Pacific Highway Upgrade – Sapphire to Woolgoolga

Operational Phase Fauna Monitoring Year 2- Grey's Dam Frog Pipes

Version 1 - Final Report

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Cover Photo: *Mixophyes iteratus* photographed moving west through the northern frog pipe at Grey's Dam

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1. Introduction

The upgrade of the Pacific Highway from Sapphire to Woolgoolga (S2W) involved construction of 25 km of dual carriageway from Campbell Close, Sapphire, to Arrawarra Beach Road, Arrawarra. The upgrade became operational in July 2014.

The Ministerial Conditions of Approval (MCoA) for the S2W upgrade included a requirement (MCoA 3.1) to prepare an Ecological Monitoring Program (EMP) to monitor the effectiveness of mitigation measures identified in MCoA 2.12(e). The EMP was developed and approved in 2009 and later amended to include data obtained during the construction phase. The final version (version 3) was completed in January 2014 (BEM 2014).

The updated EMP included an operational phase requirement to monitor dedicated frog pipes located at Grey's Dam for use by giant barred frogs (Mixophyes iteratus) as part of project-wide population monitoring of this species. The giant barred frog is currently listed as endangered by the NSW Threatened Species Conservation Act 1995 (TSC Act) and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Annual giant barred frog population monitoring is required between October and April for the first three years of operational phase (BEM 2014).

The following report presents results of year two operational phase monitoring conducted during 2015/2016. The results are discussed in relation to performance indicators detailed in the EMP (BEM 2014) and recommendations regarding future monitoring are provided.

1.1 Background

In January 2015, Roads and Maritime Services NSW (RMS) contracted Sandpiper Ecological Surveys (Sandpiper) to conduct year one operational phase monitoring of fauna mitigation measures and to assess their effectiveness. The contract was based on a monitoring proposal submitted by Sandpiper in early 2014 and subsequently accepted and approved by RMS (hereafter referred to as the Operational Monitoring Proposal (OMP) (Sandpiper 2014a). Sandpiper was subsequently contracted by RMS to conduct year two and three operational monitoring in October 2015.

Due to delays in awarding of initial contracts, commencement of year one population monitoring began in early 2015, more than three months into the Year 1 monitoring period and more than six months after the highway became operational. Such delays and the time required to source and supply equipment to monitor frog pipes at Grey's Dam, prevented inclusion of this component in year one monitoring. Year 2 frog pipe monitoring began in November 2015.

2. Study Area and Site Features

The dedicated frog pipes were located at chainage 24600, approximately 50m north of Grey's Road and 2km west of Woolgoolga (Figure 1). The two frog pipes were each 1050mm diameter reinforced concrete (RC) and extended under the highway for 55m (south pipe) and 56m (north pipe). Pipes were perpendicular to the highway and oriented in a south-west to north-east direction (Plates 1-4).

Pipe outlets were fronted by a short head-wall and up to 2m-wide wing-walls (Plate 3). Frog exclusion fence (1200mm high) extended up to 20m beyond wing-walls (Plate 5). The floor/invert of each pipe was covered by a layer of mulch 50-100mm thick designed to retain moisture and encourage frog movement (Plate 5). Western pipe outlets were positioned either side of, and approximately 10m from, a 4m-wide creek-line. The creek contained permanent water, which fed into a quad-cell RC pipe array. Both pipe outlets featured an open drain approximately 10m to the west which sloped down to the creek (Plate 1 & 2). On the eastern side, pipe outlets were 5-10m from Grey's Dam which featured deep, permanent water. The dedicated pipes were approximately 30m apart.

Adjoining habitat beyond the 20-40m-wide highway construction footprint was largely riparian and moist open forest. The construction footprint area featured natural regrowth and was planted out with a variety of native trees and shrubs, particularly mat rush (Lomandra longifolia), an important plant species associated with giant barred frog habitat (Lewis & Rohweder 2005) (Plates 1-4). Plantings extended up to the pipe outlets to encourage frog access. During November 2015, bush regenerators carried out weed control, additional plantings and spread 100mm-thick mulch around the outlet areas (Plates 1-4).

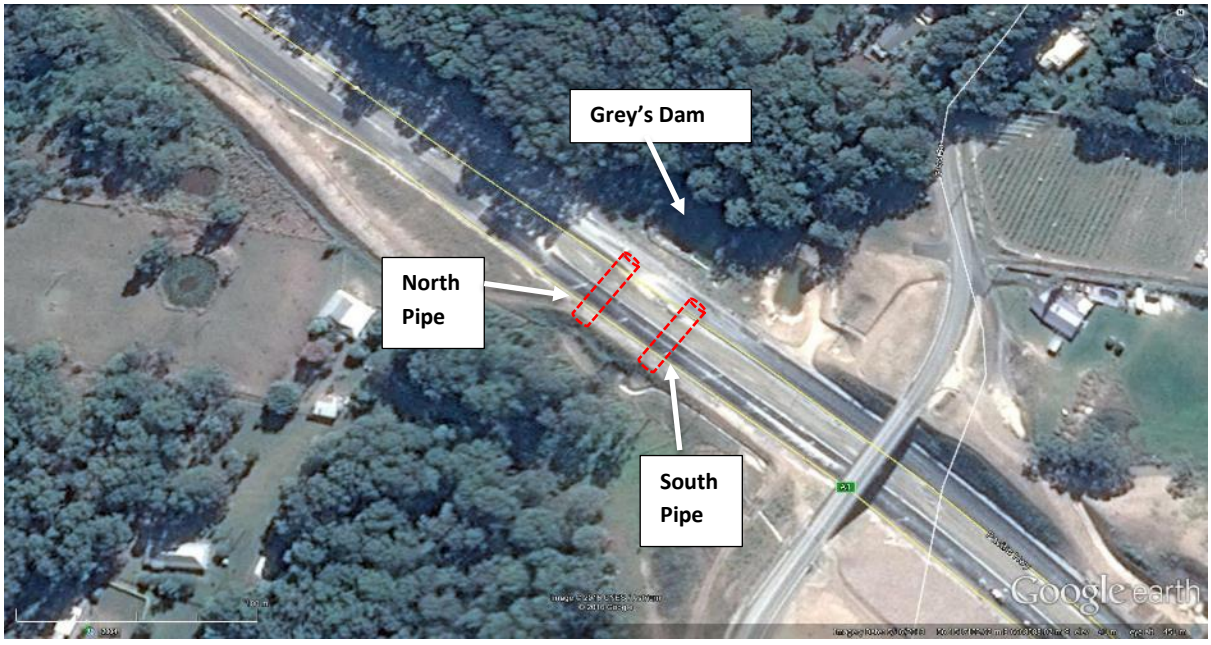

Figure 1: Location of frog pipes at Grey's Dam (chainage 24600).

Plate 1: Habitat surrounding south-west frog pipe. Note the recently spread, thick mulch covering outlet surrounds. (Picture taken 19 November 2015)

Plate 2: Habitat surrounding north-west frog pipe. (Picture taken 19 November 2015)

Plate 3: Habitat surrounding south-east frog pipe. (Picture taken 19 November 2015)

Plate 4: Habitat surrounding north-east frog pipe. (Picture taken 19 November 2015)

Plate 5: Pipe inverts/floors were covered in 50-100mm thick mulch (L). Frog exclusion fencing extended up to 20m beyond pipe wing-walls (R). (Picture taken 19 November 2015)

3. Methods

3.1 Monitoring pipe usage

The OMP initially proposed using a wireless Buckeye camera system to monitor the Grey's Dam frog pipes. Subsequent discussions between RMS and Sandpiper resolved to instead use infra-red (IR) trail cameras set to time-lapse. It was reasoned that time-lapse would be more effective than either a passive or active IR sensor system in detecting frog movements through pipes. To achieve this, four Reconyx SC950 IR cameras were installed on 19 November 2016 on the pipe obverts (crowns), each approximately 5m from and facing the outlet. Cameras were labelled according to pipe location (north or south) and outlet end (i.e. east or west).

Cameras were set on time-lapse mode and programmed to take a picture every one minute between 1800 and 0500 hours, the primary period of frog activity. Cameras were checked at 3 week intervals during which SD cards and lithium batteries were replaced. During week six of the monitoring period the NW camera was replaced with a Reconyx HC550 white flash camera to trial the efficacy of white-flash photography. White-flash cameras record colour photographs at night whereas IR-flash cameras record in black and white. It was reasoned that colour photographs would enable greater accuracy in fauna identification.

Cameras were operational for 22 weeks (153 days) and decommissioned on 20 April 2016. During this period, the four cameras recorded 381 501 photographs. Three cameras were active for >98.4% of the period and one camera (SW camera) was active for 79.1% of the monitoring period (Table 1). Battery fatigue was the primary cause of camera failure. Full details of monitoring effort are provided in Table A1, Appendix A.

Table 1: Grey's Dam frog pipes monitoring effort.

Camera Position	Pictures	Days Active	% Monitoring Period Active
NE	100 701	152.5	99.7
NW	100 058	150.5	98.4
SE	100 980	153	100
SW	79 762	121	79.1

3.2 Photo analysis

All photographs were uploaded to a computer and viewed using Windows Photo Viewer. Photographs were reviewed by an ecologist and identification was based on experience and reference to standard field guides (i.e. Tyler & Knight 2009; Swan et al. 2004; Barker et al. 1995; Van Dyck et al. 2013) and field guide Apps (i.e. Wilson & Swan 2012; Hoskin et al. 2015). Multiple ecology staff reviewed photographs featuring fauna that was difficult to identify until a consensus on identification was reached. A hierarchical approach was adopted to species identification that included: species, genus or group. Data recorded during analysis included: site, date, time, species, accuracy (definite (90%+ certainty), probable (75-90% certainty), possible (60-75% certainty)), movement direction (east or west), image numbers and crossing likelihood. Also recorded, where possible, were 'disturbance trails'. Disturbance trails were observable trails in consecutive time-lapse images created by animal movement through the mulch. For example, species such as echidnas showed clear, continuous trails, whereas macropods and bandicoots exhibited discontinuous/hopping trails. Disturbance trails were increasingly recognised after considerable photo analysis and were subsequently recorded during the latter half of the monitoring period. Recognition of disturbance trails assisted in determining both animal movement and direction.

Determining the likelihood of a completed crossing was assessed according to the following criteria:

- If an animal of the same species was photographed at both ends of a pipe moving in the same direction (mammals and reptiles within 30 minutes, frogs within 60 minutes), this was scored as a definite crossing.
- If an animal was photographed making directional movement at one end and a proportionally sized disturbance trail showing the same directional movement was detected at the other end within 30 minutes, this was scored as a definite crossing.
- If an animal was photographed showing strong directional movement into a pipe but not detected at the other end and not photographed exiting the same entry end, this was scored as a probable crossing.
- If a disturbance trail in one direction was detected at both ends within 30 minutes this was scored as a probable crossing by an un-identified animal.
- All detections of microbat species were scored as possible crossings due to the often unpredictable nature of movement.
- All animals photographed at the pipe entrances but not displaying any strong directional movement or that entered, turned around and exited the pipe were regarded as unlikely crossings and scored as Non-crossing movements (NCM).

Use of a 30-minute timeframe for determining crossings when a disturbance trail was detected reduced the likelihood of double-counting. Species such as snakes and frogs generally took 20-30 minutes to complete a crossing but these species rarely left detectable trails. Faster moving species such as bandicoots and echidnas generally crossed within 15-minutes and left clear disturbance trails.

