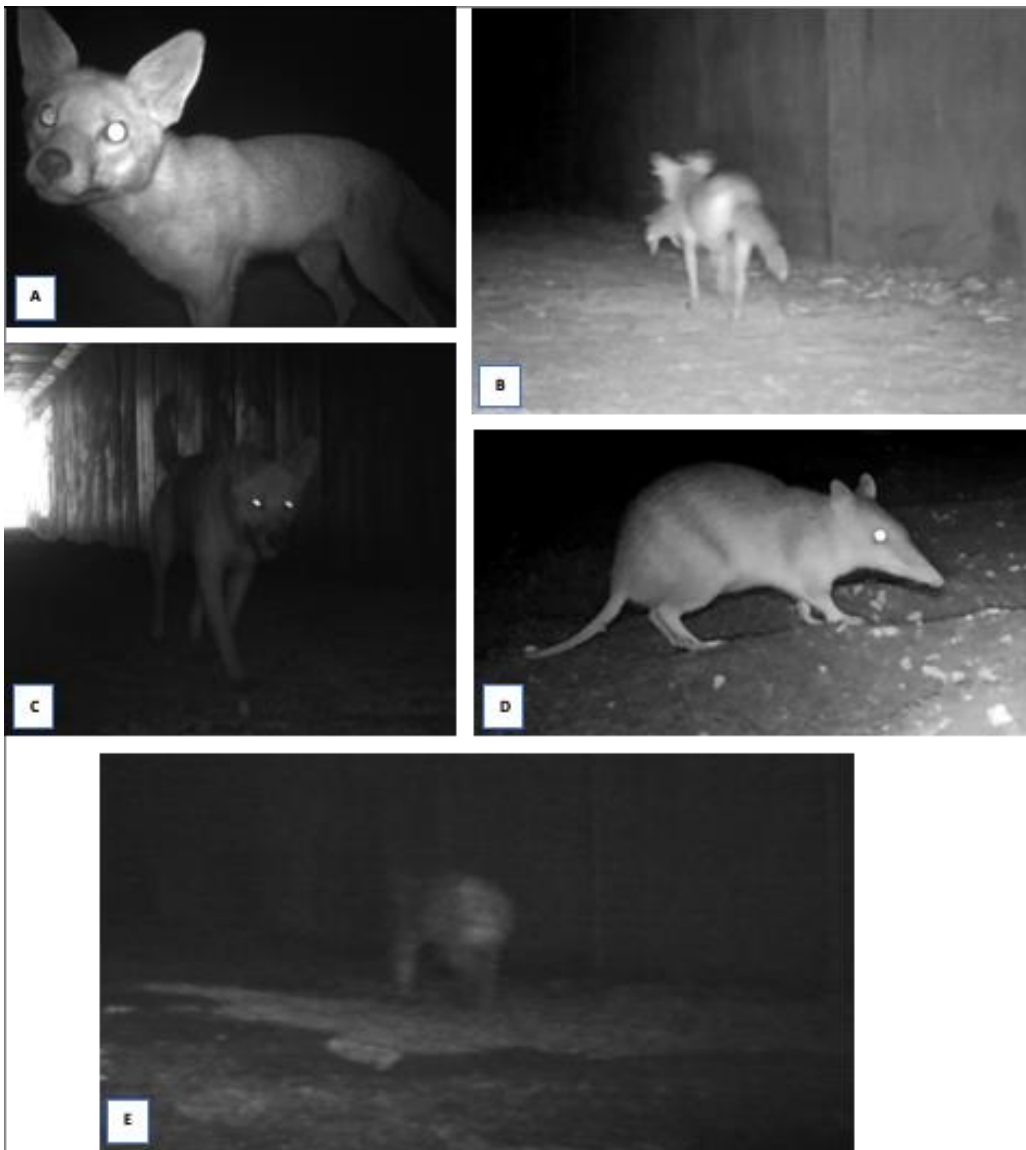
**Figure 2:** Total complete crossings (cc)/week/site by native species, feral predators (cat, wild dog and red fox) introduced/undefined rodent (combined black rat and rodent spp.) at each site during year five (spring/summer) operational monitoring, WC2NH, 2022/2023. \*K = indicates complete crossing by koala.



**Figure 3:** Mean number of complete crossing/week/underpass (+SD) for all native species, cat, wild dog and red fox during year five spring/summer operational monitoring.



**Figure 4:** Mean number of complete crossing/week/underpass (+SD) for all native species, cat, wild dog and red fox during year four spring/summer, winter and year five spring/summer operational monitoring.



**Plate 4:** A. Fox heading west at site 6. B. Fox heading east carrying a bandicoot at site 11. C. Dog heading west at site 6. D. Bandicoot at site 2. E. Koala heading east at site 4

### 3.1.2 Sand pads

Eleven species and fauna groups were recorded on sand pads in spring/summer year 5 (Appendix B, Table B2). Of the native species, *Peramelidae spp.* (Bandicoot) and Lace monitors were the most commonly recorded fauna species with tracks identified at seven of the nine sites (Appendix B, Table B2). Feral predator tracks were found at three of the nine sites (1, 3, 5/6) (Appendix B, Table B2). Of the smaller fauna groups (i.e., small mammals, reptiles and amphibians), probable *Antechinus spp.* (sites 1, 2, 5/6, 8, 9/10 and 11/12), and small and medium lizard (1, 5/6 and 11/12; and 9/10, 11/12 respectively) were recorded during inspections (Appendix B, Table B2). No species or groups were recorded in addition to those from underpass camera monitoring.

### 3.1.2 Scat and track searches and tile checks

Twelve species, and eight fauna groups were recorded during scat and track surveys during year five spring/summer monitoring (Appendix B, Table B3). As seen in camera data, native species/fauna groups were found to be using all underpasses. Records of small native fauna included scats from *Antechinus spp.* at sites 2 and 11/12, and small reptiles at sites 1 and 9/10. Bandicoot tracks were prominent at seven sites, wallaby spp. at five sites and short-beaked echidna at three sites (Appendix B, Table B3). Scats and tracks from reptile species were found at all sites except for site 2. Feral predators (fox, dog, cat) were recorded at sites 1, 2, 3, 5/6, 9/10 and 11/12, with fox tracks found at five of the nine sites.

No fauna was recorded during tile checks (Appendix B, Table B4).

## 3.2 Adjacent habitat

Thirty-three species, seven genera, and five fauna groups were recorded in habitat adjoining underpasses during the spring/summer surveys (Table 6). Most species/groups (22 in total) were detected by diurnal and nocturnal active searches (Table 6, Appendix B, Table B5 and B6). During trapping surveys, a total of ten species and one *lampropholis* spp. were recorded (Table 6, Appendix B Table B7). Hair funnels recorded eight species (Appendix B, Table B8). Threatened species records included a probable female koala found during active diurnal search at site 9/10 on two occasions, both on the east side (Table 6, Appendix B, Table B5 and B6).

**Table 6:** Detection of fauna species and groups during spring/summer year five adjacent habitat monitoring at WC2NH, 2022/23. Bold denotes threatened species. <sup>1</sup> = Introduced. Birds, bats and gliders have been excluded as they do not require underpasses for thoroughfare.

Species	Active Search	Spotlight	Trapping	Hair funnel
<b>Mammals</b>				
Brown antechinus			*	*
<i>Antechinus</i> spp.	*	*		
Northern brown bandicoot				*
<i>Peramelidae</i> spp. (bandicoot)	*	*		
<b>Koala</b>		*		
Common brushtail possum		*		*
Short-eared brushtail possum		*		
Common ringtail possum		*		
Swamp wallaby	*			
Wallaby spp.	*			
Fawn-footed melomys			*	*
Bush rat			*	*
Black rat <sup>1</sup>		*	*	*
House mouse				*
<i>Rattus</i> spp.	*			*
Red fox <sup>1</sup>	*			
Cat <sup>1</sup>				
Dog <sup>1</sup>	*			
<b>Reptiles</b>				
Lace monitor	*		*	
Eastern water dragon	*	*		
<i>Calyptotis ruficauda</i>	*		*	
Eastern crevice skink				
<i>Lampropholis delicata</i>	*		*	
<i>Lampropholis guichenoti</i>				
<i>Lampropholis</i> spp.	*		*	
Bandy bandy		*		
<i>Pygopus lepidopodus</i>		*		
Yellow-faced whipsnake				
Small-eyed snake		*		
<i>Chelidae</i> spp.				
Small reptile				
<i>Lophosaurus spinipes</i>	*			
Snake spp.	*			
<b>Frogs</b>				
Amphibian spp.	*			
<i>Litoria gracilentata</i>		*		
<i>Litoria fallax</i>		*		
<i>Litoria peronii</i>		*		
<i>Litoria caerulea</i>				
<i>Litoria tyleri</i>				
<i>Mixophyes iteratus</i>				

