Commonwealth approval EPBC 2013/6963 conditions compliance tracking and management annual report

Nambucca Heads to Urunga Pacific Highway Upgrade

February 2021 – January 2022

February 2022 | Version: 1

Contents

Glossary / Abbreviations

Acronyms used in this document

Acronym	Definition
BEM	Benchmark Environmental Management
CAR	Corrective Action Request
CEMP	Construction Environmental Management Plan
Clear Milkvine	Marsdenia longiloba
Cryptic Forest Twiner	Tylophora Woollsii
Ecos	Ecos Environmental Pty Ltd
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ER	Environmental Representative - A suitably qualified and experienced person independent of project design and construction personnel employed for the duration of construction. The principal point of advice in relation to all questions and complaints concerning environmental performance.
NCR	Non Conformance Report
NGOMP	Norton and Griffin Offset Management Plan
SAP	Sensitive Area Plan
SES	Sandpiper Ecological Surveys
TFOMP	Threatened Flora Offset Management Plan
TFMP	Threatened Flora Management Plan
TFOS	Threatened Flora Offset Strategy

Introduction

1.1 Purpose of this document

The purpose of this document is to facilitate demonstration by Transport for New South Wales (TfNSW) of satisfactory compliance with the Commonwealth approval conditions for the Nambucca Heads to Urunga Pacific Highway Upgrade project with particular reference to Condition 24, which requires an annual report addressing compliance with each of the conditions of approval. The report covers the eighth period from February 2021 to January 2022.

For each condition, one or more actions are identified which, once implemented, will achieve satisfactory compliance with the condition. Where appropriate, the timing for completion of individual actions is identified.

For each action, the minimum relevant documentation to support demonstration of compliance is identified. This documentation would inform any future compliance audit.

Where an approval condition makes reference to information being provided to the Commonwealth Minister for the Environment, the associated action(s) assumes that this information will be provided, in the first instance, to the Commonwealth Department of the Environment.

1.2 Key dates

The timing for compliance with certain approval conditions is linked to specific dates as follows:

- Commonwealth approval: 26 November 2013
- Start of construction: 4 December 2013
- Completion of construction: 14 February 2018
- Expiry of Commonwealth approval 1 January 2031
- Publish 8th Annual Compliance Report 4 March 2022

1.3 Responsibility for compliance

Responsibility for compliance with all approval conditions sits with TfNSW.

1.4 NSW planning approval

Condition 29 (of the Commonwealth approval) provides for the use of plans, strategies or reports required under the NSW approval to satisfy the requirements of the Commonwealth approval, subject to provision of a separate document demonstrating how the document addresses the relevant Commonwealth approval requirements.

Specialists in the fields of flora and fauna have been engaged by TfNSW and the construction contractor to undertake various ecology-related management activities with regard to complying with the NSW planning approval and the CEMP. The following specialist had been engaged to undertake ecology related activities prior to the EPBC approval:

- Benchmark Environmental Management (BEM) has prepared an ecological monitoring program that addresses relevant matters in the NSW planning approval. The ecological

monitoring program has been incorporated into the CEMP for the contractor to implement during construction.

- Ecos Environmental (Ecos) has been engaged by TfNSW to prepare a Threatened Flora Translocation Program that addresses relevant matters in the NSW planning approval and has additionally been engaged by the contractor to provide advice on the implementation of the translocation program and provide specialist advice on flora to implement other CEMP requirements.
- Sandpiper Ecological Surveys (SES) has been engaged by the contractor to provide specialist advice on fauna to implement CEMP requirements.
- SES has been engaged by TfNSW to undertake the ongoing operational phase monitoring as required under the approved ecological monitoring program.

This document contains actions relevant to compliance with Commonwealth approval requirements.

1.5 Definitions for action status conditions

TBA	To Be Arranged - Further works required prior to starting action.
In progress	Action initiated but not yet complete.
Ongoing	Action in place but ongoing works required to ensure compliance.
Compliant	Action completed and compliant with Condition of Approval

1.6 Non-Compliances with EPBC Conditions

No non-compliances were recorded for the period February 2021 to January 2022.

Condition 1

The person taking the action must not clear more than:

a) 171 ha of Koala habitat;

b) 184 ha of Grey-headed Flying-fox habitat

c) 166 ha of Spotted-tail Quoll habitat;

d) 73 ha of habitat for the Swift Parrot and Regent Honeyeater; and

e) 36 ha of habitat for the Cryptic Forest Twiner and Clear Milkvine.

Action	Timing	Status	Compliance evidence
1.1 Progressive review of area cleared	Regularly during construction	Compliant	Record of clearing numbers
1.2 Review outstanding clearing requirements at 75% clearing to confirm clearing limitation targets will be met	Construction (75% clearing)	Compliant	Memo provided 18-6-2014
1.3 Confirm clearing limitation targets have been met	Post-construction	Compliant	As built survey of actual clearing area.

Final Clearing Quantities (EN1 FDD + Additions)			
Habitat Type	**Final Clearing Quantity (ha)**	**Limit (ha) as per Condition 1 Approval**	**Current Difference showing remaining habitat (ha) under Condition 1 Approval**
Koala	157.89	171	13.11
Grey-headed Flying-fox	170.84	184	13.16
Spotted –tail Quoll habitat	71.40	166	94.60
Swift Parrot and Regent Honeyeater	71.40	73	1.60
Cryptic Forest Twiner and Clear Milkvine	34.11	36	1.89

Mainline clearing was completed during 2014. Small amounts of clearing were undertaken throughout 2015 and 2016.

Clearing has been completed and the table above (Final Clearing Quantities (EN1 FDD + Additions) shows the final figures for each habitat type. Clearing totals for each habitat type were less than the approved limits in accordance with Condition 1.

Condition 2

Within 30 days of the completion of *construction* works, the person taking action must:

a) notify the Minister in writing of the completion of construction; and

b) provide a report (supported by appropriate mapping) that clearly shows the location of all vegetation and EPBC species habitat cleared as a result of the action, and that demonstrates compliance with Condition 1.

Action		Timing	Status	Compliance evidence
2.1	Prepare works as executed Environmental and Clearing Plans to show extent of clearing.	Within 30 days of construction completion	Compliant	Report & supporting mapping provided
2.2	Calculate final clearing quantity and include in summary table.	Within 30 days of construction completion	Compliant	Report & supporting mapping provided
2.3	Provide written notification (letter) of completion of construction and report to Dept of the Environment	Within 30 days of construction completion	Compliant	Notification letter provided 7/03/18.

Completion of construction occurred on 14 February 2018. A report was produced and included in the February 2017 to January 2018 Annual Compliance report.

Condition 3

The *person taking the action* must undertake progressive rehabilitation of *EPBC species' habitat* in areas where *temporary infrastructure* is to occur or, where *short term* impacts are anticipated. Where appropriate, the landscaping / rehabilitation of these areas must be done in a manner that targets the needs and requirements of *EPBC species*.

	Action	Timing	Status	Compliance evidence
3.1	Finalise urban design and landscape plan to capture rehabilitation and revegetation temporary works and areas of short term impact.	Pre-construction or prior to any works in EPBC species habitat areas during construction	Compliant	Urban Design and Landscape Plan
3.2	Implement rehabilitation / landscaping of affected areas as per landscape design.	Following cessation of use of affected areas	Compliant	No EPBC species habitat was cleared as part of the creation of temporary infrastructure

Note: Urban Design Landscape Plan was approved by NSW Department of Planning (DoP) in February 2015.

Landscape planting commenced on Wednesday 4th November 2015. All permanent landscaping works have been completed across the project. Ongoing maintenance works including weed management will be undertaken by the contractor for three years following construction completion under their deed requirements.

No EPBC species habitat was cleared as part of the creation of temporary infrastructure or short term impacts as part of the project.

All sites classified as Temporary Infrastructure for the project were located in areas where no confirmed EPBC habitat was located, and also no Biometric vegetation communities were cleared for the creation of these sites i.e. located in areas previously cleared for agricultural or Forestry purposes.

Condition 4

At completion of construction (and every three years thereafter for the life of this approval or until *the Minister* has agreed in writing that further revisions are no longer required) a progress report assessing the effectiveness of restoring habitat on site (in accordance with Condition 3) must be provided to *the Minister*.

	Action	Timing	Status	Compliance evidence
4.1	Annual Compliance Report Number 3 to Dept of the Environment	March 2017	Compliant	SAP's showing temporary infrastructure was not located within EPBC Species habitat

Landscape planting commenced on Wednesday 4th November 2015. All permanent landscaping works have been completed across the project. Ongoing maintenance works including weed management will be undertaken by the contractor for three years following construction completion under their deed requirements.

No EPBC species habitat was cleared as part of the creation of temporary infrastructure or short term impacts as part of the project.

All sites classified as Temporary Infrastructure for the projects were located in areas where no confirmed EPBC habitat was located, and also no Biometric vegetation communities were cleared for the creation of these sites i.e. located in areas previously cleared for agricultural or Forestry purposes.

Condition 5

Prior to *commencement of the action* the person taking the action must engage a *suitably qualified expert* to:

a) map any areas of habitat for EPBC species that lie adjacent to the construction zone;

b) map the locations of known individuals of Clear Milkvine and Cryptic Forest Twiner that lie adjacent to the construction zone;

c) map any areas of lowland rainforest of subtropical Australia that lie adjacent to the construction zone; and

d) clearly mark exclusion zones along (or around) these areas on site.

Action		Timing	Status	Compliance evidence
5.1	Engage suitably qualified expert	Prior to start of construction	Compliant	Ecos Environmental mapped vegetation and habitat types with information included in SAPs.
5.2	SAPs to show required items	Prior to construction in affected areas	Compliant	SAPs drafted prior to start of construction. SAPs – amended as required with any updated information
5.3	Exclusion zones to be marked on site as appropriate	Prior to construction in affected areas	Compliant	Exclusion zone delineation installed prior to construction in affected areas and maintained as required. Ongoing compliance documented through surveillance checklist.
5.4	SAPs Updated	Construction	Compliant (last revised October 2014)	SAPs updated following new information or removal of sensitive area. Tracked through updated revision of the SAPs.

Condition 6

To mitigate and reduce indirect impacts on the *exclusion zones* identified as a requirement of Condition 5, the *person taking the action* must:

a) ensure that temporary and high visibility fencing will be erected to restrict access to exclusion zones. Temporary fencing must be of a design appropriate to deter the passage of vehicles or placement of construction materials, equipment and waste, in exclusion zones where accidental incursion could reasonably occur;

b) implement measures to prevent the spread or establishment of new or additional weed species, soil or plant pathogens into these exclusion zones as a result of construction;

c) implement stormwater management measures to prevent the unintentional diversion or discharge of stormwater during both construction and operation over exclusion zones; and

d) implement targeted measures for managing construction impacts to Cryptic Forest Twiner and Clear Milkvine associated with dust, sedimentation and erosion.

Action	Timing	Status	Compliance evidence
6.1 Implement protection measures:			
(a) Fencing of exclusion zones	During construction	Compliant	Exclusions zones installed prior to clearing. Exclusion delineation to be maintained until construction completion. Environmental surveillance checklist documenting compliance.
(b) Prevent spread of weeds, soil or pathogens	During construction	Compliant	CEMP measures include implementation of TfNSW best practice measures detailed in the biodiversity guidelines. Including plant wash down prior to entry onto site and separation and segregation of weed infested topsoil. Environmental surveillance checklist documenting compliance.

(c) Stormwater measures to prevent discharge of stormwater during construction and operation over exclusion zones	Detailed design and during construction	Compliant	Detailed design includes the retention and treatment of road runoff adjacent to sensitive areas. CEMP measures include implementation of best practice erosion and sediment controls during construction. Environmental surveillance checklist documenting compliance
(d) Implement target measures to manage construction impacts to threatened flora.	During construction	Compliant	Directly and indirectly impacted threatened flora removed from site through implementation of Threatened Flora Management Plan. CEMP includes best practice measures to manage dust and erosion and sedimentation impacts. Environmental surveillance checklist documenting compliance. Progressive revegetation to be undertaken to provide dense ground cover that excludes weeds. Revegetation checklists maintained monthly.
6.2 Monitor In-situ Roadside Threatened Flora	Every 6 months for the first two years and then yearly for 5 years.	Compliant - (Monitoring completed in Jan 2021)	Summary of roadside threatened plant monitoring included in the annual translocation monitoring report in Appendix 1.

Appendix 1 provides details of the results of the NH2U Year 5 (Operational phase) monitoring of Slender Marsdenia. Since the Year 3 report recommended cessation of monitoring of in-situ plants, no further evaluation of them is provided beyond that provided in the Year 4 report (Richards 2021), which showed that two of three performance indicators (PIs) had been met.

It should be noted, that all three PIs for Slender Marsdenia were met in Year 3, and the third PI was not met in Year 4. This fluctuation in survival and condition in Slender Marsdenia is discussed in more detail in the NH2U Year 5 Report (Appendix 1).

[Note- Mr Richards is a recognised species expert for slender marsdenia (*Marsdenia longiloba*) in accordance with Section 5.3 of the Biodiversity Assessment Method 2020.]

Condition 7

The *person taking the action* must engage a *suitably qualified expert* to undertake pre-clearing fauna searches within all areas proposed for disturbance, including: hollow bearing trees, logs, existing culverts and bridges, no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the *Koala* and *Spotted-tail Quoll*.

Action		Timing	Status	Compliance evidence
7.1	Engage suitably qualified expert	Prior to start of construction	Compliant	Sandpiper Ecological Surveys engaged by contractor in accordance with SWTC Appendix 5.
7.2	Pre-clearing fauna searches identified as activity in fauna management plan (or equivalent)	Prior to start of construction	Compliant	BEM Ecological Monitoring Program
7.3	Undertake pre-clearing fauna searches as required	Prior to start of construction in specified areas	Compliant	Environmental surveillance checklist.

- Sections 2.1 and 3.2 of the ecological monitoring program prepared by BEM and the approved CEMP addresses undertaking pre-clearing fauna searches and fauna relocation.
- Section 5 of the ecological monitoring program prepared by BEM addresses reporting.

Condition 8

The *person taking the action* must implement measures to relocate and/or ensure the appropriate care of individuals of *EPBC species* that are identified during searches referred to in condition 7.

Action	Timing	Status	Compliance evidence
8.1 Provide for appropriate fauna relocation measures in CEMP documentation	Prior to construction	Compliant	Fauna rescue procedure contained with the FFMP. A specific koala relocation strategy has been prepared and forms an attachment to the Clearing and Grubbing Environmental Work Method Statement.
8.2 Relocate affected fauna as per procedures in ecological monitoring program	As part of pre-clearing activities	Compliant	Environmental surveillance checklist.

Note:

- CEMP contains fauna rescue procedure and a specific koala relocation strategy was developed by SES in consultation with NSW EPA Senior Threatened Species Officer.
- No EPBC fauna was relocated or EPBC threatened flora observed during the reporting period.

Condition 9

Prior to *commencement of the action* the *person taking the action* must engage a *suitably qualified expert* to collect baseline data on *local populations* of the *Koala* and *Spotted-tail Quoll*. The data must address the likely densities and distribution of these species within all habitat *adjacent to* the *construction* footprint that are likely to contain these species and that are likely to be adversely impacted by *the action* (as determined by a *suitably qualified expert*).

Action		Timing	Status	Compliance evidence
9.1	Engage suitably qualified expert	Prior to start of construction	Compliant	TfNSW engagement of BEM.
9.2	Review existing baseline data and assess adequacy with regard to specified matters for management of impacts on identified fauna species	Prior to completion of clearing.	Compliant	Short report or equivalent documenting review outcomes and any identified information gaps
9.3	Where substantive information gaps are identified, develop strategy to obtain required information	Prior to construction activity in adjacent to areas containing potential habitat for either of the two species	Compliant	Short report or equivalent documenting methodology used for monitoring, results of monitoring and compiling the new results with existing information.

Note:

- BEM provided the report in August 2014 that consolidates actions 9.2 and 9.3. The report concluded that the local koala population in the vicinity of the Project corridor is of low density. Consequently, the available information is insufficient to determine an accurate estimate of the koala population. However, assuming there is a low density of koalas in the locality, the Project corridor appears to traverse only a small number of home ranges of individual koalas. The project design incorporates a combination of fauna exclusion fencing and fauna underpass structures within 500 metres of each sample site where koala activity was recorded. The Project is expected to have minimal impact on the viability of the local koala population by preventing direct mortalities during vegetation clearing and operation and by maintaining opportunities for safe koala movement across the Project corridor once operational.
- In reference to Spotted Tail Quolls, no quolls were identified during the study. This is not definitive evidence that the species does not occur in the study area. Whether there is a resident population is uncertain but the distribution of records and presence of recent (2010) records are sufficient to conclude that quolls utilise the study area. Quolls are predicted to occur at low densities and with heightened awareness records may be obtained during construction or in the operational phase. Given the predicted occurrence of quolls the implementation of specific measures, such as underpasses and fauna fencing is warranted to enable quolls to effectively cross the upgraded highway.

- Koala surveys completed by OEH (Jon Turbill) for Bellingen and Nambucca Shire Councils were also used to assess the need for fauna fencing. Following a meeting onsite, further fauna fencing was specified for the south of Oyster Creek. This followed Kola sightings to the immediate east of Oyster Creek during OEH monitoring. This fencing has been installed.

Condition 10

The person taking the action must construct and maintain fauna crossings and fencing in areas that are likely to benefit the Koala and Spotted-tail Quoll.

Action	Timing	Status	Compliance evidence
10.1 Provide for fauna crossings and fencing in detailed design	During design	Compliant	Final design showing required fauna crossings and fencing.
10.2 Construct fauna crossings and fencing	Construction	Compliant	As provided in previous Annual Compliance reports
10.3 Undertake regular maintenance of fauna crossings and fencing	Post-construction	Compliant	Annual reporting and/or maintenance inspection reports.

Note:

- Construction of the permanent fauna fencing commenced in June 2015.
- All combined /dedicated fauna crossing have been completed and installation of the vertical and horizontal refuge poles that offer connection from the mitigation structures to the adjacent native vegetation. A total of 22 combined and 4 incidental crossing have been constructed on the project
- The project scope has increased to include approximately 4km of additional permanent fauna fencing to be installed around the Waterfall Way intersection. The fencing will start at the Shortcut/South arm intersection and work its way to the northern most extent of the project. This followed the Koala road kill recorded in August 2014 immediately south of the existing Waterfall Way Interchange. This work was completed in the first half of 2016.
- Fauna Fencing was completed in August of 2016.
- Ongoing review and maintenance as required of the fauna fence and crossings continues during the operational phase.
- Following a Spotted Tailed quoll strike in May 2021, TfNSW completed (September 2021) an extension of the floppy top fauna fence from approximate Chainage 80950 to tie into Short Cut Rd overpass bridge abutments on both the west and eastern side of the alignment. This was an extension of approximately 550 m on both sides of the NH2U alignment, and a total of approximately 1100m of additional fauna fence. This extension of the floppy top fauna fence has effectively created a ‘closed’ fauna fencing system of approximately 5km in this section of the NH2U project, from the northern Raleigh interchange south to the Kalang River Bridge

Condition 11

The *person taking the action* must engage a *suitably qualified expert* to advise on the design and location of *fauna crossings*, fencing and road medians, for the purpose of maintaining habitat connectivity and facilitating the safe passage of the *Koala* and *Spotted-tail Quoll* across the Pacific Highway.

A *suitably qualified expert* must also be engaged to design a comprehensive monitoring program that tests the *long term success* of these measures.

Action	Timing	Status	Compliance evidence
11.1 Design development in consultation with NSW EPA Biodiversity Specialist	During design	Compliant	Environmental Design Fauna Crossing Refinements report approved by NSW DP&I.
11.2 Engage suitably qualified expert to design monitoring program	Prior to start of construction	Compliant	TfNSW engagement of BEM
11.3 Prepare monitoring program	Prior to start of construction	Compliant	BEM Ecological Monitoring Program

Note:

- Monitoring addressed via Section 3.5 of BEM ecological monitoring program.
- The Before-After Control Versus Impact (BACI) design of the monitoring program requires the monitoring of the fauna crossings prior to the installation of the fauna fence (i.e. before the underpass structures become operational).
- The first stage of the construction phase underpass monitoring was conducted in October and November 2014. The second stage was undertaken in February and March 2015.

Condition 12

To inform the *long term success* of *fauna crossings*, fencing and road medians the *person taking the action* must engage a *suitably qualified expert* to prepare a strategy for monitoring and recording any road kill sightings of the *Koala* and *Spotted-tail Quoll* along the *Pacific Highway*. Prior to *commencement of the action*, the road kill monitoring and recording strategy must be implemented.

Action	Timing	Status	Compliance evidence
12.1 Ecological Monitoring Program to include road kill monitoring and recording strategy	Prior to start of construction	Compliant	Section 3.5.3 of the Ecological Monitoring Program specifies road mortality monitoring and recording strategy
12.2 Implement strategy	Prior to start of construction and ongoing during construction	Compliant	Environmental surveillance checklist developed
12.3 Report on outcomes of monitoring strategy	Construction Post-construction	Compliant	Annual reporting- Appendix 2 includes outcomes of roadkill monitoring.

One road kill of Spotted-Tail Quoll was recorded during the reporting period.

- 12 May 2021, Spotted-Tail Quoll road kill observed approximately 400m south of the Short Cut Road Overpass.

The road strike was reported to the EPA and an inspection of the Fauna Fence was completed. The inspection identified no obvious defects in the fauna fence and all gates were closed in the surrounding areas of the road kill.

Given this was the second Spotted-Tail Quoll recorded as road kill on the project (first strike recorded 19 Nov 2020) and in the same area of the Project, TfNSW reviewed the extent of fauna fence in the areas of the quoll strikes, and considered it feasible and warranted to extend the fauna fence.

On the 15 September 2021, TfNSW completed the extension of the floppy top fauna fence from approximate Chainage 80950 to tie into Short Cut Rd overpass bridge abutments on both the west and eastern side of the alignment. This was an extension of approximately 550 m on both sides of the NH2U alignment, and a total of approximately 1100m of additional fauna fence. This extension of the floppy top fauna fence has effectively created a ‘closed’ fauna fencing system of approximately 5km in this section of the NH2U project, from the northern Raleigh interchange south to the Kalang River Bridge.

Condition 13

One year following the *completion of construction works*, the *person taking the action* must provide a report to *the Minister* detailing the success and/or failings of *fauna crossings*, fencing and road medians in achieving their intended purpose. The report must address (but need not be limited to):

a) baseline data collected as a requirement of conditions 9 and 12;

b) the number, design and location of fauna crossings, fencing and road medians, accompanied by maps and photographs;

c) details of a monitoring program to determine the long-term success of fauna crossings, fencing and road medians (including timing, duration, methodology, and performance objectives);

d) the success of fauna crossings to date; and

e) a comparison of data / results from other projects involving upgrades to the Pacific Highway regarding the long-term success of fauna crossings and/or fencing;

The report must be updated on a three-yearly basis until the *long term success* of *fauna crossings* has been proven or *the Minister* has agreed in writing that further revisions are no longer required. All updated reports must be provided to *the Minister* within three years of the last report having being submitted.

Action	Timing	Status	Compliance evidence
13.1 Provide fauna crossings, fencing and road medians outcomes report to Dept of the Environment	February 2019	Compliant	Transmittal form (and any confirmation of receipt)
13.2 Provide updated fauna crossings, fencing and road medians outcomes report to Dept of the Environment	February 2022	Compliant	Transmittal form (and any confirmation of receipt). The Operational Phase Biodiversity Monitoring Report 2021 is available in Appendix 2.
13.3 Provide updated fauna crossings, fencing and road medians outcomes report to Dept of the Environment	February 2025	TBA	Transmittal form (and any confirmation of receipt)

A summary of the ecological monitoring outcomes of the Operational Phase Biodiversity Monitoring 2021/22 is provided below, with the full report available in Appendix 2.

- Dog and fox accounted for the majority (95%) of feral predator underpass use in 2021. A proactive approach is warranted given the level of dog activity at koala sites and time between monitoring periods (i.e. year 7 - 2023). Collaborative feral dog trapping programs have been successful on other Pacific Hwy Projects (Sandpiper Ecological 2021) and it is recommended that a similar program be implemented at Dalhousie, Martells Bridge, Martells South and Martell's North.
- Monitoring has shown that fauna furniture is functional, and underpasses are providing safe passage for close to 90% of the mammal species recorded in adjacent habitat.
- Eight cover-dependent and/or low mobility species have been recorded using underpasses at NH2U, with an additional sixteen recorded in the adjacent habitat.
- During autumn monitoring, a spotted-tailed quoll was confirmed using fauna furniture at Martell's South.
- Koala was recorded on three occasions, including two complete crossings of the Dalhousie and Martell's North underpasses in spring 2021. The third record was of an individual on the west side of Dalhousie one week before the complete crossing was recorded. Complete crossings by koala have now been recorded at three of the seven impact sites, including a record at Tyson's in 2019. Results are encouraging despite low population density in the study area

Condition 14

Should monitoring associated with conditions 11 to 13 demonstrate that the use of *fauna crossings* and/or fencing is not achieving its intended purpose or is having a detrimental effect upon *EPBC species* (as determined by *the Minister*), *the Minister* may request that the *person taking the action* implement alternative forms of mitigation and/or corrective actions to address the relevant impacts to *EPBC species*. Such measures must be implemented as requested.

Action	Timing	Status	Compliance evidence
14.1 Implement additional mitigation/corrective actions	As and when directed by the Minister	TBA	As directed by the Minister

One road kill of Spotted-Tail Quoll was recorded during the reporting period.

- 12 May 2021, Spotted-Tail Quoll roadkill was observed approximately 400m south of the Short Cut Road Overpass.

The road strike was reported to the EPA and an inspection of the Fauna Fence was completed. The inspection identified no obvious defects in the fauna fence and all gates were closed in the surrounding areas of the roadkill.

Given this was the second Spotted-Tail Quoll recorded as roadkill on the project (first strike recorded 19 Nov 2020) and in the same area of the Project, TfNSW reviewed the extent of fauna fence in the areas of the quoll strikes, and considered it feasible and warranted to extend the fauna fence.

On the 15 September 2021, TfNSW completed the extension of the floppy top fauna fence from approximate Chainage 80950 to tie into Short Cut Rd overpass bridge abutments on both the west and eastern side of the alignment. This was an extension of approximately 550 m on both sides of the NH2U alignment, and a total of approximately 1100m of additional fauna fence. This extension of the floppy top fauna fence has effectively created a ‘closed’ fauna fencing system of approximately 5km in this section of the NH2U project, from the northern Raleigh interchange south to the Kalang River Bridge.

Condition 15

The *person taking the action* must implement a salvage and translocation program for all individuals of *Clear Milkvine* and *Cryptic Forest Twiner* that are proposed to be cleared as a result of *the action*. Translocation procedures must be developed and implemented by a *suitably qualified expert* in accordance with *Guidelines for the Translocation of Threatened Plants in Australia* prepared by the Australian Network for Plant Conservation.