4. Results

4.1 Pipe usage

Camera monitoring of the Grey's Dam frog pipes during the 2015/16 monitoring period revealed 91 definite crossings, 110 probable crossings and 151 possible crossings by fauna (Table 2; Plates 6-11). A further 374 detections were scored as non-crossing movements. More crossings were detected in the south pipe (229) compared to the north pipe (123). Thirty fauna species were identified and a further 16 genus/groups. Species diversity was greatest amongst mammals (14 spp.) followed by reptiles (9 spp.) and amphibians (7 spp.).

Table 2: Number of species and taxa group detections and crossing likelihoods.

Common Name	Species Name	North Pipe Detections		Crossing likelihood				South Pipe Detections		Crossing likelihood			
		E	W	Definite	Probable	Possible	NCM	E	W	Definite	Probable	Possible	NCM
Giant Barred Frog	*Mixophyes iteratus*	1			1								
Great Barred Frog	*Mixophyes fasciolatus*								1				1
Barred Frog	*Mixophyes* spp.	4	5		1		8	2	2	1			2
Striped Marsh Frog	*Limnodynastes peronii*		5		1		4	1	2				3
Green Tree Frog	*Litoria caerulea*		1				1						
Eastern Stony-creek Frog	*Litoria wilcoxii*		2				2	2	2				4
Red-backed Toadlet	*Pseudoprhyne coriacea*		6				6		2				2
Toadlet	*Uperoleia* spp.		14				14						
Small Frog		3	29		9		23	5	3		5		3
Medium Frog		12	24	1	8		26	10	33	2	7		32
Large Frog			5		1		4	3	8	4	1		4
Eastern Water Dragon	*Physignathus lesueureii*	2					2		5			1	4
Golden Crowned Snake	*Cacophis squamulosus*	3	7	3	1		3						
Brown Tree Snake	*Boiga irregularis*		1				1	3					3
Carpet Python	*Morelia spilota*	3	3	2			2	1	1				2
Rough-scale Snake	*Tropidechis carinatus*	1					1	1					1
Eastern Small-eyed Snake	*Rhinoplocephalus nigrescens*		1				1	3			3		
Southern Dwarf Crowned Snake	*Cacophis krefftii*		1				1						
Southern Leaf-tail Gecko	*Saltuarius swaini*								1				1
Skink	*Scincidae* spp.	2	4				6	5	1				6
Large Snake								2					2
Small snake			6		2		4	2					2
Snake		2	2	1			2	4	3	1	1		4
Long-nosed Bandicoot	*Parameles nasuta*	11	23	6	8		14	5	6	1	6		3
Northern Brown Bandicoot	*Isoodon macrourus*	2	5	1			5	2	4	3			3
Bandicoot	*Paramelidae* spp.	8	4	1	2		8	4	5	2	3		2

Common Name	Species Name	North Pipe Detections		Crossing likelihood				South Pipe Detections		Crossing likelihood			
		E	W	Definite	Probable	Possible	NCM	E	W	Definite	Probable	Possible	NCM
Short-beaked Echidna	*Tachyglossus aculeatus*	15	12	12	1		2	11	10	7	6		1
Common Brushtail Possum	*Trichosurus vulpecula*	1	1	1									
Common Ringtail Possum	*Pseudocheirus peregrinus*							3	2	1	3		
Black Rat	*Rattus rattus*	30	17	4	9		30	7	7		6		8
Bush Rat	*Rattus fuscipes*	2	1				3						
Swamp Rat	*Rattus lutreolus*	1					1	2	1	1	1		
Water Rat	*Hydromys chrysogaster*		1				1	5	7	3	5		1
Rodent	*Rodentia* spp.	8	7		5		10	2	2	1			3
House mouse	*Mus musculus*		3		2		1	2			1		1
Antechinus	*Antechinus* spp.	1	1				2						
Eastern Grey Kangaroo	*Macropus giganteus*	1	1				2						
Macropod	*Macropus* spp.	2					2	1	2	1			1
Eastern Horseshoe Bat	*Rhinolophus megaphyllus*		1			1		3				3	
Microbat	*Microchiropteran* spp.	9	9			18		46	39			85	
Small mammal		2	3		2		3	5	2		3		4
Medium mammal								2	3	1	2		1
Red Fox	*Vulpes vulpes*							2	2	2			
UnID animal		4			2		2	1					1
Trail of UnID animal		13	12	8		9		26	46	20	2	34	
Totals		143	217	40	55	28	269	173	202	51	55	123	105

4.2 Pipe use by giant barred frogs and other frog species

An individual giant barred frog was recorded making a probable east-west (upstream) crossing of the north pipe on 12 January 2016. The individual was first detected at 2259hrs by the northeast camera making directional westward movement (Plate 6). Unfortunately, the northwest camera was not operating at the time due to battery fatigue so a definite crossing could not be confirmed. However, the northeast camera did not detect the individual moving back so a probable crossing was presumed (Table 3).

A barred frog sp. was confirmed making a definite west to east crossing of the south pipe and a probable crossing of both pipes (1E->W and 2W->E) (Plate 7; Table 3). It is possible that some or all of these crossings were made by giant barred frog. All barred frog detections occurred between 26 December 2015 and 4 February 2016.

Most other identified frog species were hylid/tree frogs or small low-mobility frogs such as *Uperoleia spp*. and red-backed toadlets. These identified frogs did not make successful crossings but were recorded using the mulch in both pipes as refuge during the day. Identification of small frogs, particularly to species level, was difficult because of their size and grainy image resolution. Un-identifiable frogs were assigned to one of three size categories: small (<30mm), medium (30-70mm) and large (>70mm). Small-sized frogs completed nine probable crossings of the north pipe and five of the south pipe. Medium-sized frogs completed eight probable crossings of the north pipe and seven of the south pipe.

Plate 6: Giant barred frog moving west in the north pipe.

Plate 7: Barred frog sp. moves east during a confirmed crossing of the south pipe.

Table 3: Number and direction of movements and pipe crossing likelihood of frogs detected at Grey's Dam pipes.

Species	North Pipe			South Pipe			Crossing Likelihood
	Move E	Move W	Explore/ Turn-around	Move E	Move W	Explore/ Turn-around	
Giant barred frog	-	1	-	-	-	-	W->E (1Pr)
Great barred frog	-	-	-	-	-	1	-
Barred frog spp.	1	1	5	4	2	1	W->E (1Def, 2Pr); E->W (1Pr, 1Po)
Striped Marsh Frog	-	5	4	1	2	3	W->E (1Pr)
Green Tree Frog	-	1	1	-	-	-	-
Eastern Stony-creek Frog	-	2	2	2	2	4	-
Red-backed Toadlet	-	6	6	-	2	2	-
Uperoleia sp.	-	14	14	-	-	-	-
Small Frog	3	29	23	5	3	5	W<->E (14Pr)
Medium Frog	12	24	26	10	33	32	W<->E (3Def, 15Pr)
Large Frog	-	5	4	3	8	4	W<->E (4Def, 2Pr)

4.3 Pipe use by mammals and reptiles

Short-beaked echidna was the most common user amongst all taxa, recording 12 definite crossings in the north pipe and seven in the south pipe (Table 2; Plate 8). Other frequent users were long-nosed bandicoot (7 definite crossings; Plate 8), black rat (4 definite crossings) and northern brown

bandicoot (4 definite crossings). Golden crowned snake and carpet python both made definite crossings of the north pipe (three and two occasions, respectively; Plate 9).

Other species completing definite crossings included: water rat (three occasions in the south pipe), swamp rat (one occasion in south pipe), common brushtail possum (one occasion in the north pipe; Plate 10), common ringtail possum (one occasion in south pipe) and red fox (two occasions in the south pipe; Plate 10). Another species, eastern small-eyed snake, was recorded making Probable crossings on three occasions in the south pipe. Microbats were detected by cameras on 107 occasions, mostly in the southern pipe (n = 88). The only positive species identification was eastern horseshoe bat, detected on four occasions (Plate 11).

Plate 8: The Reconyx HC500 captures a short-beaked echidna moving east in the north pipe (L) and the Reconyx HC550 (white-flash camera) captures long-nosed bandicoot moving east in the north pipe (R).

Plate 9: A carpet python moving west in the north pipe (L) and a rough-scaled snake moving west in the south pipe (R).

Plate 10: Common brushtail possum moving west in the north pipe (L) and a red fox moving east in the south pipe (R).

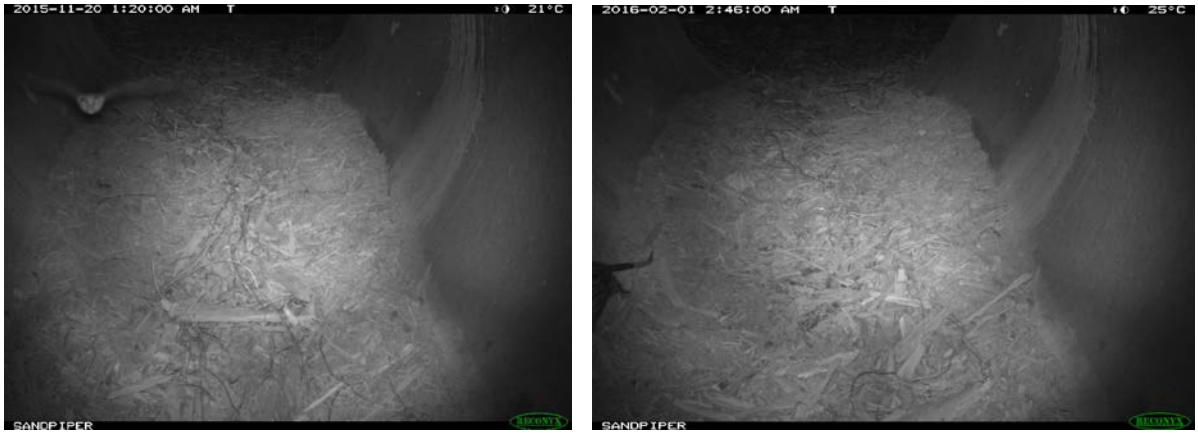

Plate 11: Eastern horseshoe bat flying into the south pipe (L) and a water rat moving east to west in the south pipe (R).

5. Discussion

5.1 Pipe use by giant barred frog and other frog species

Mitigating road barrier and fragmentation impacts on frogs has proven challenging, particularly as they are rarely reported using fauna box culverts (e.g. AMBS 2002; Taylor & Goldingay 2003). Most records of frogs using box culverts are associated with wet conditions. For example, growling grass frogs (*Litoria raniformis*, a hylid/tree frog) reportedly moved through submerged box culverts between wetlands along a Victorian highway (Gilmore & Koehler 2014). Other hylid frog species were observed in box culverts at Nambucca to Urunga Pacific Highway upgrade after heavy rainfall, though complete crossings could not be confirmed (Sandpiper 2015b).

Under-road RC pipes present another form of road crossing structure that has been rarely investigated. A small-scale mark-recapture study of 900mm RC pipes at the Coopernook to Heron Creek Pacific Highway upgrade detected no crossing by eastern sedge frogs (*Litoria fallax*) though this was attributed to below average rainfall, small pipe size and poor quality vegetation on the upstream side of the highway (Sandpiper 2014b). As such, the recorded crossing of the Grey's Dam

frog pipes by the nationally threatened giant barred frog and other records of crossings by *Mixophyes spp* (possibly giant barred frog) is highly significant and to our knowledge, the first record of underpass use by this species. Importantly, it suggests that the giant barred frog is not behaviourally averse to moving through a 55m-long, mulch-line pipe linking known habitat. Such information advances our understanding of engineering efforts to reconnect upstream and downstream populations severed by a major road. Records of other frog species (i.e. striped marsh frog and unidentified small, medium and large frog species.) completing crossings of both pipes (7 definite, 31 probable) further demonstrates the applicability of this form of mitigation for some species of ground-dwelling frog.