Species	Active Search	Spotlight	Trapping	Hair funnel
<i>Crinia signifera</i>		*		
<i>Adelotus brevis</i>		*	*	
<i>Uperoleia fusca</i>				
<i>Pseudophryne coriacea</i>		*	*	
<i>Limnodynastes peronii</i>		*	*	
Total N° Species/groups	15	22	11	8

### 3.2.1 Species recorded in underpasses and adjacent habitat

With the mentioned exclusions (see Table 7 caption), 35 species and unique genera were confirmed within the adjacent habitat, with 20 using underpasses (Table 7). The proportion of species confirmed in adjacent habitat and using underpasses was 57% (Table 7). The proportion of mammals recorded in both adjacent habitat and underpasses was 89% with the common ringtail possum and fawn-footed melomys the only mammal species not recorded in underpasses (Table 7). No species of frog was recorded using underpasses, while seven species were reported in adjacent habitat (Table 7). Notably, a frog scat was recorded during active searches at site 7 (Appendix B, Table B5) however a species designation is not possible from scats alone. Further, 9 reptile species/families were recorded during monitoring, with 3 (33%) confirmed using underpasses including lace monitor, eastern blue-tongue lizard, eastern water dragon (Table 7) and probable *Egernia mcphieii* (unidentified lizard spp.).

**Table 7:** Species and unique genera recorded in adjacent habitat and using underpasses during year five spring/summer monitoring at WC2NH, 2022/23. Due to duplication between species and fauna groups (e.g., wallaby spp. includes both red-necked and swamp wallaby), only confirmed species and unique genera have been included. Fauna in bold denotes threatened species. \*Denotes presence. + = species designation assumed based on frequent capture of only brown antechinus in adjacent habitat. # = Species presence assumed due to detection in underpass only.

Species and unique genera	Underpass	Adjacent habitat
<b>Mammals</b>		
Short-beaked echidna	*	#
Brown antechinus ^	*	*
Northern brown bandicoot^	*	*
Long-nosed bandicoot^	*	#
Bandicoot spp.	*	*
<b>Koala</b>	*	*
Short-eared brushtail possum	*	*
Common brushtail possum	*	*
Common ringtail possum		*
Swamp wallaby	*	*
Red-necked wallaby	*	#
Eastern grey kangaroo	*	#
Water rat	*	#
Fawn-footed melomys^		*
Bush rat	*	*
Black rat^	*	*
Red fox	*	*
Cat	*	#
Dog	*	*
<b>Sub-total mammals</b>	<b>17</b>	<b>19</b>
<b>Reptiles</b>		
Lace monitor	*	*
Eastern water dragon	*	*

Species and unique genera	Underpass	Adjacent habitat
<i>Lophosaurus spinipes</i>		*
Eastern blue tongued lizard <sup>^</sup>	*	#
<i>Calyptotis ruficauda</i> <sup>^</sup>		*
<i>Lampropholis delicata</i> <sup>^</sup>		*
Bandy bandy <sup>^</sup>		*
<i>Pygopus lepidopodus</i>		*
Small-eyed snake <sup>^</sup>		*
<b>Sub-total reptiles</b>	<b>3</b>	<b>9</b>
<b>Frogs</b>		
<i>Litoria gracilentia</i> <sup>^</sup>		*
<i>Litoria fallax</i> <sup>^</sup>		*
<i>Litoria peronii</i> <sup>^</sup>		*
<i>Crinia signifera</i>		*
<i>Adelotus brevis</i> <sup>^</sup>		*
<i>Pseudophryne coriacea</i> <sup>^</sup>		*
<i>Limnodynastes peronii</i>		*
<b>Sub-total frogs</b>	<b>0</b>	<b>7</b>
<b>Total N<sup>o</sup> Species/unique genera</b>	<b>20</b>	<b>35</b>

## 4. Discussion

### 4.1 Low rates of use of fauna underpasses and adjacent habitats by feral predators

A definition of “low use” by feral predators is not provided in the WC2NH EMP (RMS 2018). Cat, dog and fox were recorded across all the underpass sites and accounted for 20% of complete crossings excluding rodents. This represents a slight decrease from year 4 21%, but steady in comparison to years 1 and 2 where feral predators accounted for ~ 50% of complete crossings (Sandpiper Ecological 2019, 2020). Fox crossings have decreased from 0.29±0.1 cc/wk/site in year 4 to 0.24±0.1 cc/wk/site, in year 5, which represents a 17.3% decline. Further, there is a temporal trend of declining fox records since year 2 when 0.48±0.14 cc/wk/site was recorded (Sandpiper Ecological 2020). Cat activity has also decreased substantially from a peak of 0.53±0.4 cc/wk/site in year 4 down to 0.092±0.04 cc/wk/site (year 5 spring/summer), which represents an 83% decline. This decrease is mostly due to a reduction in complete crossings by resident cats at site 3, 3.68 cc/wk in year 4 down to 0.35 cc/wk in spring/summer year 5 (Sandpiper Ecological 2022a). Finally, dog records increased substantially from year 4 (0.0015 cc/wk/site) to year 5 (0.22±0.07 cc/wk/site). This is the highest number of dog crossings over the 5 year monitoring program. The previous highest occurrence was in year 3 (0.19±0.04 cc/wk/site) prior to the collaborative trapping program completed at WC2NH in autumn of 2021 (Saltair Flora and Fauna 2021). In year 5 dogs were recorded at six of the nine sites, an increase from one site in year 4. Overall feral predator use has remained relatively constant since year 4 and with individuals occurring throughout the WC2NH study area. The low number of complete crossings by feral predators coincide with the highest number of native fauna crossings at sites 2 (0.09cc/wk; 4.18 cc/wk), 4 (0.5 cc/wk; 5.59cc/wk) and 7 (0.18cc/wk; 3.9cc/wk) respectively. This suggests that feral predators may, to some extent, be influencing the use of underpasses by native fauna at other sites. To determine whether further action is warranted, dog usage will be assessed following year 5 winter monitoring.

### 4.2 High levels of fauna underpass use by a variety of native species

Camera monitoring of native species has seen a steady increase in crossings since the start of the monitoring program. Since year 4, complete crossings by native species increased from 2.57 cc/week/site to 3.047±0.5 cc/wk/site (Sandpiper Ecological 2021a). The highest number of native species crossings in year 5 was recorded at site 4 (5.59 cc/wk) whereas site 7 had the highest crossings in year 4. The result is not unexpected as use by native fauna is expected to increase over time as site features (i.e., vegetation at culvert entrances) improve, a trend also recorded at Sapphire to Woolgoolga and recent monitoring at Nambucca Heads to Urunga (Sandpiper Ecological 2018, 2022).

A wide variety of native species and unique genera were recorded using underpasses. In total, 35 species were recorded in the adjacent habitat, with 57% of them utilising the underpasses. Of these 46% were native fauna. This result is higher than findings at previous underpass monitoring projects including Sapphire to Woolgoolga (23% to 50%) and Nambucca Heads to Urunga (38% in 2018 and 42% in 2020) (Sandpiper Ecological 2018, 2020b). The increase in the percentage of native fauna using the underpasses coincide with the surrounding habitats forming with fauna corridors establishing in the landscape adjacent to the underpasses. The speed of uptake by a wide variety of fauna may be associated with retention of established vegetation close to underpass entrances and the location of structures within the landscape. One notable feature of monitoring is the variation in native fauna use between sites, highlighting the importance of location as a determinant of use.

Koalas continue to use underpasses at WC2NH in year 5 operational phase, with one complete crossing at site 4. A koala was also recorded on two occasions at site 9/10 during nocturnal adjacent habitat searches. The number of culverts used by koalas has fluctuated between years, from four in year 1, three in year 2, two in year 3 and three in year 4 (Sandpiper Ecological 2019b, 2020b, 2022a). Continued monitoring in winter 2023 will provide further information on underpass use by koala.

### 4.3 No change to densities, distribution, habitat use, and movement patterns compared to baseline population data of target species.

The target species for underpass monitoring, as outlined in the EMP, are spotted-tailed quoll, koala and giant barred frog. No spotted-tailed quolls have been detected to date, consistent with baseline monitoring (GeoLink 2014), and population monitoring of giant barred frogs at Upper Warrell Creek is addressed by Sandpiper Ecological (2021b). Koala records suggest that koalas continue to maintain territory on both sides of the alignment.

