

Kempsey Bypass Alliance Fauna Monitoring

Underpass Monitoring Report, Autumn 2014

Leighton Contractors Pty Ltd

November 2014

0212311_UPass_Aut 2014_Final

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CONTENTS

1	INTRODUCTION	
1.1	BACKGROUND	1
1.2	UNDERPASS MONITORING	1
1.3	PERFORMANCE MEASURES	2
2	METHODOLOGY	
2.1	DESKTOP REVIEW	3
2.2	HAIR FUNNELS	3
2.3	SCAT AND TRACK SEARCHES	3
2.4	CAMERA TRAPPING	4
2.4.1	BOAT HARBOUR CREEK	5
2.4.2	BINGIS LANE	6
2.4.3	POLA CREEK	6
2.5	FAUNA FENCING	7
2.6	ROAD KILL	7
3	RESULTS	
3.1	HAIR FUNNELS	8
3.2	SCAT AND TRACK SEARCHES	8
3.3	CAMERA TRAPPING	9
3.3.1	BOAT HARBOUR CREEK	9
3.3.2	BINGIS LANE	10
3.3.3	POLA CREEK	11
3.4	FAUNA FENCING	12
3.4.1	BOAT HARBOUR CREEK	13
3.4.2	BINGIS LANE	13
3.4.3	POLA CREEK	14
3.5	ROAD KILL	14
4	DISCUSSION	
4.1	HAIR FUNNELS	16
4.2	SCAT AND TRACK SEARCHES	16
4.3	CAMERAS	17
4.4	FAUNA FENCING	18
4.5	ROAD KILL	18
4.6	COMPLIANCE WITH PERFORMANCE MEASURES AND CONTINGENCY MEASURES REQUIRED	19
5	RECOMMENDATIONS	
5.1	COMPLIANCE WITH PERFORMANCE MEASURES AND CONTINGENCY MEASURES REQUIRED	21
5.2	CAMERA TRAPPING	22
5.3	FAUNA FENCING	22
6	REFERENCES	

LIST OF TABLES

TABLE 3.1	SPECIES RECORDED FROM HAIR FUNNELS WITHIN THE UNDERPASSES	8
TABLE 3.2	SPECIES RECORDED FROM SCAT AND TRACK SEARCHES	9
TABLE 4.1	COMPLIANCE WITH PERFORMANCE MEASURES	19
TABLE 4.3	ADDITIONAL CONTINGENCY MEASURES FOR POTENTIAL PROBLEMS	20

LIST OF FIGURES

FIGURE 3.1	FAUNA FENCE AND ROAD KILL MONITORING RESULTS, AUTUMN 2014	15
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LIST OF PHOTOGRAPHS

PHOTOGRAPH 2.1	WEST SIDE OF BOAT HARBOUR CREEK SHOWING THREE CAMERAS TRAINED ON THE GROUND, CONCRETE BENCH AND FAUNA FURNITURE	5
PHOTOGRAPH 2.2	UOVISION CAMERA, LOCATED IN ROCKS AT POLA CREEK	7
PHOTOGRAPH 3.1	EUROPEAN RED FOX (VULPES VULPES) PHOTOGRAPHED AT BOAT HARBOUR CREEK	10
PHOTOGRAPH 3.2	NORTHERN BROWN BANDICOOT (ISOODON MACROURUS) PHOTOGRAPHED AT BINGIS LANE.	11
PHOTOGRAPH 3.3	SWAMP WALLABY (WALLABIA BICOLOR) PHOTOGRAPHED AT POLA CREEK.	12
PHOTOGRAPH 3.4	COMPLETE FAUNA FENCING AT BOAT HARBOUR CREEK WITH FLOPPY TOP GRID MESH, FINE MESH AND METAL PANELS	13

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia (ERM) has been engaged by Kempsey Bypass Alliance to undertake fauna monitoring for the Kempsey Bypass Project ('the Project').

The Project has involved upgrading of the Pacific Highway between South Kempsey and Frederickton Interchange, construction of an approximately 14.5 kilometre (km) dual carriageway on a mostly new alignment. In accordance with Condition of Approval 3.1 for the Project the *Kempsey Bypass Project, Ecological Monitoring Program* (Lewis Ecological Surveys, 2012) was developed.

The Ecological Monitoring Program includes ongoing monitoring targeting:

- Glossy Black-cockatoo;
- Fauna Underpasses and Associated Fauna Fencing;
- Green-thighed Frog;
- Nest Boxes;
- Aerial Crossings; and
- Brush-tailed Phascogale.

This monitoring work is focussed on implementing the actions identified in the Ecological Monitoring Program.