Action	Timing	Status	Compliance evidence
15.1 Engage suitably qualified expert	Prior to construction	Compliant	Engagement of Ecos to prepare Threatened Flora Management Plan.
15.2 Develop translocation procedures	Prior to construction	Compliant	Ecos TFMP developed in consultation with NSW EPA Biodiversity Specialist and approved by NSW DP&I.
15.3 Implement translocation procedures	During construction	Compliant	Annual reporting. First report completed January 2015. Second report completed January 2016, third report completed 2017, and fourth report completed 2018, fifth report 2019, sixth report 2020, and seventh report 2021 (see Appendix 1).

Notes:

- These two species are referenced in Section 2.7 (*Establishment of translocation areas*) of the BEM ecological monitoring program by their scientific names, ie *Marsdenia longiloba* (Clear Milkvine), and *Tylophora woollsii* (Cryptic Forest Twiner).
- A Threatened Flora Translocation Program was developed by Ecos in consultation with the NSW Biodiversity Specialist and approved by the NSW DP&I. The program includes a salvage and translocation program for all individuals of *Clear Milkvine* and *Cryptic Forest Twiner* that are proposed to be cleared and the program is considered to meet the requirements of Condition 15.

Condition 16

One year following the *completion of construction works*, *the person taking the action* must provide a report to *the Minister* detailing the long term success of the translocation program. The report must include, but need not be limited to:

a) background information on translocated species (in relation to ecological requirements and life history);

b) the scope of the translocation program (with respect to timing, duration, methodology, and objectives, as well as comprehensive details on the recipient translocation site(s) and how they meet the ecological requirements of each species);

c) details of a comprehensive monitoring program to determine the long-term success of translocation; and

d) the success of translocation to date.

Action	Timing	Status	Compliance evidence
16.1 Prepare translocation outcomes report addressing specified matters and other relevant matters	2019	Compliant	Feb 2019 EPBC annual compliance tracking report
16.2 Provide translocation outcomes report to Dept of the Environment	Feb 2019	Compliant	Transmittal form (and any confirmation of receipt) - Feb 2019 EPBC annual compliance tracking report

Condition 17

The report must be updated on a three-yearly basis to provide further insights on the *long-term success* of translocation. All reports must be provided to *the Minister* and made available on the *person taking the action's* website for the life of this approval or until *the Minister* has agreed in writing that further revisions are no longer required.

Action	Timing	Status	Compliance evidence
17.1 Update translocation outcomes report and provide to Dept of the Environment	February 2022	Complaint	Completed report Transmittal form (and any confirmation of receipt). (Appendix 1 Threatened Flora Monitoring Report 2021)

In accordance with the approved Threatened Flora Management Plan, the following performance indicators (PIs) are used to evaluate the threatened species translocations (salvage translocation and population enhancement):

a) All directly impacted individuals of threatened species were salvaged and relocated to the receival sites.
b) At least 60% of transplant and enhancement individuals are surviving after the first year, 50% after five years and 40% after eight years.
c) At the end of the monitoring program (8 years), at least 50% of surviving individuals have a Condition Class of 3 or higher.

Slender Marsdenia

a) All directly impacted Slender Marsdenia were salvaged and relocated to the receival sites.

b) After eight years of monitoring, the mean survival rate (i.e. Condition Class 2 or better) of all Slender Marsdenia plants stands at **45.1**%, which exceeds the Performance Indicator for Year 8. The actual percentage of surviving plants is likely to be much higher, as many plants that currently lack an aerial stem (i.e. are currently in Condition Class 1) would still be alive and may resprout in the future. Many years of field observations of wild and translocated Slender Marsdenia plants by the author strongly indicates that this is a natural part of the life history of this species. As noted in the NH2U Year 4 report (Richards 2021) successful achievement of the PIs for this species is as dependent on climatic factors as much as anything else. A wet, mild 'La Niña' weather pattern arrived in October 2021 following a very dry 4-month period. It would be expected that more plants will produce aerial shoots, and be in better overall condition, should such a weather pattern persist.

c) Probably for the above reasons, only the third Performance Indicator for Slender Marsdenia has not been met. Currently, 83 plants (**28%**) are in Condition Class 3 or greater. Despite this third PI not being met, the species expert (Peter Richards) considers that the translocation program for Slender Marsdenia has been successful, and there is a very high likelihood that the translocated population will persist into the future. The translocated Slender Marsdenia population is not exhibiting a trend of continual reduction in plant numbers. Surviving plants appear to be established and

would be expected to exhibit annual change in apparent health, depending upon prevailing climatic conditions. The third PI is problematic with regard to a plant such as Slender Marsdenia which can sporadically die back to its subterranean rhizome and not produce an aerial stem for more than 4 years (Richards 2019).

[Note- Mr Richards is a recognised species expert for slender marsdenia (*Marsdenia longiloba*) in accordance with Section 5.3 of the Biodiversity Assessment Method 2020.]

Condition 18

With reference to the *department's offset policy*, the *person taking the action* must provide for *the Minister's* approval a threatened flora offset strategy for the *Clear Milkvine* and *Cryptic Forest Twiner*, within 12 months of the date of this approval. *The Minister* will only approve the Threatened Flora Offset Strategy (TFOS), if it demonstrates how a threatened flora offset meeting no less than 90 % of the direct offset requirements (as determined *by the department* in accordance with the offset user guide) will be legally secured in perpetuity within two years of the date of this approval.

Note: At the time the offset required by condition 18 is submitted for approval, the person taking *the action* may ask the Minister to consider that the salvage and translocation program required by condition 15, meets 10% of the offset requirements for the *Clear Milkvine* and *Cryptic Forest Twiner.*

Action	Timing	Status	Compliance evidence
18.1 Prepare TFOS in accordance with Dept of the Environment offset policy and addressing specified matters	By 26 Nov 2014	Compliant	Completed TFOS
18.2 Submit TFOS to Dept of the Environment for approval	By 26 Nov 2014	Compliant Final Report approved by DoE 19/07/2016	Transmittal form (and any confirmation of receipt)

Action 18.1:

- Tender assessment – (Complete)
- Draft for TfNSW review expected (Complete)
- TfNSW review (Complete)
- Final of the TFOS (Complete)

Action 18.2:

- Submitted to DoE for approval 21/11/2014
- Comments received from DoE 02/09/2015
- Amended report provided to DoE 02/10/2015
- Variation letter submitted to DoE on 20/11/2015 to request the removal of a timeframe to secure the offset property in perpetuity and tie that in with the approval of the TFOMP.
- Comments received from DoE 30/11/2015
- TFOS was resubmitted in 2/6/2016
- The TFOS was approved by DoE on 19/07/2016 and was published on the projects website.

Condition 19

The *person taking the action* must provide a plan for the management and delivery of the offset requirements of the threatened flora offset to *the Minister* for approval no later than 30 June 2015. The Threatened Flora Offset Management Plan (TFOMP) must include, but need not be limited to:

a) map(s) and shapefiles that clearly define the location and boundaries of the offset;

b) details on the quality of the offset;

c) information about Clear Milkvine and Cryptic Forest Twiner (in relation to ecology, biology and conservation status) to inform appropriate management actions;

d) performance objectives and management actions that will enable maintenance and enhancement of Clear Milkvine and Cryptic Forest Twiner the offset and habitat covered by the plan;

e) demonstration that any management actions to be undertaken will not adversely impact EPBC species (for example, this may apply to herbicide usage);

f) a description of funding arrangements or agreements including work programs and responsible entities;

g) an assessment of the baseline population and distribution for Clear Milkvine and Cryptic Forest Twiner within the offset, including:

    (i) the number of plants protected and their location;

    (ii) plant and habitat condition; and

    (iii) age classes.

h) measures for regular monitoring of the status of individuals of Clear Milkvine and Cryptic Forest Twiner and their habitat as measured against the baseline population and distribution, including:

    (i) fluctuations in population size and distribution;

    (ii) life cycle patterns

    (iii) habitat requirements; and

    (iv) response to disturbances and/or management actions.

i) Provision to revise the approved threatened flora offset management plan in response to the findings of research associated with condition 20(h).

j) The approved TFOMP must be implemented within seven days of its approval.

Action	Timing	Status	Compliance evidence
19.1 Prepare TFOMP addressing specified matters and other relevant matters	By 30 Jun 2015	Compliant	Completed TFOMP

19.2	Provide TFOMP to Dept of the Environment for approval	By 30 Jun 2015	Compliant (revised document was resubmitted to DoE on 7/11/2016) Plan approved 4/7/2017	Transmittal form (and any confirmation of receipt)
19.3	Implement TFOMP	Within 7 days of Minister's approval	Compliant	Annual reporting Gazettal of Yuraarla Flora Reserve on 15 April 2020.

Action 19.1:

- GHD engaged and property surveys completed
- An area within Boambee State Forrest has been identified and TfNSW are currently negotiating with State Forests regarding protection of this area in perpetuity as a Flora Reserve.
- TfNSW wrote to DoE on 30/06/2015 requesting urgent consideration of the TFOS and seeking an extension of time to submit the TFOMP by 3 months, until 30/09/2015.

Action 19.2

- TFOMP was submitted to DoE on the 02/10/2015 for approval.
- Comments received from DoE on 30/11/2015.
- The revised document was resubmitted to DoE on 7/11/2016.
- TFOMP approved by DoE on 4 July 2017

Action 19.3

- Boambee SF (FCNSW) – TfNSW has paid the compensation funding to FCNSW. The new Yuraarla Flora Reserve was gazetted on 15 April 2020 (NSW Government Gazette No. 107 of 29 May 2020). This was provided to Post Approvals via email on 29 June 2020.

Condition 20

Within three months from the date of this approval, the person taking the action must provide to the Minister, a strategy that details how, and when, the Norton Offset Site and Griffin Offset Site (as described in the referral documentation), will be legally secured in perpetuity by the person taking the action.

If the EPBC species habitat cleared as a result of the action is less than the impacts described in the referral documentation then any surplus biodiversity offset areas included in the offset management plans referred to in condition 19 and condition 21 could be secured as biodiversity offsets for other actions undertaken by the person taking the action and included in the offset strategies for those actions.

Action	Timing	Status	Compliance evidence
20.1 Prepare strategy to legally secure offset sites in perpetuity	By 26 Feb 2014	Compliant	Both Norton and Griffin sites have been purchased by TfNSW.
20.2 Provide strategy to Dept of the Environment	By 26 Feb 2014	Compliant	Letter provided to DoEE on 11-2-2014

Condition 21

Within 12 months from the date of this approval, the *person taking the action* must provide to *the Minister* for approval, a plan for the management of the Norton Offset Site and Griffin Offset Site. The Norton and Griffin Offset Management Plan (NGOMP) must be targeted to the ecological requirements of the *Koala*, *Grey-headed Flying-fox*, *Spotted-tail Quoll*, *Regent honey eater* and *Swift Parrot* and build upon the ideas and concepts described in the *referral*. The plan must include, but need not be limited to:

a) map(s) and shapefiles that clearly define the location and boundaries of the offset sites;

b) details on the quality of the offset with reference to all EPBC species this plan is intended to protect;

c) information about the Koala, Grey-headed Flying-fox, Spotted-tail Quoll, Regent honey eater and Swift Parrot (in relation to ecology, biology and conservation status) to inform appropriate management actions;

d) the results of targeted field surveys within both offset sites (undertaken at any ecologically appropriate time of the year) to assess habitat suitability and presence / absence of individuals in relation to the Koala, Grey-headed Flying-fox, Spotted-tail Quoll, Regent honey eater and Swift Parrot;

e) clear performance objectives and management actions that will enable maintenance and enhancement of habitat within the offset area, as well as contribute to the better protection of individuals and/or populations of EPBC species onsite;

f) an assessment of the baseline population for EPBC species which are detected within the offset area during field surveys;

g) demonstration that any management actions to be undertaken will not adversely impact EPBC species (for example, this may apply to pest control);

h) a description of funding arrangements or agreements including work programs and responsible entities;

i) details of a comprehensive long term monitoring program for determining the effectiveness of management actions;

j) commitments to undertake contingency measures and corrective actions in the event that performance objectives are not met; and

k) anticipated timeframes for achieving performance objectives.

l) The approved Norton and Griffin offset management plan must be implemented within seven days of its approval.

Action	Timing	Status	Compliance evidence
21.1 Prepare NGOMP addressing specified matters and other relevant matters	By 26 Nov 2014	Compliant	Completed NGOMP

21.2 Provide NGOMP to Dept of the Environment	By 26 Nov 2014	Compliant - submitted to DoE on the 11/12/14 Re-submitted on the 23/12/16 Plan Approved 5/7/2017	Transmittal form (and any confirmation of receipt)
21.3 Implement NGOMP	Within 7 days of Minister's approval	Compliant	Annual update / reporting Execution of BioBanking Agreements. Retirement of ecosystem credits.

Note:

- It is assumed that satisfactory documentary evidence of implementation of the NGOMP would be provided through annual reporting.

Action 21.1:

- Prepare brief for tender (Complete)
- Tender assessment (Complete);
- Draft for TfNSW review (Complete);
- TfNSW review (Complete)

Action 21.2:

- Final - (Complete)
- Submitted to DoE for approval on the 11/12/14.
- Comments received from DoE on February 2016
- NGOMP re-submitted for approval on 23 December 2016.
- NGOMP approved by DoE on 5 July 2017

Action 21.3:

- Norton (TfNSW) and Swain (private) – BioBanking Agreements have been executed by OEH and registered on title. The Swain BBA became active in February 2019, after TfNSW purchased the ecosystem credits. The ecosystem credits for Swain were retired by TfNSW on 2 September 2021. Norton became active in late February 2021 after being on-sold. TfNSW retired the required ecosystem credits from the Norton offset property on 2 September 2021.
- Griffin (TfNSW) – TfNSW transferred the management funding to NPWS in late 2021 and are in the process of transferring the land titles so NPWS can commence the gazettal process.
- During 2021, TFNSW has undertaken routine property inspections and maintenance of the Griffin property. This has included weed and track monitoring.

Condition 22

Within one month after the commencement of *the action*, the *person taking the action* must advise *the Department* in writing of the actual date of commencement.

Action	Timing	Status	Compliance evidence
22.1 Provide written advice to Dept of the Environment of actual date of commencement	4 Jan 2014	Compliant	Signed copy of letter on TfNSW letterhead. Provided to DoEE on 4-1-2014.

Condition 23

The person taking the action must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement any management plans or reports required by this approval, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media.

Action	Timing	Status	Compliance evidence
23.1 Quarterly review of the EPBC conditions compliance tracking program.	Quarterly Construction Annually Operation	Compliant	First review March 2014 Second review June 2014 Third Review September Forth Review October 2014. Fifth Review December 2014 Sixth Review February 2015 Seventh Review April 2015 Eighth Review June 2015 Ninth review August 2015 Tenth review October 2015 Eleventh review February 2016 Twelfth review May 2016 Thirteenth review July 2016 Fourteenth review December 2016 Fifteenth review 2017 Sixteenth review 2018 Seventeenth review 2019 Eighteenth review 2020 Nineteenth review 2021 Twentieth Review 2022
23.2 Provide records to Dept of the Environment as requested	As requested	TBA	Transmittal form (and any confirmation of receipt)

Condition 24

Within three months of every one year anniversary of the commencement of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing proof of the date of publication and noncompliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published.

Action	Timing	Status	Compliance evidence
24.1 Prepare compliance report and upload to project website	By 4 Mar 2015	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.2 Prepare compliance report and upload to project website	By 4 Mar 2016	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.3 Prepare compliance report and upload to project website	By 4 Mar 2017	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.4 Prepare compliance report and upload to project website	By 4 Mar 2018	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.5 Prepare compliance report and upload to project website	By 4 Mar 2019	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.5 Prepare compliance report and upload to project website	By 4 Mar 2020	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.
24.5 Prepare compliance report and upload to project website	By 4 Mar 2021	Compliant	Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.

24.5	Prepare compliance report and upload to project website	By 4 Mar 2022	Compliant	This Report uploaded to project website. Advice provided to Dept on date of publication and any non-compliances.

Condition 25

Upon the direction of the Minister, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.

Action	Timing	Status	Compliance evidence
25.1 Identify potentially suitable auditor(s)	On direction of the Minister	TBA	Tenderer(s) proposal(s) documenting expertise
25.2 Provide auditor's details to Dept of the Environment for approval	On direction of the Minister	TBA	Transmittal form (and any confirmation of receipt)
25.3 Auditor to develop audit criteria	Following receipt of Minister's approval	TBA	Completed audit criteria
25.4 Provide audit criteria to Dept of the Environment for approval	Following receipt of Minister's approval	TBA	Transmittal form (and any confirmation of receipt)
25.5 Conduct audit and document findings	Following receipt of Minister's approval	TBA	Completed audit report
25.6 Provide audit report to Dept of the Environment	At completion of audit	TBA	Transmittal form (and any confirmation of receipt)

- No independent audit of compliance has been requested from *the Minister* to date.

Condition 26

If the person taking the action wishes to carry out any activity otherwise than in accordance with the TFOS, TFOMP, or NGOMP as specified in these conditions, the person taking the action must submit to the Department for the Minister's written approval a revised version of that TFOS, TFOMP, or NGOMP. The varied activity shall not commence until the Minister has approved the varied TFOS, TFOMP, or NGOMP in writing. The Minister will not approve a varied TFOS, TFOMP, or NGOMP unless the revised TFOS, TFOMP, or NGOMP will result in an equivalent or improved environmental outcome over time. If the Minister approves the TFOS, TFOMP, or NGOMP then that TFOS, TFOMP, or NGOMP must be implemented in place of the TFOS, TFOMP, or NGOMP originally approved.

Action	Timing	Status	Compliance evidence
26.1 Assess potential departure(s) from TFOS, TFOMP and/or NGOMP as relevant	As required	TBA	Consistency assessment
26.2 Revise TFOS, TFOMP and/or NGOMP as relevant	As required	TBA	Revised TFOS, TFOMP and/or NGOMP as relevant
26.3 Provide revised TFOS, TFOMP and/or NGOMP as relevant to Minister for approval	As required	TBA	Transmittal form (and any confirmation of receipt)
26.4 Implement revised TFOS, TFOMP and/or NGOMP as relevant in accordance with the Minister's written approval	Prior to any action that would not be consistent with the original approval or subsequent modified approval(s)	TBA	Annual reporting

Condition 27

If the Minister believes that it is necessary or convenient for the better protection of listed threatened species and communities to do so, the Minister may request that the person taking the action make specified revisions to TFOS, TFOMP, or NGOMP specified in these conditions and submit the varied TFOS, TFOMP, or NGOMP for the Minister's written approval. The person taking the action must comply with any such request. The revised approved TFOS, TFOMP, or NGOMP must be implemented. Unless the Minister has approved the TFOS, TFOMP, or NGOMP, then the person taking the action must continue to implement the TFOS, TFOMP, or NGOMP originally approved, as specified in these conditions.

Action	Timing	Status	Compliance evidence
27.1 Revise TFOS, TFOMP and/or NGOMP as relevant as per directed by the Minister	As directed by the Minister	TBA	Completed revised TFOS, TFOMP and/or NGOMP as relevant
27.2 Provide revised TFOS, TFOMP and/or NGOMP as relevant to Dept of the Environment for approval	As directed by the Minister	TBA	Transmittal form (and any confirmation of receipt)
27.3 Implement revised TFOS, TFOMP and/or NGOMP as relevant in accordance with Minister's written approval	As directed by the Minister	TBA	Annual reporting

Condition 28

If, at any time after five years from the date of this approval, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the Minister.

Action	Timing	Status	Compliance evidence
28.1 Obtain written agreement of the Minister to substantially commence the project	As required after 25 Nov 2018	Compliant	Minister's written agreement. Action substantially commenced on the 4 December 2013

Condition 29

Unless otherwise agreed to in writing by the Minister, the person taking the action must publish all management plans and reports referred to in these conditions of approval on their website. Each management plan or report must be published on the website within 1 month of being approved, or where approval is not required, on the same day as the report is provided to the Minister.

Note

Any plan, strategy or report that has been prepared as a requirement of a state legislation approval (in relation to the action) may be used to satisfy the requirements of any of the above conditions, providing the relevant criteria have been met (as specified in these conditions). Where the option is employed, the plan, strategy or report must be accompanied by a standalone document detailing where each of the relevant criteria have been addressed within that plan, strategy or report. This note is particularly relevant to conditions 13, 16, 17, 19, 21 and 25.

Action	Timing	Status	Compliance evidence
29.1 Upload approved NGOMP to project website (21)	Within 1 month of the Minister's approval	Compliant	NGOMP uploaded to project website
29.2 Upload approved TFOMP to project website (19)	Within 1 month of the Minister's approval	Compliant	TFOMP uploaded to project website
29.3 Upload fauna crossings, fencing and road medians outcomes report to project website (13)	1 year following construction completion	Compliant	Report uploaded to project website
29.4 Upload translocation outcomes report to project website (16)	1 year following construction completion	Compliant	Report uploaded to project website
29.5 Upload updated fauna crossings, fencing and road medians outcomes report to project website (13)	Every 3 year following 29.3 report as above	Compliant	2021/22 Report uploaded to project website and included in this Report as Appendix 2.
29.6 Upload updated translocation outcomes report to project website (17)	Every 3 year following 29.4 report as above	Compliant	2021/22 Report uploaded to project website and included in this Report as Appendix 1.

Appendix 1 –
NH2U Threatened Flora Monitoring Report 2021.

Transport
Roads & Maritime
Services

Pacific Highway Upgrade Nambucca Heads to Urunga Operational Phase

Threatened Flora Monitoring Annual Report Year 5 – 2021/22

Transport for NSW | 14 February 2022 | Final Report

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This report, **Pacific Highway Upgrade Nambucca Heads to Urunga Operational Phase - Threatened Flora Monitoring Annual Report Year 5 2021/22**, was prepared for Transport for NSW in accordance with the NSW *Environmental Planning and Assessment Act* 1979, the NSW *Biodiversity Conservation Act* 2016 and the Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999.

The author of this report is Peter Richards, Consultant Ecologist, whose qualifications are B.Sc. (UNE).

Any opinion expressed in this report is the professional, objective opinion of the author.

14 Feb 2022

TABLES

FIGURES

GLOSSARY

TERM	MEANING
ANPC	Australian Network for Plant Conservation
BC Act	NSW *Biodiversity Conservation Act* 2016
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
In situ	Latin term meaning 'in the original place'. In this report, refers to threatened plants that are being protected where they were found
LGA	Local Government Area
MCoA	Ministers Conditions of Approval
NH2U	Nambucca Heads to Urunga Pacific Highway Upgrade Project
NSW EPA	NSW Environment Protection Authority
NSW OEH	NSW Office of Environment and Heritage
PI	Performance Indicator
RMS	NSW Roads and Maritime Services (now known as Transport for NSW)
TA	Translocation Area
TFMP	Threatened Flora Management Plan (Ecos Environmental 2013)
TfNSW	Transport for NSW (formerly RMS)
TSC Act	NSW *Threatened Species Conservation Act* 1995

INTRODUCTION

The Nambucca Heads to Urunga Pacific Highway Upgrade Project (NH2U) is a 22-km-long section of the Pacific Highway upgrade on the Mid North Coast of NSW. The NH2U project comprises the northern half of the Warrell Creek to Urunga section of the Pacific Highway upgrade, which is being built in two stages. Mitigation measures employed during the construction of NH2U included *in situ* protection, or translocation, and monitoring, of populations of the following eight threatened or rare plant species:

Spider Orchid *Dendrobium melaleucaphilum* (Endangered, BC Act)

Red Bopple Nut *Hicksbeachia pinnatifolia* (Vulnerable, BC Act & EPBC Act)

Slender Marsdenia *Marsdenia longiloba* (Endangered, BC Act; Vulnerable, EPBC Act)

Rusty Plum *Niemeyera whitei* (Vulnerable, BC Act)

Woolls's Tylophora *Tylophora woollsii* (Endangered, BC Act & EPBC Act).

Koala Bells *Artanema fimbriatum* (unlisted, nationally rare)

Gully Ironbark, Nambucca Ironbark *Eucalyptus ancophila* (unlisted, local endemic species)

Ford's Goodenia *Goodenia fordiana* (unlisted, nationally rare)

In situ flora populations

One component of the mitigation measures employed on the NH2U project involved the protection and monitoring of *in situ* plants of Spider Orchid, Slender Marsdenia and Gully Ironbark that remain within the NH2U road reserve and were not directly impacted by the project. Baseline data collection, and construction phase monitoring, has been undertaken on 76 Spider Orchid plants, five Slender Marsdenia plants and a single Gully Ironbark (Ecos Environmental 2014, 2016, 2017) which are located at various points in the road reserve along the NH2U route (Figure 1).

Translocated Flora Species

Where threatened or rare plants were recorded within the NH2U construction footprint and direct impact was unavoidable, a program was developed to guide the translocation and monitoring of Spider Orchid, Red Bopple Nut, Slender Marsdenia, Rusty Plum, Woolls's Tylophora, Koala Bells and Ford's Goodenia from the construction footprint into one of two recipient sites (Translocation Areas, TA1 and TA2) that adjoin the NH2U footprint and are owned and managed by TfNSW (Figure 1).

The translocations were conducted according to the Warrell Creek to Urunga Threatened Flora Management Plan (TFMP, Ecos Environmental 2013), which was prepared as a condition of approval by the NSW Department of Planning and the Commonwealth Department of Environment.