### 4.4 Evidence of use by dispersing individuals and different age cohorts

Accurately confirming age of individuals using underpasses is difficult using the survey methods outlined in the EMP. Other methods such as mark-release-recapture would likely be required to provide definitive proof of use by dispersing individuals and different age cohorts. Such a survey is not warranted at WC2NH.

### 4.5 Use by cover-dependent species with low mobility

Several native cover-dependent species (typically small mammals, small reptiles and frogs) were recorded in adjacent habitat, including six frog species, three native mammals (brown antechinus, fawn-footed melomys and bush rat) and eight reptile species. Of these, three cover dependent species (*Antechinus* spp, bush rat and eastern blue-tongue lizard) were recorded using underpasses. Consistent with previous surveys there were limited records of frogs and reptiles in underpasses. Low occurrence of frogs and reptiles is most likely due to the inability of cameras to detect these species as opposed to avoidance. This shortfall is assisted using sand pads and scat and tracks searches with some records of small and medium reptiles being recorded at sites 1, 5/6, 9/10 and 11/12. Tile checks have proved to be ineffective at detecting cover dependent fauna with no records recorded in year five spring/summer monitoring.



## 5. Contingency Measures and Recommendations

### 5.1 Contingency Measures

Contingency measures are summarised in Table 8.

**Table 8:** Potential problems outlined in the EMP and possible contingency measures. Proposed mitigation measures applicable to the project are addressed in bold text.

Problem	Contingency/Corrective Action	Proposed action
<b>High rates of feral predator activity;</b>	Control program	No action. Dog/Fox visitation in year 5 winter monitoring will be used to determine if further control is warranted.
<b>Low levels of native fauna movement and species diversity in underpasses;</b>	Modify habitat structure near underpass entrances and/or modify underpass fauna furniture	No action required – monitoring has shown that fauna furniture is functional and underpasses are providing safe passage for over 89% of the mammal species recorded in adjacent habitat.
<b>No use of underpasses by cover-dependent species or species with low mobility or target threatened species</b>	Modify or add potential groundcover resources	Four cover dependent species and one threatened species were recorded using underpasses. Minimising disturbance of vegetation at culvert entrances will assist in facilitating movement by cover dependent species. No action required - continue monitoring underpasses using current methods in winter year 5.
<b>High rates of fauna road mortality.</b>	Modify exclusion fencing design, location or extent depending on the species and location of mortalities	Issues relating to road mortality are addressed in the quarterly and annual road-kill reports. At this stage no modifications to the location or extent of exclusion fence is proposed. No mortality of target species has been recorded during the monitoring program.

### 5.2 Recommendations

Recommendations are summarised in Table 9. Initial monitoring in year 5 has identified a substantial increase in dog activity and further analysis of underpass use by dogs (and feral species in general) should be undertaken in the final year 5 monitoring report to determine if targeted control is warranted.

**Table 9:** Recommendations based on findings from year five operational phase monitoring and response from TfNSW.

Number	Recommendation	Transport for NSW Response
1.	Continue underpass and adjacent habitat monitoring in accordance with the EMP	Agreed.
2.	Assess the need for feral predator control in the final year 5 monitoring report.	To be considered pending outcomes of the Year 5 Autumn monitoring.

## 6. References

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## Appendix A – Species list

**Table A1:** Common and scientific names for all species recorded during operational monitoring at WC2NH. Species in bold = Threatened species.

Common Name	Scientific Name
Mammals	
<b>Koala</b>	<i>Phascolarctos cinereus</i>
Swamp wallaby	<i>Wallabia bicolor</i>
Red-necked wallaby	<i>Macropus rufogriseus</i>
Wallaby spp.	
Short-beaked echidna	<i>Tachyglossus aculeatus</i>
<b>Yellow-bellied glider</b>	<i>Petaurus australis</i>
Sugar glider	<i>Petaurus breviceps</i>
	<i>Petaurus spp.</i>
Short-eared brushtail possum	<i>Trichosurus caninus</i>
Common brushtail possum	<i>Trichosurus vulpecula</i>
Brushtail possum spp.	<i>Trichosurus spp.</i>
Common ringtail possum	<i>Pseudocheirus peregrinus</i>
Northern brown bandicoot	<i>Isodon macrourus</i>
Long-nosed bandicoot	<i>Perameles nasuta</i>
Bandicoot species	<i>Peramelidae spp.</i>
Fawn-footed melomys	<i>Melomys cervinipes</i>
	<i>Melomys spp.</i>
Water rat	<i>Hydromys chrysogaster</i>
Bush rat	<i>Rattus fuscipes</i>
Swamp rat	<i>Rattus lutreolus</i>
Brown antechinus	<i>Antechinus stuartii</i>
	<i>Antechinus spp.</i>
<b>Grey-headed flying red fox</b>	<i>Pteropus poliocephalus</i>
Flying red fox spp.	<i>Pteropus spp.</i>
Bent-wing spp.	<i>Miniopterus spp.</i>
Small mammal spp.	
	<i>Dasyuridae spp.</i>
Reptiles	
Eastern crevice skink	<i>Egernia mcphieii</i>
Garden skink	<i>Lampropholis delicata</i>
Grass skink	<i>Lampropholis guichenoti</i>
	<i>Lampropholis spp.</i>
Red-tailed calyptotis	<i>Calyptotis ruficauda</i>
Eastern water-skink	<i>Eulamprus quoyii</i>
Three-toed skink	<i>Saiphos equalis</i>
Skink spp.	<i>Scincidae spp.</i>
Coastal carpet python	<i>Morelia spilota</i>
Red-bellied black snake	<i>Pseudechis porphyriacus</i>
Yellow-faced whipsnake	<i>Demansia psammophis</i>
Black-bellied swamp snake	<i>Hemiaspis signata</i>
Blackish blind snake	<i>Anilius nigrescens</i>
Bandy bandy	<i>Vermicella annulata</i>
Coastal carpet python	<i>Morelia spilota</i>
Burton's legless lizard	<i>Lialis burtonis</i>
Lace monitor	<i>Varanus varius</i>
Eastern water dragon	<i>Intellagama lesueurii</i>
	<i>Agamid spp.</i>
Freshwater turtle spp.	<i>Chelidae spp.</i>
Frogs	
Eastern dwarf tree frog	<i>Litoria fallax</i>

Common Name	Scientific Name
Tyler's tree frog	<i>Litoria tyleri</i>
Red-eyed tree frog	<i>Litoria chloris</i>
Green tree frog	<i>Litoria cerulea</i>
Dusky toadlet	<i>Uperolia fusca</i>
Tusked frog	<i>Adelotus brevis</i>
Common eastern froglet	<i>Crinia signifera</i>
<b>Giant barred frog</b>	<i>Mixophyes iteratus</i>
Striped marsh frog	<i>Limnodynastes peronii</i>
Red-backed toadlet	<i>Pseudophryne coriacea</i>
Medium frog spp.	
Introduced	
Cat	<i>Felis catus</i>
Red fox	<i>Vulpes vulpes</i>
Black rat	<i>Rattus rattus</i>
European hare	<i>Lepus europaeus</i>
House mouse	<i>Mus musculus</i>

## Appendix B – Field data

**Table B1:** Underpass camera data recorded during spring/summer of year five operational monitoring WC2NH, 2022/2023. NDM – no directional movement