1.2 UNDERPASS MONITORING

Three dedicated fauna underpasses crossing under the Pacific Highway were constructed as part of the Project in order to maintain terrestrial fauna connectivity between identified habitats on either side of the carriageway. These underpasses include:

- Boat Harbour Creek: 4 metre (m) high and 9m wide arch shaped culvert;
- Bingis Lane: a 3m by 3m box culvert; and
- Pola Creek: two bridges providing 36m wide terrestrial and riparian fauna crossing zone.

Boat Harbour Creek and Bingis Lane both have fauna furniture installed in order to provide opportunity for arboreal species to use the underpasses. Fauna furniture is the name for an arrangement of logs, branches and other pieces of wood installed along the length of the underpass that animals will use to

climb along. All of the underpasses have raised areas within them to allow terrestrial fauna passage beneath the road, including in times of moderate flooding. A wide variety of species have the potential to use the underpasses, including two key target species, which are listed as Vulnerable under the *Threatened Species Conservation Act 1995* (TSC Act), the Brush-tailed Phascogale (*Phascogale tapoatafa*) and Koala (*Phascolarctos cinereus*). The Koala is also listed as Vulnerable under the *Environmental Protection and Biodiversity Act, 1999* (EPBC Act).

Fauna fencing has also been installed either side of the underpasses in order to reduce vehicle related fauna mortality and to guide animals towards the three culverts. 'Fauna fencing' is a fence constructed of a material and arrangement to prevent fauna from passing through, under or climbing over the fence. It is designed to exclude fauna from the road reserve and carriageway.

The specific monitoring activities outlined in the Ecological Monitoring Program regarding underpass monitoring are:

- emplacement of baited hair funnels to detect the presence of small mammals through the identification of hair samples;
- scat searches to identify fauna occurring within and surrounding the underpasses;
- automated camera monitoring to capture photographs of fauna moving through the underpasses;
- fauna fence surveys for 250m either side of fauna underpasses to confirm correct installation and that there are no gaps or areas where fauna can breach the fencing; and
- road kill surveys to determine the effectiveness of the fauna fencing within 500m of the underpasses.

1.3

PERFORMANCE MEASURES

In keeping with the Ecological Monitoring Program (Lewis Ecological Surveys 2012), the performance measures which will be used to comment on the success of the underpasses, including:

- use of fauna underpass by the nominated indicator species;
- use of the fauna underpass by key target species;
- use by fauna with low dispersal abilities;
- low rate of fauna road strike; and
- no breaches in the fauna fence.

2 *METHODOLOGY*

The field surveys were undertaken by two ERM personnel during the period from late April through May 2014.

2.1 *DESKTOP REVIEW*

All relevant literature pertaining to the locations and details of underpasses and associated fauna fencing were reviewed prior to field work to ensure that appropriate methodology was adopted during the inspection. Material reviewed prior to field work included:

- *Kempsey Bypass Project, Ecological Monitoring Program*, (Lewis Ecological Surveys 2012); and,
- *Kempsey Bypass Project, Brush-tailed Phascogale, Monitoring Episode 1* (Lewis Ecological Surveys 2011).

2.2 *HAIR FUNNELS*

Hair funnels were deployed to survey for small mammals and determine if they are using and occurring close to the underpasses. Ten hair funnels were deployed in each of the underpasses for a period of approximately two weeks (15 nights) from Wednesday 1 May 2014.

Where fauna furniture existed with the underpass (Bingis Lane and Boat Harbour Creek) the hair funnels were distributed evenly between the ground and the fauna furniture. The hair funnels were also spread evenly throughout the underpass, ensuring representative coverage of the area.

Standard vegetable bait comprising honey, rolled oats and peanut butter was used for six of the ten funnels at each location, with sardines used in the remaining four. This allowed the survey of a complete range of species including herbivores, nectivores and carnivorous species.

All wafers with hair attached were retained and sent to Barbara Triggs, 'Dead Finish' for identification.

2.3 *SCAT AND TRACK SEARCHES*

Identification of scats and tracks within and adjacent to the underpasses is one of the techniques outlined in the Ecological Monitoring Program, to determine which species are utilising the underpasses and are occurring within the surrounding area.

The ground and the fauna furniture within the underpasses were searched for scats by two ecologists for approximately 30 minutes, between Tuesday, 13 May 2014 and Thursday, 15 May 2014. The ground area adjacent to underpass entrances was also searched. Head torches were used to improve illumination of the underpasses. Tracks were identified in the underpasses using a high powered torch held horizontally at ground level thus casting a shadow over any tracks. Scats which could not be immediately identified were collected and analysed at a later date, with assistance from Tracks, Scats and other Traces (Triggs, 2004). Tracks were all identified on site with Tracks, Scats and other Traces, used as a reference (Triggs, 2004).

2.4

CAMERA TRAPPING

A review of the different underpass designs was undertaken incorporating site visits, photographs and construction plans to identify appropriate equipment and the required mounting process. Key considerations included obtaining visual coverage of the ground, concrete benches and the fauna furniture.