Despite these encouraging results, a number of factors are likely constraining the scale of giant barred frog use and access to the Grey's Dam frog pipes. Firstly, giant barred frogs are largely cover-dependent and prefer a closed sub-canopy with reasonably dense ground vegetation, notably mat rush (*Lomandra longifolia*) and dense leaf litter to move within (Lewis & Rohweder 2005). Revegetation of the construction footprint around the frog pipes has only occurred during the past two to three years and may take up to five years to establish and better facilitate giant barred frog movement.

Secondly, giant barred frog populations upstream and downstream of the site are small and variable (Sandpiper 2015a). Operational phase giant barred frog population monitoring is occurring at two sites, upstream and downstream of the highway (Sandpiper 2015a). The upstream monitoring site is approximately 20m from the western entrance to the pipes and has documented variable results. In the first two monitoring seasons (i.e. 2011/12 and 2012/13) up to five individuals were recorded, whilst no frogs were recorded in 2014/15. The monitoring site downstream of the highway is approximately 300m from the entrance of the pipes. This site was used as a release point for frogs displaced during construction. Annual surveys at the downstream site between 2011 and 2015 have recorded an average of 2-4 individuals/survey (BEM 2014). Conducting giant barred frog population surveys at Grey's Dam immediately to the east of the frog pipes would provide insight into the number of frogs present in the immediate area surrounding the pipes and help to explain the scale of pipe crossing movements.

Thirdly, rainfall is a known trigger of frog movement across road corridors (Goldingay & Taylor 2006; Taylor and Goldingay 2003). The period November 2015 to March 2016 featured below average rainfall and was less than that experienced during previous survey years. Only 408.6mm of rain fell during this period compared to 1253.2mm in 2014/15, 605.4mm in 2013/14, 1365.8mm in 2012/13, 1349.2mm in 2011/12 and 1001.8mm in 2010/11 (BOM 2016). The below average rainfall experienced during the 2015/16 season may have affected giant barred frog breeding success and movement.

5.2 Pipe use by other fauna

Most Pacific Highway fauna mitigation monitoring programs have targeted box culverts and largely ignored pipes. Nightly monitoring of Grey's Dam frog pipes over a 22-week period identified 30 species and 16 genera/taxa groups. These data suggest that mulched, 1050mm concrete pipes adjacent drainage lines provide road crossing potential for a broad range of fauna albeit a specific size range of fauna. Pipes are likely most suitable for reptiles, amphibians, and small mammals,

although swamp wallaby tracks have been recorded in 1200mm concrete pipes (D. Rohweder. pers comm). Pipes are likely unsuitable for larger macropods such as eastern grey kangaroos, despite occasional records of western grey kangaroos (*Macropus fuliginosus*) using 900mm pipes (Chachelle *et al.* 2016).

The diversity of fauna records, including 14 species of mammal, nine reptile and seven amphibian species, warrants examination of the factors that influence use. A recent study into use of crossing structures by two species of amphibian in the United States suggested that patterns of occurrence within a crossing hotspot may be linked to the physical attributes at the site (Patrick *et al.* 2010). The link between habitat type and quality surrounding underpasses and the type of fauna using them has been observed at other Pacific Highway upgrade sites (e.g. Sandpiper 2015a, 2015b, 2016). The Grey's Dam frog pipes are located on a drainage line adjacent moist open forest and the fauna detected in the frog pipes are typical of this habitat type. Frequent use by short-beaked echidna suggests that individuals are using the pipes as thoroughfare to gain access to resources on opposing sides of the highway (Sprent 2012).

Introduced predators are commonly encountered during underpass monitoring though their impact on use by native species remains equivocal (e.g. Fitzgerald 2005; Taylor & Goldingay 2014). Red fox was detected making two crossings at the south pipe. Such frequency is much lower compared to the nearby Moonee Beach underpass and other Pacific Highway upgrade underpass sites (e.g. Sandpiper 2015a, 2016). At this stage of the monitoring program, the low prevalence of fox at Grey's Dam frog pipes does not present a high predation risk although increased presence in future monitoring periods may warrant a management response.

5.3 Monitoring methodology

Other Pacific Highway upgrade fauna underpass monitoring programs have rarely detected frogs or small reptiles with passive IR cameras (e.g. Sandpiper 2015a, 2016). To counter this, the current monitoring project utilised a scheduled, time-lapse IR camera system. This method proved to be highly successful in detecting frogs and small reptiles as well as larger more mobile fauna typically detected using passive IR cameras. Due to the small size and low thermal signature of frogs, it is unlikely that passive IR cameras would have detected frog movement.

Another unexpected benefit of time-lapse was detection of disturbance trails, which assisted in confirming crossings of larger fauna. Because of the continuous nature of time lapse photography any prominent disturbance to the ground material (in this case, mulch) was largely detectable.

5.4 Project compliance

5.4.1 Monitoring requirements

The OMP (Sandpiper 2014) specified that frog pipe monitoring should occur for approximately 22 weeks between October and April. Cameras were installed 19 November 2015 and decommissioned 20 April 2016 - approximately 22 weeks. As stated in the Introduction, the later start date was due to delays in project approval and sourcing equipment. Once installed, cameras were active for 94.2% of the monitoring period and at least one camera within each pipe was operational during the entire

monitoring period. This high level of camera activity effectively minimised data loss and ensured that the period of monitoring and level of data capture complied with project requirements.

5.4.2 Monitoring aim and performance indicators

The broad aim of the EMP is "to allow the effectiveness of mitigation and offset measures to be assessed and allow for their modification if necessary" (BEM, 2014). The EMP further describes a range of performance indicators with which to assess the success of fauna mitigation measures. Section 3.3 (Giant Barred Frog Monitoring) describes four Potential Indicators of Success, three of which relate to population monitoring and one to frog pipe monitoring. This indicator reads:

- Recorded use of crossing structures by giant barred frogs

In addition to this and because frog pipes are a type of fauna underpass, indicators of success described for Fauna Underpasses (Section 3.4) are also worthy of consideration. Fauna underpass performance indicators include:

- Low rates of use of fauna underpasses and adjacent habitats by feral predators;
- High levels of fauna underpass use by a wide variety of native fauna species;
- Evidence of use by dispersing individuals and different age cohorts;
- Use by cover-dependent species and species with low mobility;
- Low incidence of fauna road strike mortality.

Each of the above six indicators are considered separately.

1. A probable crossing by giant barred frog and definite crossings by barred frog sp. (possible giant barred frog) suggests that the Grey's Dam frog pipes are facilitating movement by giant barred frog. Improvements in environmental conditions conducive to frog movement (i.e. rainfall and vegetation and leaf litter cover) may increase the frequency of crossings in subsequent monitoring although this is largely contingent on the trajectory of the local population.
2. Red fox was detected at the south pipe on four occasions and made two crossings. This level of presence is regarded as low and, at this stage of the monitoring program, is not a predation risk.
3. Over 30 species of fauna were detected using the Grey's Dam frog pipes. Such diversity is much higher than that recorded at four underpass sites along the S2W upgrade. This clearly shows that the Grey's Dam frog pipes are being utilized by a wide variety of fauna species.
4. Differences in age cohorts are difficult to establish but the range and frequency of species use suggests different age cohorts used the Grey's Dam pipes.
5. Confirmed use by giant barred frogs and other small, ground-dwelling frogs confirms use by cover-dependent species. Other cover dependent species using the pipes include bush rats, swamp rats and golden crowned snakes.
6. Fauna road mortality monitoring was not part of the project brief.

6. Recommendations

1. Include Grey's Dam immediately to the east of the frog pipes as a population monitoring site;
2. Consider purchase of another three Reconyx HC550 white-flash cameras (cost/unit ~$900 +GST) units for subsequent monitoring periods because they aid significantly in fauna identification, particularly for species of frogs.
3. Install a measuring device on the floor of the pipe to assist with species identification;
4. Continue ongoing weed suppression and supplementary plantings between frog pipes and drainage line/Grey's Dam to promote continuous giant barred frog habitat.

7. References

Australian Museum Business Services (2002). *Fauna underpass monitoring stage 2, episode 5: Bulahdelah to Coolongolook*. Report prepared for NSW Roads and Traffic Authority.

Barker, J., Grigg, G.C., and Tyler, M.J. (1995). *A Field Guide to Australian Frogs*. Surrey Beatty & Sons, Chipping Norton, NSW.

Benchmark Environmental Management (BEM) (2014). Sapphire to Woolgoolga Pacific Highway Upgrade, Ecological Monitoring Program. Prepared for Roads and Maritime Services, NSW.

Bureau of Meteorology (2016). *Monthly Rainfall*. Lower Bucca station. Station number 59006. http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_stn_num=059006

Chachelle, P.D., Chambers, B., Bencini, R., Maloney, S. (2016). Western grey kangaroo (Macropus fuliginosus) include fauna underpasses in their home range. *Wildlife Research* 43(1), 13-19.

Fitzgerald, M. (2005). *Final Report: results of sand trap monitoring in eight designated fauna crossings of the Yelgun to Chinderah Pacific Highway Upgrade, sample 3 Feb-Apr 2005*. Report prepared for Abigroup Road Maintenance.

Gilmore, D. and Koehler, S. (2014). Use of underpass culverts by the endangered growling grass frog *Litoria raniformis*. *Proceedings of the Australasian Network for Ecology & Transportation.* Coffs Harbour.

Goldingay, R.L. and Taylor, B.D. (2006). How many frogs are killed on a road in North-eastern New South Wales? In *Australian Zoologist, Volume 3 (3).* School of Environmental Science and Management, Southern Cross University, Lismore, NSW.

Hoskin, C., Grigg, G., Stewart, D., & McDonald, S. (2015). *Frogs of Australia* (1.0.2/4210) (Mobile application software). Retrieved from http://www.ugmedia.com.au

Lewis, B. D. and Rohweder, D.A. (2005). Distribution, habitat, and conservation status of the Giant Barred Frog *Mixophyes iteratus* in the Bungawalbin catchment, North-eastern New South Wales. In *Pacific Conservation Biology 2 (3*). Pp. 189-197.

Patrick, D.A., Schalk, C.M., Gibbs, J.P., and Woltz, H.W. (2010). Effective Culvert Placement and Design to facilitate passage of Amphibians across roads. *Journal of Herpetology*, Vol. 44, No. 4, pp. 618-626. New York.

Sandpiper Ecological (2014a). S2W Pacific Highway Upgrade: Operational Phase Monitoring Program - Year 1 Proposal (OMP). Proposal prepared by Sandpiper Ecological Surveys for Roads and Maritime Services NSW.

Sandpiper Ecological (2014b). Pacific Highway Upgrade: Coopernook to Herons Creek. Operational phase fauna crossing structure monitoring program. Report prepared for NSW Roads and Maritime Services.

Sandpiper Ecological (2015a). Pacific Highway Upgrade: Sapphire to Woolgoolga. Giant Barred Frog (*Mixophyes iteratus*) operational phase monitoring program. Report prepared for Roads and Maritime Services.

Sandpiper Ecological (2015b). Pacific Highway Upgrade: Nambucca Heads to Urunga. Construction phase fauna underpass monitoring program. Report prepared for NSW Roads and Maritime Services.

Sandpiper Ecological (2016). Pacific Highway Upgrade: Glenugie. Operational phase fauna crossing structure monitoring program. Report prepared for NSW Roads and Maritime Services.

Sprent, J.A. and Nicol, S.C. (2012). Influence of habitat on home-range size in short-beaked echidnas. *Australian Journal of Zoology* 60(10, 46-53.