Order	Season	Site	Underpass	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM
1	Spring/Summer	1	1	South	Cat	Introduced	Feral predator	2		
2	Spring/Summer	1	1	South	Swamp wallaby	Native	Macropod	1	1	
3	Spring/Summer	1	1	South	Rodent spp.	NA	Introduced rodent	1		
4	Spring/Summer	1	1	North	Swamp wallaby	Native	Macropod	7		1
5	Spring/Summer	1	1	North	Antechinus spp.	Native	Antechinus	1		
6	Spring/Summer	1	1	North	Fox	Introduced	Feral predator	5		
7	Spring/Summer	1	1	North	Small frog spp.	Native	Frog	1		
8	Spring/Summer	1	1	North	Lace monitor	Native	Lizard	1		
9	Spring/Summer	1	1	North	Cat	Introduced	Feral predator	1		
10	Spring/Summer	1	1	North	Black rat	Introduced	Introduced rodent	1		
11	Spring/Summer	2	2	Furniture	Antechinus spp.	Native	Antechinus	31	3	
12	Spring/Summer	2	2	Furniture	Bush rat	Native	Native rodent	1	4	
13	Spring/Summer	2	2	Furniture	Short-eared brushtail possum	Native	Possum	0	3	
14	Spring/Summer	2	2	Furniture	Lizard spp.	NA	Lizard	6		
15	Spring/Summer	2	2	Furniture	Rattus spp.	NA	Rodent	2		
16	Spring/Summer	2	2	Gound	Long-nosed bandicoot	Native	Bandicoot	35	6	
17	Spring/Summer	2	2	Gound	Short-beaked echidna	Native	Echidna	1		
18	Spring/Summer	2	2	Gound	Eastern water dragon	Native	Lizard	1		
19	Spring/Summer	2	2	Gound	Black rat	Introduced	Introduced rodent	5		
20	Spring/Summer	2	2	Gound	Swamp wallaby	Native	Macropod	5	3	
21	Spring/Summer	2	2	Gound	Wallaby spp.	Native	Macropod	3		
22	Spring/Summer	2	2	Gound	Red fox	Introduced	Feral predator	2		
23	Spring/Summer	2	2	Gound	Rattus spp.	NA	Rodent	3		
24	Spring/Summer	2	2	Gound	Short-eared brushtail possum	Native	Possum	2		

Order	Season	Site	Underpass	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM
25	Spring/Summer	2	2	Gound	Blue-tongue lizard	Native	Lizard	2		
26	Spring/Summer	2	2	Gound	Lace monitor	Native	Lizard	1		
27	Spring/Summer	2	2	Gound	Lizard spp.	NA	Lizard	2		
28	Spring/Summer	2	2	Gound	Bandicoot spp.	Native	Bandicoot	1		
29	Spring/Summer	2	2	Gound	Antechinus spp.	Native	Antechinus	1		
30	Spring/Summer	3	3	Furniture	Brush-tail possum spp.	Native	Possum	7		
31	Spring/Summer	3	3	Furniture	Short-eared brushtail possum	Native	Possum	39	3	
32	Spring/Summer	3	3	Furniture	Eastern water dragon	Native	Lizard	4		
33	Spring/Summer	3	3	Furniture	Lace monitor	Native	Lizard	1		
34	Spring/Summer	3	3	Furniture	Antechinus spp.	Native	Antechinus	1		
35	Spring/Summer	3	3	Ground	Macropod spp.	Native	Macropod	18		
36	Spring/Summer	3	3	Ground	Lace monitor	Native	Lizard	7		
37	Spring/Summer	3	3	Ground	Cat	Introduced	Feral predator	9		
38	Spring/Summer	3	3	Ground	Eastern grey kangaroo	Native	Macropod	10		
39	Spring/Summer	3	3	Ground	Wallaby spp.	Native	Macropod	7		
40	Spring/Summer	4	4	Furniture	Lace monitor	Native	Lizard	7		
41	Spring/Summer	4	4	Furniture	Rattus spp.	NA	Rodent	78	2	
42	Spring/Summer	4	4	Furniture	Short-eared brushtail possum	Native	Possum	17	1	
43	Spring/Summer	4	4	Furniture	Black rat	Introduced	Introduced rodent	8		
44	Spring/Summer	4	4	Furniture	Bush rat	Native	Native rodent	4		
45	Spring/Summer	4	4	Ground	Koala	Native	Koala	1		
46	Spring/Summer	4	4	Ground	Black rat	Introduced	Introduced rodent	1		
47	Spring/Summer	4	4	Ground	Bandicoot spp.	Native	Bandicoot	5		
48	Spring/Summer	4	4	Ground	Long-nosed bandicoot	Native	Bandicoot	13	3	
49	Spring/Summer	4	4	Ground	Swamp wallaby	Native	Macropod	16		
50	Spring/Summer	4	4	Ground	Red fox	Introduced	Feral predator	0	2	
51	Spring/Summer	4	4	Ground	Short-beaked echidna	Native	Echidna	1		
52	Spring/Summer	4	4	Ground	Lace monitor	Native	Lizard	23	1	
53	Spring/Summer	4	4	Ground	Wallaby spp.	Native	Macropod	13		
54	Spring/Summer	4	4	Ground	Cat	Introduced	Feral predator	2		

Order	Season	Site	Underpass	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM
55	Spring/Summer	4	4	Ground	Dog	Introduced	Feral predator	9		
56	Spring/Summer	4	4	Ground	Short-eared brushtail possum	Native	Possum	1		
57	Spring/Summer	4	4	Ground	Eastern water dragon	Native	Lizard	1		
58	Spring/Summer	4	4	Ground	Brush-tail possum spp.	Native	Possum	21		
59	Spring/Summer	5	5/6	North	Dog	Introduced	Feral predator	1		
60	Spring/Summer	5	5/6	North	Bandicoot spp.	Native	Bandicoot	1		
61	Spring/Summer	5	5/6	North	Rattus spp.	NA	Rodent	1		
62	Spring/Summer	5	5/6	North	Water rat	Native	Native rodent	1	2	
63	Spring/Summer	5	5/6	North	Black rat	Introduced	Introduced rodent	0	7	
64	Spring/Summer	5	5/6	North	Antechinus spp.	Native	Antechinus	1		
65	Spring/Summer	5	5/6	South	Dog	Introduced	Feral predator	0	1	
66	Spring/Summer	5	5/6	South	Water rat	Native	Native rodent	1		
67	Spring/Summer	6	5/6	Furniture	Rattus spp.	NA	Rodent	48	2	
68	Spring/Summer	6	5/6	Furniture	Antechinus spp.	Native	Antechinus	4		
69	Spring/Summer	6	5/6	Ground	Cat	Introduced	Feral predator	6	1	
70	Spring/Summer	6	5/6	Ground	Wonga pigeon		Bird	0	1	
71	Spring/Summer	6	5/6	Ground	Long-nosed bandicoot	Native	Bandicoot	12	1	
72	Spring/Summer	6	5/6	Ground	Red fox	Introduced	Feral predator	5	1	
73	Spring/Summer	6	5/6	Ground	Lace monitor	Native	Lizard	18	1	
74	Spring/Summer	6	5/6	Ground	Dog	Introduced	Feral predator	10	1	
75	Spring/Summer	6	5/6	Ground	Swamp wallaby	Native	Macropod	12	1	
76	Spring/Summer	6	5/6	Ground	Wallaby spp.	Native	Macropod	1		
77	Spring/Summer	6	5/6	Ground	Chicken	Introduced	Bird	2	3	
78	Spring/Summer	6	5/6	Ground	Bandicoot spp.	Native	Bandicoot	1		
79	Spring/Summer	6	5/6	Ground	Black rat	Introduced	Introduced rodent	1		
80	Spring/Summer	6	5/6	Ground	Eastern water dragon	Native	Lizard	1		
81	Spring/Summer	7	7	Furniture	Bush rat	Native	Native rodent	4		
82	Spring/Summer	7	7	Furniture	Short-eared brushtail possum	Native	Possum	56		
83	Spring/Summer	7	7	Furniture	Rattus spp.	Introduced	Rodent	51	6	
84	Spring/Summer	7	7	Furniture	Black rat	Introduced	Introduced rodent	4	4	
85	Spring/Summer	7	7	Furniture	Lace monitor	Native	Lizard	7	1	