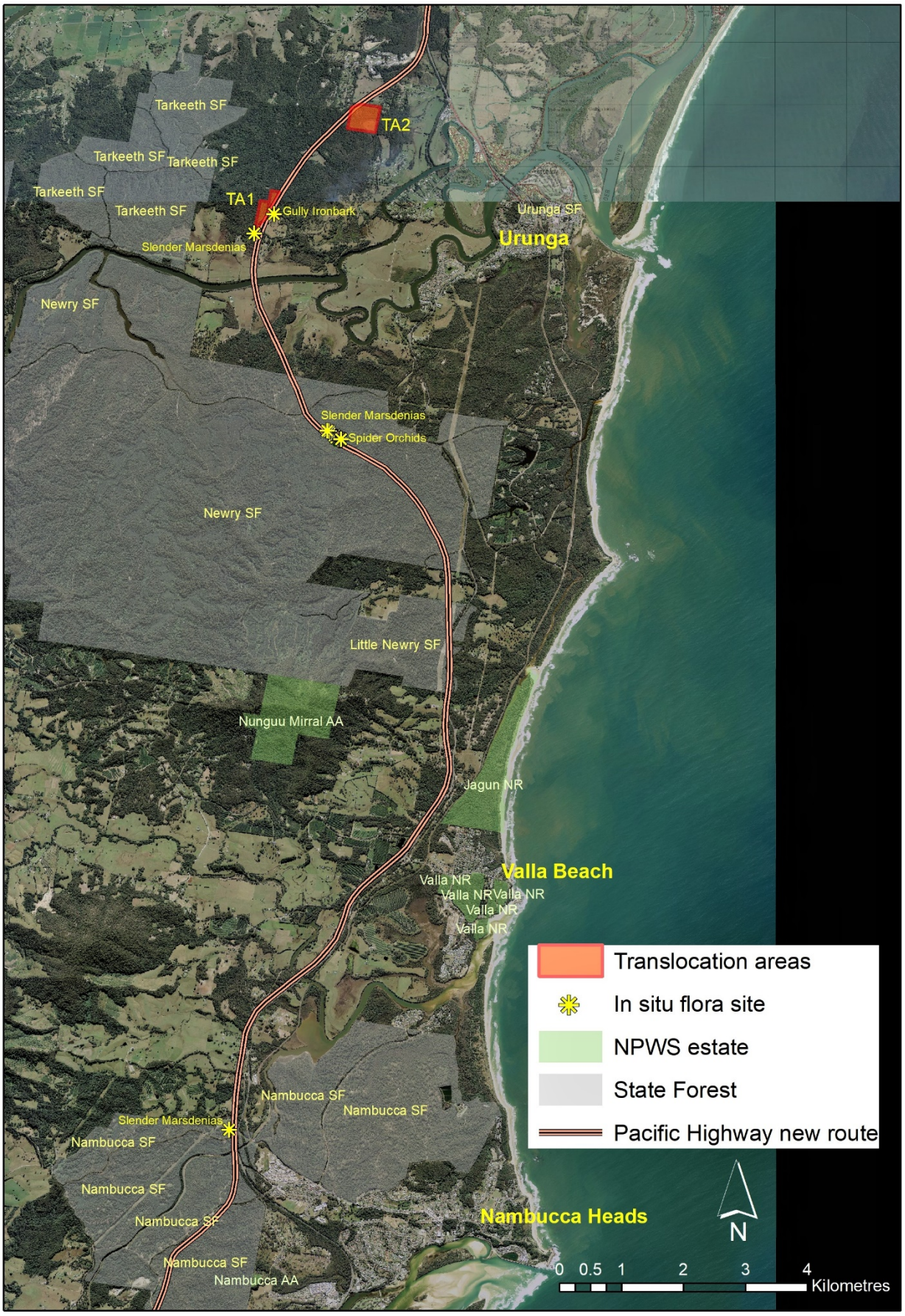

Figure 1: Location of NH2U in situ and translocated threatened or rare flora monitoring sites.

Translocation methods and planting layout

A detailed description of the actual salvage and translocation methodology is provided in Ecos Environmental (2013, 2014a, 2016a, 2016b). The summary provided below is also drawn from these Ecos Environmental reports and explains the source of plant material (transplanted from construction footprint or propagated off-site), whether a slow-release fertiliser was applied, and the location within TA1 or TA2 of the transplants or enhancement plantings.

Translocation Area 1

TA1 was divided into ten sectors (A to J, Figure 2) each receiving one species and different introduction treatments, as described below:

- Transplanted from construction footprint with no addition of fertiliser.

  Sector A Slender Marsdenia

  Sector B Woolls's Tylophora

- Transplanted from construction footprint with no fertiliser except initial watering with seaweed solution.

  Sector C Ford's Goodenia

  Sector D Koala Bells

  Sector E Rusty Plum

- Propagated vegetatively and planted in experimental grids with and without addition of slow-release fertiliser.

  Sector F Slender Marsdenia

  Sector G Woolls's Tylophora

  Sector I Woolls's Tylophora

- Propagated from seed and planted in an experimental grid with and without addition of slow-release fertiliser.

  Sector J Slender Marsdenia

- Transplanted from construction footprint with no fertiliser except initial watering with seaweed solution.

  Sector H Red Bopple Nut

Translocation Area 2

TA2 consists of two sectors, for the Spider Orchid and Koala Bells (Figure 3).

- Spider Orchid transplanted from construction footprint, no fertiliser addition – Sector A
- Koala Bells population enhancement, no fertiliser addition – Sector B

Individuals were planted at a regular spacing, with rows about 10m apart and individual plants about 5 metres apart along rows. Where a sector was on a hill slope, grid lines were laid out parallel with the slope contour. This facilitated comparison of species performance in relation to slope position.

Monitoring, to date, has been undertaken for a total of 681 translocated plants (Ecos Environmental 2014, 2016, 2016a) as detailed in Table 1 below.

Table 1:Number and location of translocated plants and enhancement plantings at NH2U Translocation Areas.

Translocation Area (TA)	Species	Sector / Method	Number of plants
TA1	Slender Marsdenia	Sector A – transplants	104
		Sector F – population enhancement (veg) & fertilizer experiment	90
		Sector J – population enhancement (seed) & fertilizer experiment	103
	Woolls's Tylophora	Sector B – transplants	42
		Sector G – population enhancement (veg) & fertilizer experiment	87
		Sector I – population enhancement (veg)	51
	Rusty Plum	Sector E – transplants and population enhancement (seed)	3 trees 40 seeds
	Red Bopple Nut	Sector H - transplant	1
	Koala Bells	Sector D - transplants	35
	Ford's Goodenia	Sector C – transplants	5 patches
TA2	Spider Orchid	Sector A - transplants	55
	Koala Bells	Sector B - population enhancement (veg)	69

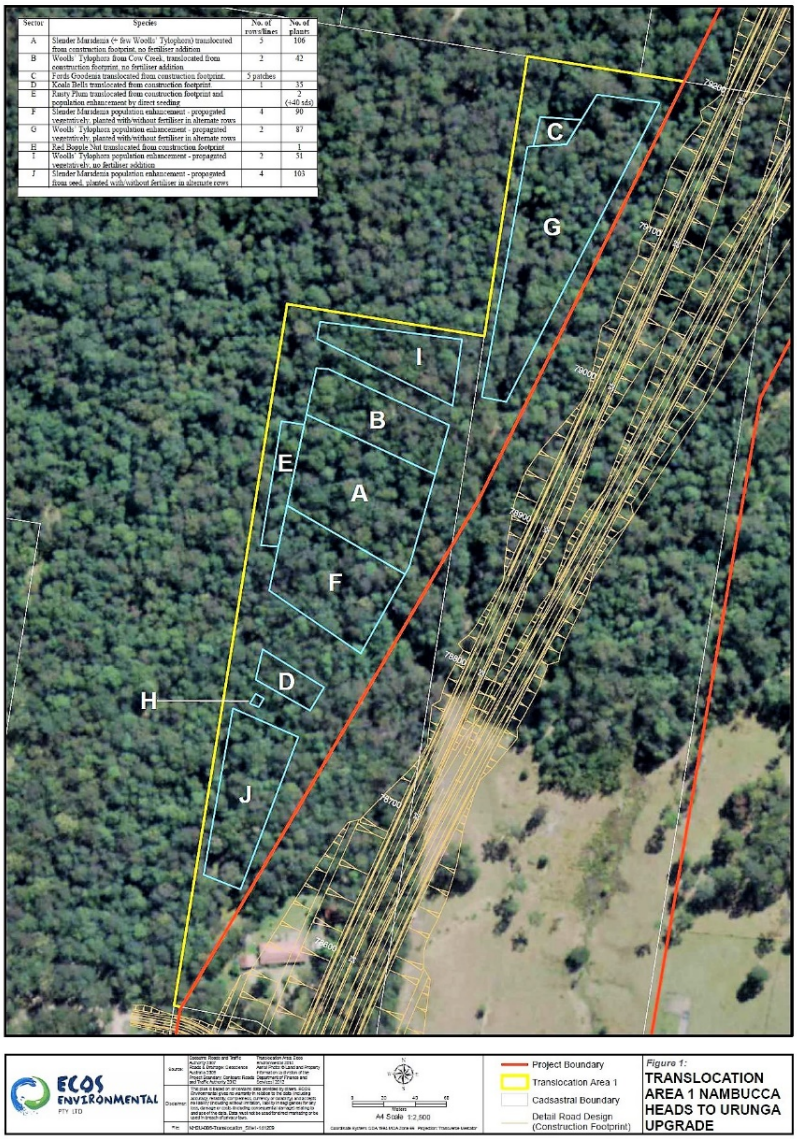

Figure 2: Translocation Area 1 (TA1) showing sectors supporting different species and treatments (from Ecos Environmental 2016a).

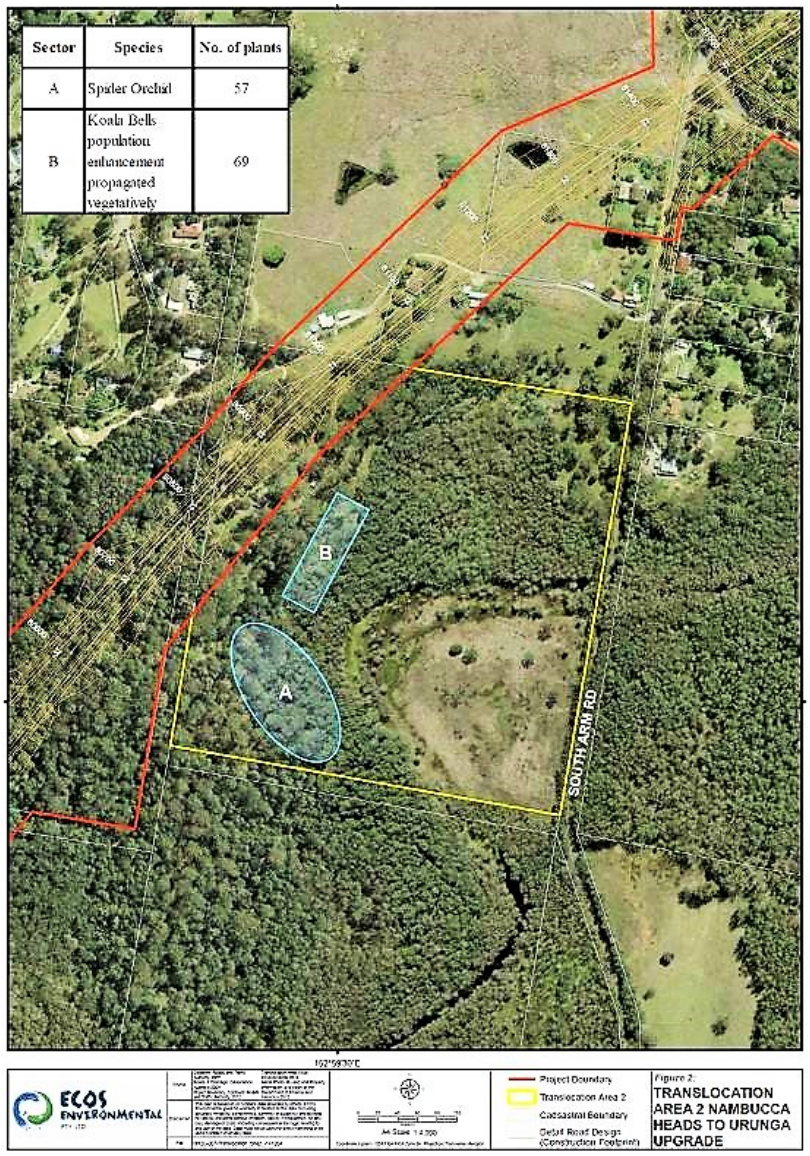

Figure 3: Translocation Area 2 (TA2) showing sectors supporting different species and treatments (from Ecos Environmental 2016a).

Objectives of translocation

The objectives of the translocation project set out in the TFMP are:

- To salvage and re-establish impacted individuals of threatened (TSC/BC/EPBC Act) species.
- To re-establish species at a recipient site near the original site with closely matching habitat and long-term security of tenure.
- To enhance the size and genetic diversity of the translocated population by propagation and introduction of individuals additional to those salvaged from the road footprint.
- To maintain good quality habitat to the relocation site(s).
- To preserve individuals of threatened species *in situ* wherever possible and limit translocation to plants within the highway footprint and construction buffer.

In accordance with the Ministers' Conditions of Approval (MCoA) for the TFMP, an annual monitoring report is to be prepared which addresses the monitoring goals, provides an evaluation of the effectiveness of the mitigation measures against performance indicators, documents any corrective actions implemented, and identifies recommendations for any adaptive management.

Upon completion of the construction phase of the NH2U upgrade, responsibility for operational management passed to TfNSW. This report describes the results of Year 5 (operational phase) monitoring of flora for the NH2U upgrade. It should be noted that, upon completion of construction phase monitoring of translocated plants, monitoring of those species not listed as threatened under the BC Act or the EPBC Act (Koala Bells and Ford's Goodenia) has been discontinued.

MONITORING METHODS

Monitoring of all *in situ* and translocated plants was undertaken in November and December 2021.

The following description of the NH2U flora monitoring methodology is adapted from Ecos Environmental (2014 to 2017). During the NH2U construction phase, monitoring of transplants was conducted every 3 months in Year 1, every 6 months in Year 2 and annually in Year 3. Population enhancement individuals were monitored twice in Year 1 thence at the same time as transplanted individuals. Ongoing monitoring during the NH2U operational phase is to be undertaken annually for a minimum five years.

Each transplanted and propagated plant was given a unique identification number which was written on flagging tape and attached to the plant itself, or to its protective wire cage. Transplants were located in the field using a hand-held GPS to navigate to a set of coordinates that had been recorded when the plants were introduced to the sites (in some cases coordinates were not available – in such cases a thorough search of the relevant sector was undertaken by the author, and each transplant found had locality coordinates recorded with a GPS unit). Data were recorded as per Section 3.8 of the TFMP and listed in Table 2 below.

Table 2: Monitoring data recorded for each translocated species.

Data Recorded	Slender Marsdenia	Woolls's Tylophora	Rusty Plum	Red Bopple Nut	Spider Orchid
Monitoring Number	y	y	y	y	y
Date	y	y	y	y	y
Line	y	y	-	-	-
Source Label	y	y	y	-	y
Translocation Label	y	y	y	y	y
Species - Current ID	y	y	-	-	-
Condition Class	y	y	y	y	y
No. leaves	y	y	-	-	
Height (cm)	y	y	y	y	
New Shoots – New Active Growth (Y/N)	y	y	y	y	y
Comment	y	y	y	y	y
No. of pseudobulbs with leaves	-	-	-	-	y
Length of the longest pseudobulb	-	-	-	-	y
Waypoint	y	y	y	y	y
Coordinates	y	y	y	y	y

Condition Class Scores

The key attribute for evaluating species survival and performance was Condition Class, which was scored on a scale of 0 to 5. The scores were defined differently according to plant type, as detailed below in Table 3, Table 4 and Table 5.

Table 3: Condition scores applied to Slender Marsdenia and Woolls's Tylophora.

Score	Condition
0	dead
1	stem died back to ground, no leaves or green stem, live stem stub may be present
2	plant < 75 cm tall; stem with leaves, with or without new shoots (active growth), or green leafless stem
3	plant > 75 cm tall, stem with leaves, with or without new shoots (active growth), if green leafless stem <1m or leaves discoloured score as 2
4	plant > 1.5m tall with > 15 leaves, mature or nearing maturity
5	plant flowering or seeding

Table 4: Condition scores applied to Rusty Plum and Red Bopple Nut.

Score	Condition
0	dead
1	leafless and no sign of re-shooting
2	pruned foliage retained, or small amount of re-shooting after defoliating, or foliage sparse/discoloured (<40 cm tall Koala Bells)
3	vigorous re-shooting (>40 cm tall Koala Bells)
4	crown recovering, foliage healthy
5	growing actively, flowering or seeding recorded

Table 5: Condition scores applied to Spider Orchid.

Score	Condition
0	dead
1	pseudobulbs discoloured/grazed/withering, no new growth
2	pseudobulbs healthy in colour, not withering, no new growth
3	plant small, not many healthy pseudobulbs, new growth occurring
4	several healthy pseudobulbs present, new growth occurring
5	several good sized, healthy pseudobulbs, flowering or seeding recorded

Data Analysis

Monitoring data were stored and processed in Excel™ spreadsheets.

Species survival rate was calculated as:

(no. of individuals in condition classes 2+3+4+5/total no. plants) X 100

Species 'thrival' rate (a term used by Ecos Environmental to describe the general trend in vigour of plants in individual sectors or subject to different treatments) was calculated as:

(no. of individuals in condition classes 3+4+5/total no. plants) X 100

The thrival rate provides, according to Ecos Environmental (2016a) a better indication of the percentage of plants likely to reach reproductive maturity. Mean species height was calculated for all plants including those with zero height (i.e., plants that had died back to the ground – condition class 1 - not just plants in condition classes 2 to 5).

YEAR 1 MONITORING RESULTS AND RECOMMENDATIONS

The Year 1 NH2U threatened flora monitoring report (Richards 2017) found that whilst the survival of Slender Marsdenia transplants was comparable to that achieved in other translocation projects, many transplants had died back as a result of a very dry winter-spring in 2017. Furthermore, it was discovered that the Woolls's Tylophora plants were in fact the common *Tylophora paniculata*, and that the Rusty Plum enhancement plantings had been almost entirely lost. Therefore, the following recommendations were made:

1. Discontinue monitoring of *Tylophora paniculata* plants in Sectors G and I in TA1.
2. Direct seed an additional 40 Rusty Plum seeds into Sector E in TA1.
3. Install protective cages on all new and surviving Rusty Plum enhancement plantings.

The direct seeding of Rusty Plum seed, and installation of cages, was undertaken in October 2018 and is described in a separate report (Richards 2018). From 2018 on, Sectors G and I in TA1 will no longer be monitored.

YEAR 2 MONITORING RESULTS AND RECOMMENDATIONS

The Year 2 NH2U threatened flora monitoring report (Richards 2018a) found that performance indicators were met for *in situ* plants of Slender Marsdenia and Gully Ironbark, but that Spider Orchid had failed to meet the target for percentage of plants in condition class 3 or better. Results for translocated plants were mixed, with target survival rates after five years not met for Slender Marsdenia, Woolls's Tylophora and Rusty Plum. Recommendations arising from the Year 2 report were:

1. Monitor Rusty Plum enhancement plantings six months after planting (i.e., April 2019) to assess condition of protective cages, incursion of weeds or competing native species, whether any seeds have germinated, and to undertake any necessary maintenance of the enhancement plantings.
2. Engage a qualified bush regenerator to assess the current level of infestation of Broad-leaved Paspalum and Lantana in TA1, and, if necessary, provide an appropriate control program. Observations by the author during monitoring surveys suggests that both weed species have increased in density in parts of TA1, particularly in the vicinity of old vehicular tracks. Early action to control both species would be beneficial.

As of February 2020 (when Year 3 monitoring surveys occurred, see below), the Year 2 recommendations had not been implemented, due to a lapse in communication between different contractors and TfNSW personnel. In addition, the direct-seeded Rusty Plum enhancement planting unfortunately failed (due to extreme drought conditions). Recommendations detailed in the Year 3 report provided appropriate mitigation measures, as described below.

YEAR 3 MONITORING RESULTS AND RECOMMENDATIONS

The 'Black Summer' wildfires of September 2019 to January 2020 compelled the author to postpone field-based surveys until early February 2020. The Year 3 NH2U threatened flora monitoring report (Richards 2020) found that performance indicators were met for *in situ* Slender Marsdenia and Gully Ironbark. Despite *in situ* Spider Orchid meeting only two of three performance indicators, it was considered that this was due to three seasons of drought and recent tree fall in the site making it very difficult to re-locate all tagged plants. Translocated Spider Orchid, Rusty Plum, Red Bopple Nut and Slender Marsdenia had, to date, met performance indicators. Woolls's Tylophora and Rusty Plum enhancement plantings had not met performance indicators. Based upon these results, recommendations arising from the Year 3 report were:

1. Cessation of monitoring of all *in situ* plants. After six years of monitoring, it is considered that all extant *in situ* plants are highly likely to survive into the future.
2. Cease monitoring the translocated Spider Orchids in TA2.
3. Continue monitoring of all currently monitored sectors and plants in TA1.
4. Repeat the Rusty Plum enhancement planting program. Rather than direct-planting of seeds, it is recommended that collected seeds are germinated and grown on in nursery conditions. Planting of seedlings into TA1 would occur only when weather conditions are favourable. The protective tree guards from the previous attempt in 2018 are already in place within TA1 and can be re-used. The planting should be followed up with regular inspections and hand-watering as required.
5. Implement weed control program in TA1 targeting Broad-leaved Paspalum and Lantana in areas identified by bush regenerator as requiring action.

While all the above recommendations were accepted by TfNSW, endorsed by NSW EPA, and approved by DPIE, the monitoring of *in situ* Slender Marsdenia was continued in the current survey. This is because Slender Marsdenia is also listed as threatened under the EPBC Act, and Commonwealth approval of the Year 3 recommendations had not been received at the time of Year 4 surveys and preparation of the Year 4 report.

YEAR 4 MONITORING RESULTS AND RECOMMENDATIONS

The Year 4 monitoring report (Richards 2021) described the survey of *in situ* and translocated Slender Marsdenia and translocated Woolls's Tylophora, Rusty Plum and Red Bopple Nut. This report also detailed the implementation and follow-up assessment of the recommended weed control program and the collection and potting up of Rusty Plum seeds for enhancement planting in TA1.

During the preparation of the Year 4 report, it was discovered that the translocated plants in Sector B, originally identified as Woolls's Tylophora, were actually the non-threatened species *Tylophora paniculata*. The following actions were recommended in the Year 4 report.

1. Discontinue monitoring of *Tylophora paniculata* plants in Sector B in TA1;
2. Continue monitoring of all other translocated plants in TA1;
3. Assess success of weed control program during Spring 2021 monitoring and advise on whether further weed control is required.

This current (Year 5) report provides an assessment of the weed control program undertaken in the previous year, an assessment of the Slender Marsdenia, Rusty Plum and Red Bopple Nut translocations, and an evaluation of the overall (8-year) success of the NH2U translocation program. Details regarding the proposed Rusty Plum enhancement planting program are also provided.

RESULTS – WEED CONTROL PROGRAM

The areas treated for Broad-leaved Paspalum and Lantana in November 2020 and January 2021 were inspected in November and December 2021. The areas were in excellent condition, with both weed species almost completely absent from the treated sites (Figure 4, Figure 5). It is considered that these weed species currently pose no threat to any translocated plants, and that follow-up treatment is not necessary.

Figure 4: Area treated for Broad-leaved Paspalum infestation, November 2021.

Figure 5: Area treated for Lantana infestation, November 2021. Note translocated Rusty Plum in right hand background.

RESULTS - TRANSLOCATED FLORA MONITORING

Appendix 2 provides full details of the results of the NH2U Year 5 monitoring of translocated flora within TA1. A summary of Year 5 results is provided below.

Slender Marsdenia

Slender Marsdenia was planted in three sectors in TA1:

- Sector A - Directly transplanted from construction footprint with no fertiliser.
- Sector F - Propagated vegetatively and introduced with and without fertiliser.
- Sector J - Propagated from seed and introduced with and without fertiliser.

Sector A

Survival rate for all 106 plants in Sector A was 37.7%, a small decrease on the previous year (40.6%). Mean plant height increased from 46.6cm to 47.3cm. 24 of these plants were a metre or more in height. The percentage of plants with active shoot growth was 32.1%. 65 plants had died back. Survival and mean height results recorded during all Sector A surveys are summarised in Table 6 below.

After eight years the 'thrival rate' of Slender Marsdenia in Sector A was 27.3% (29 plants out of 106 with a Condition Class score of 3, 4 or 5), a slight decrease from the previous survey rate of 28.3%. Five plants were in flower at the time of survey (Figure 6).

Table 6: Slender Marsdenia in TA1 Sector A - mean height in centimetres and percent survival of transplants – all surveys.

All plants n = 106	Mar 2014	Dec 2014	Jan 2016	Nov 2016	Oct 2017	Nov 2018	Feb 2020	Jan 2021	Dec 2021
Survival %	90.5	87.6	71.2	67.9	40	36.8	39.6	40.6	37.7
Mean height (cm)	36.25	36.25	42.38	39.97	36.3	40.7	40.4	46.6	47.3

Figure 6: Slender Marsdenia transplant in flower, TA1 Sector A, December 2021.

Sector F

The survival rate of all 90 plants in Sector F was 50%, a decline from the 58.9% recorded in the previous survey. Mean plant height was 54.7cm, a slight decrease compared to the previous survey.

Survival and mean height results recorded during all Sector F surveys are summarised below in Table 7.

The thrival rate after eight years was 32.2%, lower than the 37.8% of the previous survey. 21 plants with a condition class score of 3 or more were more than one metre in height. No plants were in bud or flower at the time of the current survey.

Table 7: Slender Marsdenia in TA1 Sector F - mean height in centimetres and percent survival of transplants.

All plants n = 90	Jul 2014	Jan 2016	Nov 2016	Oct 2017	Nov 2018	Feb 2020	Jan 2021	Dec 2021
Survival %	83.63	77.1	66.75	61.1	42.2	51.1	58.9	50
Mean height (cm)	21.04	68.50	55.89	52.44	30.7	46.1	56.6	54.7

Sector J

103 propagated Slender Marsdenia seedlings were planted in Sector J in August 2014. Results from the current survey reveal a decrease in survival rate to 47.6% and in mean plant height to 41.5 cm since the last monitoring survey (Table 8).

The current thrival rate of Slender Marsdenia in Sector J is 25.2% which is slightly lower than the previous year rate of 30.1%. 19 plants were one metre or more in height, with two in bud.

Table 8: Slender Marsdenia in TA1 Sector J - mean height in centimetres and percent survival of transplants.

All plants n = 103	Dec 2014	Jan 2016	Nov 2016	Oct 2017	Nov 2018	Feb 2020	Jan 2021	Dec 2021
Survival %	92.2	86.4	82.5	54.39	43.7	48.5	58.3	47.6
Mean height (cm)	46.75	69.15	64.19	54.61	32.3	37.2	41.98	41.5

It is worth noting here that the above results in all sectors show that there is some degree of fluctuation in plant survival and thrival, with a reduction in survival, thrival and mean height followed by general improvement in scores as seen from 2018 to the present, and likely coinciding with recovery from the 2017-2019 drought. The translocated population does not appear to be exhibiting a trend of continual reduction in plant numbers. Surviving plants appear to be established and would be expected to exhibit annual change in apparent health, depending upon prevailing climatic conditions.

Rusty Plum

Translocated Rusty Plums

Two small Rusty Plum trees (4-8m high) were transplanted into Sector E in TA1. One tree had split and was separated into two pieces (plants 1 and 2) before planting. The other tree (plant 3) was pruned back to remove most of the branch system before being transplanted. Plant 2 died in 2017. The current survey revealed no losses since the previous survey, with a survival rate of 67%. Plant 1 bore a healthy, basal stem shoot which had grown significantly since the previous survey and was starting to produce major lateral branches (Figure 7). Plant 3 was in excellent health (Figure 5).

Figure 7: Rusty Plum transplanted tree No. 1 in excellent health with new growth and lateral branching.

Rusty Plum enhancement plantings

Rusty Plum fruits were collected and potted up in spring 2020. Of those potted seeds, 12 successfully germinated. The remainder either germinated then died or failed to germinate. Brent Hely (New Earth Regeneration) collected and potted fresh seed in spring 2021. As of January 2022, the original 12 plants had attained 50cm height (Figure 8a) and are ready for transplanting, and 30 seeds had germinated and grown up to 15cm high (Figure 8b, estimated 4 weeks until ready for planting). The current La Niña climatic conditions with above-average rainfall provides the ideal opportunity to transplant the plants into TA1 in February 2022 (see below for details in 12 month work plan recommendations).