Camera trapping was undertaken previously for the Underpass Monitoring event in Summer 2014 (ERM 2014). A key concern was the security of the cameras and the degree of underpass use by people which was unknown. Fauna monitoring cameras are often stolen or vandalised, especially if people perceive that cameras are recording their behaviour. Security measures included keeping the cameras out of reach of people, locking the cameras, and camouflaging the cameras within access of people. The underpasses were found to be used only occasional by people and there was no tampering, vandalism or removal of any cameras.

Although the cameras recorded several species during the previous Summer 2014 monitoring, the number of events were lower than expected, with few small animals recorded. In response to these findings the number of cameras was increased for both Bingis Lane and Boat Harbour Creek. This allowed the field of vision to be reduced for each camera, with each camera being closer to the subject area which should result on higher detection rates for smaller species. The coverage at Pola Creek was considered adequate and therefore was not altered for the autumn monitoring event.

Installation of the cameras was conducted by ERM using stepladders where required, with concrete anchors used to attach the cameras to the underpasses at Boat Harbour Creek and Bingis Lane. The concrete anchors are threaded allowing the mounting brackets to be completely removed and then remounted for subsequent mounting events. In addition the mounting brackets have provision for cable locks ('python' locks) allowing the cameras and external batteries to be secured. Cameras were mounted to the fauna furniture using mounting brackets and wood screws.

The cameras were installed on 30 April and 1 May 2014 operating continuously for a period of 30 days. The cameras were checked during this period which provided the opportunity to check the battery charge status and replace batteries when required and ensure that the cameras were functioning correctly. The cameras were removed at the end of the 30 day monitoring period on 6 June 2014 to minimise the time they are in place and consequently reduce the risk of theft and vandalism.

2.4.1 *Boat Harbour Creek*

Boat Harbour Creek is a large arch shaped underpass with the creek running through the centre. A total of ten cameras were installed, which were divided between the eastern and western ends to provide coverage of the whole width of the underpass (refer to *Photograph 2.1*).



Photograph 2.1 West Side of Boat Harbour Creek Showing Three Cameras Trained on the Ground, Concrete Bench and Fauna Furniture

Three BuckEye X7 cameras and seven UOVISION (UV565) cameras were selected for this underpass, provided by specialist fauna equipment suppliers Faunatech Ltd. Faunatech also provided custom mounting brackets and external batteries to allow the continuous operation of the cameras as well as an aerial to allow the transmission of captured photographs for the X7 cameras. The cameras were positioned as follows:

- two cameras at either end (east and west) of the fauna furniture;
- two cameras at either end of the northern concrete bench;
- two cameras at either end of the southern concrete bench;
- two cameras at either end on the ground on the northern side of the creek;
and
- two cameras at either end on the ground on the southern side of the creek.

2.4.2 *Bingis Lane*

Bingis Lane is a small box culvert with fauna furniture along one wall. Two cameras were mounted on the fauna furniture, with one mounted at either end of the culvert. Two additional cameras were used to monitor the ground of the cameras, with one at either end. The relatively narrow culvert allowed a single camera to significantly cover the width of the ground (at each end) within the culvert.

2.4.3 *Pola Creek*

During the planning phase it was identified that the Pola Creek underpass had few fixed attachment points suitable for the cameras that would obtain the desired field of view. If the cameras were attached to the underside of the bridge, the trigger length focussing on the ground below would be too distant to trigger photo capture. Four UOVISION (UV565) cameras were placed in among the large rocks adjacent to the rock platform. Smaller rocks were then used to conceal the camera (refer to *Photograph 2.2*). The field of view was over the rock platform designed for fauna passage. Cameras were placed at eastern and western ends of the underpass in order to detect complete passage of fauna from one side to the other. This set up was duplicated on both the north and south sides of Pola Creek which passes through the centre of the underpass.



Photograph 2.2 UOVISION Camera, Located in Rocks at Pola Creek

2.5 FAUNA FENCING

Surveys are required to determine if there are any breaches in the fauna fencing where fauna may be able to pass through, and if any maintenance or modifications are required.

The fencing was checked by two ecologists for a distance of 250m either side of each underpass during the survey period. Any breaches, maintenance items and any modifications required were noted and marked with GPS.

2.6 ROAD KILL

The Ecological Monitoring Program requires surveys to be undertaken for fauna killed by vehicle strike for 500m either side of the underpasses. This will help to determine the success of the underpasses and associated fauna fencing in allowing successful crossing of the road by fauna using the underpasses and preventing mortality from vehicles.

Two ecologists walked the 500m distance either side of the underpass and on both the eastern and western side of the carriageway totalling 2000m for each underpass. These surveys were conducted on Tuesday 13 May 2014 and Thursday 15 May 2014.

Binoculars were used to identify carcasses which were on the carriageway or close to it, rather than physical inspection in order to avoid placing personnel in danger from vehicles on the operational carriageway.