Order	Season	Site	Underpass	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM
86	Spring/Summer	7	7	Furniture	Rattus spp.	NA	Rodent	3	2	
87	Spring/Summer	7	7	Furniture	Lizard spp.	NA	Lizard	2		
88	Spring/Summer	7	7	Ground	Swamp wallaby	Native	Macropod	2		
89	Spring/Summer	7	7	Ground	Long-nosed bandicoot	Native	Bandicoot	4	2	
90	Spring/Summer	7	7	Ground	Dog	Introduced	Feral predator	1		
91	Spring/Summer	7	7	Ground	Black rat	Introduced	Introduced rodent	8	1	
92	Spring/Summer	7	7	Ground	Red fox	Introduced	Feral predator	3		
93	Spring/Summer	7	7	Ground	Rattus spp.	NA	Rodent	5		
94	Spring/Summer	7	7	Ground	Short-beaked echidna	Native	Echidna	0	1	
95	Spring/Summer	7	7	Ground	Wallaby spp.	Native	Macropod	5		
96	Spring/Summer	7	7	Ground	Lace monitor	Native	Lizard	2		
97	Spring/Summer	7	7	Ground	Bandicoot spp.	Native	Bandicoot	4		
98	Spring/Summer	8	8	Furniture	Short-eared brushtail possum	Native	Possum	4		
99	Spring/Summer	8	8	Furniture	Lizard spp.	Native	Lizard	7		
100	Spring/Summer	8	8	Furniture	Antechinus spp.	Native	Antechinus	2		
101	Spring/Summer	8	8	Furniture	Brush-tail possum spp.	Native	Possum	6	2	
102	Spring/Summer	8	8	Furniture	Black rat	Introduced	Introduced rodent	2		
103	Spring/Summer	8	8	Furniture	Rattus spp.	NA	Rodent	5		
104	Spring/Summer	8	8	Furniture	Bush rat	Native	Native rodent	0	1	
105	Spring/Summer	8	8	Ground	Wallaby spp.	Native	Macropod	20		
106	Spring/Summer	8	8	Ground	Long-nosed bandicoot	Native	Bandicoot	1		
107	Spring/Summer	8	8	Ground	Red fox	Introduced	Feral predator	9		
108	Spring/Summer	8	8	Ground	Swamp wallaby	Native	Macropod	14		
109	Spring/Summer	8	8	Ground	Brush-tail possum spp.	Native	Possum	1		
110	Spring/Summer	8	8	Ground	Bandicoot spp.	Native	Bandicoot	9		
111	Spring/Summer	8	8	Ground	Dog	Introduced	Feral predator	5		
112	Spring/Summer	8	8	Ground	Lace monitor	Native	Lizard	7		
113	Spring/Summer	8	8	Ground	Short-eared brushtail possum	Native	Possum	2		
114	Spring/Summer	8	8	Ground	Rattus spp.	NA	Rodent	1		
115	Spring/Summer	9	9/10	Furniture	Bush rat	Native	Native rodent	0	1	
116	Spring/Summer	9	9/10	Furniture	Lizard spp.	NA	Lizard	37		

Order	Season	Site	Underpass	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM
117	Spring/Summer	9	9/10	Furniture	Black rat	Introduced	Introduced rodent	3		
118	Spring/Summer	9	9/10	Furniture	Rattus spp.	NA	Rodent	40	3	
119	Spring/Summer	9	9/10	Furniture	Antechinus spp.	Native	Antechinus	1		
120	Spring/Summer	9	9/10	Ground	Northern-brown bandicoot	Native	Bandicoot	0		
121	Spring/Summer	9	9/10	Ground	Brush-tail possum spp.	Native	Possum	1		
122	Spring/Summer	9	9/10	Ground	Red fox	Introduced	Feral predator	1		
123	Spring/Summer	9	9/10	Ground	Lizard spp.	NA	Lizard	1		
124	Spring/Summer	9	9/10	Ground	Long-nosed bandicoot	Native	Bandicoot	1		
125	Spring/Summer	9	9/10	Ground	Black rat	Introduced	Introduced rodent	2		
126	Spring/Summer	9	9/10	Ground	Dog	Introduced	Feral predator	1		
127	Spring/Summer	10	9/10	Furniture	Brush-tail possum spp.	Native	Possum	5	1	
128	Spring/Summer	10	9/10	Furniture	Lizard spp.	NA	Lizard	7		
129	Spring/Summer	10	9/10	Furniture	Short-eared brushtail possum	Native	Possum	3	1	
130	Spring/Summer	10	9/10	Furniture	Rattus spp.	NA	Rodent	3	1	
131	Spring/Summer	10	9/10	Ground	Red fox	Introduced	Feral predator	8		
132	Spring/Summer	10	9/10	Ground	Bandicoot spp.	Native	Bandicoot	10	2	
133	Spring/Summer	10	9/10	Ground	Swamp wallaby	Native	Macropod	0	1	
134	Spring/Summer	10	9/10	Ground	Dog	Introduced	Feral predator	18		
135	Spring/Summer	10	9/10	Ground	Long-nosed bandicoot	Native	Bandicoot	8		
136	Spring/Summer	10	9/10	Ground	Wallaby spp.	Native	Macropod	7		
137	Spring/Summer	10	9/10	Ground	Lace monitor	Native	Lizard	4		
138	Spring/Summer	10	9/10	Ground	Red-necked wallaby	Native	Macropod	1	1	
139	Spring/Summer	10	9/10	Ground	Black rat	Introduced	Introduced rodent	2		
140	Spring/Summer	10	9/10	Ground	Rattus spp.	NA	Rodent	1		
141	Spring/Summer	11	11/12	Furniture	Rattus spp.	NA	Rodent	92	2	
142	Spring/Summer	11	11/12	Furniture	Bush rat	Native	Native rodent	13	2	
143	Spring/Summer	11	11/12	Furniture	Short-eared brushtail possum	Native	Possum	44		
144	Spring/Summer	11	11/12	Furniture	Brush-tail possum spp.	Native	Possum	7		

Order	Season	Site	Underpass	Cam Location	Common name	Class	Specific taxa	Complete	Incomplete	NDM
145	Spring/Summer	11	11/12	Furniture	Black rat	Introduced	Introduced rodent	2		
146	Spring/Summer	11	11/12	Furniture	Lizard spp.	NA	Lizard	0	1	
147	Spring/Summer	11	11/12	Ground	Wonga pigeon		Bird	1		
148	Spring/Summer	11	11/12	Ground	Bandicoot spp.	Native	Bandicoot	17		
149	Spring/Summer	11	11/12	Ground	Red fox	Introduced	Feral predator	10		
150	Spring/Summer	11	11/12	Ground	Dog	Introduced	Feral predator	7		
151	Spring/Summer	11	11/12	Ground	Lace monitor	Native	Lizard	2		
152	Spring/Summer	11	11/12	Ground	Wallaby spp.	Native	Macropod	1		
153	Spring/Summer	11	11/12	Ground	Lizard spp.	NA	Lizard	1		
154	Spring/Summer	12	11/12	Furniture	Short-eared brushtail possum	Native	Possum	8		
155	Spring/Summer	12	11/12	Ground	Red fox	Introduced	Feral predator	26		
156	Spring/Summer	12	11/12	Ground	Northern-brown bandicoot	Native	Bandicoot	7		
157	Spring/Summer	12	11/12	Ground	Long-nosed bandicoot	Native	Bandicoot	4		
158	Spring/Summer	12	11/12	Ground	Dog	Introduced	Feral predator	6		
159	Spring/Summer	12	11/12	Ground	Lace monitor	Native	Lizard	3		
160	Spring/Summer	12	11/12	Ground	Black rat	Introduced	Introduced rodent	1	1	
161	Spring/Summer	12	11/12	Ground	Red-necked wallaby	Native	Macropod	1		
162	Spring/Summer	12	11/12	Ground	Wonga pigeon		Bird	0	6	
163	Spring/Summer	12	11/12	Ground	Bandicoot spp.	Native	Bandicoot	7		
164	Spring/Summer	12	11/12	Ground	Cat	Introduced	Feral predator	1		
165	Spring/Summer	12	11/12	Ground	Blue tongue lizard	Native	Lizard	1		
166	Spring/Summer	12	11/12	Ground	Short-eared brushtail possum	Native	Lizard	1		
167	Spring/Summer	12	11/12	Ground	Swamp wallaby	Native	Macropod	4	1	

**Table B2:** Sand pad data recorded over 8 nights in spring/summer (ss) during year five of operational phase monitoring WC2NH, 2022/2023. <sup>1</sup>= Introduced, + = probable records.