Swan, G., Shea, G. and Sadlier, R. (2004). *A Field Guide to Reptiles of New South Wales*. Second Edition. Reed New Holland, Sydney.

Taylor, B. D. & Goldingay, R. L. (2003). Cutting the carnage: wildlife usage of road culverts in north-eastern New South Wales. *Wildlife Research*: **30,** 529-537.

Taylor, B. D. & Goldingay, R. L. (2014). Use of highway underpasses by bandicoots over a 7-year period that encompassed road widening. *Australian Mammalogy:* **36,** 178-83.

Tyler, M. J. and Knight, F. (2009). *Field Guide to the Frogs of Australia*. CSIRO publishing. Collingwood.

Van Dyck, S., Gynther, I., and Baker, A. (2013). *Field Companion to The Mammals of Australia*. New Holland Publishers, Sydney.

Wilson, S. and Swan, G. (2012). *Complete Guide to Reptiles of Australia (fourth edition)*. Mobile application software.

Appendix A – Camera Monitoring Effort

Table A1: Camera monitoring effort for 2015/16 Grey's Dam frog pipe monitoring.

Camera Position	Check Date	Battery %	Battery type	Pictures	Days Active	Time & date (EST)	Cam settings & changes
North east	19/11/15	99	Li	Na	Install		TL=1min; On=1800; Off=0500
	8/12/15	99	Left in	12540	19	Ok	No changes
	16/12/15	75	New Li	5280	8	Ok	No changes
	13/1/16	Flat	New Li	18201	27.5	Ok	No changes
	1/2/16	99	New Li	12540	19	Ok	No changes
	17/2/16	99	New Li	10560	16	Ok	No changes
	9/3/16	99	New Li	13860	21	Ok	No changes
	29/3/16	99	New Li	13200	20	Ok	No changes
	20/4/16	84	Nil	14520	22	Ok	Cam removed
North west	19/11/15	99	Li	Na	Install	EST	TL=1min; On=1800; Off=0500
	8/12/15	78	Left in	12850	19	Ok	No changes
	16/12/15	Flat	New Li	5028	7.5	Ok	No changes
	13/1/16	Flat	New Li	17500	26	Ok	No changes
	1/2/16	99	New Li	12540	19	Ok	Changed cam to HC600 - white flash
	17/2/16	99	New Li	10560	16	Ok	No changes
	9/3/16	0	New Li	13860	21	Ok	No changes
	29/3/16	99	New Li	13200	20	Ok	No changes
	20/4/16	99	Nil	14520	22	Ok	Cam removed
South east	19/11/15	99	Li	Na	Install	EST	TL=1min; On=1800; Off=0500
	8/12/15	99	Left in	12540	19	Ok	No changes
	16/12/15	1	New Li	5280	8	Ok	No changes
	13/1/16	Flat	New Li	18480	28	Ok	No changes
	1/2/16	99	New Li	12540	19	Ok	No changes
	17/2/16	66	New Li	10560	16	Ok	No changes
	9/3/16	89	New Li	13860	21	Ok	No changes
	29/3/16	6	New Li	13200	20	Ok	No changes
	20/4/16	99	Nil	14520	22	Ok	Cam removed
South west	19/11/15	99	Li	Na	Install	EST	TL=1min; On=1800; Off=0500
	8/12/15	Flat	New Li	2000	3	Ok	Settings ok; No changes
	16/12/15	99	Left in	5280	8	Ok	No changes
	13/1/16	Flat	New Li	7802	12	Ok	No changes
	1/2/16	99	New Li	12540	19	Ok	No changes
	17/2/16	99	New Li	10560	16	Ok	No changes
	9/3/16	93	New Li	13860	21	Ok	No changes
	29/3/16	84	New Li	13200	20	Ok	No changes
	20/4/16	52	Nil	14520	22	Ok	Cam removed

Appendix B – Grey's Dam Frog Pipes Fauna Detections

Table B1: Fauna detected during 2015/16 camera monitoring of Grey's Dam NORTH frog pipe.

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
19/11/15	1837	EW Dragon	Pr	EE	Un								
20/11/15	0405	Black Rat	Pr	EE	Un								
20/11/15	1807	Skink so	Pr	EE	Un								
						20/11/15	1830	Skink spp. X 2	D	EE	0691	Po	
20/11/15	2227	Black Rat	Pr	NDM	Po								
20/11/15	2228	Long nose Bandicoot	Pr	EE	In								
21/11/15	2032	Black Rat	Pr	NDM	Po								
						21/11/15	2138	Medium frog	D	ETE	1539-1551	Un	
						21/11/15	2247	Medium frog	Po	EE	1608-1616	Un	
22/11/15	0319	Black Rat	Pr	NDM	Po								
22/11/15	1942	Rodent sp		NDM	Po								
						22/11/15	2206	Med/Lg Frog	Pr	ETE	2227-2229	Un	
23/11/15	0319	Black Rat	Pr	EP	Po								
23/11/15	1916	Black Rat	PR	EP	Pr	23/11/15	1938	Black Rat	Pr	EE	2739-2749	Pr	
						23/11/15	1954	Medium Frog	Pr	ETE	2753-2763	Un	
23/11/15	2015	Black Rat	Pr	NDM	Po								
						23/11/15	2356	Medium frog	D	EE	2997-3004	Un	
24/11/15	0428	Black Rat	Pr	NDM	Po								
						24/11/15	2001	Black Rat	D	MW	3422-3426	Po	
						25/11/15	1850	Med skink	D	NDM	4011	Po	
						25/11/15	2017	Black Rat	Pr	EP	4098-115	Po	
						26/11/15	0342	Med frog	D	ME	4545-52	Po	
						26/11/15	0429	Med frog	D	MW	4590-612	Po	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						27/11/15	0306	Sm frog	D	EP	5167-209	Po	
27/11/15	2348	Medium Frog	D	EE	Po								
						28/11/15	0303	Sm frog	D	EP-dig	5824-56	Un	Burrowed under mulch
						28/11/15	1800	Sm frog	D	Emerge-MW	5941-72	Un	Emerge from mulch
28/11/15	1852	Medium Frog	D	EE	Un								
29/11/15	0347	Small Frog	D	MW	Po								
						29/11/15	1823	Sm frog	D	Emerge-MW	6623-25	Un	Emerge from mulch
29/11/15	1902	Black Rat	Pr	EE	Po								
29/11/15	2042	Black Rat	Pr	NDM	Po								
30/11/15	0353	Black Rat	Pr	NDM	Po								
						30/11/15	0415	Sm frog	D	ME	7216-22	Po	
						30/11/15	1808	Sm frog	D	MW	7269-310	Un	
1/12/15	0048	Medium Frog	Pr	EE	Un								
						1/12/15	0258	Sm frog	D	ME	7799-813	Po	
						1/12/15	0355	Sm frog	D	EP-dig	7856-80	Un	Burrowed under mulch
						1/12/15	0441	Sm frog	D	MW	7902-04	Po	
1/12/15	1910	Antechinus sp.	Pr	NDM	Po								
						1/12/15	1935	Med/Lg Frog	D	ETE	8011-17	Un	
						2/12/15	0251	Med Frog	D	ETE	8452-61	Un	
						3/12/15	0240	Med Frog	D	ME	9101-12	Po	
						3/12/15	0352	Med Frog	D	ETE	9173-78	Un	
						4/12/15	0407	Sm frog	D	EP-dig	9848-57	Un	Burrowed under mulch
4/12/15	2235	Black Rat	D	NDM	Po								
4/12/15	2241	L-n bandicoot	Pr	EE	Un								
5/12/15	2123	Bandicoot	Pr	EE	Un								

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
		sp											
						5/12/15	2125	Rodent sp	D	EE	7856-80	Un	
6/12/15	2217	Black Rat x 2	Pr	EE	Po								
8/12/15	1901	Rodent sp	Po	Blur	Po								
						9/12/15	0027	Med frog	D	EE	388-409	Un	
						9/12/15	0158	Rodent sp	D	EE	479	Un	
						9/12/15	0438	Skink spp	D	MW	639-645	Un	
						9/12/15	1815	Small frog	D	MW	676-687	Po	
						9/12/15	1856	Med frog	D	ME	717-721	Po	
						9/12/15	1956	Med frog	D	EE	777-781	In	
						9/12/15	2012	Small frog	D	ME	793-795	Po	
9/12/15	2127	Med frog	D	ME	Po								
9/12/15	2155	Med frog	D	ME	Po								
						10/12/15	1810	Blind Snake	Po	MW	1331-1344	Po	
10/12/15	1910	Rodent sp	Pr	MW	Pos								
						11/12/15	0227	NB Bandicoot	D	EE	1828-1830	Un	
						13/12/15	0159	Small frog	D	EE	3120-3124	In	
						13/12/15	0410	Uperolia sp	Po	ME	3251-3256	Po	
						13/12/15	2101	Rodent sp	D	MW	3482-3483	Po	
						14/12/15	0407	Small frog	D	ME	3908-3914	Po	
						14/12/15	1841	Small frog	D	MW	4002-4012	Po	
15/12/15	2047	UnID		EE	Un								
						16/12/15	1841	Small frog	D	EE	0042-0049	Un	CARD SWAP
						16/12/15	2112	Black Rat	Pr	MW	0193-0199	Po	
18/12/15	1249	Black Rat	Pr	ME	Po								
18/12/15	1822	Skink spp	D	Ndm	Un								
19/12/15	0338	Snake spp.	D	ME	D	19/12/15	0243	Snake spp	D	ME	1844-1845	D	
						19/12/15	2346	Small snake	D	EE	2327-2333	Un	
19/12/15	2352	Bandicoot spp	Pr	MW	D	19/12/15	2354	Bandicoot spp.n	Pr	MW	2335	D	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						20/12/15	0026	UnID mammal	Pr	ME	2367	Po	Send for ID
20/12/15	0113	Bandicoot spp	Po	EE	Un								
						20/12/15	0244	UnID mammal	Pr	EE	2505	Po	Send for ID
						20/12/15	2235	Horseshoe bat	Po	ME	2916	Po	
21/12/15	0128	Snake spp.	D	MW	Po	21/12/15	0206	Snake spp.	D	MW	3127-3128	D	Send for ID
21/12/15	2215	Carpet Python	D	ME	D	21/12/15	2133	Carpet Python	D	ME	3513-3515	D	
						22/12/15	1952	Lim. peronii x 3	Pr	EE	4073-4125	Un	
22/12/15	0139	Macropod spp	Pr	EE	Un								
						22/12/15	2127	Rattus spp.	Pr	EE	4163	Un	
						22/12/15	2139	Med frog	D	EE	4180-4204	Po	
						22/12/15	2004	Lit. caerulea	Pr	ETE	4205-4234	Un	
						24/12/15	0117	Small mammal	D	NDM	5058	Po	
						24/12/15	1930	Small snake	D	EE	5371-5490	Un	
						24/12/15	2319	Small frog	D	ETE	5600-5642	Po	
						25/12/15	0009	Black Rat	Pr	EE	5650	Un	
						25/12/15	0024	Small snake	D	EE	5665-5668	Un	
						25/12/15	0238	UnID small mammal	D	EE	5799	Un	
						25/12/15	0337	Small frog	D	ETE	5858-5904	Un	
						25/12/15	0434	Small snake	Pr	ETE	5915-5934	Un	
						26/12/15	0006	Small frog	D	ETE	6307-6312	Un	
						26/12/15	0024	Pseudophrine coreacea	Po	ETE	6325-6406	Po	Crawling motion
						26/12/15	2049	NB Bandicoot	Pr	EE	6770	Un	
26/12/15	2052	Macropod spp.	Pr	EE	Un								