This section presents the results for each of the monitoring techniques used to survey the underpasses and the results of associated fauna fence and road kill monitoring.

3.1

HAIR FUNNELS

Hairs of three species were captured in the hair funnels; two native species: the Brown Antechinus (*Antechinus stuartii*) and the Northern Brown Bandicoot (*Isodon macrourus*) and one exotic species: the House Mouse (*Mus musculus*) (refer to Table 3.1). There was also a tentative record of a Brushtail Possum (*Trichosurus vulpecula*) from Bingis Lane. No threatened species were recorded.

The Brown Antechinus was the most common species and was identified from 90% of the hair funnels records at Bingis Lane, both on the ground and on the fauna furniture mounted hair funnels. The Northern Brown Bandicoot was the only species identified at Bingis Lane with three records. The House Mouse was the only species recorded at Pola Creek.

Table 3.1 *Species Recorded from Hair Funnels within the Underpasses*

Underpass Location	Brown Antechinus	Northern Brown Bandicoot	Brushtail Possum	House Mouse*
Pola Creek	-	-	-	3
Bingis Lane	-	4	1 (tentative)	-
Boat Harbour Creek	9	-	-	-

* denotes exotic species

3.2

SCAT AND TRACK SEARCHES

At least eight native species were recorded from signs including scats, tracks and diggings including; Brown Antechinus, Red-necked Wallaby (*Macropus rufogriseus*), Swamp Wallaby (*Wallabia bicolor*), Eastern Grey Kangaroo (*Macropus giganteus*), Australian Wood Duck (*Chenonetta jubata*), an unidentified Gecko species and an unidentified Bandicoot species, likely to be a Northern Brown Bandicoot. The Wood Duck is not a target of this study as they do not require the underpasses to successfully cross the highway, being a volant (flying) species. Three exotic species were also recorded, Black Rat (*Rattus rattus*), Domestic Dog (*Canis lupus familiaris*) and European Red Fox (*Vulpes vulpes*). No threatened species were recorded from any of the underpasses.

Table 3.2 *Species Recorded from Scat and Track Searches*

Species	Pola Creek	Bingis Lane	Boat Harbour Creek
Red-necked Wallaby	Abundant	-	-
Swamp Wallaby	2+ scats & diggings	-	-
Eastern Grey Kangaroo	-	-	Abundant scats and tracks
Brushtail Possum	2 Scats	-	-
Brown Antechinus	Abundant	-	Abundant scats and also few tracks
Black Rat*	-	2 Scats	Tracks present
Bandicoot Species		Diggings	
Domestic Dog*	2 Scats	-	-
European Red Fox*	1 Scat	-	-
Australian Wood Duck	Occasional	-	-
Unidentified Gecko Species		Occasional	-

* Denotes an exotic species

3.3 CAMERA TRAPPING

An event is considered as occurring when an animal is identified from the photographs. If the subject is recorded leaving the field of view for more than two minutes, then a separate event is recorded. If an animal remains in the field of view for an extended period this was considered the same event. Complete crossings were identified when an individual animal was recorded at either end of the underpass in quick succession.

3.3.1 Boat Harbour Creek

Two native species were identified at Boat Harbour Creek: the Eastern Grey Kangaroo (*Macropus giganteus*), recorded on three occasions and an Antechinus which was recorded 46 times. The Antechinus could not be identified from the photographs; however it is likely to be Brown Antechinus based on the trapping studies conducted within the area. Exotic species identified include the Black Rat, European Red Fox (*Photograph 3.1*) and Domestic Cat (*Felis catus*).

All species except the Domestic Cat were recorded on the ground, with the Antechinus the only species recorded on the fauna furniture.

A large number of events on the concrete benches were triggered by Antechinus with the Domestic Cat and Black Rat also recorded.

Complete crossing were completed by all five species, each were recorded making a complete crossing once.

At total of 80 events were recorded, the majority of which were Antechinus (45) and Black Rat (19).



Photograph 3.1 European Red Fox (Vulpes vulpes) Photographed at Boat Harbour Creek

3.3.2 *Bingis Lane*

A total of five native species were recorded using the underpass, four species were recorded on the ground including the Lace Monitor (*Varanus varius*), Brown Antechinus, Northern Brown Bandicoot (*Photograph 3.2*) and an unidentified Macropod species. The Brushtail Possum was the only native species recorded using the fauna furniture.

Exotic species recorded include the Black Rat, Domestic Cat, European Hare (*Lepus europaeus*) and European Red Fox.

The Northern Brown Bandicoot was the only species completing multiple crossings (four), with each of the other species recorded once, these include the native Lace Monitor and Brushtail Possum and the exotic Domestic Cat and Black Rat.

At total of 47 events were captured on the ground with seven on the fauna furniture.