Species/group	1	2	3	4	5/6	7	8	9/10	11/12
Short-beaked echidna				*					
<i>Antechinus</i> spp.	*	*			*		*	*	*
<i>Peramelidae</i> spp. (bandicoot)	*		*	*	*	*	*	*	
<i>Trichosurus</i> spp.			*					*	
Red-necked wallaby									
Swamp wallaby									
Wallaby spp.	*	*		*		*			
House mouse									
Water rat									
Rodent spp.		*		*	*	*	*	*	*
Dog									
Red fox <sup>1</sup>	*				*				
Cat <sup>1</sup>			*						
Lace monitor		*		*	*	*	*	*	*
Water dragon			*						
Skink								*	*
Small lizard	*				*				*
Small reptile									*
Medium lizard								*	*
Medium reptile					*				
Medium frog spp.									
Bird spp.									
Total no. Species/groups	5	4	4	5	7	4	4	7	7

**Table B3:** Scat and track data recorded during camera monitoring in spring/summer during year five operational phase monitoring WC2NH, 2022/2023. BtP = brush-tailed possum

Site	Check no.	Date	Scats	Tracks	Comments
1	1	14/10/22	Small reptile	BtP, fox, Wallaby	
	2	25/11/22	NR	Wallaby, rodent	

Site	Check no.	Date	Scats	Tracks	Comments
2	1	14/10/22	Antechinus on rail	Wallaby sp., rodent spp	
	2	25/11/22	Antechinus on rail	Bandicoot, fox, wallaby rodent	
3	1	14/10/22	Cat	Cat, eastern water dragon	
	2	25/11/22	Swallow	Nil	
4	1	14/10/22	NR	Btp, rodent, bandicoot	
	2	25/11/22	NR	Lace monitor, rodent wallaby	
5	1	14/10/22	Bandicoot	Dog	
	2	25/11/22	Rodent spp.	Nil	
6	1	14/10/22	BTP sp.	Fox, bandicoot rodent, antechinus	
	2	25/11/22	NR	Lace monitor, short-beaked echidna	
7	1	14/10/22	Rodent	Swamp wallaby, rodent spp., bandicoot spp.	
	2	25/11/22	NR	Bandicoot, rodent, lace monitor, wallaby	
8	1	14/10/22	SeBtp on rail	Rodent spp., swamp wallaby, lace monitor, bandicoot	
	2	25/11/22	NR	Swamp wallaby, rodent, bandicoot, lace monitor	
9e	1	14/10/22	Bandicoot, small lizard on rail	Bandicoot, fox, short beaked echidna, antechinus	
	2	25/11/22	Small reptile	Bandicoot, rodent, antechinus,	
10w	1	14/10/22	NR	Bandicoot, rodent, fox	
	2	25/11/22	NR	Rodent, fox, bandicoot, small lizard	
11e	1	14/10/22	Antechinus	Fox, bandicoot, rodent	
	2	25/11/22	NR	Fox, bandicoot, rodent, medium lizard	
12w	1	14/10/22	NR	Echidna, fox, bandicoot, rodent	
	2	25/11/22	NR	Bandicoot and rodent	

**Table B4:** Tile inspection data recorded in spring/summer during year five operational phase monitoring WC2NH, 2022/2023.

Site	No. Tiles	Check no.	Date	Fauna present	Comments
<b>2</b>	1	1	31/01/23	Nil	1 tile destroyed
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>3</b>	1	1	31/01/23	Nil	1 tile destroyed/missing
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>4</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>5N</b>	1	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>5S</b>	1	1		No check	Missing
		2		No check	
		3		No check	
		4		No check	
		5		No check	
		6		No check	
		7		No check	

Site	No. Tiles	Check no.	Date	Fauna present	Comments
		8		No check	
<b>6</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>7</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>8</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>9 East</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>10 West</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	

Site	No. Tiles	Check no.	Date	Fauna present	Comments
<b>11 East</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	nil	
<b>12 West</b>	2	1	31/01/23	Nil	
		2	01/02/23	Nil	
		3	02/02/23	Nil	
		4	03/02/23	Nil	
		5	04/02/23	Nil	
		6	05/02/23	Nil	
		7	06/02/23	Nil	
		8	07/02/23	Nil	



**Table B5:** Daytime searches of adjacent habitat data during year five WC2NH monitoring, 2023. Msb = moves small branches, Mlb = moves large branches and RL = rustles leaves.

Location	Side	Obs. No.	Date	Observers	Start	Finish	Species	Wind	Cloud	Rain	Air Temp	Humidity	Comment
11&12	E	1	1/02/2023	AE&EL	1:15	1:30	3 lampropholis delicata wallaby scat bandicoot digs	Nil	Nil	Nil	28	73	Nil
	W	1	1/02/2023	AE & EL	1:30	1:45	2 lampropholis delicata	Nil	Nil	Nil	28	73	Nil
	E	2	3/02/2023	LA/FM	9:05	9:20	L. Delicata	Nil	Nil	Nil	25.2	81	Nil
	W	2	3/02/2023	LA/FM	9:21	9:34	Lampropholis >20	Nil	Nil	Nil	25.2	81	Nil
9&10	E	1	1/02/2023	AE & EL	2:15	2:30	5 lampropholis delicata wallaby scat	Nil	Nil	Nil	28	73	Nil
	W	1	1/02/2023	AE & EL	2:30	2:45	3 lampropholis delicata	Nil	Nil	Nil	28	73	Nil
	E	2	3/02/2023	LA/FM	10:05	10:20	Antechinus spp	Nil	Nil	Nil	25.2	81	antechinus running along log
	W	2	3/02/2023	LA/FM	10:23	10:35	Lace monitor, lampropholis x 6, wallaby spp.	Nil	Nil	Nil	25.2	81	Nil
8	E	1	1/02/2023	AE & EL	11:15	11:30	wallaby scat bandicoot dig 4 lampropholis spp.	Nil	Nil	Nil	28	73	Nil
	W	1	1/02/2023	AE & EL	11:35	11:50	7 lampropholis spp	Nil	Nil	Nil	28	73	Nil
	E	2	3/02/2023	LA/FM	10:54	11:08	Nil	Nil	Nil	Nil	25.2	81	Nil
	W	2	3/02/2023	LA/FM	11:12	11:28	Lace monitor	Nil	Nil	Nil	25.2	81	Nil
7	E	1	1/02/2023	LA	10:33	11:03	Bandicoot digs, wallaby tracks, rodent scat	Nil	Nil	Nil	25.4	73	Nil
	W	1	1/02/2023	LA	11:05	11:35	Wallaby scat	Nil	Nil	Nil	25.4	73	Nil
	E	2	3/02/2023	AE & EL	11:15	11:30	amphibian scat 6 x lampropholis spp.	Nil	Nil	Nil	26	77	Nil
	W	2	3/02/2023	AE & EL	12:03	12:13	5 x lampropholis spp.	Nil	Nil	Nil	26	77	Nil
5&6	E	1	1/02/2023	AE/LA/EL	12:23	12:33	Lace monitor, swamp wallaby	Nil	Nil	Nil	28	73	Nil
	W	1	1/02/2023	AE/LA/EL	10:40	10:55	Nil	Nil	Nil	Nil	28	73	Nil
	E	2	3/02/2023	AE & EL	10:57	11:12	dog scatt wallaby scatt lampropholis spp.	Nil	Nil	Nil	26	77	Nil
	W	2	3/02/2023	AE & EL	11:55	12:20	4 lampropholis delicata	Nil	Nil	Nil	26	77	Nil
4	E	1	1/02/2023	LA	12:23	12:53	Lampropholis delicata x 7	Nil	Nil	Nil	25.4	73	Nil
	W	1	1/02/2023	LA	8:16	8:31	Nil	Nil	Nil	Nil	25.4	73	Nil
	E	2	3/02/2023	LA/FM	8:34	8:49	Angle headed dragon, bandicoot diggings	Nil	Nil	Nil	25.2	81	Nil
	W	2	3/02/2023	LA/FM	13:01	13:16	Nil	Nil	Nil	Nil	25.2	81	Nil
3	E	1	1/02/2023	LA	13:19	13:49	Lampropholis delicata x3, calyptotis. Wallaby scat	Nil	Nil	Nil	25.4	73	Nil

Location	Side	Obs. No.	Date	Observers	Start	Finish	Species	Wind	Cloud	Rain	Air Temp	Humidity	Comment
	W	1	1/02/2023	LA	9:05	9:20	Bandicoot and wallaby tracks	Nil	Nil	Nil	25.4	73	Nil
	E	2	3/02/2023	AE & EL	9:45	10:00	amphibian scat 6 x lampropholis spp.	Nil	Nil	Nil	26	77	Nil
	W	2	3/02/2023	AE & EL	10:05	10:20	3 x lampropholis spp. wallaby track bandicoot dig	Nil	Nil	Nil	26	77	Nil
2	E	1	1/02/2023	LA	13:55	14:25	Lace monitor, snake spp, lampropholis spp. >10	Nil	Nil	Nil	25.4	73	Snake too quick, likely yellow-faced whipsnake
	W	1	1/02/2023	LA	14:31	15:01	Nil	Nil	Nil	25.4	73	Nil	
	E	2	3/02/2023	LA/FM	9:25	9:40	lampropholis delicata x2 wallaby scat bandicoot dig fox scat	Nil	Nil	Nil	26	77	Nil
	W	2	3/02/2023	LA/FM	12:15	12:30	10x lampropholis spp. wallaby scat	Nil	Nil	Nil	26	77	Nil
1	E	1	1/02/2023	AE & EL	12:30	12:45	Lace monitor eastern water dragon 4 lampropholis delicata	Nil	Nil	Nil	28	73	Nil
	E	1	1/02/2023	AE & EL	8:10	8:40	eastern water dragon 2 lampropholis delicata	Nil	Nil	Nil	28	0.6	Nil
	W	2	3/02/2023	AE	8:10	8:40	eastern water dragon 1 lampropholis delicata	Nil	Nil	Nil	26	73	Nil
	W	2	3/02/2023	EL	8:10	8:40	nil	Nil	Nil	Nil	26	77	Nil

**Table B6:** Nocturnal spotlight surveys of adjacent habitat during year five WC2NH monitoring, 2022/2023. GHFF = grey-headed flying fox, SuG = sugar glider, Lit. = Litoria, SEBtP = short-eared brushtail possum, FtG = feathertail glider sp., CBtP = common brushtail possum, BtPoss = Brushtail possum species, TF = Tawny Frogmouth, CRtP = common ringtail possum, Pseud. = Pseudophryne species, Lim = Limnodynastes species, Lit = Litoria species, A. brevis = Adelotus brevis, ONJ = Owlet-Nightjar. Msb = moves small branches, Mlb = moves large branches and RL = rustles leaves. Sm = saw movement, hc = heard call, se = saw eyeshine.