Figure 8: Germinated Rusty Plum seeds (a) >50cm high; (b) up to 15cm high.

Red Bopple Nut

A single Red Bopple Nut tree was transplanted to Sector H in TA1. The tree was recorded in excellent condition during the current survey. Flowering had occurred, with several developing fruits observed (Figure 9) as well as new inflorescences.

Figure 9: Immature fruits and fresh inflorescence observed on Red Bopple Nut transplant in TA1 Nov 2021

DISCUSSION

Evaluation of Flora Translocation Program

In accordance with the MCoA of the NH2U TFMP (Ecos Environmental 2013), each annual monitoring report must include an assessment of the success or failure of protective measures for *in situ* threatened flora, and an assessment of the success or failure of the threatened flora translocation program (salvage translocation and population enhancement measures). Since the Year 3 report recommended cessation of monitoring of *in-situ* plants, no further evaluation of them is provided beyond that provided in the Year 4 report (Richards 2021) which showed that two of three performance indicators (PIs) had been met. It should be noted here, that all three PIs for Slender Marsdenia were met in Year 3, and the third PI was not met in Year 4. This fluctuation in survival and condition in Slender Marsdenia is discussed more fully below.

Assessments of translocated plants are provided below. The MCoA also requires a recommended work plan for the next 12 months. This, too, is provided below.

The following performance indicators (PIs) are used to evaluate the success of the threatened species translocations (salvage translocation and population enhancement):

a) All directly impacted individuals of threatened species were salvaged and relocated to the receival sites.
b) At least 60% of transplant and enhancement individuals are surviving after the first year, 50% after five years and 40% after eight years.
c) At the end of the monitoring program (8 years), at least 50% of surviving individuals have a Condition Class of 3 or higher.

Table 11 below summarises how the above PIs have been met to date.

Table 9: Evaluation of performance indicators for translocated flora.

Species	All directly impacted individuals of threatened species were salvaged and relocated to the receival site(s).	At least 60% of transplant and enhancement individuals are surviving after the first year, 50% after five years and 40% after eight years	At the end of the monitoring program (8 years), at least 50% of surviving individuals have a Condition Class of 3 or higher.	Performance indicators met?
Slender Marsdenia	Y	Y, Y, Y	N	2 of 3
Rusty Plum transplants	Y	Y, Y, Y	Y	3 of 3
Rusty Plum enhancement plantings	n/a	N, N, N	N	0 of 3 to date
Red Bopple Nut	Y	Y, Y, Y	Y	3 of 3

Slender Marsdenia

After eight years of monitoring, the mean survival rate (i.e. Condition Class 2 or better) of all Slender Marsdenia plants stands at **45.1**%, which exceeds the second PI for Year 8. The actual percentage of surviving plants is likely to be much higher, as many plants that currently lack an aerial stem (i.e. are currently in Condition Class 1) would still be alive and may resprout in the future. Many years of field observations of wild and translocated Slender Marsdenia plants by the author strongly indicates that this is a natural part of the life history of this species. As noted in the NH2U Year 4 report (Richards 2021) successful achievement of the PIs for this species is as dependent on climatic factors as much as anything else. A wet, mild 'La Niña' weather pattern arrived in October 2021 following a very dry 4-month period. It would be expected that more plants will produce aerial shoots, and be in better overall condition, should such a weather pattern persist.

Probably for the above reasons, the third PI for Slender Marsdenia has not been met. Currently, 83 plants (**28%**) are in Condition Class 3 or greater. Despite this third PI not being met, the author considers that the translocation program for Slender Marsdenia has been successful, and there is a very high likelihood that the translocated population will persist into the future. As stated above in the results chapter, the translocated Slender Marsdenia population is not exhibiting a trend of continual reduction in plant numbers. Surviving plants appear to be established and would be expected to exhibit annual change in apparent health, depending upon prevailing climatic conditions. The third PI is problematic with regard to a plant such as Slender Marsdenia which can sporadically die back to its subterranean rhizome and not produce an aerial stem for more than 4 years (Richards 2019).

Rusty Plum transplants

Rusty Plum transplants meet all ongoing performance criteria.

Rusty Plum enhancement plantings

The Rusty Plum enhancement planting will be repeated when material and conditions allow. As described above, by January 2022 12 plants had attained 50cm height and were ready for transplanting; 30 seeds had germinated and were up to 15cm high. See below for the Rusty Plum work plan.

Red Bopple Nut transplant

The single translocated Red Bopple Nut tree is in excellent condition, flowering and sparse fruiting and fresh inflorescences occurring in November 2021. This specimen meets ongoing performance criteria.

RECOMMENDATIONS AND RUSTY PLUM WORK PLAN

The following actions are recommended here with the aim of achieving the principle objectives and performance indicators of the TFMP for *in situ* and translocated flora.

1. Discontinue monitoring of all translocated flora in TA1
2. Implement Rusty Plum enhancement planting program. The following program is proposed:

Rusty Plum enhancement plantings: 40 Rusty Plum seedlings were planted out into TA1 on the 11 February 2022 during suitable weather conditions. This task was undertaken by New Earth Regeneration (2 personnel). Seedlings were individually transplanted into tree guards, watered in with addition of a dilute seaweed-based fertiliser to reduce transplant shock, and mulched. Condition and height of each transplant to be recorded in accordance with current monitoring methodology.

Follow-up Maintenance: Contingent upon local rainfall post-transplant. This action should be avoidable if planting occurs during the wettest time of year. However, if no rain is recorded for the week after transplant, then hand watering will be required on a weekly basis until adequate rainfall occurs. As TA1 is remote from vehicular access this will require transport of water and equipment on foot over approx. 500 metres to the Rusty Plum planting site (a small creek on the site is intermittent during dry weather but may contain sufficient water at times to assist with this action).

Follow-up Monitoring: Monitoring of the seedlings will occur monthly for 3 months post-planting then once every 3 months for a year after that, then once again after 6 months. For example, assuming seedlings are planted in February 2022, monitoring will be undertaken in March, April and May 2022, then August and November 2022, February and May 2023 then November 2023.

Maintenance of plantings: During monitoring, check for, and remove, native vines or weeds that are shading, choking, crowding or otherwise competing with the Rusty Plum seedlings.

Reporting: Brief reports describing the planting program and results of ongoing monitoring and maintenance will be prepared and submitted as required.

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APPENDIX 1:

Monitoring Results –Translocated Flora in TA1 - December 2021

Slender Marsdenia - Sector A transplants

No	Date	Species	Line	Source Label	Cond	No. lvs	Height (cm)	New Shoots (Y/N)	Comment
1	Nov-Dec 2021	Marslong	L7 east	ML14	1		0		db. P. dorrigoensis on cage
2		Marslong	L7	ML2010-2	1		0		db
3		Marslong	L7	MLN-5	2	6	10		
4		Marslong	L7	ML14A	1		0		db
5		Marslong	L7	ML14A	1		0		db. P. dorrigoensis in cage
6		Marslong	L7	ML14A	1		0		db
7		Marslong	L7	ML13	1		0		db
8		Marslong	L7	ML14A	1		0		db
9		Marslong	L7	ML11	1		0		db
10		Marslong	L7	UTW-2	5	24	300	y	In flower, on small Turpentine - pics
11		Marslong	L7	UTW-2	5	60	150	y	Large, healthy sprawling plant in heavy bloom - pics
12		Marslong	L7	TWN-1	1		0		db
13		Marslong	L7	UTW-2	3	7	90	y	
14		Marslong	L7	ML20	3	4	140	y	
15		Marslong	L7	ML21	2	4	20	y	
16		Marslong	L7	TWN-1	0		0		gone
17		Marslong	L7	UTW-2	1		0		db
18		Marslong	L7	UTW-2	1		0		db
19		Marslong	L7	UTW-1	4	19	100	y	In good health amongst Gynocthodes jasminoides
20		Marslong	L7 west	UTW-4	1		0		db
21		Marslong	L6 west	TWN-1	1		0		db
22		Marslong	L6	TWN-1	2	6	50	n	
23		Marslong	L6	TWN-1	1		0		db
24		Marslong	L6	TWN-1	1		0		db
25		Marslong	L6	UML-6	3	6	120	y	same as previous survey
26		Marslong	L6	UML-6	3	10	120	y	

No	Date	Species	Line	Source Label	Cond	No. lvs	Height (cm)	New Shoots (Y/N)	Comment
27		Marslong	L6	MLN-6	1		0		db
28		Marslong	L6	UML-5	3	7	100	y	
28b/41		Marslong	L6	UML-5	1		0		db
29		Marslong	L6	ML17	1		0		db
30		Marslong	L6	new near ML18	1		0		db
30b/42		Marslong	L6	UML-5	1		0		db
31		Marslong	L6	new near ML18	1		0		db
32		Marslong	L6	MLN-6	5	38	300	y	In flower plus new shoot from rhizome - on Cryptocarya rigida
33		Marslong	L6	ML18	1		0		db
33b/40		Marslong	L6	ML21	2	2	10	y	
34		Marslong	L6	ML18	1		0		db
35		Marslong	L6	MLN6	3	3	240	y	Climbing Cryptocarya rigida
36		Marslong	L6	ML19	4	40	240	y	Climbing Cryptocarya rigida
37		Marslong	L6	ML19	5	100	350	y	Climbing dead sapling and Forest Oak. In heavy bloom.
38		Marslong	L6	ML20	1		0		db
39		Marslong	L6 east	ML21	2	3	10	y	
43		Marslong	L5	ML18	1		0		db
44		Marslong	L5	ML30	1		0		db
45		Marslong	L5	TW29	3	10	90	y	
46		Marslong	L5	ML32	1		0		db
47		Marslong	L5	new adj. ML33	1		0		db
48		Marslong	L5	new adj. ML33	2	4	10	n	
49		Marslong	L5	new adj. ML33	1		0		db
50		Marslong	L5	MLN-2	2	0	400		Leafless green stem - on Cryptocarya rigida
51		Marslong	L5	ML15	1		0		db
52		Marslong	L5	ML15	1		0		db
53		Marslong	L5	new adj. ML33	1		0		db
54		Marslong	L5	new adj. ML33	5	32	200	y	In flower - pics
55		Marslong	L5	new adj. ML33	2	2	5	n	resprout
56		Marslong	L5	new adj. ML33	3	8	90	n	
57		Marslong	L5	new adj. ML33	1		0		db
58		Marslong	L5	ML45-	1		0		db

No	Date	Species	Line	Source Label	Cond	No. lvs	Height (cm)	New Shoots (Y/N)	Comment
59		Marslong	L5	ML45-11	1		0		db
60		Marslong	L5	ML47-1	1		0		db
61		Marslong	L5	ML47-2	1		0		db
62		Marslong	L5	ML45-4	1		0		db
63		Marslong	L5 west	ML45-	1		0		db
106		Marslong	L4	ML2010-3	1		0		db
107		Marslong	L4	ML2010-3	1		0		db
108		Marslong	L4	ML2010-3	2	5	80	y	
109		Marslong	L4	MLN-4	1		0		db
110		Marslong	L4	ML126	3	13	110	y	
111		Marslong	L4	ML126	1		0		db
112		Marslong	L4	ML127	3	12	100	y	
113		Marslong	L4	ML2010-3	1		0		db
114		Marslong	L4	ML2010-3	4	32	190	y	
115		Marslong	L4	ML2010-3	1		0		db
116		Marslong	L4	ML127	1		0		db
117		Marslong	L4	MLN-3	3	6	100	y	
118		Marslong	L4	MLN-3	3	6	90	y	
119		Marslong	L4	MLN-3	1		0		db
120		Marslong	L4	MLN-3	3	7	120	y	
121		Marslong	L4	ML2010-4	3	6	100	y	
122		Marslong	L4	ML2010-4	2	3	5	y	
123		Marslong	L4	MLN-4	3	12	100	y	
124		Marslong	L4	MLN-4	3	6	100	y	
125		Marslong	L4	TWN-2	1		0		db
126		Marslong	L4	TWN-2	1		0		db
127		Marslong	L4	TWN-2	1		0		db
128		Marslong	L3	MLN-4	3	6	80	y	
129		Marslong	L3	MLN-4	1		0		db
130		Marslong	L3	MLN-4	4	20	240	y	on Cryptocarya rigida
131		Marslong	L3	MLN-4	1		0		db
132		Marslong	L3	MLN-3	2	12	50	y	3 shoots within cage

No	Date	Species	Line	Source Label	Cond	No. lvs	Height (cm)	New Shoots (Y/N)	Comment
133		Marslong	L3	MLN-3	1		0		db
134		Marslong	L3	MLN-3	1		0		db
135		Marslong	L3	ML3	1		0		db
136		Marslong	L3	ML3	3	6	130	y	resprout amongst Gynocthodes
137		Marslong	L3	ML3	4	19	200	y	good condition
138		Marslong	L3	ML3	1		0		db
139		Marslong	L3	ML3	1		0		db recent tree fall
140		Marslong	L3	ML2	3	12	70	y	under tree fall
141		Marslong	L3	ML2	1		0		db - cage collapsed
142		Marslong	L3	ML3	1		0		db - Parsonsia dorrigoensis in cage
143		Marslong	L3	ML3	1		0		db
144		Marslong	L3	UTW10	1		0		db
145		Marslong	L3	UTW10	1		0		db
146		Marslong	L3	UML8	1		0		db - under tree fall
147		Marslong	L3	ML3	1		0		db
148		Marslong	L3	ML3	1		0		db - cage crushed tree fall

Slender Marsdenia - Sector F transplants

No	Species	Line	Date	Cond.	No. leaves	Height (cm)	New Shoots (Y/N)	Comment
F1	Marslong	Line 1 fert	Nov-Dec 2021	1		0		db
F2	Marslong	Line 1 fert		3	3	90	y	
F3	Marslong	Line 1 fert		3	10	110	y	
F4	Marslong	Line 1 fert		1		0		db
F5	Marslong	Line 1 fert		4	26	200	y	
F6	Marslong	Line 1 fert		1		0		db
F7	Marslong	Line 1 fert		2	2	20	n	
F8	Marslong	Line 1 fert		1		0		db
F9	Marslong	Line 1 fert		2	4	70	n	
F10	Marslong	Line 1 fert		2	2	50	y	
F11	Marslong	Line 1 fert		1		0		db
F12	Marslong	Line 1 fert		2	7	50	n	under tree fall
F13	Marslong	Line 1 fert		4	36	220	y	on Cordyline stricta
F14	Marslong	Line 1 fert		1		0		db
F15	Marslong	Line 1 fert		3	6	80	y	
F16	Marslong	Line 1 fert		1		0		db
F17	Marslong	Line 1 fert		1		0		db
F18	Marslong	Line 1 fert		1		0		db
F19	Marslong	Line 1 fert		1		0		db - under tree fall debris
F20	Marslong	Line 1 fert		3	14	90	y	
F21	Marslong	Line 1 fert		1		0		db
F22	Marslong	Line 1 fert		3	12	110	y	
NF23	Marslong	Line 2 no fert		2	6	30	y	
NF24	Marslong	Line 2 no fert		4	36	180	y	
NF25	Marslong	Line 2 no fert		1		0		db
NF26	Marslong	Line 2 no fert		1		0		db
NF27	Marslong	Line 2 no fert		1		0		db
NF28	Marslong	Line 2 no fert		1		0		db
NF29	Marslong	Line 2 no fert		1		0		db
NF30	Marslong	Line 2 no fert		2	2	20	n	
NF31	Marslong	Line 2 no fert		1		0		db
NF32	Marslong	Line 2 no fert		1		0		db

No	Species	Line	Date	Cond.	No. leaves	Height (cm)	New Shoots (Y/N)	Comment
NF33	Marslong	Line 2 no fert		1		0		db - under dense Cissus hypoglauca
NF34	Marslong	Line 2 no fert		2	5	90	n	
NF35	Marslong	Line 2 no fert		1		0		db
NF36	Marslong	Line 2 no fert		1		0		db
NF37	Marslong	Line 2 no fert		1		0		db
NF38	Marslong	Line 2 no fert		1		0		db
NF39	Marslong	Line 2 no fert		2	9	50	n	on cage and dead limb
NF40	Marslong	Line 2 no fert		1		0		db - cage knocked over
NF41	Marslong	Line 2 no fert		4	15	180	y	
NF42	Marslong	Line 2 no fert		1		0		db
NF43	Marslong	Line 2 no fert		1		0		db
NF44	Marslong	Line 2 no fert		2	2	10	n	
NF44a	Marslong	Line 2 no fert		2	3	30	y	resprout
NF44b	Marslong	Line 2 no fert		4	13	190	y	
F45	Marslong	Line 3 fert		1		0		db
F46	Marslong	Line 3 fert		1		0		db
F47	Marslong	Line 3 fert		1		0		db
F48	Marslong	Line 3 fert		4	60	220	y	
F49	Marslong	Line 3 fert		1		0		db
F50	Marslong	Line 3 fert		2	4	10	n	
F51	Marslong	Line 3 fert		1		0		db
F52	Marslong	Line 3 fert		3	13	90	y	
F53	Marslong	Line 3 fert		1		0		db
F54	Marslong	Line 3 fert		3	10	110	y	
F55	Marslong	Line 3 fert		3	11	120	y	on Tabernaemontana. Good condition
F56	Marslong	Line 3 fert		3	9	80	y	
F57	Marslong	Line 3 fert		3	14	180	y	on Cordyline stricta - yellowing lower leaves
F58	Marslong	Line 3 fert		3	9	180	y	Under tree fall debris but now climbing on Cordyline stricta
F59	Marslong	Line 3 fert		3	12	140	y	
F60	Marslong	Line 3 fert		1		0		db
F61	Marslong	Line 3 fert		1		0		db
F62	Marslong	Line 3 fert		1		0		db
F63	Marslong	Line 3 fert		2	3	30	n	
F64	Marslong	Line 3 fert		4	30	210	y	Growing on Tabernaemontana
F65	Marslong	Line 3 fert		1		0		db

No	Species	Line	Date	Cond.	No. leaves	Height (cm)	New Shoots (Y/N)	Comment
F66	Marslong	Line 3 fert		2	3	40	n	
NF67	Marslong	Line 4 no fert		2	2	170	n	Growing up Gynocthodes, declining
NF68	Marslong	Line 4 no fert		3	14	200	y	on Cord stricta
NF69	Marslong	Line 4 no fert		3	12	100	y	
NF70	Marslong	Line 4 no fert		4	36	320	y	on small dead shrub and Trochocarpa laurina
NF71	Marslong	Line 4 no fert		3	13	70	n	some leaves yellowing, losing condition
NF72	Marslong	Line 4 no fert		1		0		db
NF73	Marslong	Line 4 no fert		1		0		db
NF74	Marslong	Line 4 no fert		1		0		db
NF75	Marslong	Line 4 no fert		3	10	120	y	
NF76	Marslong	Line 4 no fert		1		0		db
NF77	Marslong	Line 4 no fert		1		0		db
NF78	Marslong	Line 4 no fert		3	12	130	y	
NF79	Marslong	Line 4 no fert		3	7	100	y	
NF80	Marslong	Line 4 no fert		3	7	90	y	
NF81	Marslong	Line 4 no fert		2	2	70	y	
NF82	Marslong	Line 4 no fert		1		0		db
NF83	Marslong	Line 4 no fert		3	6	90	y	
NF84	Marslong	Line 4 no fert		2	3	70	y	
NF85	Marslong	Line 4 no fert		3	7	110	y	
NF86	Marslong	Line 4 no fert		1		0		db
NF87	Marslong	Line 4 no fert		1		0		db
NF88	Marslong	Line 4 no fert		0		0		gone

Slender Marsdenia - Sector J transplants

Monit. No.	Species	Line	Fertiliser	Date	Cond	No. Lvs	Ht (cm)	New Shoots (Y/N)	Comment
Line 1 1	Marslong	L1	no fert	01-Dec-21	4	18	150	y	
2	Marslong	L1	no fert		2	2	70	y	
3	Marslong	L1	no fert		3	9	100	y	
4	Marslong	L1	no fert		4	18	180	y	Climbing Cissus hypoglauca
5	Marslong	L1	no fert		3	16	120	y	
6	Marslong	L1	no fert		3	10	110	y	
7	Marslong	L1	no fert		3	11	80	y	
8	Marslong	L1	no fert		1		0		db
9	Marslong	L1	no fert		3	12	80	y	on Morinda and Endiandra sieberi
10	Marslong	L1	no fert		1		0		db
11	Marslong	L1	no fert		3	6	110	y	on Hibbertia scandens
12	Marslong	L1	no fert		3	6	150	y	
13	Marslong	L1	no fert		1		0		db
14	Marslong	L1	no fert		1		0		db
15	Marslong	L1	no fert		1		0		db
16	Marslong	L1	no fert		1		0		db
17	Marslong	L1	no fert		2	4	30	y	
18	Marslong	L1	no fert		1		0		db
19	Marslong	L1	no fert		1		0		db
20	Marslong	L1	no fert		1		0		db
21	Marslong	L1	no fert		1		0		db - under tree fall debris
22	Marslong	L1	no fert		1		0		db
23	Marslong	L1	no fert		1		0		db
24	Marslong	L1	no fert		3	4	80	y	
25	Marslong	L1	no fert		2	6	10	y	
Line 2 1	Marslong	L2	fert		3	8	95	y	
2	Marslong	L2	fert		4	22	150	y	
3	Marslong	L2	fert		1		0		db
4	Marslong	L2	fert		1		0		db
5	Marslong	L2	fert		3	11	110	y	
6	Marslong	L2	fert		3	6	100	y	
7	Marslong	L2	fert		2	5	15	n	poor health
8	Marslong	L2	fert		4	21	120	y	
9	Marslong	L2	fert		1		0		db

10	Marslong	L2	fert	1		0		db
11	Marslong	L2	fert	2	8	30	y	
12	Marslong	L2	fert	2	4	70	y	
13	Marslong	L2	fert	1		0		db
14	Marslong	L2	fert	1		0		db
15	Marslong	L2	fert	1		0		db
16	Marslong	L2	fert	4	16	170	y	
17	Marslong	L2	fert	1		0		db
18	Marslong	L2	fert	1		0		db
19	Marslong	L2	fert	1		0		db - cage crushed
20	Marslong	L2	fert	1		0		db
21	Marslong	L2	fert	3	12	110	y	
22	Marslong	L2	fert	1		0		db - under pile of Cissus and Melodinus
23	Marslong	L2	fert	2	0	90	n	Green leafless stem
24	Marslong	L2	fert	1		0		db - cage crushed
25	Marslong	L2	fert	5	46	210	y	In bud - on Synoum glandulosum
Line 3 1	Marslong	L3	no fert	1		0		db
2	Marslong	L3	no fert	2	14	10		14 leaves on 4 small ramets - pic
3	Marslong	L3	no fert	2	5	60	y	
4	Marslong	L3	no fert	3	8	90	y	growing up Cordyline stricta
5	Marslong	L3	no fert	3	7	80	y	
6	Marslong	L3	no fert	5	26	220	y	In bud - on Ripogonum fawcettianum
7	Marslong	L3	no fert	1		0		db
8	Marslong	L3	no fert	1		0		db
9	Marslong	L3	no fert	3	3	80	n	wild Marsdenia longiloba also present
10	Marslong	L3	no fert	2	9	60	y	
11	Marslong	L3	no fert	1		0		db
12	Marslong	L3	no fert	1		0		db
13	Marslong	L3	no fert	2	3	15	n	
14	Marslong	L3	no fert	1		0		db
15	Marslong	L3	no fert	1		0		db
16	Marslong	L3	no fert	2	2	5	y	
17	Marslong	L3	no fert	1		0		db
18	Marslong	L3	no fert	2	4	40	n	
19	Marslong	L3	no fert	4	70	240	y	
20	Marslong	L3	no fert	1		0		db - cage knocked over
21	Marslong	L3	no fert	1		0		db
22	Marslong	L3	no fert	1		0		db

23	Marslong	L3	no fert	1		0		db
24	Marslong	L3	no fert	1		0		db
25	Marslong	L3	no fert	1		0		db - cage overgrown
26	Marslong	L3	no fert	1		0		db
27	Marslong	L3	no fert	1		0		db
Line 4 1	Marslong	L4	fert	2	5	70	y	
2	Marslong	L4	fert	1		0		db
3	Marslong	L4	fert	3	7	100	y	
4	Marslong	L4	fert	2	6	40	y	
5	Marslong	L4	fert	3	8	200	y	east side of creekline
6	Marslong	L4	fert	3	6	150	y	
7	Marslong	L4	fert	1		0		db
8	Marslong	L4	fert	1		0		db
9	Marslong	L4	fert	1		0		db
10	Marslong	L4	fert	1		0		db
11	Marslong	L4	fert	1		0		db
12	Marslong	L4	fert	1		0		db
13	Marslong	L4	fert	2	4	50	n	
14	Marslong	L4	fert	1		0		db
15	Marslong	L4	fert	2	5	25	y	
16	Marslong	L4	fert	2	4	5	y	resprout
17	Marslong	L4	fert	2	7	70	y	
18	Marslong	L4	fert	1		0		db
19	Marslong	L4	fert	2	5	20	y	ramet arising just outside cage
20	Marslong	L4	fert	2	6	50	y	
21	Marslong	L4	fert	2	8	10	y	2 ramets 4 leaves each
22	Marslong	L4	fert	1		0		db
23	Marslong	L4	fert	1		0		db
24	Marslong	L4	fert	1		0		db
25	Marslong	L4	fert	1		0		db
26	Marslong	L4	fert	2	2	40		Under fallen Forest Oak but resprouted

Rusty Plum & Red Bopple Nut transplants

Monitoring Number	Condition notes	Condition Score	Height (m)	Comments
Rusty Plum 1	split one from Boggy Creek shooting	4	2.1	In excellent health. One shoot from base of main stem with vigorous new growth
Rusty Plum 2	split one from Boggy Creek shooting	0	0	dead
Rusty Plum 3	good - lot of new shoots	4	4.3	In excellent health. No evidence of flowering this past season
Red Bopple Nut	Excellent health	5	3.3	Flowered spring 2021, with several young developing fruit present Nov 2021, as well as fresh inflorescences.

Appendix 2 - Operational Phase Biodiversity Monitoring Report 2021

Transport for
New South Wales

Nambucca Heads to Urunga Pacific Highway Upgrade:

Operational Phase Biodiversity Monitoring – Year five, 2021.

Transport for NSW | February 2022

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1. Introduction

Transport for NSW (TfNSW), in conjunction with Lendlease Engineering (LLE) commenced the upgrade of the Pacific Highway between Nambucca Heads and Urunga in 2013. The Nambucca Heads to Urunga (NH2U) upgrade is located on the mid-north coast of New South Wales and covers a 22-kilometre section of highway stretching from Link Road at Nambucca Heads to Waterfall Way, north of Urunga (Figure 1). The project was opened to traffic in July 2016 and construction completed in February 2018.