Photograph 3.2 Northern Brown Bandicoot (Isoodon macrourus) Photographed at Bingis Lane.

3.3.3 Pola Creek

Three native species were recorded at Pola Creek, the Swamp Wallaby (*Photograph 3.3*), Ringtail Possum and Brushtail Possum. Exotic species recorded included Domestic Dog, European Red Fox, Black Rat and House Mouse. In the absence of fauna furniture at this site, all of the records were from the ground.

There were three complete crossings by Domestic Dogs with one crossing recorded of a Swamp Wallaby.

A total of 37 events were recorded.



Photograph 3.3 Swamp Wallaby (Wallabia bicolor) Photographed at Pola Creek.

3.4 FAUNA FENCING

The fauna fencing was assessed for 250m either side of each underpass. *Figure 3.1* shows the results of the survey with the location of any breaches in the fencing identified.

Photograph 3.4 below shows the fauna fence as constructed with the floppy top grid mesh, metal panelling and fine mesh at the base. The grid mesh is bent towards the fauna habitat at the base (away from the highway).



Photograph 3.4 *Complete Fauna Fencing At Boat Harbour Creek with Floppy Top Grid Mesh, Fine Mesh and Metal Panels*

3.4.1 *Boat Harbour Creek*

A number of potential breaches were identified and the base of the fence was poorly secured to the ground for almost the entirety of the fence on the western side of the highway at Boat Harbour Creek (refer to *Figure 3.1, Insert A*). Bandicoot diggings were common along the mulched areas adjacent to the woodland on the northern side. A number of eastern grey kangaroos were observed within adjacent woodland at this location.

A number of potential breaches were located and the edge of the fence was poorly secured to the ground for almost the entirety of the fence on the eastern side of the highway at Boat Harbour Creek (refer to *Figure 3.1, Insert A*).

3.4.2 *Bingis Lane*

A number of potential breaches were located and the edge of the fence was poorly secured to the ground for almost the entirety of the fence on the western side of the highway at Bingis Lane (refer to *Figure 3.1, Insert B*). Bandicoot diggings were common along the mulched areas adjacent to the woodland.

A number of potential breaches were located and the edge of the fence was poorly secured to the ground for almost the entirety of the fence on the eastern side of the highway at Bingis Lane (refer to *Figure 3.1, Insert B*).

3.4.3 *Pola Creek*

There were several small breaches within the fencing at Pola Creek (refer to *Figure 3.1, Insert C*). One dead Eastern Snake-necked Turtle (*Chelodina longicollis*) was recorded trapped under the fauna fence (refer to *Figure 3.1, Insert C*).

3.5 **ROAD KILL**

A total of three carcasses were identified which can be attributed to vehicle related mortality. Two of the carcass were reduced to skeletal material and were also recorded during the previous survey conducted in Summer 2014. These have not been considered further as part of this report, as they were discussed in the Underpass Monitoring Report – Summer 2014 (ERM 2014).

The third carcass was an unidentified macropod which still had some tissue and fur present but the state of the carcass (dismembered) made it difficult to identify to species level. It is likely to be a Red-necked Wallaby. This carcass was recorded approximately 81 m north of the Bingis Lane underpass, on the western side of the highway. Refer to *Figure 3.1* for location of the macropod carcass and its relative location to the fauna fencing.

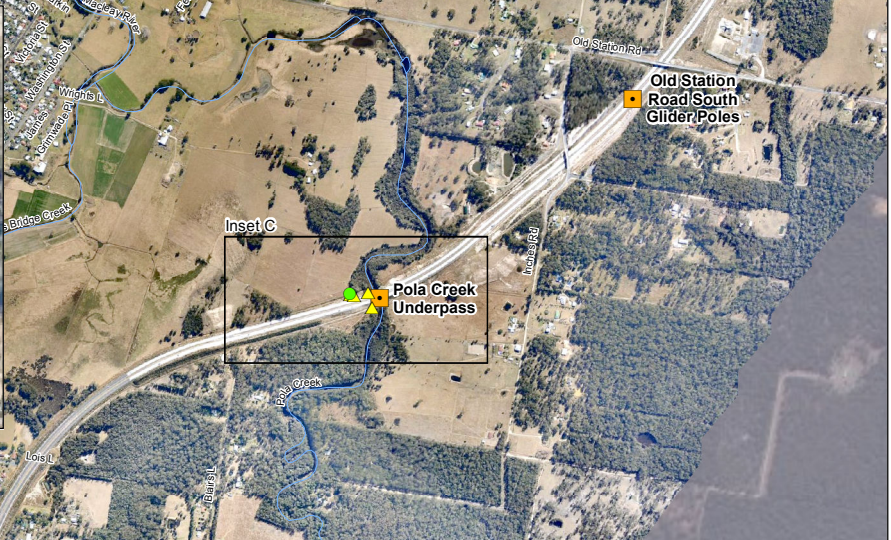
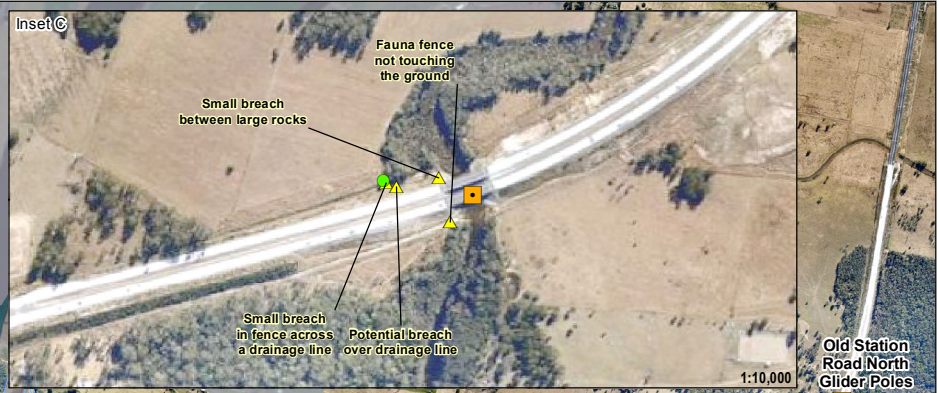
Legend