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
27/12/15	1222	Black Rat	Pr	ETE	Un								
						28/12/15	0407	Pseud. Coreacea	Po	ME	7868-7870	Po	
						28/12/15	2238	Mixophyes spp.	Pr	ETE	8199-8249	Un	
						30/12/15	0022	Small snake	Pr	MW	8963-8981	Po	
						30/12/15	0040	Antechinus spp.	Po	EE	8981	Un	Looked to predate on worm
						30/12/15	0256	Pseuod. Coreacea	Pr	ETE	9117-9156	Un	
30/12/15	1944	Med frog	D	EE	Un								
						1/1/16	2121	NB Bandicoot	Pr	EE	0763-0764	Po	
2/1/16	0019	Mixophyes spp.	Pr	EE	Un								
						2/1/16	0202	LN Bandicoot	D	EE	1044-1045 second set	Un	
2/1/16	2146	Echidna	D	ME	Po								
3/1/16	0119	Echidna	D	ME	D	3/1/16	0112	Echidna	D	ME	1654	D	
						3/1/16	2036	Mixophyes spp.	Pr	EE	2038-2050	Un	
						4/1/16	0102	Lit. caerulea	Pr	ETE	2304-2313	Un	
						4/1/16	0415	Pseudo. Coreacea	Pr	EE	2497-2520	Un	
						5/1/16	2030	Large frog	Pr	ETE	3351-3359	Un	
						6/1/16	0010	LN Bandicoot	D	NDM	3572	Po	
						6/1/16	0108	Large frog	D	EE	3630-3647	Un	
6/1/16	0145	Echidna	D	MW	D	6/1/16	0205	Echidna	D	MW	3687	D	
						6/1/16	2155	Small snake	Pr	EE	4097-4100	Un	
6/1/16	2217	Black rat	Pr	ME	D	6/1/16	2214	Black Rat	Pr	ME	4116	D	
						6/1/16	2219	Bandicoot spp	Pr	ME	4121	Po	
6/1/16	2221	Bandicoot	Pr	EE	Po								

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
		spp											
6/1/16	2257	Black Rat	Pr	MW	Po								
7/1/16	2017	Snake	D	EE	Un								
7/1/16	2125	Bandicoot spp.	Pr	EE	Un								
						11/1/16	0035	LN Bandicoot	Pr	ME	6897	Po	
11/1/16	1929	Mixophyes spp.	Pr	ETE	Un								
11/1/16	2213	Black Rat	Pr	ME	Po								
						11/1/16	2237	Large snake	D	EE	7439	Un	
11/1/16	2326	Bandicoot	Pr	EE	Un								
12/1/16	2259	***M. iteratus***	D	MW	Po								
						13/1/16	2109	Small frog	D	ETE	190-206	Un	CARD SWAP
						14/1/16	0042	Microbat sp.	D	ME	403	Po	
						14/1/16	0228	LN Bandicoot	D	EE	509	Un	
						14/1/16	0410	Pseudo coriacea	Pr	ETE	611-629	Un	
15/1/16	0037	Black Rat	Pr	EE	Un								
						15/1/16	0352	Small frog	D	EE	1253	Un	
						15/1/16	2132	Blind Snake x3	Po	EE	1533-1607	Un	
						16/1/16	0047	Black Rat	D	EE	1728-1729	Po	
						16/1/16	0434	Pseudophyrne coriacea	Pr	EE	1955 - 1974	Un	
16/1/16	1937	Black Rat	Pr	EE	Un								
						16/1/16	2331	Pseudo coriacea	Pr	MW	2312-2317	Un	
18/1/16	2225	Bush Rat	Po	EE	Un								
						20/1/16	2101	Black Rat	Pr	MW	4802	Po	
22/1/16	0032	Carpet Python	D	MW	D	22/1/16	0104	Carpet Python	D	MW	5705-5717	D	
						22/1/16	1524	Pseudo coriacea	Pr	EE	5845-5895	Pr	
						23/1/16	0018	Large frog	D	ME	6319-6329	Po	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						23/1/16	0040	Lim. peroni	Pr	EE	6341-6367	Un	
23/1/16	1917	Black Rat	Pr	ME	Po								
						23/1/16	1928	Med frog	D	EE	6689-6857	Un	
						23/1/16	2234	Med frog	D	MW	6875-6900	Po	
						23/1/16	2356	Small frog	D	ME	6957-6974	Po	
						24/1/16	0016	Small frog x 3	D	EE	6977-7039	Un	
24/1/16	2217	Med frog	D	ME	Po	24/1/16	2119	Med frog	D	ME	7460-7465	Po	
25/1/16	0053	Mixophyes sp.	Po	MW	Po								
25/1/16	1848	Med frog	D	ME	Po								
						26/1/16	0152	Small frog	D	ETE	8393-8454	Un	
						26/1/16	0302	Small frog	D	MW	8463-8490	Po	
						26/1/16	1951	Mixophyes sp.	Pr	ETE	8692-8748	Un	
						27/1/16	2002	Brown Tree Snake	Pr	ETE	9359-9363	Un	
28/1/16	0207	Small frog	D	ETE	Un								
28/1/16	1851	Rough Scale Snake	Pr	ETE	Un								
						29/1/16	2155	Bandicoot spp.	D	EE	797 second set	Un	
						30/1/16	0005	Small frog	D	EE	927-961	Un	
30/1/16	0139	Black Rat	Pr	ME	Po								
30/1/16	0141	Med frog	Pr	EE	In								
						30/1/16	0144	Small frog	D	EE	1026-1036	Un	
						30/1/16	1916	Black Rat	Pr	EE	1298	Po	
						30/1/16	2204	Small snake	D	MW	1466	Po	
30/1/16	2235	Microbat spp.	Pr	?	Po								
						31/1/16	2311	Mixophyes sp.	Pr	EE	2223-2233	Un	
						2/2/16	0448	Mouse spp.	Pr	EE	648-650	Un (white flash)	CARD SWAP
						2/2/16	2046	Black Rat	D	ETE	827-842	Un	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						2/2/16	2255	Microbat spp.	D	NDM	956	Po	
3/2/16	0137	Med frog	D	EE	Un								
3/2/16	2156	Med frog	D	EE	Un								
3/2/16	2322	Microbat spp.	D	MW	Po								
						4/2/16	0338	Pseudo. coriacea	Pr	ETE	1899-1908	Un	
						4/2/16	1906	Uperolia sp.	D	ETE	2047-2071	Un	
						4/2/16	2227	Mixophyes sp.	Po	Ease	2248-2255	Un	
						5/2/16	2351	Litoria wilcoxii	Pr	EE	2992-3042	Un	
						6/2/16	0404	Water Rat	D	NDM	3245	Po	
						6/2/16	0459	Uperolia sp.	D	EE	3291-3300	Un	
						8/2/16	0108	LN Bandicoot	D	ETE	43884394	Un	
						9/2/16	0228	LN Bandicoot	D	EE	5129-5142	Un	
						9/2/116	2340	UnID small mammal	D	ME	5621	Po	
						10/2/16	0303	Black Rat	Pr	NDM	5824	Un	
11/2/16	0220	UnID small mammal	D	EE	Un								
						11/2/16	2233	Microbat spp	D	NDM	6874	Po	
						12/2/16	2200	Microbat spp.	D	MW	7501	Po	
						13/2/16	0105	Black Rat	Po	MW	7686	Po	
13/2/16	1820	Echidna	D	EE	Un								
13/2/16	2029	Microbat spp.	D	NDM	Un								
						14/2/16	0154	LN Bandicoot	Pr	EE	8395	Un	
14/2/16	0345	Microbat spp.	D	MW	Po								
						14/2/16	2135	Golden Crowned Snake	D	ME	8795-8803	Po	
						15/2/16	0248	Golden Crowned Snake (Slept under clump, emerged next	D	MW	9190-9126	Po	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
								night)					
						15/2/16	1907	Golden Crowned Snake	D	MW	9275-9369	Po	
						15/2/16	2332	Litoria wilcoxii	Pr	ETE	9568-9594	Po	
						17/2/16	0236	LN Bandicoot	Pr	EE	418-420 (second set)	Un	
17/2/16	2022	Black Rat	D	ME	Po	17/2/16	2022	Black Rat	D	ME	143	Po	CARD SWAP
18/2/16	0237	LN Bandicoot	D	ETE	Un	18/2/16	0237	LN Bandicoot	D	ETE	518-522	Un	
18/2/16	2020	Med frog	D	ETE	Un	18/2/16	2020	Med frog	D	ETE	801-823	Un	
18/2/16	0907	Small frog	D	ETE	Po								
19/2/16	1933	Echidna	D	ME	D	19/2/16	1918	Echidna	D	ME	1399-1340	D	
19/2/16	1924	UnID mammal?	Po	ME	Po								
20/2/16	1949	Bandicoot sp	D	EE	Un								
						20/2/16	2116	Striped Marsh Frog	D	ME	2177	Po	
						21/2/16	0058	Small frog	D	ETE	2399-2460	Un	
						21/2/16	2318	Microbat spp	D	ME	2959	Po	
						22/2/16	2118	Small rodent	D	EE	3499-3507	Un	
23/2/16	2010	Carpet Python	D	ETE	Un								
						24/2/16	0409	Uperolia sp	Pr	ME	4570-4597	Po	
25/2/16	2329	Golden Crowned Snake	Pr	ME	Pr	25/2/16	2240	Golden Crowned Snake	D	ME	5561-5563	Pr	
						26/2/16	2028	Large frog	D	ETE	6089-6176	Un	
						26/2/16	2311	LN Bandicoot	D	ME	6252-6256	Po	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						27/2/16	1843	Bush Rat	Po	ETE	6644-6647	Un	
						28/2/16	0358	Uperolia sp	Po	ME	7200-7210	Un	
						28/2/16	0451	EG Kangaroo	Pr	EE	7252	Un	
29/2/16	0053	Echidna (trail)	Pr	ME	Pr	29/2/16	0049	Echidna	D	ME	7670	Pr	
29/2/16	2010	Black Rat	Po	ME	Po								
						1/3/16	2256	Upe emerging	Pr	ME	8877-8883	Un	
						2/3/16	0017	LN Bandicoot	Pr	MW	8957-8960	Po	
2/3/16	0219	Small mammal	Pr	ME	Po								
6/3/16	0036	Microbat spp.	D	MW	Po								
6/3/16	0145	Bandicoot spp.	Pr	EE	Un								
						6/3/16	2326	Med frog	D	ETE	12207-12212	Un	
7/3/16	0458	Medium mammal	D	EE	Un								
8/3/16	1854	Med frog	D	ETE	Un								
8/3/16	2338	Bush Rat	Po	EE	Un								
9/3/16	2110	Trail - Bandicoot spp?	Po	ME?	Po								CARD SWAP
9/3/16	2306	LN Bandicoot	D	ME	Po	9/3/16	2306	LN Bandicoot	D	ME	0307	Po	
10/3/16	1809	EW Dragon	D	EE	Un								
						10/3/16	2022	Med frog	D	EE	803-809	Un	
						11/3/16	1850	Med frog	D	EE	1371-1375	Un	
11/3/16	2302	LN Bandicoot	Pr	ME	Pr	11/3/16	2301	LN Bandicoot	D	ME	1622	Pr	
12/3/16	2111	Black Rat	Pr	ETE	Un								
14/3/16	0320	LN	Pr	ME	Pr	14/3/16	0318	LN Bandicoot	D	MW	3199	Pr	