The Minister for Planning approved the NH2U upgrade under Part 3A (now repealed), Section 75J of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 19 July 2011 subject to the Minister's Conditions of Approval (CoA) being met. The project was granted approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 21 November 2013. As part of the obligations under the Minister's CoA B10, an Ecological Monitoring Program (EMP) was to be produced and implemented. Transport for NSW engaged Benchmark Environmental Management to prepare the EMP and in June 2013 the plan was finalised (Benchmark 2013). The EMP and threatened species management strategies outline the detailed monitoring requirements to satisfy the Minister's CoA.

The EMP specified that the following mitigation measures be monitored during construction and operation:

- Pre-clearing and clearing procedure;
- Fauna underpass structures and exclusion fencing;
- Widened vegetated medians;
- Nest box installation;
- Landscape rehabilitation;
- Protection of in-situ flora populations; and
- Establishment of translocation areas.

1.1 Scope

As outlined in the project EMP (Benchmark 2013), operational phase biodiversity monitoring intends to investigate the effectiveness of habitat connectivity mitigation measures (i.e., fauna underpasses, vegetated medians and exclusion fencing). A requirement of the EMP was construction phase (Year 3) monitoring of underpasses, which was conducted in spring 2014 and autumn 2015 (Sandpiper Ecological 2015a). The construction phase monitoring established a baseline dataset of fauna recorded adjacent to the alignment and refined methods for underpass monitoring that have been adopted during the operational phase. It also provided an opportunity to monitor underpasses prior to installation of exclusion fence. In May 2017, Sandpiper Ecological Surveys (SES) was engaged to conduct biodiversity monitoring as part of the operational phase of the NH2U upgrade. Year two and three operational phase monitoring occurred in autumn and spring of 2018 and 2019 (Sandpiper Ecological 2019a, 2020a). The following report discusses the results of year five (2021) operational monitoring of fauna underpasses, exclusion fencing, and widened vegetated medians. The results are discussed in relation to the potential indicators of success detailed in the EMP (Benchmark 2013), and recommendations regarding future monitoring are provided.

1.1.1 Fauna underpasses and exclusion fence monitoring

Underpasses and exclusion fence have been installed at NH2U "to maintain the viability of local populations of terrestrial fauna by facilitating wildlife movement between proximate areas of habitat either side of the Upgrade corridor" (Benchmark 2013). The EMP also stipulates that where possible underpass structures will be designed to accommodate use by threatened fauna species including the spotted-tailed quoll (*Dasyurus maculatus*), brush-tailed phascogale (*Phascogale tapoatafa*) and koala (*Phascolarctos cinereus*). To assess the effectiveness of exclusion fencing and underpass structures the EMP outlines potential indicators of success. These 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; and
- Low incidence of fauna road strike mortality.

The monitoring program included seven fauna underpasses and one reference underpass (Table 1). Six underpasses were newly constructed box culverts with one as a bridge over the railway and a reference culvert on the old Pacific Highway at McGrath's Creek. In 2021, the railway bridge was replaced due to access restrictions imposed by the Australian Rail track Corporation. A bridge structure further north (Martell's bridge) was selected as a suitable replacement (Table 1, Figure 1). Monitored underpasses were named Tyson's, Access G, Martell's North, Martell's South, Martell's Bridge, Dalhousie, Burke's, and McGrath's (Figure 1, Table 1). All structures, apart from Burkes, were combined underpasses that provide the dual function of fauna passage and drainage. Burkes was a dedicated underpass. Dalhousie and Tyson's underpasses consist of corresponding culverts (split) on either side of a vegetated median. Dual cells (culverts side by side) were present at the Tyson's and Access G underpasses, with the remaining sites being single cell underpasses (Table 1). The McGraths reference site was a three-cell drainage culvert beneath the old Pacific Highway.

Floppy top fauna exclusion fence is connected to all monitored structures, except McGraths, and extends for most of the alignment. The purpose of monitoring the exclusion fence was to determine which species move through the fence and compare species encountering the fence with those recorded in nearby underpasses.

Table 1: Location, type and size of monitored underpasses on the NH2U alignment. MOF = Moist open forest, DOF = Dry open forest, Cl = Cleared land, SF = Swamp forest, R = Riparian forest. *Details to be confirmed.

Chainage & Habitat	Location	Type	Purpose	Culvert arrangement	Length	No. & Size (# x W x H)
68470 (SF/MOF/DOF)	Burke's	RCBC	Dedicated	Single	72.4	1 x 3.6 x 2.4 4 x 3.6 x 1.2
73800 (R/DOF)	Dalhousie	RCBC	Combined	Split	36.5 (SB) 42 (NB)	1 x 2.4 x 2.4
Chainage (MOF)	Martell's	Bridge	Combined	Single	*	*
75250 (MOF)	South Martell's	RCBC	Combined	Single	67.4	1 x 3 x 3
75800 (MOF)	North Martell's	RCBC	Combined	Single	75.7	1 x 3 x 3
78800 (MOF/Cl)	Access G	RCBC	Combined	Dual	58.9	2 x 2.4 x 3.0
80220 (MOF)	Tyson's	RCBC	Combined	Split/dual	27 (SB) 25 (NB)	2 x 3 x 2.1
Off site (MOF/R)	McGrath's	RCBC	Combined	Dual	18	3 x 2.4 x 1.5

1.1.2 Vegetated medians

As with the underpass mitigation structures, the EMP outlined several potential indicators of success for vegetated medians:

- Evidence of regular use of median vegetation by the target glider species;
- Evidence of use by dispersing individuals and different age cohorts; and
- Use by glider species other than threatened species e.g. sugar glider.

The vegetated median operational monitoring data for year five is assessed against the performance criteria in section four of this report.

The NH2U upgrade includes two widened vegetated medians to provide connectivity for gliders, with a particular focus on yellow-bellied glider (*Petaurus australis*) and squirrel glider (*Petaurus norfolcensis*) which are both listed as vulnerable by the *Biodiversity Conservation (BC) Act* 2016. The location of the Dalhousie and Tyson's vegetated medians are illustrated on Figure 1 and described in Table 2.

Table 2: Location and length of monitored vegetated medians on the NH2U alignment. MOF = Moist open forest, DOF = Dry open forest

Chainage & Habitat	Location	Type	Length
MOF/DOF CH 73800	Dalhousie	Vegetated Median	1035m
MOF CH 80220	Tyson's	Vegetated Median	570m

1.2 Study area

The NH2U project extends for 22km from Link Road, Nambucca Heads in the south to Waterfall Way, Urunga in the north. The single reference and seven impact sites monitored during 2021 were spaced along the NH2U Pacific Highway upgrade alignment between chainage 68470 (Burke's) and 80220 (Tyson's Flat) (Figure 1). The context of each impact site differed and included: vegetated median (Dalhousie & Tyson's); underpass with adjoining service roads (Burke's);; combined structures situated within vegetated medians (Dalhousie and Tyson's) and a small bridge underpass (Martells bridge). The reference site at McGrath's Creek was located under the old Pacific Highway, 280m east of the alignment (Figure 1).

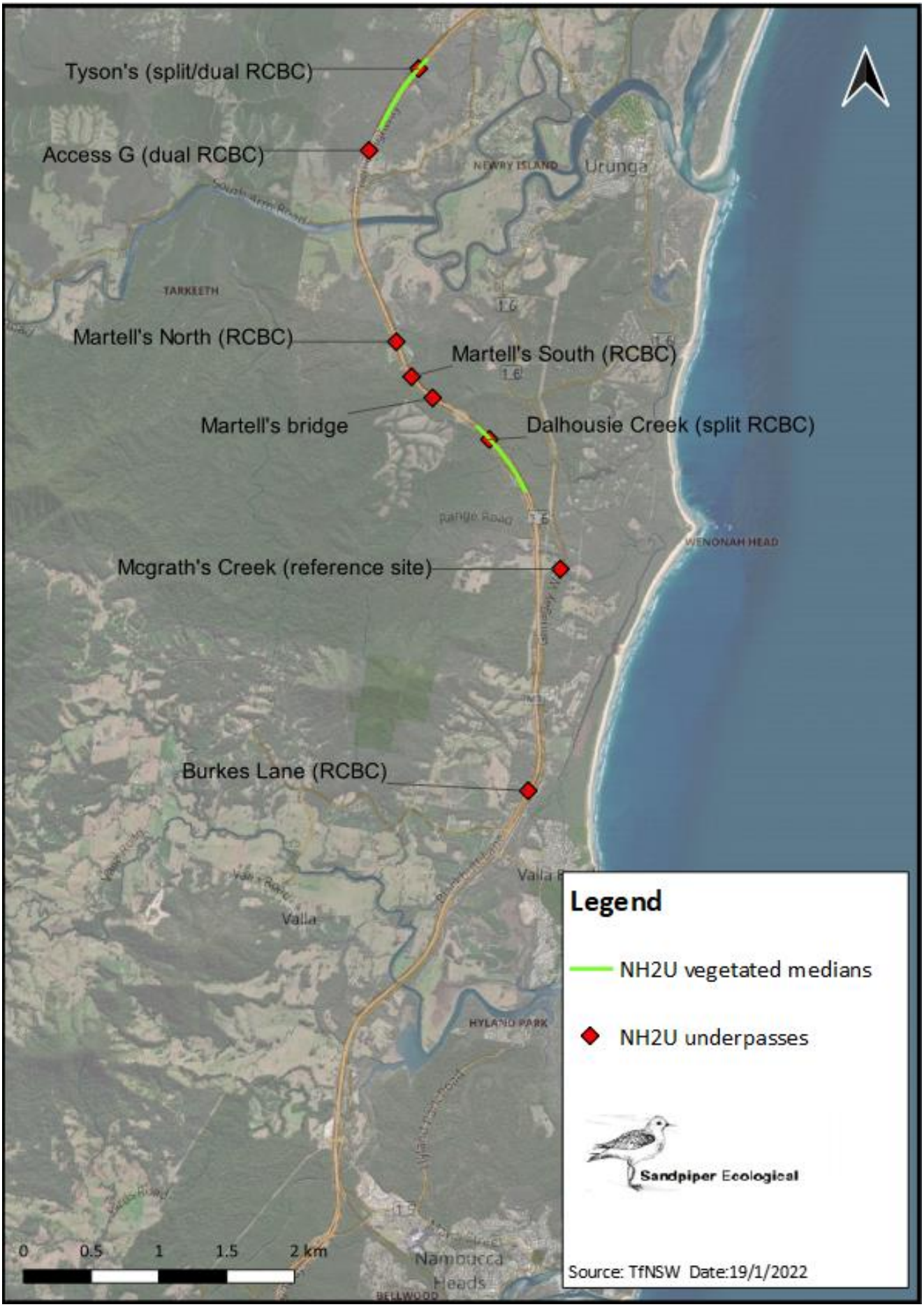

Figure 1: Underpasses and vegetated medians monitored during year five operational monitoring at NH2U, 2021.

2. Methods

2.1 Survey timing and effort

Year five monitoring was conducted in autumn and spring 2021. The autumn monitoring period extended from 27 March to 14 May and the spring period from 16 August to 8 November (Table 3). Survey effort for each monitoring component during each sample period is presented in Table 3. All surveys were undertaken according to the EMP unless otherwise agreed with the EPA.

Table 3: Survey effort for each year five (2021) operational phase monitoring component. VM = Vegetated Median, HF = Hair Funnels, UP = Underpass, Ad Hab = Adjacent Habitat, FF = Fauna Fence, av = average. *= complete wash out of sand pads on two occasions during autumn.

Survey method	Autumn	Spring
Adj. habitat cameras	26 days/site/side (av.)	30.9 days/site (av.)
Adj. habitat spotlight	32 person hours/site	32 person hours/site
Adj. habitat active search	32 person hours/site	32 person hours/site
Underpass cameras	65.43 days/cam/site (av.)	83.47 days/site (av.)
Sand pads	4 checks/site *	4 checks/site
Tracks/Scat searches	3 traverses/site	3 traverses/site
Frog traverse	60 minutes/site	100 minutes/site
Underpass hair funnels	40 days/site	36 days/site
Fauna fence Cameras	26.2 days/cam/site (av.)	25.46 days/cam/site (av.)
Vegetated median cameras	91 days/cam/site (av.)	59 days/cam/site (av.)
Road-kill	2 samples	2 samples
Habitat assessment	Nil	1 assessment/site

2.2 Adjacent habitat surveys

2.2.1 Baited camera traps

Scoutgaurd KG680V cameras were deployed in habitat adjoining each underpass. One camera was installed on a tree on the east and west side of each underpass within 50m of the underpass entrance and orientated towards a bait station containing chicken and tuna oil (Plate 1). Four cameras (2/side) were installed at McGrath's Creek control site to detect fauna on both sides of the creek. Cameras were set to take a burst of three photos with a ten-second delay between activation. Cameras were installed at approximately 0.5m above ground and positioned 2.5m from a bait station. Cameras were deployed for four weeks during each sampling period (i.e. autumn and spring) and were operational during the period of underpass monitoring (Table 3).

Plate 1: Adjacent habitat camera trap set up showing camera mounted on a tree directed at a bait station.

2.2.2 Diurnal and nocturnal active searches

Diurnal and nocturnal active searches were conducted within a one-hectare area of habitat adjoining each side of each underpass. Diurnal searches were focused on detecting herpetofauna (i.e. reptiles and frogs) and were generally conducted during late morning/early afternoon. Sampling involved ecologists searching for fauna under logs, ground vegetation, leafy debris, decorticating bark, and hollow logs. Any animals observed or captured were identified to species level (if possible) and released at the point of capture.

Nocturnal surveys involved two ecologists spotlighting fence lines, the forest edge, tracks and sections of intact forest where applicable. Fauna were detected by sight, behaviour, call and identified to species or genus level. All fauna and signs of fauna, along with standard weather variables (i.e. wind, rain, relative humidity, cloud cover and air temperature) were recorded during diurnal and nocturnal searches. Each site was sampled twice during autumn and spring for a minimum of one person hour/sample. A total of 32 person-hours were spent conducting diurnal and nocturnal searches in each season (Table 3).

2.3 Underpass monitoring

2.3.1 Camera monitoring

A combination of Reconyx HC 500 and Swift Enduro cameras were installed in underpasses to monitor fauna use. Reconyx cameras were set to take a series of three photos with no delay between activation and Swift Enduros recorded 10 seconds of video with no delay between activations. Each cell that supported fauna furniture had a Reconyx HC 500 installed centrally on the horizontal rail facing east and a Swift Enduro camera a installed centrally on vertical fauna furniture post or culvert wall at approximately 300mm above floor level, facing east. A single Enduro camera was installed in cells without fauna furniture. All cameras were housed in security cases. At the McGraths Creek reference site, due to the higher likelihood of inundation, two Scoutgaurd KG680V cameras were installed on star pickets at the eastern entrance to the culvert facing the entrance (i.e. facing west). A total of 23 cameras were deployed during each monitoring event for a minimum duration of eight weeks, with batteries and SD cards checked and/or swapped after four weeks (Table 3).

2.3.2 Sand pad monitoring

To complement camera monitoring, sand pads were installed in the centre of each cell at each site. Sand pads were installed using a 1:1 mix of brickie's sand and beach sand and smoothed out with a cement trowel at the start of monitoring and after each inspection (Plate 2). Pads were approximately 1m wide and 50mm deep. A small channel (200mm wide) was left in the centre of pads in combined structures to allow for drainage. Sand pads were monitored for a minimum of four consecutive days during each monitoring period. The change in method from previous years (when pads were checked weekly) was to align sampling with the method used on the Warrell Creek to Nambucca Heads (WC2NH) project and reduce the loss of data from washouts.

During each inspection, pads were systematically scanned for prints with the aid of a hand-held torch if required. An ecologist with experience identifying fauna tracks inspected each pad. Tracks were identified to species, genus, or group and the number and direction of crossings recorded. Repeated washouts occurred at several sites in autumn, resulting in some data loss; however, cameras remained active during this period (Table 3).

Plate 2: Sand pad installation at Tyson's underpass.

2.3.3 Scat and track searches

An ecologist searched each underpass for scats and tracks on three occasions during the autumn and spring sample periods (Table 3). The search involved a slow systematic traverse of each culvert using a hand-held spotlight (Led Lenser P14). Fauna furniture, the culvert floor, and joints were targeted. Sand pads and areas of accumulated fine sediment were targeted for tracks. Tracks and scats were identified in situ, with reference to Triggs (2004) and the ecologist's experience or photographed and sent to colleagues for identification.

2.3.4 Frog survey

Frog surveys of underpasses were conducted when conditions were conducive to frog dispersal (i.e. after or during rainfall and when relative humidity exceeded 80%). Each survey involved a foot-based traverse of the underpass entrance and structure by two ecologists with spotlights for a period of 20 person minutes (Table 3). Weather variables and detected frogs were recorded on a standard proforma.

2.3.5 Hair funnels

Two hair funnels were installed on fauna furniture at sites containing fauna furniture (i.e. all sites except McGrath's). Funnels were baited with peanut butter, oats and honey and left in situ for a minimum of two weeks per monitoring event (Table 3). Wafers were collected and sent to Scatsabout Hair Identification for analysis.

2.4 Exclusion fence monitoring

Fence cameras were installed at all sites except McGraths. The setup involved installation of a camera on each side of each culvert entrance (total of 28 cameras). Cameras were attached to a bracket fixed to a fence post at approximately 400mm above ground and orientated along the fence towards the underpass entrance (Plate 3). Distance from the culvert entrance ranged from 10m to 60m and depended on obtaining a reasonable line of sight. Ground vegetation was trimmed at all sites in autumn to improve visibility and reduce the incidence of false triggers. Scoutgaurd KG680V cameras were used at all sites except Burke's west where Reconyx HC500 cameras were installed. Scoutguard cameras were scheduled to arm at 4pm and disarm at 9am. Cameras were set to take a series of three photos with a ten second delay between activation. Exclusion fence camera monitoring effort is described in Table 3 (see full details in Appendix B, Table B11).

Plate 3: Typical exclusion fence camera set up. It shows a Scoutgaurd KG680V camera attached to a steel bracket fixed to a fence post.

2.5 Road-kill monitoring

The road mortality survey method was revised to ensure compliance with the updated TfNSW Traffic Control at Worksites Manual (TfNSW 2020). The updated guidelines require vehicles to be parked 3m from (& behind) wire rope, 11m from the fog line if there is no wire rope, and pedestrians to walk 3m behind wire rope. As distance restrictions could not be achieved the method and was revised prior to the autumn 2021 survey.

Surveys were conducted by a two-person team from a constantly moving vehicle driven at 80-90km/hr in the left lane. The vehicle was equipped with an amber (flashing) light and warning sign (Plate 4). The team consisted of a driver and an ecologist passenger with experience identifying road-killed fauna. The entire NH2U alignment was surveyed twice during each seasonal sample period, with surveys commencing within three-four hours of sunrise. During each survey the ecologist scanned the road surface and road shoulder for fauna. When road-kill fauna were detected the species or fauna group was recorded into an audio recorder with the record number, and a "drop pin" showing the site location was placed on an iPad running Motion-X. Fauna records considered likely to be an unidentified target species (i.e. spotted-tailed quoll, koala, grey-headed flying-fox, giant

barred frog) were inspected more closely from a safe location. After each survey, the audio recordings were played back, and data were uploaded to Microsoft Excel on a desktop computer, with GPS coordinates downloaded from the iPad.

Broad size classes used to group fauna included:

- Small mammal – rodent, juvenile bandicoot
- Medium mammal – bandicoot, brushtail possum, ringtail possum, cat
- Large mammal – wallabies and kangaroos
- Small bird – noisy miner, honeyeaters
- Medium bird – magpies, pigeons, frogmouth, swamp hen, ducks
- Large bird – Ibis, large forest owl, egret

Plate 4: Work vehicle with signage, flashing amber light and indicators

2.6 Vegetated median monitoring

Monitoring of vegetated medians at NH2U has previously been conducted through spotlighting and arboreal hair funnel surveys (Sandpiper Ecological 2020). After completing the 2019 sample, approval was attained from TFNSW and the EPA to amend the survey method to align with the method adopted for the Woolgoolga to Ballina and Warrell Creek to Nambucca Heads highway upgrades. The new method involved installation of baited camera traps at approximately 5m above ground near potential crossing points (Plate 5). Each trap consisted of one Swift Enduro passive infrared camera and a bait station (100mm diameter PVC pipe) installed at opposite ends of a 500 mm long platform (Plate 5). Traps were baited with a 50/50 honey/water solution and left insitu for the 2021 autumn and spring sample period (March-November). The honey water solution and SD cards were periodically replaced approximately eight week intervals. Four camera traps were installed in both the Dalhousie and Tyson's vegetated median between 29 and 30 March and collected on 26 November (Table 3).

Plate 5: Arboreal camera trap used to monitor glider presence in vegetated medians along the Pacific Highway.

2.7 Habitat Assessment

A habitat assessment was conducted on both sides of each underpass site. Assessments involved one ecologist recording habitat type, dominant canopy, mid-story, and groundcover species.

2.8 Image review and analysis

All underpass, adjacent habitat and exclusion fence camera images were uploaded to a computer and viewed using Windows Photo Viewer©. An ecologist reviewed all images with reference to standard field guides (i.e. Menkhorst & Knight 2003; Pizzey & Knight 2007). Input from multiple ecologists was sought to identify some images.

2.8.1 Adjacent habitat

Fauna detected in adjacent habitat was scored on a presence-absence basis. All detections are presented in Appendix B, Table B2.

2.8.2 Underpasses

Fauna detected in underpasses were scored making a complete or incomplete crossing:

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

Crossing definitions are consistent with those used at other Pacific Highway monitoring sites (e.g. Sandpiper Ecological 2021) and crossing structure research programs (e.g. Soanes *et al.* 2015). Further, the method represents a conservative approach to the identification of complete crossings. Data recorded for each active image included: site, date, time, species, accuracy (definite 90%+ certainty, probable 75-90% certainty, and possible 60-75% certainty), movement direction (east, west, no directional movement (animal stationary, returned), number of images and image numbers. A hierarchical approach was adopted to species identification that included: species, genus or group. Microbats were recorded as presence only due to their transient nature and none-reliance on underpasses for thoroughfare. These data are presented in Appendix B, Table B6.

To adequately assess “use of underpasses” as per the project aim, “complete crossing” was used as the standard of measure as it encompasses the purpose of fauna underpasses (i.e. A structure that allows fauna to access habitat that has been fragmented by the construction of a road or highway). To account for variations in survey effort between sites, complete crossings/week and complete crossings/week/underpass were adopted. Birds and microbats were excluded from analysis as they do not require underpasses for thoroughfare. Complete crossings have been pooled and presented in relation to monitoring periods (i.e. operational 2018 vs 2019), taxa (i.e. bandicoots, possums and wallabies) and sites (i.e. McGraths, Burkes and Dalhousie). While pooling data, complete crossings of fauna have been averaged according to the number of cameras per underpass (i.e. Tyson’s n=6).

One of the potential indicators of success (see introduction), was use by fauna with low mobility, however, such species were not defined within the EMP. As such, fauna with low mobility has been assumed to include species whose movement is generally limited by their size or behaviour. Hence, fauna with low mobility/cover dependence have been interpreted as frogs, small reptiles (excluding goanna and water dragon), rodents, and bandicoots. Rodent sp. were considered to be “undefined” in relation to whether they were introduced or native given the presence of black rats (*Rattus rattus*), bush rats (*R. fuscipes*) and fawn-footed melomys (*Melomys cervinipes*).

2.8.3 Exclusion fence

Data recorded for fence cam detections included species, accuracy, direction of movement (e.g. toward underpass, away from underpass), and interaction with fence (e.g. climbs through fence, climbs up fence). These data are presented in Appendix B, Table B12.

3. Results

3.1 Adjacent Habitat Surveys

Adjacent habitat surveys recorded a total of 37 species and three genera (*Trichosurus* spp., *Acrobates* spp. *Antechinus* spp.) via camera trap monitoring, active searches and spotlighting (Table 4). Impact sites recorded a similar diversity of fauna ranging from 17 species/genera at Tyson’s to 21 at Martell’s south and Burkes (Table 4). McGrath’s (reference site) recorded the lowest diversity with a total of 12 species/genera, eight of which were mammals (Table 4).

Species recorded within adjacent habitat included 17 (42.5% of all species recorded) native mammals, 10 (25%) frogs, 8 (20%) reptiles and five (12.5%) introduced mammals (Table 4). Most mammals were detected via camera trap monitoring (77%), with frogs (100%) and reptiles (75%) typically recorded during active searches (Table 4). Noteworthy detections included a koala on the eastern side of the Dalhousie underpass during spotlighting (Appendix B, Table B4) and a long-nosed potoroo (*Potorous tridactylus*) on the western side of North Martell’s underpass by a camera trap in spring (Plate 6; Appendix B, Table B2). Both species are listed as vulnerable by the NSW *BC Act 2016* and *EPBC Act 1999*.

3.1.1 Baited camera traps

A total of 18 species and one unique genera (*Antechinus* spp.) were detected by cameras installed in adjacent habitat (Table 4). Twelve species/genera (63%) were native mammals, five (26%) were introduced mammals, and two (11%) were reptiles. No amphibians were recorded (Table 4). Black rat, bush rat, long-nosed and northern brown bandicoot were detected in adjacent habitat at all sites (Table 4). Feral predator detections included red fox at three sites (Tysons, Martells north and Martells bridge), cat at three sites (Access G, Martells north and Dalhousie) and dog at two sites (Martells north and Martells bridge), (Table 4). A long-nosed potoroo was observed in habitat on the western side of Martells north during September 2021 (Plate 4; Appendix B, Table B2).

3.1.2 Active searches

Active searches recorded 12 species and one fauna group (Table 4). Species detections included seven (54%) reptile species, four (30%) native mammals, two frogs (15%), and one introduced species (1%, dog scat). Reptile species recorded included: lace monitor, garden sun-skink, red-tailed skink, bar-sided skink, bandy bandy, yellow-faced whipsnake and marsh snake (Table 4). No mammal species were recorded in addition to those from baited camera monitoring (Table 4).

3.1.3 Spotlighting

A total of 17 species were recorded during spotlight surveys in adjacent habitat (Table 5). Of these, ten (59%) were frogs and seven (41%) were mammals (Table 4). Frog species included: eastern dwarf tree frog, common eastern froglet, striped marsh frog, Peron's tree frog, red-backed toadlet, graceful tree frog, broad-palmed rocket frog, whirring tree frog, great barred frog and Tyler's tree frog (Plate 6, Table 4). Three mammal species were recorded in addition to those from baited camera monitoring including common ringtail possum, *Acrobates* spp. and sugar glider (Table 4).

Table 4: Detection of fauna species and unique genera during year 5 adjacent habitat monitoring at NH2U, 2021. C = camera monitoring, DS= Diurnal searches and NS = Nocturnal searches. Bold denotes threatened species. [I] = Introduced. Birds have been excluded, as they do not require underpasses for thoroughfare.