- Underpass and Crossing Location
- ▲ Fauna Fence Defect
- Long-necked Turtle Carcass (Trapped Under Fence)
- Macropod Carcass (Roadkill)

N

0 250 500 750m

1:30,000




Client:	Leightons Contractors Pty Ltd
Drawing No:	0212311b_UNDERPASS_AUT14_G001_R0.mxd
Date:	24/09/2014
Drawn By:	TC
Drawing Size:	A4
Reviewed By:	EL

Figure 3.1 - Fauna Fence and Road Kill Monitoring Results

Kempsey Bypass Alliance Fauna Monitoring Underpass Monitoring Autumn 2014

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Melbourne, Newcastle, Perth, Port Macquarie, Sydney



Imagery Source:
 Higher resolution - neamap captured 30/07/2014.
 Lower resolution - ESRI World Imagery captured 13/04/2010

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

DISCUSSION

Monitoring results show that the underpasses are providing suitable crossing points for a wide range of fauna to pass between habitats on the eastern and western side of the highway. No threatened species were recorded, however it appears that fauna have adapted quickly to using these crossing points following construction of the upgraded highway.

Following is a discussion of the results of the specific monitoring techniques.

4.1

HAIR FUNNELS

The hair funnel results demonstrate that small to medium native mammals are utilising two of the underpasses. There was no evidence from the hair funnels of arboreal species using the underpasses apart from the Brown Antechinus at Bingis Lane. This species is not solely arboreal, also spending some of the time foraging on the ground. There was an absence of native small mammals detected at Pola Creek with only the exotic House Mouse recorded.

In this monitoring event the hair funnels only detected the smaller mammals present within the underpasses. In conjunction with the other techniques discussed in this report, hair funnels remain a valid technique for identifying small mammals.

4.2

SCAT AND TRACK SEARCHES

The scat and tracks searches identified that three macropod species are using the underpasses including Pola Creek and Boat Harbour Creek, with no records from Bingis Lane. The use of the underpasses by macropods is important as they are vulnerable to vehicle strike and being terrestrial, are not able to cross at the other arboreal fauna crossings.

The underpasses also provide an opportunity for exotic mammals to cross the highway safely with European Red Fox, Domestic Dog and Black Rat recorded.

Scat searches can under represent smaller species as the scats are more difficult to detect. This was particularly noticeable amongst the dark soil and mulch within Bingis Lane and Boat Harbour Creek. Few small scats were also found on the rock platforms at Pola Creek and it is likely that dry scats could fall between the gaps in the rocks. This was not an issue with the larger scats, such as European Red Fox and waterbird scats which were clearly visible and often adhered to the rocks. Smaller scats are also more detectable on the smooth concrete benches at Boat Harbour and Pola Creek.

The tracks searches is a technique most useful for the areas adjacent to the underpass where soft mud and soil provided identifiable tracks, although usefulness is impacted by the preceding rainfall and other weather conditions.

The scat and track searches confirmed use of the underpasses by several species and is useful in conjunction with the other detection techniques used as part of the monitoring plan. For future scat searches, particular attention should be focused on the identification of any new species especially threatened species.

4.3

CAMERAS

All of the underpasses were utilised by several native and exotic species, with no threatened species recorded during the monitoring period. Additional cameras installed at Boat Harbour Creek and Bingis Lane since the Summer 2014 monitoring event resulted in the increased detection of mammals (especially small mammals) compared with the Summer 2014 results. These results indicate that there is the potential that small mammals were underrepresented during the Summer 2014 monitoring. The camera configuration used during the Autumn 2014 monitoring event was considered to largely represent the actual movements of animals utilising the underpasses.