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
		Bandicoot											
14/3/16	2042	Trail		MW?	Po								
15/3/16	0111	Trail	D	MW	Pr	15/3/16	0108	Trail	D	MW?	3729	Pr	
						15/3/16	1900	Black Rat	Po	EE	4021	Po	
16/3/16	2309	LN Bandicoot	Pr	ME	Po								
						16/3/16	0042	LN Bandicoot	D	MW	4363-4364	Po	
						16/3/16	0145	Rodent spp.	Pr	EE	4426	Un	
						16/3/16	2218	LN Bandicoot	D	ME	4879-4925	Po	
16/3/16	2351	LN Bandicoot	Pr	MW	Pr								
						17/3/16	0125	Bandicoot spp.	D	MW	5066	Pr	
17/3/16	0121	Trail		MW	Po								
18/3/16	2035	Echidna	D	ME	D	18/3/16	2020	Echidna	D	ME	6081	D	
19/3/16	0028	Echidna	D	MW	D	19/3/16	0041	Echidna	D	MW	6342	D	
19/3/16	1856	Echidna	D	ME	D	22/3/16	2258	Echidna	D	ME	8879	Po	
19/3/16	2328	Black rat	Pr	EE	Un								
						20/3/16	0213	House mouse	Po	ME (trail)	7094	Po	
						20/3/16	0345	House mouse	Po	ME (trail)	7187	Po	
						20/3/16	2324	Uperolia sp.	Po	ETE	7585-7606	Un	
21/3/16	0158	Swamp Rat	Pr	ETE	Un								
						21/3/16	0452	Microbat spp.	D	ME	7913	Po	
22/3/16	2303	Echidna (trail)	Pr	ME (pr)	Pr	22/3/16	2258	Echidna	D	ME	8879	Po	
25/3/16	0137	NB Bandicoot	Pr	EE	Un								

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						25/3/16	0258	Southern Dwarf Crown Snake	D	ETE	440-485 (second set)	Po	
						25/3/16	0442	Rattus sp.	Pr	MW	544	Po	
25/3/16	1928	Trail (echidna)	Pr	MW	Pr	25/3/16	1936	Echidna	D	MW	658	Pr	
25/3/16	2133	Microbat spp.	D	MW	Po								
25/3/16	2350	Med frog	D	ETE	Un								
						26/3/16	0100	Uperolia spp.	D	ETE	982-1171	Un	
26/3/16	0104	Black Rat	Pr	EE	Un								
26/3/16	0107	Med frog	D	EE	Un								
						26/3/16	1831	Golden Crowned Snake	D	ETE	1253-1279	Un	
						26/3/16	2021	Trail?	D	MW?	1362-1363	Po	
						26/3/16	2138	Golden Crowned Snake	D	ETE	1440-1488	Po	
						27/3/16	0154	Microbat spp.	D	NDM	1696	Po	
						27/3/16	0146	Uperolia sp.	Pr	EE	1688-1756	Un	
						28/3/16	2208	Black Rat	Pr	ME	2790-2792	Po	CARD SWAP
29/3/16	2250	LN Bandicoot	Pr	ETE	Un								
30/3/16	1907	Trail	D	MW	Pr	30/3/16	1909	Trail	D	ME	730-731	Pr	
30/3/16	2037	Echidna	D	ETE	Un								
30/3/16	2236	Black Rat	Pr	ETE	Un								
31/3/16	1854	Echidna	D	MW	D	31/3/16	1901	Echidna	D	MW	1382	D	
1/4/16	1842	Rodent sp.	D	ME	Po								
2/4/16	0009	Rodent sp	D	ETE	Un								
						2/4/16	0019	Trail	D		2360-2362	Po	
2/4/16	0114	Trail	D		Po								
2/4/16	0155	Microbat spp.	D	ME	Po								

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
2/4/16	2243	EG Kangaroo	Pr	EE	Un								
						2/4/16	2300	NB Bandicoot	D	EE	2941-2949	Un	
3/4/16	0022	CBT Possum	D	MW	D	3/4/16	0025	CBT Possum	D	MW	3026	D	
3/4/16	0200	Trail	D	ME	D	3/4/16	0159	Trail	D	ME	3120-3121	D	
3/4/16	0205	Small rodent	Pr	EE	Un								
						3/4/16	2258	Carpet Python	D	ETE	3599-3604	Un	
4/4/16	0420	Small Rodent	D	EE	Un								
5/4/16	0139	Trail	D	WthenbackE	Pr	5/4/16	0143	LN Bandicoot	D	WthenbackE	4424	Pr	
						5/4/16	0229	Uperolia sp.	Pr	ETE	4470-4491	Un	
						5/4/16	2145	LN Bandicoot	D	ETE	4844-4866	Un	
6/4/16	0351	Rodent sp.	D	EE	Un								
						7/4/16	0350	LN Bandicoot	D	EE	5871-5872	Un	
						8/4/16	0128	E Small-eyed Snake	D	ETE	6388-6415	Un	
8/4/16	0443	Microbat sp.	D	MW	Po								
8/4/16	1959	Golden Crowned Snake	Pr	ME	D	8/4/16	1914	Golden Crowned Snake	Pr	ME	6675-6676	D	
9/4/16	0050	Mixophyes sp.	Pr	EE	Un								Huge frog
						9/4/16	0054	Pseudophryne sp.	Po	EE	7015-7022	Un	
9/4/16	1957	Trail	D	MW	Po								
9/4/16	2043	Trail	D		Po	9/4/16	2042	Trail	D		7423-7424	Po	
9/4/16	2320	NB Bandicoot	Pr	ME	D	9/4/16	2316	Trail	D	ME	7577-7578	D	
10/4/16	0004	Echidna	D	MW	D	10/4/16	0015	Trail	D		7636-7637	D	
						10/4/16	2348	Small frog	D	EE	8269-8281	Un	
11/416	2110	Trail	D		D	11/4/16	2107	Trail	D		8768-8769	D	
						12/4/16	1936	Microbat spp.	D	MW	9337	Po	
12/4/16	1949	Small mammal	D	ME	Po								

Date	Time	Species	Accu-racy	Move-ment	Crossing Likelihood	Date	Time	Species	Accu-racy	Move-ment	Pic No.	Crossing Likelihood	Comments
East End						West End							
						12/4/16	2036	Microbat spp.	D	NDM	9397	Po	
12/4/16	2029	Echidna	D	MW	Pr	12/4/16	2044	Trail	D		9405-9406	Pr	
12/4/16	2341	Trail	D	ME	Pr	12/4/16	2337	Trail	D		9578-9579	Po	
						13/4/16	0415	Trail	D		9856-9867	Po	
14/4/16	0042	LN Bandicoot	D	ME	D	14/4/16	0040	Trail	D	ME	302-303 (2nd set)	D	
						15/4/16	0157	LN Bandicoot	D	EE	1036-1040	Un	
15/4/16	2055	Trail	D	MW	Pr	15/4/16	2056	Trail	D		1398-1399	Pr	
15/4/16	2113	Microbat spp.	D	ME	Po								
						17/4/16	2354	Trail	D		2894-2895	Po	
						18/4/16	0443	Black Rat	Pr	EE	3184-3185	Un	
						18/4/16	0156	Black Rat	Pr	EE	3678	Un	
20/4/16	0154	Trail	D		Pr	20/4/16	0154	Trail	D		4336-337	Pr	

Table B2: Fauna detected during 2015/16 camera monitoring of Grey's Dam SOUTH frog pipe.

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
							19/11/15	1800	sm skink	D	EP	1-12	Un	
							19/11/15	2129	black rat	Pr	EE	210	Po	
20/11/15	0120	Estn horseshoe bat	Pr	MW	441	Pr								
22/11/15	0008	Rodent sp	D	EE	1689	Po								
							22/11/15	0013	Str marsh frog	Pr	ETE	1694-1700	Un	
22/11/15	0025	black rat	Pr	EP	1706	Po								
22/11/15	1836	sm skink	D	EP	2017	Un								
22/11/15	2245	Microbat	D	ME	2266	Pr								
26/11/15	2350	Sm-eyed Snake	Pr	MW	4969-70	Pr								
27/11/15	2134	Br tree snake	Pr	MW,ME	5495-97	Un								
28/11/15	1856	Med frog	D	ETE	5997-99	Un								
30/11/15	1918	Sm-eyed Snake	Pr	MW	7339-40	Pr								
30/11/15	2054	Br tree snake	Pr	ME	7435-37	Pr								
1/12/15	0452	sm lizard	D	ETE	7913-16	Un								
1/12/15	2022	Mixophyes sp.	Po	ETE	8066-73	Un								
27/11/15	2134	Br tree snake	Pr	MW,ME	5495-97	Un								
2/12/15	1909	Med frog	D	ME	8650-52	Pr								
2/12/15	1959	Med frog	D	ME	8700-01	Pr								
2/12/15	2021	Med frog	D	ETE	8722	Un								
6/12/15	0019	Rodent sp	D	EE	0941/2	Un								
							8/12/15	1958	Southern Leaf tail Gecko	D	ETE	115-141	Un	
							9/12/15	1902	Med Frog	D	EE	723-731	Un	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
							9/12/15	2033	Black Rat	Pr	MW	814	Po	
							9/12/15	2040	Med frog	D	EP	821-822	Un	
							10/12/15	0442	Med Frog	D	ME	1030-1305	Po	
							10/12/15	1915	Med frog	D	EE	1391-1399	Un	
							11/12/15	1813	EW Water Dragon	D	EE	1994-2022	Un	
							11/12/15	2340	Black Rat	Pr	EE	2321-2325	Un	
							12/12/15	1808	Med frog	D	ME	2649-2652	Po	
							12/12/15	2001	Black Rat	Pr	ME	2762	Po	
							12/12/15	2329	NB Bandicoot	Pr	EE	2970-2971	Un	
13/12/15	0428	sm Skink	D	EE	3269-3273	Un								
13/12/15	0445	SM Skink	D	MW	3286-3294	Po								
13/12/15	2108	Microbat spp	D	MW	3489	Po								
							14/12/15	2008	Med Frog	D	EE	4089-4096	Un.	
16/12/15	0213	Swamp Rat	Po	MW	5114	Po								CARD SWAP
							16/12/15	1904	Med frog	D	EE	0065-0071	Un	
							16/12/15	1923	Med snake	D	EE	0084-0159	Un	
							17/12/15	0403	Pseudo. coreacea	Pr	EE	0603-0647	Un	Burrowing for day
							19/12/15	1932	Med frog	D	EE	2073-2084	Un	
							19/12/15	2303	Med frog	D	ETE	2284-2287	Un	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
							19/12/15	2326	Med frog	D	ETE	2307-2332	Un	
20/12/15	1830	Lampropholis spp	Pr	ME	2671-2673	Po								
							20/12/15	1922	Pseudo. coreacea	Po	ETE	2723-2796	Un	
22/12/15	0134	Med frog	D	ME	3755-3762	Pr	22/12/15	0109	Med frog	D	ME	3729-3730	Pr	
							22/12/15	0409	Med frog	D	ME	3910-3912	Po	
22/12/15	1825	Small frog	D	ME	3986-4019	Po								
22/12/15	2043	Small snake	D	EE	4123-4135	Po								
							22/12/15	2132	Med frog	D	ME	4173-4225	Po	
22/12/15	2142	GTF?	Po	ETE	4183-4263	Un								
23/12/15	1945	Med frog	D	MW	4726-4755	Pr	23/12/15	2033	Med frog	D	MW	4774-4798	Pr	
							23/12/15	2229	Med frog	D	EE	4890-4918	Un	
							23/12/15	2305	Med frogx2	D	ETE	4926-4954	Un	
							24/12/15	0348	Microbat spp.	Pr	?	5209	Po	Unable to determine direction of movement
							25/12/15	2045	Med frog	D	ETE	6106-6145	Un	
							26/12/15	1823	EW Dragon	D	EE	6624-629	Un	
							26/12/15	1925	Lim. peronii	Pr	ETE	6686-6691	Un	
							26/12/15	2036	Mixophyes sp.	Pos	ETE	6757-6775	Un	Wide set eyes and strongly fingered digits, wide set hips