Species	Tyson's			Access G			Martell's N			Martell's S			Dalhousie			Burkes			Martell's B			McGrath's		
	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS
Mammals																								
Short-beaked echidna	X				X		X			X						X			X					
Antechinus spp.	X			X			X			X			X						X			X		
Sugar glider						X			X									X						
Acrobates spp.												X						X						
Long-nosed bandicoot	X			X			X			X			X			X			X			X		X
Northern brown bandicoot	X			X			X			X	X		X			X			X			X		
Koala															X									
Common ringtail possum																		X						
Short-eared brushtail possum	X			X						X			X					X	X			X		
Common brushtail possum	X			X									X			X		X	X			X		
Trichosurus spp. (brushtail possum)					X						X													
Long-nosed potoroo										X														
Red-necked Wallaby																			X					
Swamp wallaby	X	X		X	X	X	X	X			X	X		X		X	X	X	X	X	X	X	X	X
Water rat							X																	
Bush rat	X			X			X			X			X			X			X			X		
House mouse[I]																X			X					
Black rat[I]	X			X			X			X			X			X			X			X		
Fawn-footed melomys	X						X			X			X			X			X					

Species	Tyson's			Access G			Martell's N			Martell's S			Dalhousie			Burkes			Martell's B			McGrath's		
	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS	C	DS	NS
Dog[I]							X				X								X					
Red fox[I]	X						X												X					
Cat[I]				X			X						X											
Reptiles																								
Lace monitor	X			X			X			X	X		X				X		X					
Eastern water dragon	X												X											
Garden sun-skink					X			X			X			X			X			X			X	
Red-tailed skink					X												X							
Bar-sided skink											X													
Bandy bandy																	X							
Yellow-faced whipsnake																				X				
Marsh snake		X						X						X										
Frogs																								
Eastern dwarf tree frog		X	X		X	X		X			X	X		X	X			X		X				X
Common eastern froglet					X	X			X		X	X			X			X		X				X
Striped marsh frog						X		X						X	X		X							
Peron's tree frog			X									X						X						X
Red-backed toadlet			X									X			X			X						
Graceful tree frog						X																		
Broad-palmed rocket frog									X															
Whirring tree frog												X												
Great barred frog												X												
Tyler's tree frog						X																		
Total spp./survey	**13**	**3**	**3**	**10**	**7**	**7**	**13**	**5**	**3**	**10**	**9**	**8**	**11**	**5**	**5**	**9**	**6**	**10**	**15**	**5**	**1**	**8**	**2**	**5**
Total spp./site	**17**			**19**			**20**			**21**			**19**			**21**			**19**			**12**		

Plate 6 Long-nosed potoroo detected in habitat to the west of Martells north(L) and a Tyler's tree frog detected in adjacent habitat at Martells south (R)

3.2 Underpass Monitoring

3.2.1 Camera monitoring

Year five species diversity and native fauna use

Twenty-three species and five fauna groups were confirmed making complete crossings (cc) at NH2U during year five operational phase camera monitoring (Table 5). Fauna groups included five taxa that could only be identified to genus or group - *Antechinus* spp., rodent spp., bandicoot spp., snake spp., *Egernia* spp. and *Trichosurus* spp. (Table 5). Rodent, bandicoot and *Trichosurus* spp. likely belong to confirmed species in Table 5 (i.e. *Trichosurus* spp. either short-eared brushtail possum or common brushtail possum). Of the fauna recorded, 17 were native species with four native fauna groups also recorded (Table 5). The diversity of fauna using underpasses was highest among impact sites including Tyson's with 18 species/groups, followed by Dalhousie and Martell's south (16 species/groups), Martells north (15 species/groups), Access G (14 species/groups), Burkes (nine species/groups) and Martell's bridge (six species/groups) (Table 5). Native fauna diversity was lowest at McGraths (reference site) with four species recorded (Table 5). Five introduced species were also recorded including feral predators (cat, dog and red fox) and introduced rodents (black rat and house mouse; Table 5).

Complete crossings by native species were recorded at all sites (Figure 2). Martell's south, Dalhousie and Tyson's featured the highest use by native fauna with an average of 4.88cc/week, 3.95cc/week and 2.77cc/week respectively (Figure 2). Martell's bridge and McGrath's exhibited the lowest use by native fauna, recording 0.6cc/week and 1.49cc/week (Figure 2). Native fauna use was higher than feral predators at all sites and typically higher than introduced rodents at most sites (Figure 2). Exceptions were Dalhousie where introduced rodent use (4.04cc/week) exceeded native fauna (3.95cc/week) use primarily due to frequent crossings by black rat (Figure 2, Table 5).

Short-eared brushtail possum was the most frequently recorded native species with a total of 5.69cc/week across all sites (Plate 7, Table 5). This was followed by *Antechinus* spp. (4.07cc/week), lace monitor (1.49cc/week) and bandicoot spp. (including long-nosed and northern brown bandicoots) with 1.43 cc/week (Plate 4, Table 5).

Noteworthy detections included a koala using the culvert floor (ground) to make a complete crossing during spring at North Martell's and Dalhousie, and a spotted-tailed quoll using fauna furniture at Martell's south during autumn monitoring (Plate 7, Table 5). Both species are listed as vulnerable by the NSW *BC Act 2016* and *EPBC Act 1999*.

Table 5: Complete crossings/week/site made by each species/group at each of the eight underpasses monitored on the NH2U upgrade during year five operational monitoring. Species in bold denote threatened species, ^=Cover dependent species, FF= fauna furniture and G = ground (culvert floor). Martell's bridge and McGrath's did not contain fauna furniture. See Appendix B, Table B6 for all data.

Species and fauna groups	Site and camera location														Total cc/week/spp.
	Access G		Burke's		Dalhousie		Martell's N		Martell's S		Tyson's		Martell's B	McGrath's	
	FF	G	FF	G	FF	G	FF	G	FF	G	FF	G	G	G	
Native mammals															
Short-beaked echidna		0.15						0.22		0.33		0.22			0.92
Antechinus spp.^	0.01	0.04			2.34	0.23	0.62	0.04	0.27		0.5	0.01			4.07
Spotted-tailed quoll									0.02						0.02
Northern brown bandicoot^		0.01		0.13								0.1			0.25
Long-nosed bandicoot^		0.03		0.18		0.02				0.13		0.02			0.39
Bandicoot spp.^				0.69				0.04		0.02		0.02	0.02		0.79
Koala						0.01		0.02							0.03
Short-eared brushtail possum	0.56	0.01	0.49	0.02		0.1		0.04	2.36	0.11	0.31	0.53		1.13	5.69
Common brushtail possum												0.01			0.01
Trichosurus spp.				0.09					0.6		0.01	0.01			0.71
Swamp wallaby													0.56		0.56
Fawn-footed melomys^					0.62	0.02	0.02		0.13						0.8
Bush rat^					0.08	0.01									0.09
Swamp rat^		0.04													0.04
Water rat		0.3				0.08		0.42		0.11		0.31	0.02	0.03	1.27
Introduced and undefined rodents															
Black rat^	0.01	0.31	0.02	0.49	2.23	1.8	0.2	0.71		0.71	0.38	1.95		0.03	8.86
House mouse^		0.19		0.33		0.01						0.05			0.59
Rodent spp.^		0.03			0.59	0.3		0.07		0.04		0.04			1.07
Feral predators															
Dog						0.44		0.07		0.09			0.38		0.97
Fox		0.03		0.4		0.13		0.27		0.36		0.02	0.06		1.26
Cat						0.07		0.02					0.02		0.11
Reptiles															
Land mullet^		0.01													0.01
Egernia spp.^					0.09		0.07		0.02		0.01				0.19
Eastern water dragon	0.04	0.27			0.01	0.12		0.02		0.13	0.07	0.22		0.33	1.21
Eastern bearded dragon^												0.01			0.01
Lace monitor	0.06	0.16			0.09	0.12	0.02		0.22	0.4	0.05	0.36			1.49
Coastal carpet python			0.02	0.07											0.09
Snake spp.												0.02			0.02
Total no. species/groups	**14**		**9**		**16**		**15**		**16**		**18**		**6**	**4**	**31.52**

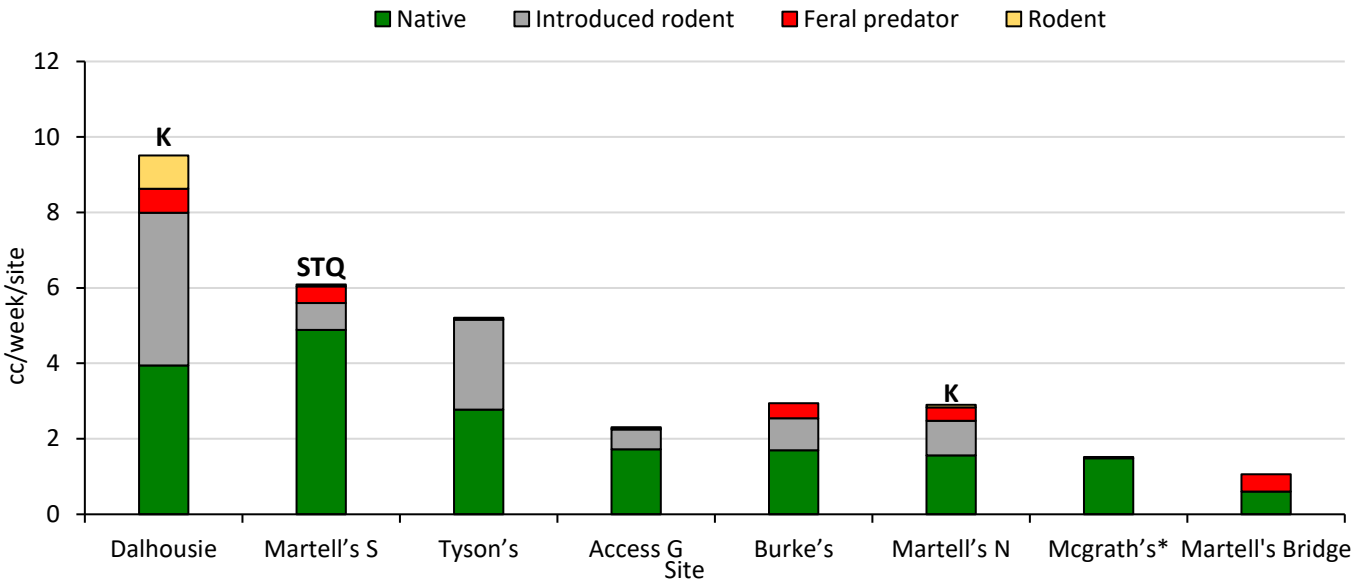

Figure 2: Complete crossings (cc)/week/site by native species, feral predators (combined cat, dog, red fox) introduced rodents (combined black rat and house mouse), and rodents (undefined native or introduced) at each site during year five (combined autumn and spring) operational monitoring, NH2U, 2021. **K** = indicates complete crossing by koala. **STQ =** indicates complete crossing by spotted-tailed quoll. *= indicates reference site (McGrath's).

Use by cover dependent species with low mobility

Cover-dependent fauna with low mobility (see classification in methods) were recorded using underpasses at all impact sites (Table 5). The introduced black rat displayed the highest use with 8.86 cc/week (Table 5). In order of use, records of native cover dependent species included *Antechinus* spp. (4.07 cc/week), bandicoot spp. (1.43cc/week), *Egernia* spp. (0.19cc/week), bush rat (0.9 cc/week), fawn-footed melomys (Plate 7, 0.8cc/week), eastern bearded dragon (0.01cc/week) and land mullet (0.01cc/week) (Table 5). No frogs were recorded using underpasses during camera monitoring.

Furniture vs Floor

Fauna was recorded using both the culvert floor and furniture during year five operational phase monitoring (Table 5). Furniture use accounted for a majority (52.1%) of complete crossings by native fauna, attributed mainly to high preferential use by brushtail possums (combined short-eared brushtail possum, common brushtail possum and *Trichosurus* spp.) and *Antechinus spp.* (Table 5). Introduced rodents (67% of crossings) and feral predators (100% of crossings) used the underpass floor more frequently than furniture (Table 5). Of the threatened fauna, koalas were recorded using the floor only with the spotted-tailed quoll recorded on furniture (Table 5; Plate 7).

Year 5 feral predator activity

Feral predators were recorded at all impact sites with no detections at McGraths (reference site, Figure 3, Table 5). Fox recorded the highest combined use (1.26cc/week), followed by dog (0.97cc/week) and cat (0.11cc/week) (Figure 3, Table 5). Fox was recorded at all sites (other than McGraths) with the highest activity at Burkes (0.4cc/week) and Martell's South (0.36cc/week) (Figure 3, Table 5). Dog was recorded at four sites with the highest use at Dalhousie (0.44cc/week) and Martell's Bridge (0.38cc/week) (Figure 3, Table 5). Cat was recorded at three sites and exhibited relatively low use of underpasses ranging from 0.02cc/week at Martell's Bridge and Martell's North to 0.07 cc/week at Dalhousie (Figure 3, Table 5).

One interesting record from year 5 was a fox attacking a brushtail possum in the Burkes underpass on 15 May 2021. This is the first direct evidence of attempted predation within an underpass on the NH2U project.

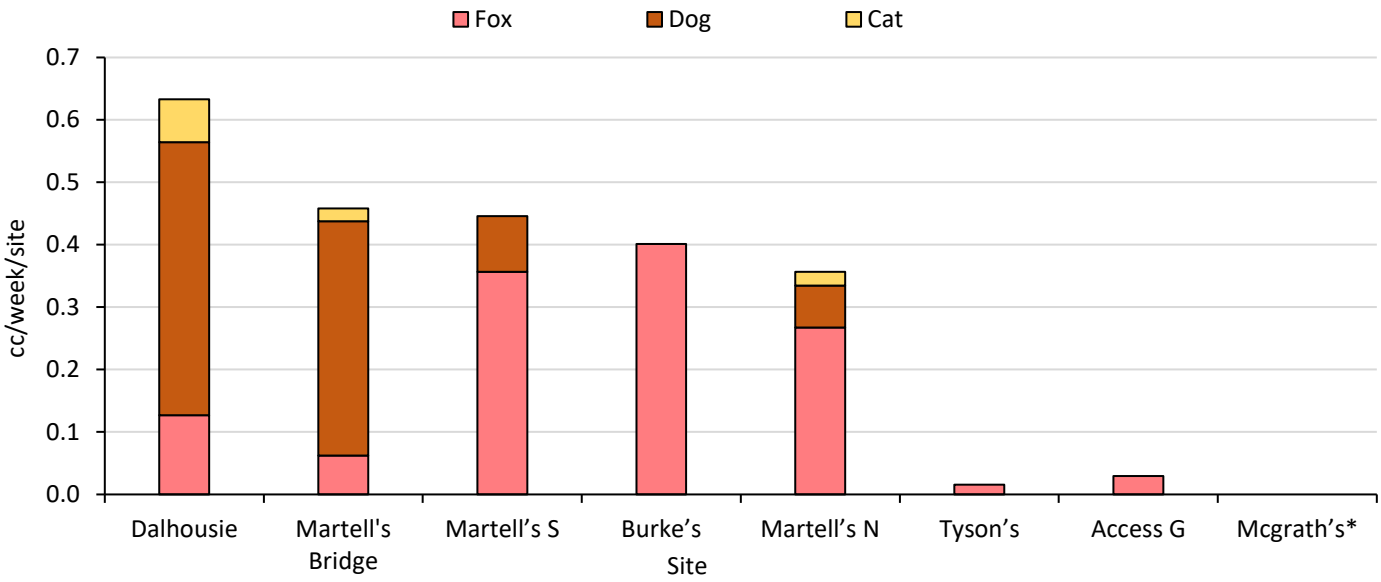

Figure 3: Complete crossings (cc)/week/site by feral predators during operational monitoring of underpasses at NH2U, 2021. *= indicates reference site (McGrath's).

Operational monitoring program

Underpass use by native and feral predators has continually increased during operational monitoring (Figure 4). Native species use has increased from 0.32 ± 0.2cc/week/site in year two of the operational phase (2018) to 1.82 ± 1.65 cc/week/site in year five (2021; Figure 4). Similarly, feral predator use was higher in year five (0.27 ± 0.28 cc/week/site) than year three (0.14 ± 0.19cc/week/site) and year 2 (0.12 ± 0.06cc/week/site) of the operational phase (Figure 4). Comparatively, introduced rodent use peaked at 1.58 ± 2.18cc/week/site in year two (2019) and decreased to 1.13 ± 1.72cc/week/site in year five (2021) (Figure 4). While overall feral predator use increased between 2019-2021, only fox and dog crossings increased with cat crossing decreasing from a peak of 0.09 ± 0.2 cc/week/site in 2019 to 0.01 ± 0.03cc/week/site in 2021 (Figure 5). During the same period dog and fox use increased from 0.01 ± 0.03cc/week/site and 0.04 ± 0.06 cc/week/site to 0.14 ± 0.23 cc/week/site and 0.12 ± 0.1 cc/week/site respectively (Figure 5). This represents a 10-fold increase in dog visitation from year three to year five, and a three-fold increase in fox visitation over the same period.

Plate 7: Koala recorded travelling east at Dalhousie during spring (Top left). Koala using the culvert floor to travel east at Martell's North during spring (Top right). Fawn-footed melomys travelling west on furniture at Dalhousie (Middle left). Lace monitor travelling east along the culvert floor at Access G (Middle right). Short-eared brushtail possum recorded on fauna furniture at Tyson's underpass (Bottom left). Spotted-tailed quoll travelling west on fauna furniture at Martell's South during spring (Bottom right).

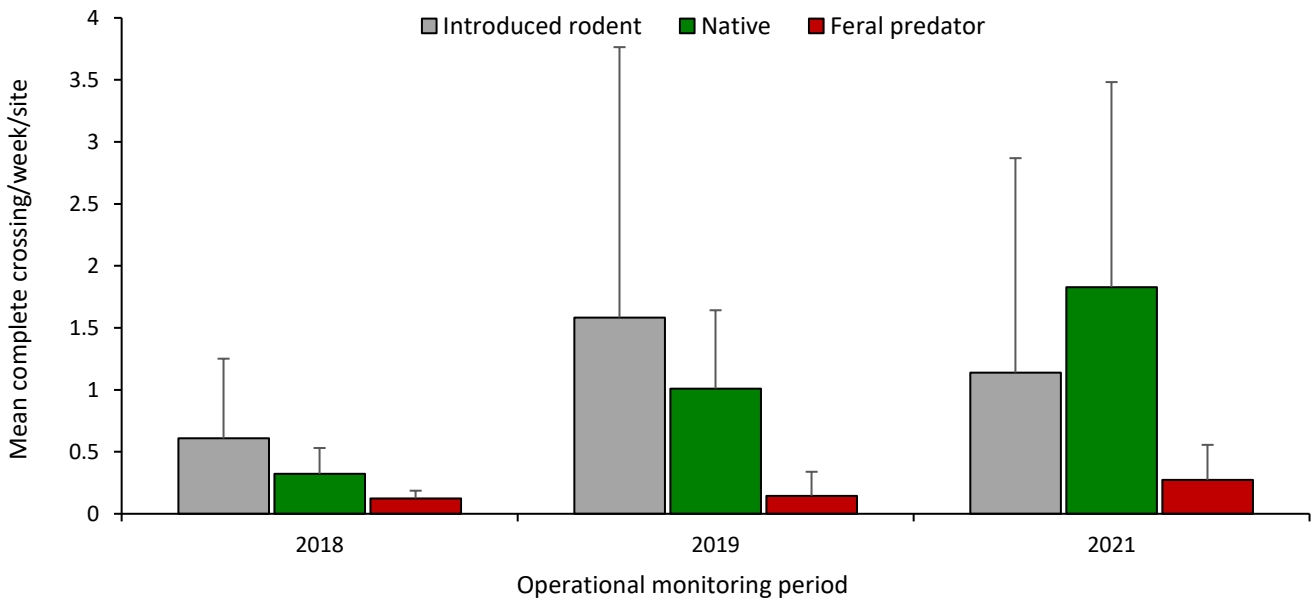

Figure 4: Mean (+SD) number of complete crossings (cc)/week/site by natives, introduced rodents (black rat and house mouse) and feral predators (combined cat, dog, red fox) species during 2018-2021 underpass monitoring at NH2U, 2021. 2018 = Year two monitoring, 2019 = Year three monitoring and 2021 = year five monitoring.

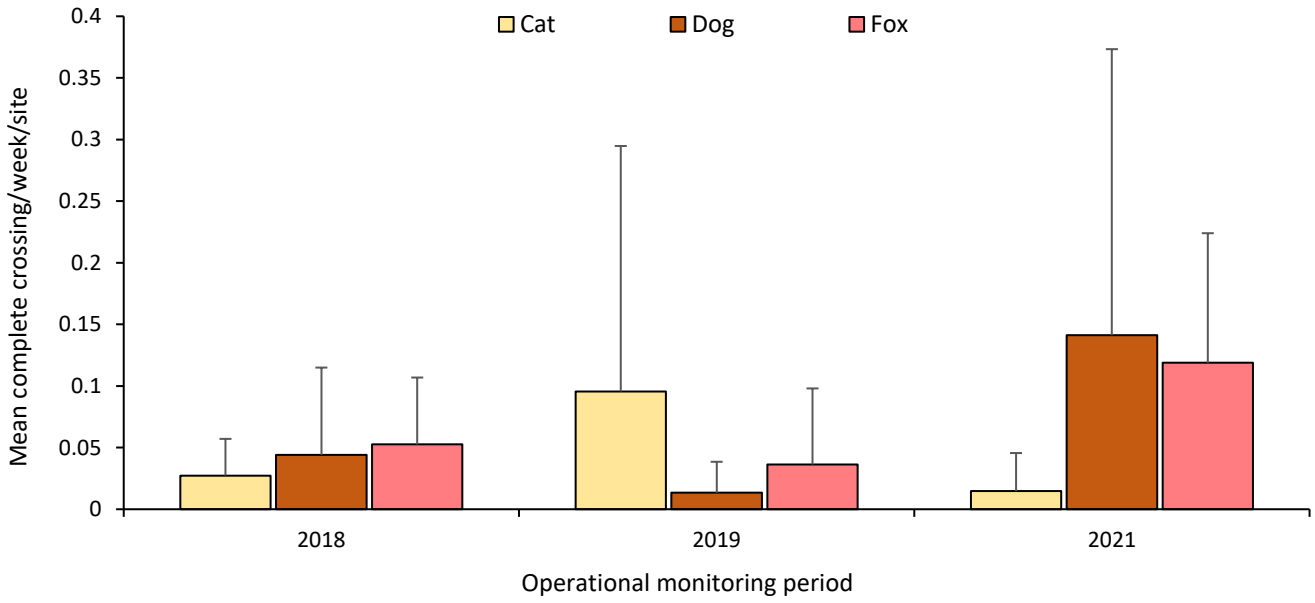

Figure 5: Mean (+SD) number of complete crossings/week/site by feral predators during 2018-2021 underpass monitoring at NH2U, 2021. 2018 = Year two monitoring, 2019 = Year three monitoring and 2021 = year five monitoring.

3.2.2 Sand pad monitoring

Five species and three fauna groups were recorded during sand pad monitoring of underpasses (Appendix B, Table B8). Species included dog, house mouse, water rat, short-beaked echidna and lace monitor. Fauna groups included rodent sp., wallaby sp. and *Antechinus* spp. No species or groups were recorded in addition to those from underpass camera monitoring. Sandpads were not installed at the McGrath's reference site due to inundation in both sample periods.

3.2.3 Scat and track search

Five species and an additional seven fauna groups were recorded during scat and track surveys in 2021. Evidence of underpass use was recorded through scats and tracks from, reptile sp., *Trichosurus* spp., bird sp., rodent sp., Antechinus spp., swamp wallaby, bandicoot sp., lace monitor, reptile sp., short-beaked echidna, dog and green tree frog (probable) (Appendix B, Table B7). Green tree frog was the only fauna detected in addition to those recorded during underpass camera monitoring. No scat and track data were collected at the McGrath's control site due to inundation in both sample periods

3.2.4 Frog survey

In year five, ten frog species were recorded in habitat adjoining underpasses (see Table 4). During the autumn monitoring period, a striped marsh frog (*Limnodynastes peronii*) was recorded moving west within the Tysons SW culvert (north side). Full details of frog surveys are provided in Appendix B, Table B9.

3.2.5 Underpass hair funnels

Five species/ fauna groups were detected via hair analysis from hair funnels installed on fauna furniture. These were *Rattus* spp., *Trichosurus* spp., house mouse, brown antechinus with probable records of yellow-footed or dusky antechinus at South Martell's and Tyson's (see Appendix B, Table B10 for full details). All species/groups detected by hair funnels were recorded using underpasses by cameras.

3.3 Underpass and Adjacent Habitat Comparison

Forty-three species and unique genera were confirmed within adjacent habitat, with 25 species/genera (or 58%) recorded using underpasses (Table 6). The proportion of mammals recorded in both adjacent habitat and underpasses was 86% with the common ringtail possum, long-nosed potoroo and red-necked wallaby the only mammal species recorded in adjacent habitat but not in underpasses (Table 6). Two species of frog were recorded using underpasses, while eleven species were reported in adjacent habitat (Table 6). Further, eleven reptile species/families were recorded during monitoring, with five confirmed using underpasses (lace monitor, land mullet, coastal carpet python, eastern water dragon & *Egernia* spp.; Table 6).

Table 6: Species and unique genera recorded in adjacent habitat and using underpasses during year five (2021) monitoring at NH2U. Due to duplication between species and fauna groups (e.g. wallaby spp. includes both red-necked and swamp wallaby), only confirmed species and unique genera have been included. Fauna that does not require underpasses for thoroughfare have also been excluded (sugar glider and *Acrobates* spp.) Bold text denotes threatened species. [I]= Introduced species. # = Species presence assumed due to detection in only the underpass.

Species	Underpass	Adjacent habitat
Mammals		
Short-beaked echidna	X	X
Antechinus spp.	X	X
Spotted-tailed quoll	X	**#**
Long-nosed bandicoot	X	X
Northern brown bandicoot	X	X
Koala	X	X
Common ringtail possum		X
Short-eared brushtail possum	X	X
Common brushtail possum	X	X
Long-nosed potoroo		X
Red-necked Wallaby		X
Swamp wallaby	X	X
Water rat	X	X
Bush rat	X	X
Swamp rat	X	**#**
House mouse[I]	X	X
Black rat[I]	X	X
Fawn-footed melomys	X	X
Dog[I]	X	X
Red fox[I]	X	X

Species	Underpass	Adjacent habitat
Cat[l]	X	X
Sub-total mammals	**18**	**21**
Reptiles		
Lace monitor	X	X
Eastern water dragon	X	X
Land mullet	X	#
Garden sun-skink		X
Red-tailed skink		X
Bar-sided skink		X
Egernia spp.	X	#
Coastal carpet python	X	#
Bandy bandy		X
Yellow-faced whipsnake		X
Marsh snake		X
Sub-total reptiles	**5**	**11**
Frogs		
Eastern dwarf tree frog		X
Common eastern froglet		X
Striped marsh frog	X	X
Peron's tree frog		X
Red-backed toadlet		X
Graceful tree frog		X
Green tree frog	X	#
Broad-palmed rocket frog		X
Whirring tree frog		X
Great barred frog		X
Tyler's tree frog		X
Subtotal frogs	2	11
Total spp./survey	**25**	**43**

3.4 Exclusion Fence Monitoring

Eight species, one genus, and two fauna groups were recorded during fauna fence monitoring, including four introduced species (Table 8). A total of 75 fauna detections were recorded during exclusion fence monitoring (Appendix B, Table B12). The most commonly recorded species were black rat with 34 detections, followed by house mouse (10 detections) and bandicoot spp. (4 detections; Appendix B, Table B12). All species/groups were recorded using underpasses (Table 8). Fauna recorded exhibited movement through the fence on 37 (49%) occasions (all rodents), no directional movement on 16 occasions (21%), towards the underpass on 10 (13%), away from the underpass on 9 occasions (12%) and towards the adjacent habitat (i.e. individual turned back) on three occasions (0.04%) (Appendix B, Table B12).