Many of the events recorded were triggered by small mammals such as Brown Antechinus and Black Rats, a large proportion of which, were as a result of foraging behaviour or sheltering in the culverts. Few complete crossing were recorded for these species, however this may also result in some crossings not being detected due to the species being obscured by debris such as rocks. Although the cameras were not baited, the field of view included some of the hair funnels, which were simultaneously deployed during two weeks for the camera survey period. Several species appeared to investigate the hair funnels including Brown Antechinus and Black Rats, which appeared to skew the number of detection events.

The majority of the animals were recorded on the ground with relatively few records on the fauna furniture. At each of the underpasses any of the fauna would be required to travel across the ground to reach the underpasses and many may simply continue in this trajectory. The requirement to travel across the ground may also likely to reduce the number of more strictly arboreal mammal such as gliders. Several species did use the fauna furniture and it may provide a refuge from some predators such as dogs. Several exotic and native animals were recorded using the underpass to move between habitat on the east and west side of the highway, making complete crossings. The use of the underpasses by all species was relatively intermittent, with few species regularly using the underpass to move between habitats on the eastern and western side of the highway.

The underpasses should be considered successful as they will maintain connectivity for several native species and help to prevent populations becoming isolated by the road upgrade. However a concern is the presence of several exotic apex predators, at all of the underpasses as the underpasses have relatively little shelter within them and native species may be vulnerable to increased predation risk compared to more natural habitats. That being so, it is difficult to make a conclusion about whether the underpasses increase the predation risk to native fauna posed by exotic apex predators without detailed data on the density and predatory behaviour of the apex predators in the surrounding woodland.

4.4 FAUNA FENCING

Several defects were found with the fauna fencing, which may allow the fencing to be breached by some species, however the length of the gaps/maintenance issues were small and could be readily fixed (refer to *Figure 3.1*).

It was observed that at the base of the fauna fencing the chain mesh typically was bent back along the ground towards fauna habitat side (ie away from the carriageway side) (refer to *Photograph 3.4*). This would deter many species from passing through the fence however; it was often flicked up at the edge, providing potential for burrowing species to pass underneath the fencing. Two Eastern Snake-necked Turtle (*Chelodina longicollis*) carcasses have been recorded to date, one was recorded during the Summer 2014 monitoring, with the second recorded during this most recent monitoring event. On both occasions the turtles have become wedged under the lip of the fencing. Pegging down the edge of the fence would help to prevent this mortality and also reduce the chance of animals burying underneath.

4.5 ROAD KILL

The macropod carcass was recorded on the west side of the road, where the fauna fencing was intact, but terminating approximately 120m to the north. It is likely that animal accessed the road from the north or from the opposite side of the road where there is a large gap in the fauna facing.

Overall there were few carcasses recorded considering the 6km of road surveyed, and less than the previous monitoring in Summer 2014.

No small mammals were recorded, however this does not necessarily mean an absence of road based mortality. Small mammals are readily picked up and carried off for consumption by a wide variety of scavenging species. In contrast large mammals such as wallabies or kangaroos are typically consumed in situ.

The absence of animal carcasses within areas of the highway fenced on both side, indicates that the fauna fencing is successful in preventing the majority of animals accessing the road at these points. Further monitoring events will help to improve the reliability of this conclusion. The underpasses are being used by a range of native species and exotic species and many of the animals may use these after encountering the fauna fencing and moving parallel to the fencing until they encounter the underpass.

It can also be expected that a proportion of fauna will move parallel to the fauna fencing in the opposite direction to the underpasses. This would likely result in higher road mortality adjacent to where the fencing finishes. One macropod carcass was recorded on the western side of Bingis Lane underpass. Although the fauna fencing was present on that side of the road, the fencing terminated on the eastern side of the road immediately opposite.

4.6 COMPLIANCE WITH PERFORMANCE MEASURES AND CONTINGENCY MEASURES REQUIRED

Table 4.1 shows whether the performance measures, as per the Ecological Monitoring Program (Lewis Ecological Surveys 2012) and as identified in Section 1.3, are being met.

Table 4.1 Compliance with Performance Measures

Performance Measure/Potential Problems	Compliance Statement	Contingency Measures
Low usage rates of native species	Compliant. Several native species were recorded making complete crossing through the underpass at each of the underpasses.	None required.
One of more of the indicator species groups not using the underpass	<p>Boat Harbour Creek Only one of the indicator species groups (Macropods) was recorded, out of a possible five.</p> <p>Bingis Lane Four out of five indicator groups were recorded. Frogs were the only indicator group not recorded.</p> <p>Pola Creek Two of the four indicator groups were recorded. The two groups absent were frogs and reptiles. None of the underpasses were fully compliant on this performance measure. In addition no key target species were detected within any of the underpasses.</p>	<p>Contingency measures;</p> <ul style="list-style-type: none"> • Review/modify underpass fauna furniture or groundcover attributes adjoining the underpass. • Consider additional monitoring • Consult with the EPA.