Location	Side	Obs. No.	Date	Observers	Start Time	Finish Time	Species	Wind	Rain	Visibility	Air Temp	RH (%)	Comment
11&12	E	1	31/01/23	FM & AE	20:08	20:23	sm 3x flying fox hc 1 flying fox hc Crinia signifera, tusked frog striped mash frog	ML	nil	mod	23	95	
	W	1	31/1/23	EL, LA	20:06	20:21	Feather tail glider (SM), red backed toadlet (HC)	Nil	Absent	Fair	22.9	93%	
	E	2	2/2/23	LA/FM	20:18	20:32	C. Nigrescens (SM), Adelotus brevis, ff spp. microbat spp.	MLB	Nil	Good	25.3	81	Nil
	W	2	2/02/23	AE & EL	20:11	20:26	fly fox		mb	good	26	79	
9&10	E	1	31/01/23	FM & AE	21:00	21:15	koala 496651 6609328 prob female healthy se, sug se, grey headed flying fox hc	nil	nil	poor	23	97	
	W	1	31/1/23	EL, LA	20:57	21:12	Red backed toadlet, Crinia.signifera, Lit. peronii, tusked frog (all HC)	Nil	Absent	Fair	22.9	93%	
	E	2	2/2/23	LA/FM	21:04	21:19	Bandy bandy (SM), koala (SE)	MLB	Nil	Good	25.3	81	same individual as previous night
	W	2	2/02/23	AE & EL	20:58	21:13	Flying fox hc FtG sm rattus spp. sm redback toadlet hc	mb	nil	good	26	79	
8	E	1	31/1/23	EL, LA	20:37	20:52	Striped marsh frog, ringtail possum, red backed toadlet	Nil	Absent	Fair	22.9	0.93	
	W	1	31/01/23	FM & AE	20:33	20:49	red backed toadlet microbats present	nil	nil	poor	23	9700%	

Location	Side	Obs. No.	Date	Observers	Start Time	Finish Time	Species	Wind	Rain	Visibility	Air Temp	RH (%)	Comment
	E	2	2/02/23	AE & EL	20:37	20:52	red back toadlet	mb	nil	good	26	79	
	W	2	2/2/23	LA/FM	20:35	20:55	ftg (SM), c signifera, sugar glider, P. Coriacea	MLB	Nil	Good	25.3	81	Nil
7	E	1	31/01/23	FM & AE	21:25	21:40	L. fallax red backed toadlet tusked frog	nil	nil	poor	23	97	
	W	1	31/1/23	EL, LA	21:25	21:40	Tusked frog, red backed toadlet	Nil	Absent	Fair	22.9	93%	
	E	2	2/02/23	AE & EL	21:15	21:30	tusked frog hc antechinus se	mb	nil	good	26	79	
	W	2	2/2/23	LA/FM	21:27	21:52	Nil	MLB	Nil	Good	25.3	81	Nil
	E	1	31/01/23	FM & AE	21:45	22:00	Lit. fallax, red backed toadlet tusked and bandicoot all hc	nil	nil	poor	23	97	
5&6	W	1	31/1/23	EL, LA	21:47	22:02	Sugar glider, tawny frogmouth, redback toadlet, Lit. fallax	Nil	Absent	Fair	22.9	93%	
	E	2	2/2/23	LA/FM	21:53	22:08	Lim peronii, lit fallax	MLB	Nil	Good	25.3	81	Nil
	W	2	2/02/23	AE & EL	21:46	22:01	stripped marsh frog, tusked frog, peronii, red backed toadlet and scaly foot	mb	nil	good	26	79	
	E	1	31/01/23	FM & AE	22:22	22:37	nil	nil	nil	poor	23	97	
4	W	1	31/1/23	EL, LA	22:37	22:57	Red backed toadlet	Nil	Absent	Fair	22.9	93%	
	E	2	2/02/23	AE & EL	22:45	23:00	bandicoot hc red back toadlet hc	mb	nil	good	26	79	
	W	2	2/02/23	LA/FM	22:44	23:00	P. coriacea	mb	nil	good	26	79	
	E	1					No search, last monitoring period house tenants on east side seemed concerned						Need to get contact number for the house
3 (E only)	E	2					No search, last monitoring period house tenants on east side seemed concerned						
	E	1	31/1/23	EL, LA	22:11	22:27	Nil	Nil	Absent	Fair	22.9	0.93	
2	W	1	31/01/23	FM & AE	22:47	22:52	common btp se red back toadlet hc	nil	nil	poor	23	9700%	
	E	2	2/02/23	AE & EL	22:15	22:30	small eyed snake	mb	nil	good	26	79	
	W	2	2/2/23	LA/FM	22:15	22:30	Nil	MLB	Nil	Good	25.3	81	Nil
	E	1	6/2/2023	LA/AE	20:04	20:16	Eastern water dragon, Black rat	Nil	Nil	Good	24.4	69	Combined with GBF surveys
1	W	1	6/2/2023	LA/AE	23:37	0:00	Short-eared brushtail possum, Litoria fallax (HC), Striped marsh frog (SI)	Nil	Nil	Good	24.4	6900%	Combined with GBF surveys
	E	2	7/2/23	LA/AE	20:04	20:16	Nil	Nil	Good	23.9	75	Combined with GBF surveys	
	W	2	7/2/23	LA/AE	22:54	22:10	Eastern water dragon, L. Gracilenta (SM)	Nil	Nil	Good	23.9	75	Combined with GBF surveys

**Table B7:** Fauna captured during adjacent habitat trapping surveys during year five operational monitoring WC2NH,2022/2023. Uk = unknown, F = female, M = male. Arb = arboreal, Pit = pitfall.

Site	E or W	Date	Trap type	Species	Sex	Weight (g)	Comments
1	E	1/02/2023	Gr	Brown Antechinus	F	19	
1	E	2/02/2023	Gr	Bush rat	F	Uk	

Site	E or W	Date	Trap type	Species	Sex	Weight (g)	Comments
1	E	2/02/2023	Gr	Brown Antechinus	F	Uk	
1	W	2/02/2023	-	Nil			Raided by brushtail possum
1	E	3/02/2023	-	Nil			
1	W	3/02/2023	Arb	Brown Antechinus	F	23	
2	E	31/01/2023	Gr	Bush rat	M	150	
2	E	31/01/2023	Gr	Brown Antechinus	F	32	
2	E	31/01/2023	Gr	Bush rat	M	135	
2	E	31/01/2023	Pit	Tusked frog			
2	W	31/01/2023	Gr	Black rat			Euthanized
2	W	31/01/2023	Gr	Black rat			Euthanized
2	E	1/02/2023	Gr	Bush rat	M	133	
2	W	1/02/2023	Gr	Bush rat	F	119	
2	E	2/02/2023	Gr	Bush rat	F	Uk	
2	E	2/02/2023	Pit	P. coriacea			
2	W	2/02/2023	Gr	Bush rat	M	Uk	
2	W	2/02/2023	Gr	Bush rat	F	Uk	
3	E	31/01/2023	Gr	Black rat			Euthanized
3	W	31/01/2023	-	Nil			
3	E	1/02/2023	Pit	P. coriacea			
3	W	1/02/2023	Pit	Lampro x2			
3	E	2/02/2023	Pit	Lampro delicata x5			
3	W	2/02/2023	Pit	Lampro delicata x2			
4	E	1/02/2023	Gr	Bush rat (w/ 3 young)	F	125	
4	E	1/02/2023	Gr	FF Melomys	M	72	
4	W	1/02/2023	Gr	FF Melomys	M	82	
4	W	1/02/2023	Arb	FF Melomys	F	66	
4	E	2/02/2023	Gr	Bush rat	M	Uk	
4	E	2/02/2023	Gr	Bush rat	F	Uk	
4	E	2/02/2023	Arb	FF Melomys	F	Uk	
4	W	2/02/2023	Gr	Black rat			Escaped