3.5 Road-kill Monitoring

A total of 30 individuals were recorded at an overall rate 0.34 individuals/km/week at NH2U during autumn and spring surveys (n=4) (Appendix B, Table B13). Of the 30 individuals, 14 were fauna that are not excluded by the fauna fence, including bird (11 records), reptile (2 records) and small mammal (1 record) (Appendix B, B13). The remaining records are individuals that should be excluded by fence and include bandicoot (6 records), medium mammal (4 records), possum spp. (2 records), wallaby spp. (2 records) and cat (1 record) (Appendix B, Table B13). Broad clusters of road-kill occurred between Martell's N and Access G and also to the north of the Tyson's underpass (Figure 6).

An opportunistic record of a road-killed spotted-tailed quoll was obtained on 12 May 2021 to the north of the Tyson's underpass (Figure 6). The individual was a male believed to have entered the northbound carriageway near the end of exclusion fence. Another spotted-tailed quoll was previously recorded in the same locality in November 2020 (F. Makin pers comm). No other threatened fauna species were recorded during road-kill surveys. TfNSW completed an extension of the fauna fence on both sides of the alignment in the area of the spotted-tailed quoll strike to effectively create a 'closed' fauna fence system during September 2021.

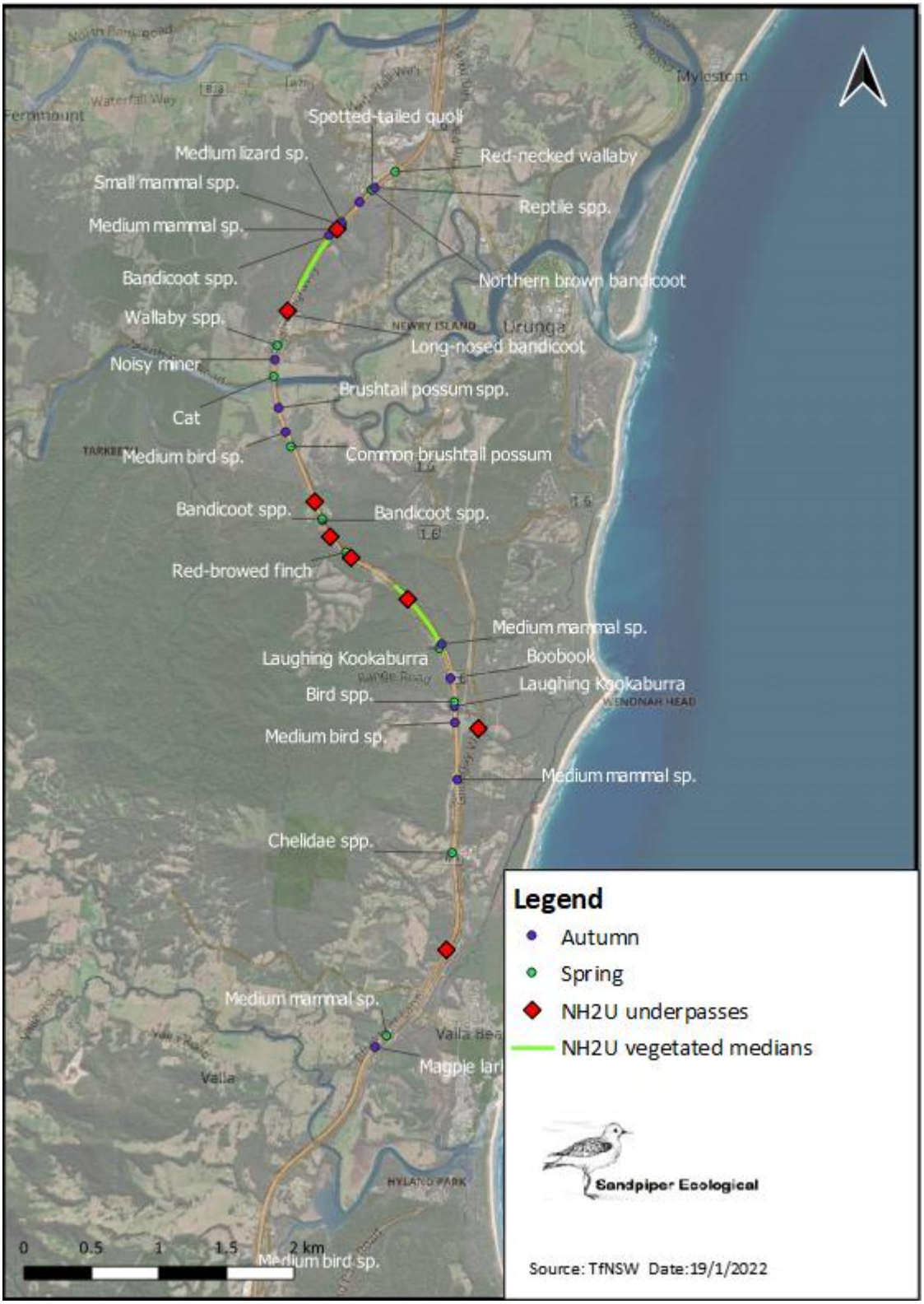

Figure 6: Location of road-killed fauna recorded during autumn and spring 2021 surveys at NH2U.

3.6 Vegetated Median Monitoring

Three species, including two gliders (A*crobates* spp. and sugar glider) and *Antechinus* spp. were confirmed using the Tysons and Dalhousie medians during camera trap monitoring (Appendix B, Table B15). Sugar gliders accounted for 81% of all detections and were recorded at higher average rate in the Dalhousie median (2.41 visitations/site/week) compared to the Tysons median (0.96 visitations/site/week) (Figure 7). *Acrobates* spp. accounted for 8.9% of detections and was recorded at a rate of 0.25 visitations/week in the Tysons and 0.16 visitations/week in the Dalhousie medians (Figure 7). No threatened gliders were recorded during monitoring.

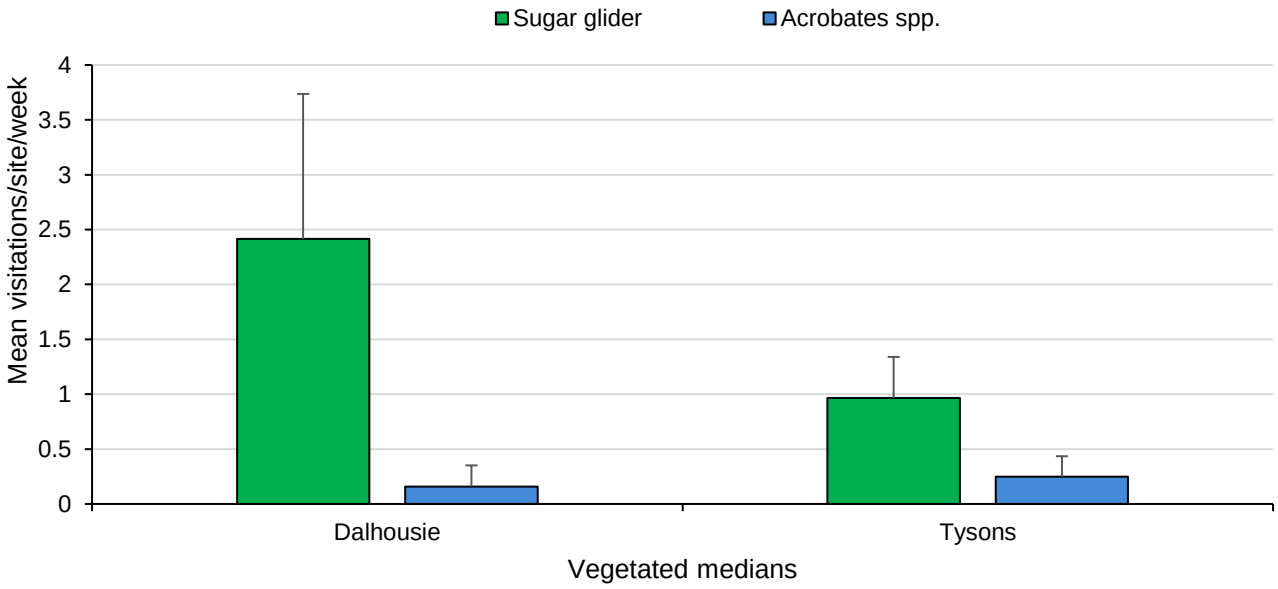

Figure 7: Mean number of camera visitations/site/week (n=4) recorded by *Acrobates* spp. (feathertail glider) and sugar glider in vegetated medians at NH2U during 2021 monitoring.

3.7 Habitat Assessment

Habitat adjoining the sample sites has undergone negligible change since 2019 monitoring. Results of habitat assessment can be found in Appendix B, Table B13.

4. Discussion

Results of year five operational phase monitoring are discussed with reference to the performance criteria described in the Ecological Monitoring Program (Benchmark 2013) and outlined in section 1.2 of this report.

4.1 Underpass and exclusion fencing monitoring

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

A definition of "low use" is not provided in the EMP (Benchmark 2013). Underpass use by feral predators has been considered high at Warrell Creek to Nambucca Heads (WC2NH) at an overall rate of 1.79 ± 1.34 cc/week/site and accounting for ~50% of complete crossings (Sandpiper Ecological 2021). Comparatively, feral predator use at NH2U could be considered low to moderate with an overall rate of 0.27 ± 0.28 cc/week/site and ~13% of complete crossings attributed to cat, dog and fox combined. Feral predator use was recorded at all impact sites yet not at the McGraths reference site. This finding is interesting and is likely due to combination of factors including the absence of exclusion fence, regular inundation at the McGraths site, and the ease with which feral species can cross the old highway safely.

Dog and fox accounted for the majority (95%) of feral predator underpass use in 2021. Substantial increases in use were recorded for both species between year three (2019) to year five monitoring (2021). While the magnitude of the increase is concerning, this may partly be due to drought conditions, which affected the study area throughout 2019. Further, the change in sample sites (i.e. inclusion of Martell's Bridge and removal of Railway) in year five may have influenced overall use rates given the high activity of dog at Martell's Bridge. Nonetheless, levels of dog use still increased at Dalhousie, Martell's South and Martell's North with several individuals recorded. Of particular concern are sites where koalas have been recorded, such as Dalhousie and Martell's North. A proactive approach is warranted given the level of dog activity at koala sites and time between monitoring periods (i.e. year 7 - 2023). Collaborative feral dog trapping programs at WC2NH have been successful (Sandpiper Ecological 2021) and it is recommended that a similar program be implemented at Dalhousie, Martells Bridge, Martells South and Martell's North before the next monitoring period.

4.1.2 High levels of fauna underpass use by a wide variety of native fauna species

A wide variety of native species and unique genera were recorded using underpasses. Of the 43 species recorded in adjacent habitat, 58% were recorded using underpasses. The proportion of species using underpasses is an improvement on year two (38%) and three (42%) monitoring and may be associated with improved access for cover-dependent species through sedimentation of scour protection and increased vegetation cover around culvert entrances (Sandpiper Ecological 2019a and 2020a). In comparison to previous underpass monitoring projects, the result is encouraging with a higher percentage of species using underpasses than at Sapphire to Woolgoolga (23% to 50%) and comparable to findings at the adjacent Warrell Creek to Nambucca Heads section where 57% of species recorded in adjacent habitat have used underpasses (Sandpiper Ecological 2019b, 2020b and 2021a).

Year five operational phase monitoring provided evidence of a temporal increase in underpass use by native species, which increased from 0.32 and 1.01 cc/week/site in year two and three, respectively, to 1.82 cc/week/site in year five. As mentioned in the previous report (Sandpiper Ecological 2020b), increased fauna use of underpasses between years two (2018) and three (2019) is partly attributed to the change in camera placement. However, camera placement remained consistent between 2019 and 2021, and native fauna recorded an 80% increase in underpass use. The result is not unexpected as use by native fauna is likely to increase over time as site features improve, and the trend is consistent with underpass monitoring at WC2NH and Woolgoolga to Ballina (Sandpiper Ecological 2020b, 2021a).

The frequency of native fauna crossings varied amongst sites, with impact sites typically exhibiting the highest use. Of the species recorded at impact sites, short-eared brushtail possum accounted for the majority of crossings. The high frequency of short-eared brushtail possum detections, early detections of underpass use in 2018, and few records from exclusion fence monitoring suggest that possums have habituated to the presence of underpasses as opposed to being funneled by fauna fence. Rapid habituation of underpasses has previously been recorded for other species, including bandicoots and rodents (Bond and

Jones 2008). In addition to site features (see Clevenger & Waltho 2003), variation in use between sites can be attributed to the abundance and/or occurrence of species that use underpasses. There is evidence to show that even within areas of relatively homogenous habitat a species use of underpasses can vary substantially (Goldingay *et al.* in prep).

Further, the level and diversity of native fauna use between sites at NH2U may be related to their location within the landscape. The highest species richness was recorded at Tyson's, Dalhousie and Martell's South. These sites are situated in large contiguous areas of moderate to high quality habitat with dense ground vegetation, abundant woody debris and are situated on creeks or drainage lines. Fauna often use riparian strips as corridors through landscapes and as a source of shelter, water and prey (Lada *et al*, 2008).

4.1.3 Evidence of use by dispersing individuals and different age cohorts

Use by different age cohorts is difficult to confirm using the methods applied at NH2U. Other methods such as mark-release-recapture would likely be required to provide definitive proof of use by dispersing individuals and different age cohorts. Such a survey is not warranted at NH2U

4.1.4 Use by cover-dependent species and species with low mobility

Eight cover-dependent and/or low mobility species have been recorded using underpasses at NH2U, with an additional sixteen recorded in the adjacent habitat. Low occurrence of frogs and reptiles is most likely due to the inability of cameras to detect these species as opposed to avoidance. We have attempted to overcome this shortfall by the use of sand pads, targeted frog survey, and scat and track surveys. Scat and track searches detected the probable record of a green-tree frog at Tyson's, which was not detected on cameras.

The culvert floor and furniture were both used by cover dependent species. Fawn-footed melomys, *Antechinus* spp., and eastern crevice skink predominantly used fauna furniture, highlighting the value of this feature in providing connectivity for cover dependent species. The increasing presence of lizards, such as eastern bearded dragon and land mullet, using the culvert floor in year 5 is encouraging, as these species tend to have small home ranges and predominantly reside in habitat with dense cover. Notably, records of bandicoots using the culvert floor were far lower at NH2U (1.43 cc/week) in comparison to WC2NH (6.54 cc/week; Sandpiper Ecological 2021), with few records at sites with extensive scour protection such as Dalhousie, Tyson's and North Martell's. The difference between the two projects is likely due to the retention of vegetation close to underpass entrances at WC2NH. Findings highlight the importance of establishing cover within scour protection. There is some evidence of vegetation growth within scour protection at NH2U.

4.1.5 Low incidence of fauna road strike

The road-kill rate recorded at NH2U in 2021 (i.e. 0.34 individuals/km/week) was the same as recorded on the adjoining WC2NH section of upgrade (Sandpiper Ecological 2022). One notable distinction between the WC2NH and NH2U upgrades is that approximately 50% of the WC2NH upgrade is unfenced whilst almost the entire length of the NH2U alignment is fenced. Sixteen records were of fauna that should be blocked by exclusion fence with a majority being bandicoots (6 individuals) or medium mammals (5 individuals). Both fauna groups are capable of accessing the alignment through small gaps in fauna fence such as around drains, gates, and areas where the fence abuts hard structures such as culverts (Sandpiper Ecological 2022). There is slight evidence for a cluster of road-kill of fauna that should be blocked by exclusion fence at, and to the north of, the Tysons underpass. This includes the same area where two road-killed spotted-tailed quolls were recorded in November 2020 and May 2021. Both quoll records corresponded to the end of fauna exclusion fence. The road strike triggered the contingency measure to extent the exclusion fencing 550 m north on both sides of the alignment to adjoin the Short Cut Road overpass. Fence construction was completed in September 2021. No further threatened fauna records were detected in the area during spring road-kill surveys.

4.2 Widened Vegetated Medians

4.2.1 Evidence of use of median vegetation by the target glider species

The absence of yellow-bellied gliders in the vegetated median is not unexpected given the absence of records during previous surveys and recent evidence of population declines in lowland forests on the New South Wales north coast (Sandpiper Ecological 2021b). Habitat within and adjoining the median is suitable for yellow-bellied glider; however, use of the median may only occur if the population recovers. Successive years of above-average rainfall and consistent flowering events may assist recovery, although the exact reason for the decline is unknown and could be due to landscape issues, particularly long-term forest management (Eyre & Smith 1997; Eyre 2007). Detection of yellow-bellied gliders by arboreal camera traps in the Parker Road vegetated median within the Woolgoolga to Ballina upgrade provides confidence that the species would be detected if present (Sandpiper Ecological 2021b). The absence of squirrel glider is expected, as that species is not known to occur in forests adjoining the NH2U upgrade.

4.2.2 Evidence of use by dispersing individuals and different age cohorts

No adult animals with back young or pouch young were observed, and all gliders were determined to be adults.

4.2.3 Use by glider species other than threatened species

Camera monitoring suggests that vegetated medians at Dalhousie and Tyson's are facilitating movement across the highway by sugar gliders and feathertail gliders. Whilst gliders may be denning in the median, individuals would still need to cross the carriageways to forage as medians have insufficient habitat to support a family group. Further, the confirmed presence of sugar gliders in the vegetated median suggests its likely to be viable for use by yellow-bellied gliders to cross the highway corridor. The gap width at NH2U is in the order of 20-40m and adjoining trees are between 25 and 30m tall. This presents a gap-crossing scenario that is well within the performance capability of a yellow-bellied glider (Goldingay 2014b; Jackson 2002). Indeed, the forest gap from edge to median and tree height is similar to that at Halfway Creek where yellow-bellied gliders have been recorded crossing the carriageway by using a central (median) glide pole (Taylor & Rohweder 2020).

4.3 Targeted Threatened Species

4.3.1 Scansorial threatened species

During autumn monitoring, a spotted-tailed quoll was confirmed using fauna furniture at Martell's South. Previously, spotted-tailed quolls have been recorded using the underpass floor at several sites in north-east New South Wales (i.e. Glenugie 2016 & 2019, Oxley Highway to Kempsey 2018, and Coolongolook 2000), although use tends to be sporadic, which is likely due to the species low density and large home range. The low density of quolls is supported by Bionet data with five records near the NH2U alignment since 2000. The individual is not one of the road-kill records as it was detected after the May 12 2021 record. The presence of three quolls in the locality over a period of seven months is encouraging. No brush-tailed phascogales have been recorded during operational phase monitoring. This finding is not unexpected as the study area is largely unsuitable for phascogales (Sandpiper Ecological 2019a).

4.3.2 Arboreal threatened species

Koala was recorded on three occasions, including two complete crossings of the Dalhousie and Martell's North underpasses in spring 2021. The third record was of an individual on the west side of Dalhousie one week before the complete crossing was recorded. Complete crossings by koala have now been recorded at three of the seven impact sites, including a record at Tyson's in 2019. Results are encouraging despite low population density in the study area (Sandpiper Ecological 2020a).

No yellow-bellied gliders were recorded during vegetated median monitoring. The absence of yellow-bellied glider records during the operational (2018 - 2021) and construction (2013 and 2014) phases suggests that the species is uncommon in the study area. This is supported by the Bionet database, which includes four records in habitat surrounding the vegetated medians for the period January 2000 to January 2019 (Bionet 2019).

4.3.3 Other threatened species

In 2021, long-nosed potoroo was detected in habitat to the east of Martell's North. This record adds to previous detections in adjacent habitat at Tyson's in 2018 and 2019 (Sandpiper Ecological 2019a and 2020a) and west of Dalhousie in 2015 (Sandpiper Ecological 2015a). Potoroos are known to utilise underpasses (see Sandpiper Ecological 2015b, AMBS 2002) and the absence of records at NH2U may be due to the timing of monitoring, short duration of monitoring, and or low local abundance of potoroos. Continuation of underpass monitoring in year seven (2023) will increase the likelihood of detecting potoroos.

5. Contingency measures and recommendations

5.1 Contingency Measures

Contingency measures are summarised in Table 7.

Table 7: Potential problems outlined in the EMP and possible contingency measures. Mitigation measures applicable to the project are addressed in bold text in table below.

Problem	Contingency/Corrective Action	Proposed action
High rates of feral predator activity;	Control program	Liaise with land management agencies responsible for pest management (i.e. NSW National Parks and Wildlife Service; Local Land Services NSW; Forestry Corporation NSW) and implement trapping at Koala use sites (Dalhousie, Martells North).
Low levels of native fauna movement and species diversity in underpasses;	Modify habitat structure near underpass entrances and/or modify underpass fauna furniture	No action required – monitoring has shown that fauna furniture is functional and underpasses are providing safe passage for close to 90% of the mammal species recorded in adjacent habitat.
No use of underpasses by cover-dependent species or species with low mobility or target threatened species	Modify or add potential groundcover resources	Eight cover dependent species and two threatened species were recorded using underpasses. Minimising disturbance of vegetation at culvert entrances will assist in facilitating movement by cover dependent species. No action required - continue monitoring underpasses using current methods in year 7.
High rates of fauna road mortality.	Modify exclusion fencing design, location or extent depending on the species and location of mortalities	The extension of fauna fence related to the spotted-tailed quoll mortality was completed in Sept 21. No further action is warranted. Continue monitoring in year 7 and observe effectiveness of the fence extension.

5.2 Recommendations

Recommendations are summarised in Table 8.

Table 8: Recommendations based on findings from year five operational phase monitoring and response from TfNSW.

Number	Recommendation	Transport for NSW Response
1.	Liaise with Forestry Corporation and Local Land Services to link with landscape wide feral predator control programs and undertake canid control at sites used by koalas including Dalhousie and Martell's North.	Agree to be adopted
2.	Continue operational phase monitoring as per the EMP.	Agree to be adopted.

6. References

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Appendix A – Scientific names

Table A1: Common and scientific names for all species recorded during operational phase monitoring on NH2U.

Species	Scientific name
Koala	*Phascolarctos cinereus*
Short-beaked echidna	*Tachyglossus aculeatus*
Common brushtail possum	*Trichosurus vulpecula*
Short-eared brushtail possum	*Trichosurus caninus*
Brushtail possum sp.	*Trichosurus sp.*
Common ringtail possum	*Pseudocheirus peregrinus*
Sugar glider	*Petaurus breviceps*
Squirrel Glider	*Petaurus norfolcensis*
Yellow-bellied glider	*Petaurus australis*
Feathertail glider sp.	*Acrobates spp.*
Fawn-footed melomys	*Melomys cervinipes*
Water rat	*Hydromys chrysogaster*
Bush rat	*Rattus fuscipes*
Swamp rat	*Rattus lutreolus*
Rat spp.	*Rattus spp.*
Rodent spp.	*Rodentia spp.*
Yellow-footed antechinus	*Antechinus flavipes*
Brown antechinus	*Antechinus stuartii*
Dusky antechinus	*Antechinus swainsonii*
Antechinus spp.	*Antechinus spp.*
Eastern bent-wing	*Miniopterus orianae oceanensis*
Microbat spp.	
Swamp wallaby	*Wallabia bicolor*
Red-necked wallaby	*Macropus rufogriseus*
Eastern Grey Kangaroo	*Macropus giganteus*
Wallaby spp.	
Long-nosed potoroo	*Potorous tridactylus*
Macropod spp.	
Long-nosed bandicoot	*Parameles nasuta*
Northern brown bandicoot	*Isoodon macrourus*
Bandicoot spp.	
Grey-headed flying-fox	*Pteropus poliocephalus*
Black flying fox	*Pteropus alecto*
Flying-fox spp.	*Pteropus spp.*
Eastern small-eyed snake	*Rhinoplocephalus nigrescens*
Red-bellied black-snake	*Pseudechis porphyriacus*
Marsh snake	*Hemiaspis signata*
Carpet python	*Morelia spilota*
Green tree snake	*Dendrelaphis punctulatus*
Yellow-faced whipsnake	*Demansia psammophis*
Eastern water dragon	*Physignathus lesueurii*
Eastern bearded dragon	*Pogona barbata*
Lace monitor	*Varanus varius*
Eastern crevice skink	*Egernia mcpheei*
Land mullet	*Bellatorias major*
Burtons legless lizard	*Lialis burtonis*
Blue-tongue lizard	*Tiliqua scincoides*
Garden sun-skink	*Lampropholis delicata*
Grass sun-skink	*Lampropholis guichenoti*
Lampropholis spp.	*Lampropholis spp.*
Bar-sided skink	*Concinnia spp.*
Scincidae spp.	*Scincidae spp.*
Clicking froglet	*Crinia signifera*
Toadlet spp.	*Uperolia spp.*
Red-backed broodfrog	*Pseudophryne coriacea*
Tusked frog	*Adelotus brevis*
Great barred frog	*Mixophyes fasciolatus*
Striped marsh frog	*Limnodynastes peronii*
Whirring tree frog	*Litoria revelata*
Eastern sedge frog	*Litoria fallax*
Emerald-spotted tree frog	*Litoria peronii*
Laughing tree frog	*Litoria tyleri*
Striped rocket frog	*Litoria nasuta*
Broad-palmed rocket frog	*Litoria latopalmata*
Graceful tree frog	*Litoria gracilenta*

Species	Scientific name
Tree frog spp.	*Litoria spp.*
Tawny frogmouth	*Podargus strigoides*
Barn owl	*Tyto delicata*
Southern boobook	*Ninox boobook*
Powerful Owl	*Ninox strenua*
Australian owlet nightjar	*Aegotheles cristatus*
Grey goshawk	*Accipiter novaehollandiae*
Noisy pitta	*Pitta versicolor*
Glossy-black cockatoo	*Calyptorhynchus lathami*
Wonga pigeon	*Leucosarcia melanoleuca*
Pacific emerald dove	*Chalcophaps longirostris*
Eastern whipbird	*Psophodes olivaceus*
Eastern yellow robin	*Eopsaltria australis*
Australian brush turkey	*Alectura lathami*
Rufous fantail	*Rhipidura rufifrons*
Grey fantail	*Rhipidura albiscapa*
Superb fairywren	*Malurus cyaneus*
Variegated fairywren	*Malurus lamberti*
Fairywren spp.	
Welcome swallow	*Hirundo neoxena*
Australian logrunner	*Orthonyx temminckii*
Red-browed finch	*Neochmia temporalis*
Sacred kingfisher	*Todiramphus sanctus*
Azure kingfisher	*Ceyx azureus*
Grey shrike thrush	*Colluricincla harmonica*
Yellow-faced honeyeater	*Caligavis chrysops*
Lewin's honeyeater	*Meliphaga lewinii*
White-cheeked honeyeater	*Phylidonyris niger*
Yellow thornbill	*Acanthiza nana*
White-browed scrubwren	*Sericornis frontalis*
Australian magpie	*Cracticus tibicen*
Laughing kookaburra	*Dacelo novaeguineae*
Buff-banded rail	*Gallirallus philippensis*
Dollarbird	*Eurystomus orientalis*
Pacific black duck	*Anas superciliosa*
Striped gudgeon	*Gobiomorphus australis*
Mosquito fish	*Gambusia affinis*
House mouse	*Mus musculus*
Black rat	*Rattus rattus*
Red fox	*Vulpes vulpes*
Dog	*Canis lupus familiaris*
Cat	*Felis catus*
Cow	*Bos taurus*
Human	*Homo sapien*

Appendix B Survey data

Table B1: Effort of adjacent habitat cameras during autumn and spring at NH2U, 2021.