Performance Measure/Potential Problems	Compliance Statement	Contingency Measures
Use by fauna with low dispersal abilities.	Compliant, small mammals with low dispersal ability were recorded from scats and by cameras within each of the underpasses. Brown Antechinus, a small native species was found at all of the underpasses.	None required.
Low rate of fauna road strike.	Compliant, with no fauna mortality with the areas of fauna fencing	None required.
No breaches in the fauna fence.	Not fully compliant, some small breaches were present and require maintenance.	No contingency measures triggered as there were no accompanying road kill. Maintenance is recommended

In addition to the five performance measures used to comment on the success of the underpasses and the related contingency measures, it was identified that the presence of several exotic predators within the underpasses is of some concern. *Table 4.2* below outlines this potential problem and the related contingency measures, are per the Ecological Monitoring Program (Lewis Ecological Surveys 2012).

Table 4.2 *Additional contingency measures for potential problems*

Potential Problem	Compliance Statement	Potential Contingency Measures
High visitation rates by exotic predators	Moderate visitation by Domestic Dog, European Fox and Domestic Cat were recorded and may present a threat to native species.	Potential contingency measures include Review/modify design. Seek advice from Livestock Health and Pest Authority concerning potential control methods.

5.1 COMPLIANCE WITH PERFORMANCE MEASURES AND CONTINGENCY MEASURES REQUIRED

The underpasses were found to be successful and largely compliant with the performance measures, however there were two areas which triggered contingency measures:

- for each of the underpasses at least one of indicator species groups were not detected using the underpass. Frogs were not recorded using any of the underpasses, however this may represent a lack of detection rather than complete absence. Many of the monitoring techniques are unlikely to detect this group. Nocturnal visual surveys in periods of warm, wet weather would help to determine if the indicator group are using the underpasses. It is likely that the other indicator groups would be detected by the monitoring techniques used, therefore it is likely that the species are not using the underpasses or doing so infrequently or seasonally. If the continuing underpass monitoring fails to detect these indicator groups using the underpasses, it is recommended that contingency measures are considered as outlined in *Table 4.1*;
- the presence of several exotic predators recorded within the underpasses is of some concern, however based on the monitoring to date is best described as moderate visitation, rather than high (which would trigger the contingency measure). It is advised that this issue is reviewed on subsequent monitoring round. Potential control methods will need to consider the proximity of the underpasses to several private properties; and

Additional cameras installed at Boat Harbour Creek and Bingis Lane since the Summer 2014 monitoring event resulted in the increased detection of mammals (especially small mammals) compared with the Summer 2014 results. These results indicate that there is the potential that small mammals were underrepresented during the Summer 2014 monitoring. The camera configuration used during the Autumn 2014 monitoring event was considered to largely represent the actual movements of animals utilising the underpasses. Other contingency measures include reviewing/modifying the underpass fauna furniture or groundcover attributes adjoining the underpass and consulting with the EPA. However, these key target species (Brush-tailed Phascogale and Koala) are likely to exist in relatively low numbers within the surrounding habitat and are unlikely to make regular passes through the underpasses.

5.2 *CAMERA TRAPPING*

It is recommended that the placement and number of cameras used at all three of the underpasses are maintained for any future monitoring events. The current arrangement was considered to largely represent the actual movements of animals utilising the underpasses.

5.3 *FAUNA FENCING*

Several maintenance activities should be conducted on the existing fauna fence including, reattaching metal panels, re-joining fence panels and making sure the base of the fencing is effectively contacting the ground.

Recommended maintenance actions are:

- reattachment of the metal panels to the fauna fence, south of Boat Harbour Creek underpass;
- ensuring the fence contacts the ground, south of Harbour Creek underpass;
- ensuring the fence contacts the ground, east, south east and north west of Bingis Lane underpass;
- re-join the chain mesh fencing panels, south of Bingis Lane underpass;
- close off a breach over a drainage line, north west of Bingis Lane;
- fix breaches in fencing over two drainage lines, west and north of Pola Creek;
- fix a small breach between rocks north of Pola Creek; and
- ensuring the fence contacts the ground south of Pola Creek

A modification of the fencing design is also recommended, pegging the edge of the fauna fence to the ground. Currently the lip of the fauna fence flicks up, in any many areas. There is the potential for fauna to force themselves underneath the fence and this has resulted in the mortality of two Eastern Snake-necked Turtles, which had become trapped beneath the fence. Pegging down this edge of the fencing may also reduce the ability of burying animals to force their way beneath the fence.

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