Site	E or W	Date	Trap type	Species	Sex	Weight (g)	Comments
4	E	3/02/2023	Gr	Black rat			Unsure of ID released
4	E	3/02/2023	Gr	Bush rat	M	Uk	
4	E	3/02/2023	Gr	Bush rat	F	Uk	
4	W	3/02/2023	Gr	Bush rat	M	Uk	
4	W	3/02/2023	Gr	FF Melomys Juvenile	Uk	Uk	
5/6	E	31/01/2023	Gr	Melomys	F	80	
5/6	E	31/01/2023	Gr	Melomys	M	90	
5/6	W	31/01/2023	Gr	Brown Antechinus	Uk	23	
5/6	W	31/01/2023	Gr	Bush rat	M	94	
5/6	W	31/01/2023	Gr	Brown Antechinus	F	28	
5/6	W	31/01/2023	Gr	Melomys	M	80	
5/6	W	31/01/2023	Pit	Antechinus, Striped marsh frog (deceased)			
5/6	E	1/02/2023	Gr	FF Melomys	F	68	
5/6	E	1/02/2023	Pit	P. coriacea			
5/6	W	1/02/2023	Gr	Brown Antechinus	F	32	
5/6	W	1/02/2023	Gr	Brown Antechinus	F	27	
5/6	W	1/02/2023	-	Black rat			Euthanized
5/6	E	2/02/2023	Pit	Lampropholis spp.			
5/6	E	2/02/2023	Gr	Brown Antechinus	F	Uk	
5/6	E	2/02/2023	Arb	Black rat			Euthanized
5/6	E	2/02/2023	Arb	Black rat			Euthanized
5/6	W	2/02/2023	Gr	Brown Antechinus	F	16	
7	E	31/01/2023	Arb	FF Melomys	F	72	
7	E	31/01/2023	Gr	FF Melomys	M	82	
7	E	31/01/2023	Pit	Red backed toadlet, F antechinus			
7	W	31/01/2023	Gr	Bush rat	F	135	
7	W	31/01/2023	Gr	Bush rat	M	175	
7	W	31/01/2023	Gr	Bush rat	M	165	
7	E	1/02/2023	Gr	FF Melomys	M	75	

Site	E or W	Date	Trap type	Species	Sex	Weight (g)	Comments
7	E	1/02/2023	Gr	FF Melomys	Uk	55	
7	W	1/02/2023	Gr	Bush rat	F	89	
7	W	1/02/2023	Gr	Bush rat	M	166	
7	E	2/02/2023	Gr	FF Melomys	-	-	Escaped
7	E	2/02/2023	Gr	Brown Antechinus	F	26	
7	E	2/02/2023	Gr	FF Melomys	F	67	
8	E	31/01/2023	Gr	Black rat			Euthanized
8	W	31/01/2023	Gr	Brown Antechinus	F	37	
8	W	31/01/2023	Gr	Bush rat	M	164	
8	W	31/01/2023	-	Black rat			Euthanized
8	W	31/01/2023	Pit	Brown Antechinus	M	-	Deceased
8	W	31/01/2023	Pit	Brown Antechinus	F	22	
8	W	31/01/2023	Pit	Brown Antechinus	M	16	
8	W	31/01/2023	Pit	FF Melomys	F	28	
8	E	1/02/2023	-	Nil			
8	W	1/02/2023	Gr	Brown Antechinus	M	21	
8	W	1/02/2023	Cage	Lace monitor			Released during day AdHab searches
8	E	2/02/2023	Gr	Bush rat	M	70	
8	E	2/02/2023	Gr	Bush rat	Uk	65	
8	W	2/02/2023	Pit	Lampro delicata x2, P. Coriacea x1			
8	W	2/02/2023	Gr	Bush rat	F	Uk	
9/10	E	31/01/2023	Pit	Antechinus	F	34	
9/10	E	31/01/2023	Gr	Melomys	F	89	
9/10	W	31/01/2023	Gr	Bush rat	M	130	
9/10	W	1/02/2023	Arb	Melomys	M	87	
9/10	W	1/02/2023	Cage	Bush rat	Uk	Uk	
9/10	W	1/02/2023	Pit	Red backed toadlet			
9/10	W	1/02/2023	Gr	Melomys	F	61	
9/10	E	2/02/2023	-	Nil			

Site	E or W	Date	Trap type	Species	Sex	Weight (g)	Comments
9/10	W	2/02/2023	Arb	Melomys	F	70	
9/10	W	2/02/2023	Pit	L. delicata			
11/12	E	31/01/2023	Gr	Bush rat	M	187	
11/12	E	31/01/2023	Pit	Antechinus	F	23	
11/12	E	31/01/2023	Gr	Bush rat	F	128	
11/12	E	1/02/2023	Gr	Bush rat	F	127	
11/12	E	1/02/2023	Gr	Bush rat	F	151	
11/12	E	1/02/2023	Gr	Black rat			Escaped
11/12	W	31/01/2023	Gr	Black rat			Euthanized
11/12	W	1/02/2023	Pit	Red backed toadlet			
11/12	E	2/02/2023	Gr	Bush rat	M	Uk	
11/12	E	2/02/2023	Gr	FF Melomys	F	Uk	
11/12	E	2/02/2023	Pit	Calyptotis ruficauda			

**Table B8:** Fauna recorded in hair funnel surveys during year five operational monitoring WC2NH, 2022/2023.

Site	Position	Date	Species	Species
1	East 1	2/06/2023	Trichosurus vulpecula	
1	East 2	2/06/2023	Trichosurus vulpecula	
1	West 1	2/06/2023	Rattus sp.	
1	West 2	2/06/2023	Rattus fuscipes	
2	East 1	2/06/2023	Rattus fuscipes	
2	East 2	2/06/2023	Isoodon macrourus	
2	West 1	2/03/2023	Rattus fuscipes	
2	West 2	2/03/2023	Rattus fuscipes	
3	East 1	2/03/2023	No hair	
3	East 2	2/03/2023	No hair	
3	West 1	2/03/2023	No hair	
3	West 2	2/03/2023	No hair	
4	East 1	2/06/2023	Rattus fuscipes	
4	East 2	2/06/2023	Trichosurus vulpecula	
4	West 1	2/06/2023	Trichosurus vulpecula	Isoodon macrourus
4	West 2	2/06/2023	Rattus fuscipes	Isoodon macrourus

<b>5/6</b>	East 1	2/03/2023	No hair	
<b>5/6</b>	East 2	2/03/2023	Melomys cervinipes	
<b>5/6</b>	West 1	2/03/2023	Trichosurus vulpecula	Antechinus stuartii
<b>5/6</b>	West 2	2/03/2023	Antechinus stuartii	
<b>7</b>	East 1	2/03/2023	Antechinus stuartii	
<b>7</b>	East 2	2/03/2023	Antechinus stuartii	
<b>7</b>	West 1	2/03/2023	Rattus fuscipes	
<b>7</b>	West 2	2/03/2023	Rattus fuscipes	
<b>8</b>	East 1	2/03/2023	Trichosurus vulpecula	Mus musculus
<b>8</b>	East 2	2/03/2023	Antechinus stuartii	Rattus rattus
<b>8</b>	West 1	2/03/2023	Antechinus stuartii	
<b>8</b>	West 2	2/03/2023	Trichosurus vulpecula	
<b>9/10</b>	East 1	2/03/2023	Trichosurus vulpecula	
<b>9/10</b>	East 2	2/03/2023	Rattus sp.	Trichosurus vulpecula
<b>9/10</b>	West 1	2/03/2023	Rattus fuscipes	
<b>9/10</b>	West 2	2/03/2023	Rattus fuscipes	
<b>11/12</b>	East 1	2/03/2023	Antechinus sp.	
<b>11/12</b>	East 2	2/03/2023	Rattus sp.	
<b>11/12</b>	West 1	2/03/2023	No hair	
<b>11/12</b>	West 2	2/03/2023	Antechinus sp.	