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
							27/12/15	0050	Mixophyes fasciolatus	Po	ETE	7011-7050	Un	Faint barring?
28/12/15	0050	Microbat spp.	Pr	MW	7671	Po								SW cam died 0301 28/12/15.
28/12/15	2312	Black Rat	Pr	EE	8233	Un								
1/1/16	0229	UnID sm mammal	D	NDM	0411(2nd set)	Po								
4/1/16	2035	Med frog	D	ETE	2697-2717	Un								
4/1/16	2157	Microbat spp.	D	MW	2779	Po								
6/1/15	2114	Echidna	D	ME	4056-4066	Pr								
6/1/16	2147	Echidna	D	MW	4089-4090	Pr								
7/1/16	0314	Black Rat	Pr	MW	4416	Po								
7/1/16	1830	Rough Scale snake	Pr	ETE	4552-4573	Un								
7/1/16	1932	Small snake	D	ETE	4614-4615	Un								
9/1/16	0000	Bandicoot spp.	Pr	MW	5542	Po								
12/1/16	0140	Horseshoe bat	Po	MW	7622	Po								
13/1/16	2028	Carpet Python	D	ETE	149-157	Un								CARD SWAP
							14/1/16	2349	Black Rat	Pr	ME	1010	Po	
15/1/16	0050	Microbat spp.	D	ME	1071	Po								
15/1/16	0144	Black Rat	Pr	EE	1125	Po								
15/1/16	0221	Microbat spp.	D		1162	Po								
							15/1/16	0416	Water Rat	D	MW	1277	Po	
							15/1/16	2042	Microbat spp.	D	ME	1483	Po	
							16/1/16	0054	Small frog	D	ME	1735	Po	
							16/1/16	1921	Med frog	D	ETE	2063-2125	Po	
16/1/16	2327	Microbat spp	D		2308	Po								
16/1/16	2322	Blind Snake spp.	Po	EE	2303-2327	Un								
18/1/16	2012	Small frog	D	ME	3433-3447	Po								
							19/1/16	1900	EW Dragon	D	EE	4021	Un	
							19/1/16	2117	Microbat spp.	D	NDM	4158	Po	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
							20/1/16	2124	Med frog	D	ETE	4825-4854	Po	
21/1/16	0032	Microbat spp.	Po	ME	5013	Po								
21/1/16	2238	Mixophyes sp.	Pr	ME	5559-5564	Pr	21/1/16	2138	Mixophyes sp.	Pr	ME	5499-5502	Pr	
21/1/16	2343	Small eyed snake	Po	NDM	5624	Po								
							22/1/16	0055	Black Rat	Pr	NDM	5696	Po	
							22/1/16	2018	Carpet Python	D	ETE	6079-6098	Un	
23/1/16	0000	Small frog	D	ME	6301-6302	Po								
							23/1/16	0241	Microbat spp.	D	NDM	6462	Po	
							23/1/16	0409	Med frog	D	ETE	6550-6571	Un	
							23/1/16	0831	Med frog	D	ETE	6752-6835	Un	
23/1/16	2044	Microbat/small frog	D	NDM	6765	Po								
							23/1/16	1029	Small frog	D	ETE	6870-6881	Un	
							23/1/16	1053	Small frog (different ind)	D	ETE	6894-6917	Un	
25/1/16	0420	Microbat spp	D	NDM	7881	Po								
							25/1/16	2125	Lim. peronii	Pr	ETE	8124-8148	Un	
26/1/16	2314	Horseshoe bat	Pr	Roosting	8895-8896	-								
27/1/16	0257	Microbat spp.	D	Ndm	9118	Po								
27/1/16	2005	Mixophyes sp.	Pr	MW	9366-9367	Pr	27/1/16	2027	Large frog	D	MW	9388-9395	Pr	
27/1/16	2252	Microbat spp.	D	NDM	9533	Po								
28/1/16	2118	Large snake	D	EE	100-101 second set	Un								
							29/1/16	0221	Microbat spp.	D	ME	403 (second set)	Po	
30/1/16	0000	Mixophyes	Pr	ME	922-923	Po	29/1/16	2340	Large frog	D	ME	902-903	Pr	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
		spp.												
							30/1/16	2146	Microbat spp.	D	ME	1448	Po	
							31/1/16	2217	Microbat spp.	D	ME	2139	Po	
							1/2/16	0215	Microbat spp.	D	NDM	2377	Po	CARD SWAP
1/2/16	0246	Water Rat	Pr	MW	2408	Po								
4/2/16	0117	Black Rat	Po	MW	1758	Po								
							4/2/16	0121	Large frog	D	EE	1762-1810	Un	
							4/2/16	0158	Microbat spp.	D	ME	1799	Po	
							4/2/16	0445	Large frog	D	ME	1966-1970	Po	
							4/2/16	0937	Large frog	D	EE	2198-2203	Un	
5/2/16	2123	Large frog	D	MW	2843-2844	Pr	5/2/16	2145	Large frog	D	MW	2866-2867	Pr	
5/2/16	2305	Microbat spp.	D	MW	2947	Po								
							6/2/16	0043	Microbat spp.	D	NDM	3044	Po	
							6/2/16	0340	Water Rat	D	ETE	3221-3227	Un	
							7/2/16	2150	Med frog	D	EE	4191-4247	Un	
							8/2/16	0324	Macropod spp.	D	EE	4525	Un	
9/2/16	2251	Microbat spp.	D	NDM	5572	Po								
							9/2/16	2321	Microbat spp.	D	NDM	5602	Po	
10/2/16	2311	Large snake	D	EE	6252-6253	Un								
							11/2/16	0218	Microbat spp.	D	NDM	6439	Po	
							11/2/16	0407	Bandicoot sp	Pr	EE	6548	Un	
							11/2/16	1913	Microbat spp.	D	ME	6674	Un	
11/2/16	2226	Water Rat	D	ME	6867	Po								
12/2/16	0038	Microbat spp.	D	NDM	6999	Po								
							12/2/16	0201	NB	Pr	EE	7082-7084	Un	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
									Bandicoot					
12/2/16	2117	Echidna	D	MW	7458	Pr	12/2/16	2121	Echidna	Pr	MW	7462	Pr	
14/2/16	0350	Bandicoot	D	EE	8511	Un								
14/2/16	0414	Black Rat	Po	EE	8535-8538	Un								
14/2/16	1922	Microbat spp.	D	NDM	8663	Po								
							14/2/16	2331	Microbat spp.	D	NDM	8912	Po	
							15/2/16	0149	Small mammal	D	NDM	9050	Po	
15/2/16	0302	Microbat spp.	D	NDM	9123	Po								
15/2/16	2103	Microbat spp.	D	NDM	9424	Po								
							15/2/16	2304	Microbat spp.	D	MW	9545	Po	
							16/2/16	0200	Echidna	D	ME	9721	Po	
							16/2/16	0419	Small mammal	Pr	MW	9860	Po	
17/2/16	0310	Microbat spp. X 2	D	MW	0452 (second set)	Po								CARD SWAP
							17/2/16	1953	Large frog	D	EE	114-156	Un	
							18/2/16	1911	Large frog	D	ETE	732-740	Un	
							18/2/16	2121	Med frog	D	ETE	862-870	Un	
18/2/16	0002	Echidna (trail)	Po	ME	1017-1023	Pr	18/2/16	2337	Echidna	D	ME	998	Po	
20/2/16	0025	NB Bandicoot	Po	MW	1706	Po								
							20/2/16	2027	Lit. wilcoxii	Po	ETE	2128-2168	Un	
							20/2/16	2180	Microbat spp	D	NDM	2180-	Po	
							21/2/16	0146	Med mammal	Po	MW	2447	Po	
22/2/16	0819	Microbat spp.	D	MW	3440	Po								
							23/2/16	1800	E Water Dragon	D	MW	3961-4009	Po	
							23/2/16	2211	LN Bandicoot	D	MW	4212-213	Po	
							23/2/16	2219	NB	Po	MW	4220-4235	Po	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
									Bandicoot					
							24/2/16	0025	LN Bandicoot	Pr	ME	4345	Po	
							25/2/16	0131	NB Bandicoot	Pr	MW	5072-5073	Po	
25/2/16	2107	Microbat spp.	D	MW	5468	Po								
							26/2/16	0105	Microbat spp.	Pr	NDM	5706	Po	
							26/2/16	1937	Bandicoot sp	Pr	MW	6038	Po	
26/2/16	2159	Microbat spp.	D	ME	6180-6181	Po								
26/2/16	2242	Microbat spp.	D	MW	6223	Po								
26/2/16	2350	Small mammal	D	ME	6291	Po								
27/2/16	0050	Microbat spp.	D	MW	6351	Po								
							27/2/16	0112	Microbat spp.	D	NDM	6873	Po	
27/2/16	0329	Microbat spp.	D	NDM	6510	Po								
							27/2/16	0336	Microbat spp.	D	ME	6517	Po	
							27/2/16	1947	Microbat spp.	D	NDM	6708	Po	
							28/2/16	0101	Small mammal	D	MW	7022	Po	
28/2/16	0216	Microbat spp.	D	ME	7097	Po								
28/2/16	0354	Microbat spp.	D	MW	7195	Po								
							28/2/16	0428	Med frog	D	EE	7229-7230	Un	
							28/2/16	0438	LN Bandicoot	Pr	EE	7231	Un	
							28/2/16	2005	Common Ringtail Possum	Prob	MW	7386	Po	
28/2/16	2123	LN Bandicoot	Po	ME	7464	Po								
28/2/16	2148	House mouse	Pr	ME	7489	Po								
28/2/16	2230	Lit. wilcoxii	Pr	ETE	7531-7611	Un								
29/2/16	0445	Microbat spp.	D	NDM	7906	Po								
29/216	2254	LN Bandicoot	D	ETE	8215-8224	Po								

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East End							West End							
1/3/16	0017	Common Ringtail Possum	Pr	MW	8298	Po								
1/3/16	2021	Med Snake	D	EE	8721-8805	Po								
1/3/16	2217	Microbat spp.	D	ME	8838	Po								
							1/3/16	2246	LN Bandicoot, microbat spp.	Pr	MW	8867	Po	
							1/3/16	2346	LN Bandicoot	Pr	EE	8927	Po	
2/3/16	0130	LN Bandicoot	Pr	ME	9031	Po								
							3/3/16	0439	Microbat spp.	D	ME	9880	Po	
4/3/16	0028	Small mammal	Pr	MW	290 (second set)	Po								
5/3/16	0203	Microbat spp	D	MW	1045	Po								
6/3/16	1858	Lit. Wilcoxii	Po	ETE	1940-1963	Un								
							6/3/16	2231	Water Rat	D	MW	2153 (second set)	Po	
							7/3/16	0433	Microbat spp.	D	ME	2515	Po	
7/3/16	2149	Med snake	Pr	EE	2771	Un								
							9/3/16	0353	Echidna	Po	EE	3796-3798	Un	
							9/3/16	1822	Med frog	D	ETE	23-48	Un	CARD SWAP
9/3/16	1844	Microbat spp.	D	MW	45	Po								
							10/3/16	0356	Hopping trail			597-598	Po	
10/3/16	1852	CRTP	Po	MW	713	Pr	10/3/16	1853	Trail	D		714-715	Pr	
							10/3/16	2056	Microbat spp.	D	ME	837	Po	
							11/3/16	2043	Trail	D		1484-1485	Po	
							12/3/16	0024	Trail	D		1704-1705	Po	
							12/3/16	1801	EW Dragon	D	EE	1982-2001	Un	
12/3/16	1925	Med mammal	Pr	MW	2066	Pr	12/3/16	1926	Trail	D		2067-2068	Pr	

Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Date	Time	Species	Accu-racy	Movement	Pic No.	Crossing Likelihood	Comments
East End							West End							
12/3/16	2051	Microbat spp.	D	NDM	2152	Po								
							12/3/16	2241	Hopping trail	Pr		2262-2263	Po	
14/3/16	0422	Trail			3263-3264	Po	14/3/16	0424	Trail	D		3265-3266	Pr	
							14/3/16	1946	Small frog	D	ETE	3407-3410	Un	
14/3/16	2309	Microbat spp.	D	MW	3610	Pr								
							15/3/16	1921	Trail	D		4042-4043	Po	
							15/3/16	2106	Water Rat	Pr	ME	4147	Po	
15/3/16	2312	Trail			4273-4274	Po								
15/3/16	2328	Trail			4289-4290	Po								
16/3/16	0137	Water Rat	Po	EE	4418-4419	D	16/3/16	0139	Water Rat	D	MW	4420	D	
16/3/16	1937	Microbat spp.	D	MW	4718	Po								
16/3/16	2244	Trail			4905-4906	Po	16/3/16	2251	Echidna	D	MW	4912	D	
17/3/16	0028	Hopping trail			5009-5010	Po	17/3/16	0030	Hopping trail			5010-5011	Pr	
							17/3/16	0244	Trail	D		5144-5145	Po	
17/3/16	0319	NB Bandicoot	Pr	NDM	5181	Po								
17/3/16	1909	Med snake	D	ETE	5350/5351	Po	19/3/16	2210	Trail	D		6858-6859	Pr	
18/3/16	2151	Echidna	D	MW	6172	Pr	18/3/16	2215	Trail	D		6196-6197	Pr	
18/3/16	2210	Med frog	Pr	EE	6191-6192	Un								
							18/3/16	2304	Trail	D		6246-6247	Po	
							18/3/16	2308	Microbat spp.	D	ME	6249	Po	
							18/3/16	2321	Med frog	D	ETE	6262-6268	Un	
19/3/16	2216	Fox	Pr	MW	6857	Pr	19/3/16	2210	Trail	D		6858-6859	Pr	
							20/3/16	1910	Lit. wilcoxii	Pr	ETE	7331-7340	Un	
							21/3/16	1846	Med snake	D	ETE	7967	Un	

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East End							West End							
21/3/16	2139	Trail			8140-8141	Po								
							21/3/16	2139	Trail	D		8139-8140	Po	Something has crossed but two trails at west end
							21/3/16	2204	Trail	D		8165-8166	Po	
							22/3/16	0447	Microbat spp.	D	ME	8568	Po	
							22/3/16	2043	Trail	D		8743-8744	Po	
24/3/16	0347	Trail			9827-9828	Pr	24/3/16	0349	Trail	D		9829-98230	Pr	
							25/3/16	0205	Microbat	D	NDM	387 (2nd set)	Po	
							26/3/16	2129	Microbat	D	NDM	1431	Po	
							26/3/16	1840	Trail	D		1922-1923	Po	
					(2nd set)									
27/3/16	1949	LN Bandicoot	Po	ME	1991 (2nd set)	Pr	27/3/16	1947	Hopping trail	D		1989-1990	Pr	
27/3/16	2123	Microbat spp.	D	NDM	2085	Po								
28/3/16	0359	Small mammal	Pr	EE	2481	Un								
							28/3/16	1840	Trail	D		2581-2582	Po	
28/3/16	2003	CRTP	Po	ME	2665	Po								
28/3/16	2236	Trail			2818-2819	Pr	28/3/16	2254	Bandicoot spp.	Po	MW	2836	Pr	
														CARD SWAP
29/3/16	1840	Microbat spp.	D	MW	0041	Po	29/3/16	1836	Microbat spp. X 2	D	MW	0037	Po	
							30/3/16	0122	Bandicoot spp.	D	MW	443	Po	
30/3/16	0203	Macropod spp.	D	MW	0484-486	D	30/3/16	0205	Hopping trail	D	MW	486-487	D	Med macropod?
30/3/16	0343	Microbat spp.	D	MW	584	Po								
30/3/16	2316	Echidna	D	ETE	977-993	Un								
31/3/16	0258	Small trail	D		1199-1200	Pr	31/3/16	0257	Trail	D		1198-1199	Pr	Rodent?
31/3/16	1849	Trail	D		1370-1371	Po								

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East End							West End							
31/3/16	2018	Trail	D		1459-1460	Pr	31/3/16	0837	Hopping trail	D		1478-1479	Pr	Bandicoot?
1/4/16	0135	Microbat spp.	D	MW	1776	Po								
							1/4/16	2003	Rodent sp.	D	NDM	2104	Po	
1/4/16	2132	Echidna	D	MW	2193	Po								
							2/4/16	0157	Black Rat	D	ETE	2458-2468	Un	
2/4/16	1914	Trail	D	MW	2715-2716	D	2/4/16	1920	Trail	D	MW	2721-2722	D	Echidna?
2/4/16	2026	Small trail	D		2787-2788	Po								
							3/4/16	0011	Microbat spp. X 2	D	?	3012	Po	
4/4/16	0426	Swamp Rat	D	ME	3927-3928	D	4/4/16	0421	Trail	D		3922-3923	D	
							4/4/16	1959	Echidna	D	ME	4080	Po	
							4/4/16	2017	Microbat spp.	D	ME	4098	Po	
							5/4/16	0007	Trail	D		4327-4328	Po	Prob same echidna as next below
5/4/16	0132	Echidna	D	ME then W	4413-4417	D	5/4/16	0153	Echidna	D	MW	4434	D	
							5/4/16	0346	Hopping trail	D		4547-4548	Po	
							5/4/16	0419	Microbat spp.	D		4580	Po	
							6/4/16	0134	Trail	D		5075-5076	Po	
							6/4/16	0234	Trail	D		5135-5136	Po	Poss same animal as above
							6/4/16	1910	Trail	D		5351-5352	Po	
6/4/16	2338	LN Bandicoot	D	ETE	5619-5621	Pr								
7/4/16	0029	Small mammal	D	ETE	5670-5671	Un								
							7/4/16	1807	Med frog	D	ETE	5948-5959	Un	
							7/4/16	2149	Med frog	D	EE	6170		
							8/4/16	0205	Trail	D		6426-6427	Po	
8/4/16	0443	Microbat spp.	D	MW	6584	Po								
8/4/16	1829	Microbat spp.	D	MW	6630	Po								
8/4/16	2149	Med snake	D	ME	6830-6831	Pr								
							8/4/16	2216	Trail	D		6857-6868	Po	
8/4/16	2326	Black Rat	Pr	EE	6927	Un								
							9/4/16	0042	Med frog	D	EE	7003	Un	
9/4/16	0214	Trail	D		7095-7096	Pr	9/4/16	0214	Fox	D	ME	7095	P	

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East End							West End							
9/4/16	0226	Trail	D		7107-7108	Po	9/4/16	0220	Trail	D		7101-7102	Pr	Prob echidna
							9/4/16	0420	Small Rodent	Pr	NDM	7221	Po	
9/4/16	1812	Microbat spp.	D	NDM	7273	Po								
10/4/16	0223	Trail	D		7764-7765	Po	10/4/16	0214	Echidna	Pr	ME	7755-7756	D	
10/4/16	1816	House mouse	Pr	NDM	7937	Po								
							10/4/16	2141	Trail	D		8142-8143	Po	
10/4/16	2325	Microbat spp.	D	MW	8246	Po								
10/4/16	2359	Microbat spp.	D	MW	8280	Po								
							11/4/16	0259	Microbat spp.	D		8460	Po	
11/4/16	2041	Echidna	D	MW	8742	D	11/4/16	2046	Echidna	D	MW	8747	D	
11/4/16	2129	Trail	D		8790-8791	Pr	11/4/16	2131	Trail	D	MW	8792-8793	Pr	Direction from time
							12/4/16	0012	Med frog	D	EE	8953	Un	
12/4/16	0316	Trail	D		9137-9138	Pr	12/4/16	0317	Trail	D	MW	9138-9139	Pr	Direction from time
12/4/16	0356	Trail	D		9177-9178	Po	12/4/16	0404	Hopping trail	D	MW	9185-9186	Pr	Direction from time
12/4/16	1809	Trail	D		9250-9251	Po	12/4/16	1809	Trail	D		9250-9251	Pr	
12/4/16	2106	Microbat spp.	D	NDM	9427	Po								
13/4/16	0002	Trail	D		9603-9604	Po								
13/4/16	0039	Trail	D		9640-9641	Pr	13/4/16	0027	Trail	D	ME	9628-9629	Pr	
13/4/16	1831	Trail	D	MW	9932-9933	D	13/4/16	1832	Water Rat	D	MW	9933	D	
13/4/16	2008	Microbat spp.	D	MW	0030 (2nd set)	Po								
							14/4/16	0130	Trail	D		352-353 (2nd set)	Po	
14/4/16	0348	Hopping trail	D	MW	490-491	Pr	14/4/16	0353	Hopping Trail	D	MW	495-496	Pr	Direction from time
14/4/16	1919	Microbat spp.	D	MW	641	Po								
							14/4/16	2224	Trail	D		826-827	Po	
							15/4/16	0425	Hopping trail	D		1187-1188	Po	
15/4/16	2210	Trail x 2	D		1472-1475	Po								
15/4/16	2343	Trail	D		1565-1566	Pr	15/4/16	2334	Trail	D		1556-1557	Pr	
							16/4/16	0041	Trail	D		1623-1624	Po	
16/4/16	0418	Trail	D		1840-1841	Po								
							16/4/16	1812	Trail	D		1894-1895	Po	

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East End							West End							
16/4/16	2324	Bandicoot spp.	D	ME	2206	D	16/4/16	2322	Bandicoot spp.	Pr	ME	2204-2205	D	
17/4/16	0428	Trail	D	MW	2510-2511	Po	17/4/16	0434	Hopping Trail	D	MW	2516-2517	D	Direction from time
17/4/16	1807	Med frog	D	ETE	2549-2551	Un								
17/4/16	2045	Water Rat	D	MW	2707	Pr	17/4/16	2047	Trail	D	MW	2708-2709	D	
							17/4/16	2105	Med frog	D	ETE	2727-2733	D	
							17/4/16	2236	Trail	D		2818-2819	D	
							17/4/16	2303	Microbat spp.	D		2845	Po	
18/4/16	0323	Trail	D	MW	3105-3106	Po	18/4/16	0325	Trail	D	MW	3106-3107	Pr	Direction from time
							18/4/16	1817	Trail	D		3219-3220	Po	
							18/4/16	1852	Trail	D		3254-3255	Po	
							18/4/16	2231	Microbat spp.	D	ME	3473	Po	
							19/4/16	0014	Microbat spp.	D	ME	3576	Po	
19/4/16	0155	Med mammal	D	EE	3677	Un								
19/4/16	0232	Trail	D		3714-3715	Po	19/4/16	0220	Hopping trail	D		3701-3702	Po	
							19/4/16	0425	Trail	D		3827-3828	Po	
							19/4/16	1810	Trail	D		3872-3873	Po	
							20/4/16	0419	Med mammal	D	ME	4481	Po	