Site	Side	Easting	Northing	Season	Install	Retrieve	No. of vids	Battery (%)	Date of last image	Days active	Notes
Tyson	W	498618	6627473	Autumn	27/03/2021	30/04/2021	15	Flat	7/4/2021	11	
Tyson	E	498740	6627371	Autumn	27/03/2021	30/04/2021	15	50		34	
Access G	W	497901	6626258	Autumn	27/03/2021	30/04/2021	27	50		34	
Access G	E	498033	6626241	Autumn	27/03/2021	30/04/2021	14	Flat	13/04/21	17	
Martells N	W	498289	6623350	Autumn	28/03/2021	4/05/2021	101	66		37	
Martells N	E	498407	6623441	Autumn	28/03/2021	4/05/2021	871	66		37	
Martells S	W	498522	6622851	Autumn	28/03/2021	4/05/2021	2	Flat	30/03/2021	2	
Martells S	E	498610	6622920	Autumn	28/03/2021	4/05/2021	8	66		37	low contrast video hard to see
Dalhousie	W	499626	6621962	Autumn	27/03/2021	30/04/2021	2	Flat	30/03/2021	3	
Dalhousie	E	499782	6622053	Autumn	27/03/2021	30/04/2021	54	60		34	
Burkes	W	500233	6616846	Autumn	27/03/2021	30/04/2021	61	66		34	
Burkes	E	500364	6616739	Autumn	27/03/2021	30/04/2021	68	66		34	
Martells bridge	W			Autumn	16/04/2021	14/05/2021	98	50		28	
Martells bridge	E			Autumn	16/04/2021	14/05/2021	93	50		28	
McGraths	WS	500708	6619987	Autumn	28/03/2021	30/04/2021	11	60		33	
McGraths	EN	500793	6619987	Autumn	28/03/2021	30/04/2021	10	Flat	10/04/2021	13	
Tyson	W	498618	6627473	Spring	16/08/2021	21/09/2021	92	Active		36	
Tyson	E	498740	6627371	Spring	16/08/2021	21/09/2021	248	Flat	3/9/2021	18	
Access G	W	497901	6626258	Spring	16/08/2021	22/09/2021	155	Active		37	
Access G	E	498033	6626241	Spring	16/08/2021	22/09/2021	12	Flat	25/8/2021	9	
Martells N	W	498289	6623350	Spring	16/08/2021	20/09/2021	385	Active		35	
Martells N	E	498407	6623441	Spring	16/08/2021	20/09/2021	0	Active		35	
Martells S	W	498522	6622851	Spring	16/08/2021	21/09/2021	147	Active		36	
Martells S	E	498610	6622920	Spring	16/08/2021	21/09/2021	631	Active		36	
Dalhousie	W	499626	6621962	Spring	16/08/2021	22/09/2021	0	Flat		0	Malfunction
Dalhousie	E	499782	6622053	Spring	16/08/2021	22/09/2021	28	Active		37	
Burkes	W	500233	6616846	Spring	16/08/2021	20/09/2021	111	Active		35	
Burkes	E	500364	6616739	Spring	16/08/2021	20/09/2021	25	Active		35	
Martells bridge	W			Spring	16/08/2021	23/09/2021	3	Flat	9/9/2021	24	
Martells bridge	E			Spring	16/08/2021	23/09/2021	643	Active		38	
McGraths	WS	500708	6619987	Spring	16/08/2021	20/09/2021	0	Active		35	
McGraths	EN	500793	6619987	Spring	16/08/2021	20/09/2021	62	Active		35	

Table B2: Presence/absence of fauna detected by cameras in adjacent habitat during year 5 monitoring at NH2U, 2021.

Species	Tyson's Flat (8022)		Access Rd G (78800)		Martells Rd North (75800)		Martells Rd South (75250)		Dalhousie Ck (73800)		Burkes Ln (68470)		Martells Bridge		McGraths Ck (Control)	
	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W
Autumn 2021																
Short-beaked echidna	*	*			*	*										
Antechinus spp.						*			*				*	*		
Long-nosed bandicoot			*		*				*			*		*		
Northern brown bandicoot	*			*		*	*		*	*		*	*	*	*	
Short-eared brushtail possum	*			*					*				*	*	*	*
Common brushtail possum		*	*								*	*	*			*
Trichosurus spp.																
Long-nosed potoroo																
Red-necked Wallaby																
Swamp wallaby	*	*		*	*						*	*	*			
Water rat						*										
Bush rat						*			*				*	*		
Black rat			*		*	*	*		*		*	*	*	*		
Rodent sp.				*		*	*	*	*		*	*	*	*		
Fawn-footed melomys						*						*		*		
House mouse													*			
Dog													*			
Red fox					*								*			
Cat																
Lace monitor																
Eastern water dragon																
Spring 2021																
Short-beaked echidna		*				*	*				*	*		*		
Antechinus spp.	*	*	*		*			*	*					*	*	
Long-nosed bandicoot	*	*	*	*	*	*	*	*		*		*	*	*	*	
Northern brown bandicoot	*	*	*	*	*	*	*			*			*		*	
Short-eared brushtail possum		*	*													
Common brushtail possum	*									*					*	
Trichosurus spp.	*											*				
Long-nosed potoroo								*								
Red-necked Wallaby														*		
Swamp wallaby	*	*	*	*	*	*					*	*	*		*	
Water rat																

Bush rat	*			*	*		*	*	*		*	*			*	
Black rat	*	*			*		*				*	*			*	
Rodent sp.	*	*											*			
Fawn-footed melomys	*						*		*							
House mouse											*					
Dog					*								*			
Red fox	*				*									*		
Cat			*	*	*	*			*							
Lace monitor	*	*	*	*	*		*	*	*	*			*			
Eastern water dragon	*									*						

Table B3: Daytime searches of adjacent habitat data during year five NH2U monitoring, 2021. Msb = moves small branches, Mlb = moves large branches, RL = rustles leaves, Pseud. = Pseudophryne species, Lim = Limnodynastes species, Lit = Litoria species, Poss = possible, Prob = probable, E. water dragon = Eastern water dragon.

Location	Side	Season	Sample	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
Tyson's	East	Autumn	1	28/3/21	LA/DW	1438	1508	Wallaby scat, Lampropholis, lit fallax	RL	nil	Good	26.2	57	
	West	Autumn	1	28/3/21	LA/DW	1510	1540	Nil	RL	nil	Good	26.2	57	
	East	Autumn	2	30/3/21	NM/LA	1445	1505	Lampropholis.	RL	Nil	Good	22.5	66	
	West	Autumn	2	30/3/21	NM/LA	1505	1530	Swamp snake	RL	Nil	Good	22.5	66	
Access G	East	Autumn	1	28/3/21	LA/DW	1352	1422	Lampropholis, medium reptile scat, bandicoot diggings, Swamp wallaby scat	RL	nil	Good	26.2	57	
	West	Autumn	1	28/3/21	LA/DW	1321	1351	Lampropholis delicata, calyptotis ruficauda	RL	nil	Good	26.2	57	Water dragon in underpass
	East	Autumn	2	30/3/21	NM/LA	1532	1552	Crinia signifera	RL	Nil	Good	22.5	66	
	West	Autumn	2	30/3/21	NM/LA	1548	1614	Crinia signifera , BtP scat	RL	Light showers	Good	22.5	66	
Nth martells	East	Autumn	1	28/3/21	LA/DW	1156	1224	Lim peronii, Lampropholis.	RL	nil	Good	23.8	57	
	West	Autumn	1	28/3/21	LA/DW	1124	1154	Lim peronii, Lampropholis, marsh snake	RL	nil	Good	23.8	57	Marsh snake choked on lim peronii
	East	Autumn	2	30/3/21	LA/NM	1400	1420	Crinia signifera	Nil	Nil	Good	21.1	63	
	West	Autumn	2	30/3/21	LA/NM	1420	1440	Crinia signifera	Nil	Nil	Good	21.1	63	
Sth martells	East	Autumn	1	27/3/21	LA/DW	1555	1625	3 x Lampropholis delicata, fallax, Concinna tenuis	Nil	Nil	Good	25.4	70	
	West	Autumn	1	27/3/21	LA/DW	1630	1700	Bandicoot diggings, Lampropholis delicata	Nil	Nil	Good	25.4	70	
	East	Autumn	2	31/3/21	LA/NM	1435	1500	Prob lace monitor scats	Nil	Nil	Good	22.3	63	
	West	Autumn	2	31/3/21	LA/NM	1504	1532	nil	Nil	Nil	Good	22.3	63	
Dalhousie	East	Autumn	1	28/3/21	LA/DW	1107	1137	Wallaby scat, bandicoot diggings, Lampropholis delicata,	RL	nil	Good	23.8	57	

Location	Side	Season	Sample	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
								fallax						
	West	Autumn	1	28/3/21	LA/DW	1024	1054	Lampropholis delicata, snake skin prob mash snake	RL	nil	Good	23.8	57	
	East	Autumn	2	31/3/21	LA/NM	1615	1640	nil	Nil	Nil	Good	22.3	63	
	West	Autumn	2	31/3/21	LA/NM	1641	1705	nil	Nil	Nil	Good	22.3	63	
Burke's	East	Autumn	1	27/3/21	LA/DW	1405	1435	Lampropholis, swamp wallaby scat, lim peronii	Nil	Nil	Good	25.4	70	
	West	Autumn	1	27/2/21	LA/DW	1330	1400	16 Lampropholis delicata, calyptotis ruficauda, wallaby scat	Nil	Nil	Good	25.4	70	
	East	Autumn	2	30/3/21	NM/LA	1115	1140	Bandy bandy	Nil	Light showers	Good	21.1	63	
	West	Autumn	2	30/3/21	NM/LA	1140	1205	Nil	Nil	Nil	Good	21.1	63	
McGraths	East	Autumn	1	27/2/21	LA/DW	1445	1515	Lampropholis delicata x 9, wallaby scat	Nil	Nil	Good	25.4	70	
	West	Autumn	1	27/2/21	LA/DW	1516	1532	Nil	Nil	Nil	Good	25.4	70	
	East	Autumn	2	30/3/21	NM/LA	1230	1255	Nil	Nil	Light showers	Good	21.1	63	
	West	Autumn	2	30/3/21	NM/LA	1305	1400	Lampropholis	Nil	Light showers	Good	21.1	63	
Martell's Bridge	East	Autumn	1	30/4/21	LA/NM	1030	1100	Nil	Nil	Light showers	Good	21.1	63	
	West	Autumn	1	30/4/21	LA/NM	1103	1133	Wallaby scat, Lampropholis, lit fallax	Nil	Light showers	Good	21.1	63	
	East	Autumn	2	10/5/21	LA/GR	1414	1444	Lampropholis delicata	Nil					
	West	Autumn	2	10/5/21	LA/GR	1444	1514	Crinia signifera	Nil					
Tyson's	East	Spring	1	18/8/21	LA/AE	1215	1235	Lampropholis x8	ML	0	Good	19	59	
	West	Spring	1	18/8/21	LA/AE	1240	1300	Nil	ML	0	Good	19	59	
	East	Spring	2	21/9/21	NM/AE	1610	1640	Wallaby diggings	Rl	Nil	Good	15	43	
	West	Spring	2	21/9/21	NM/AE	1530	1600	Bandicoot diggings, wallaby scat, lit fallax	Rl	Nil	Good	15	43	
Access G	East	Spring	1	18/8/21	LA/AE	1455	1520	Litoria fallax, wallaby scat bandicoot diggings, Lampropholis x 1	ML	0	Good	19	59	
	West	Spring	1	18/8/21	LA/AE	1525	1545	Echidna diggings wallaby scat, Crinia signifera	ML	0	Good	19	59	
	East	Spring	2	22/9/21	NM/AE	1330	1400	Wallaby scat, Lampropholis x 1	Msb	Nil	Good	21	46	
	West	Spring	2	22/9/21	NM/AE	1405	1435	Marsh snake, bandicoot diggings, wallaby scat, lampropholis x 1	Msb	Nil	Good	21	46	
Nth martells	East	Spring	1	19/8/21	LA	1216	1301	Lampropholis, lit fallax, small reptile scat	ML	Nil	Good	17.4	67	
	West	Spring	1	19/8/21	AE	1216	1301	Lampropholis	ML	Nil	Good	17.4	67	
	East	Spring	2	21/9/25	NM/AE	1500	1530	Lampropholis x 2	Ml	Nil	Good	21.6	73	
	West	Spring	2	21/9/25	NM/AE	1545	1615	L.fallax, Lampropholis x 1, wallaby scat	Ml	Nil	Good	21.6	73	
Sth	East	Spring	1	19/8/21	LA	1506	1545	Crinia sig, lit fallax	ML	Nil	Good	20.8	50	

Location	Side	Season	Sample	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
martells														
	West	Spring	1	19/8/21	AE	1506	1545	Crinia sig, btp scat, bandicoot diggings, lampropholis	ML	Nil	Good	20.8	50	
	East	Spring	2	21/9/21	NM/AE	1330	1400	Lampropholis x 1, wallaby scat, dog, rodent and Btposs scat, bandicoot diggings	Mlb	Nil	Good	19.8	27	
	West	Spring	2	21/9/21	NM/AE	1420	1450	Bandicoot diggings	Mlb	Nil	Good	19.8	27	
Dalhousie	East	Spring	1	19/8/21	LA	1115	1200	Lampropholis, bandicoot diggings, wallaby scat	ML	Nil	Good	17.4	67	
	West	Spring	1	19/8/21	AE	1115	1200	Lampropholis	ML	Nil	Good	17.4	67	
	East	Spring	2	22/9/21	NM/AE	1530	1600	Wallaby scat	Msb	Nil	Good	18.9	56	
	West	Spring	2	22/9/21	NM/AE	1605	1635	Lampropholis x 1, wallaby scat	Msb	Nil	Good	18.9	56	
Burke's	East	Spring	1	19/8/21	LA	1430	1500	Bandicoot diggings	ML	Nil	Good	20.8	50	
	West	Spring	1	19/8/21	AE	1430	1500	Wallaby scat, Litoria fallax Lampropholis	ML	Nil	Good	20.8	50	
	East	Spring	2	21/9/25	NM/AE	1300	1330	Marsh snake, Wallaby scat, lampropholis x 2, bandicoot diggings	Msb	Nil	Good	23	55	
	West	Spring	2	21/9/25	NM/AE	1145	1215	Wallaby scat, lampropholis spp x 5, lace monitor, bandicoot diggings, small reptile scat	ML	Nil	Good	23	55	
McGraths	East	Spring	1	21/9/25	NM/AE	1345	1415	Lampropholis x 3, wallaby scat	Msb	Nil	Good	21.6	73	
	West	Spring	1	21/9/25	NM/AE	1420	1450	Lampropholis x 2	Msb	Nil	Good	21.6	73	
	East	Spring	2	23/9/21	NM/AE	1200	1230	Lampropholis x 3, wallaby scat	Rl	Nil	Good	22.9	31	
	West	Spring	2	23/9/21	NM/AE	1232	1302	Lampropholis x 1	Rl	Nil	Good	22.9	31	
Martell's Bridge	East	Spring	1	19/8/21	LA	1002	1047	Lampropholis, Demansia psammophis, Crinia signifera.	ML	Nil	Good	17.4	67	
	West	Spring	1	19/8/21	AE	1002	1047	Nil	ML	Nil	Good	17.4	68	
	East	Spring	2	23/9/21	NM/AE	1045	1115	Lampropholis x 3, Crinia signifera	Ml	Nil	Good	23.1	34	
	West	Spring	2	23/9/21	NM/AE	1117	1147	Lampropholis x 2, wallaby scat, bandicoot diggings	Ml	Nil	Good	23.1	34	

Table B4: Nocturnal spotlight surveys of adjacent habitat during year five NH2U monitoring, 2021. GHFF = grey-headed flying fox, SuG = sugar glider, Lit. = Litoria, SEBtP = short-eared brushtail possum, FtG = feathertail glider sp., CBtP = common brushtail possum, BtPoss = Brushtail possum species, TF = Tawny Frogmouth, CRtP = common ringtail possum, Pseud. = Pseudophryne species, Lim = Limnodynastes species, Lit = Litoria s pecies, A. brevis = Adelotus brevis, Upe sp. = Uperolia species, ONJ = Owlet-Nightjar.

Location	Side	Season	Sample	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
Tyson's	East	Autumn	1	27/3/21	LA/DW	2224	2239	Litoria peronii, Lim peronii	Nil	Nil	Good	17.9	75	
	West	Autumn	1	27/3/21	LA/DW	2241	2256	P. coriacea	Nil	Nil	Good	17.9	75	
	East	Autumn	2	29/3/21	LA/DW	2100	2115	Nil	Nil	Nil	Good	18.4	77	
	West	Autumn	2	29/3/21	LA/DW	2117	2132	P. coriacea	Nil	Nil	Good	18.4	77	
Access G	East	Autumn	1	27/3/21	DR	2000	2030	Swamp wallaby	Nil	Nil	Good	21	83	
	West	Autumn	1	27/3/21	DR	2050	2120	Nil	Nil	Nil	Good	21	83	
	East	Autumn	2	29/3/21	LA/DW	2141	2205	L. fallax, Cr. signifera, Lim peronii,	Nil	Nil	Good	18.4	77	Marsh snake head west in

Location	Side	Season	Sample	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
								Sug						culvert
	West	Autumn	2	29/3/21	LA/DW	2205	2235	Litoria gracilenta	Nil	Nil	Good	18.4	77	
Nth martells	East	Autumn	1	29/3/21	DR/NM	2000	2030	Owlet nightjar, sugar glider	Nil	Nil	Good	20	81	
	West	Autumn	1	29/3/21	DR/NM	2000	2030	Litoria nasuta	Nil	Nil	Good	20	81	
	East	Autumn	2	31/3/21	NM/LA	2015	2045	Crinia signifera	RL	Rain	Poor	21.2	91	
	West	Autumn	2	31/3/21	NM/LA	2045	2115	nil	RL	Rain	Poor	21.1	91	
Sth martells	East	Autumn	1	27/3/21	LA/DW	2124	2139	Crinia signifera	Nil	Nil	Fair	18.6	72	
	West	Autumn	1	27/3/21	LA/DW	2141	2155	P. coriacea, revelata.	Nil	Nil	Fair	18.6	72	
	East	Autumn	2	29/3/21	LA/DW	2008	2023	FtG, fallax, coriacea	Nil	Nil	Good	19.7	74	
	West	Autumn	2	29/3/21	LA/DW	2028	2043	Fasciolatus, revelata, signifera	Nil	Nil	Good	19.7	74	
Dalhousie	East	Autumn	1	27/3/21	DR	2130	2200	Striped marsh frog	Nil	Nil	Good	20	90	
	West	Autumn	1	27/3/21	DR	2220	2252	Nil	Nil	Nil	Good	20	90	
	East	Autumn	2	29/3/21	LA/DW	2315	2330	Coriacea	Nil	Nil	Good	18.4	77	
	West	Autumn	2	29/3/21	LA/DW	2255	2310	Coriacea	Nil	Nil	Good	18.4	77	
Burke's	East	Autumn	1	27/3/21	LA/DW	1955	2010	Coriacea, common brushtail	Nil	Nil	Fair	18.6	72	
	West	Autumn	1	27/3/21	LA/DW	2015	2030	Sug, coriacea, TF swamp wallaby	Nil	Nil	Fair	18.6	72	
	East	Autumn	1	29/3/21	DR/NM	2139	2210	Common brushtail possum, Black flying-fox	Nil	Nil	Good	19.5	88	
	West	Autumn	1	29/3/21	DR/NM	2139	2210	Feathertail glider, Lit. peronii, Ps. coriacea, Wallaby Spp., Grey-headed flying-fox	Nil	Nil	Good	19.5	88	
Martell's bridge	East	Autumn	1	10/5/21	LA	1825	1855	Lit fallax	Nil	Nil	Good	15.8	90	
	West	Autumn	1	10/5/21	GR	1825	1855	Nil	Nil	Nil	Good	15.8	90	
	East	Autumn	2	16/8/21	AE/LA	1930	1945		Nil	Nil	Good	16.8	68	Completed in Winter
	West	Autumn	2	16/8/21	AE/LA	1945	2000	Crinia signifera, Litoria fallax	Nil	Nil	Good	16.8	68	
McGraths	East	Autumn	1	27/3/21	LA/DW	2045	2100	Nil	Nil	Nil	Fair	18.6	72	
	West	Autumn	1	27/3/21	LA/DW	2100	2115	Nil	Nil	Nil	Fair	18.6	72	
	East	Autumn	2	29/3/21	DR/NM	2055	2125	Nil	Nil	Nil	Good	20	85	
	West	Autumn	2	29/3/21	DR/NM	2055	2125	Nil	Nil	Nil	Good	20	85	
Tyson's	East	Spring	1	18/8/21	AE	2010	2025	Nil	Nil	Nil	Good	16	69	18/08/2021
	West	Spring	1	18/8/21	LA	2010	2025	Nil	Nil	Nil	Good	16	69	18/08/2021
	East	Spring	2	22/9/21	NM/AE	2015	2045	L. fallax	Nil	Nil	Good	15	72	
	West	Spring	2	22/9/21	NM/AE	2050	2120	L. fallax, bandicoot spp, GhFF	Nil	Nil	Good	15	72	
Access G	East	Spring	1	18/8/21	AE	2028	2058	Litoria fallax, Crinia signifera	Nil	Nil	Good	16	69	
	West	Spring	1	18/8/21	LA	2028	2058	Nil	Nil	Nil	Good	16	69	
	East	Spring	2	23/9/21	NM/AE	2030	2100	L. fallax, L. tyleri, L. peronii, GhFf	Rl	Nil	Good	18	61	
	West	Spring	2	23/9/21	NM/AE	2102	2132	GhFf	Rl	Nil	Good	18	61	
Nth martells	East	Spring	1	16/8/21	AE/LA	1906	1921	Nil	Nil	Nil	Good	16	68	
	West	Spring	1	16/8/21	AE/LA	1921	1934	Nil	Nil	Nil	Good	16	68	
	East	Spring	2	21/9/21	NM/AE	2055	2125	Nil	Nil	Nil	Good	12.9	43	
	West	Spring	2	21/9/21	NM/AE	2130	2200	Nil	Nil	Nil	Good	12.9	43	
Sth martells	East	Spring	1	16/8/21	AE/LA	1800	1815	Crinia signifera	Nil	Nil	Good	16.8	68	
	West	Spring	1	16/8/21	AE/LA	1825	1840	Lit revelata, lit peronii, Crinia signifera	Nil	Nil	Good	16.8	68	
	East	Spring	2	22/9/21	NM/AE	1937	2007	L. fallax, L. Peronii, wallaby spp	Nil	Nil	Good	16.5	66	

Location	Side	Season	Sample	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
	West	Spring	2	22/9/21	NM/AE	1905	1935	L. fallax, bandicoot spp, wallaby spp	Nil	Nil	Good	16.5	66	
Dalhousie	East	Spring	1	16/8/21	LA/AE	2006	2021	Litoria fallax, Crinia signifera	Nil	Nil	Good	16	69	
	West	Spring	1	16/8/21	LA/AE	2030	2045	Nil	Nil	Nil	Good	16	69	
	East	Spring	2	21/9/21	NM/AE	2300	2330	Koala	Msb	Nil	Good	13.1	54	
	West	Spring	2	22/9/21	NM/AE	2210	2240	GhFf, L. fallax	Rl	Nil	Good	13.8	75	
Burke's	East	Spring	1	18/8/21	AE	1758	1828	Litoria fallax	Nil	Nil	Good	16	69	
	West	Spring	1	18/8/21	LA	1758	1828	SuG	Nil	Nil	Good	16	69	
	East	Spring	1	21/9/21	NM/AE	1830	1900	Nil	Nil	Nil	Good	13.2	46	
	West	Spring	1	21/9/21	NM/AE	1905	1935	SEBtP, CRtP	Nil	Nil	Good	13.2	46	
Martell's bridge	East	Spring	1	18/8/21	AE	2107	2137	Lit fallax	Nil	Nil	Good	16	69	
	West	Spring	1	18/8/21	LA	2107	2137	Crinia signifera, lit fallax, wallaby spp.	Nil	Nil	Good	16	69	Wallaby heard bouncing
	East	Spring	2	23/9/21	NM/AE	2140	2210	Lit fallax, lit peronii, ghff	Rl	Nil	Good	14	77	
	West	Spring	2	23/9/21	NM/AE	2215	2245	Lit fallax, lit peronii, Long-nosed bandicoot, melomys, ghff	Rl	Nil	Good	14	77	
McGraths	East	Spring	1	18/8/21	AE	1833	1903	Swamp wallaby	Nil	Nil	Good	16	69	
	West	Spring	1	18/8/21	LA	1833	1903	Nil	Nil	Nil	Good	16	69	
	East	Spring	2	21/9/21	NM/AE	1940	2010	Nil	Nil	Nil	Good	13.1	44	
	West	Spring	2	21/9/21	NM/AE	2015	2045	Nil	Nil	Nil	Good	13.1	44	

Table B5: Underpass camera effort during year five NH2U monitoring, 2021.

Site	Location	Camera type	Cam ID	Sample	Install	Check	Status	Battery (%)	No. Vids	Date last vid	Retrieve	Status	Battery (%)	No.vids	Date last vid (if flat	Active days	Comments
Burke's	Gound	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	47		11/6/21	Active	95	137		73	
Burke's	Furniture	Reconyx	-	Autumn	30/3/21	4/5/21	Active	80	186		11/6/21	Active	44	0		73	
McGraths	North	Scout guard	-	Autumn	30/3/21	4/5/21	Flat	0	29	30/04/2021	11/6/21	Flat	0	1		35	Malfunction
McGraths	South	Scout guard	-	Autumn	30/3/21	4/5/21	Active	66	180		11/6/21	Flat	4	66	1/06/2021	63	
South Martell's	Gound	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	61		11/6/21	Active	95	88		73	
South Martell's	Furniture	Reconyx	-	Autumn	30/3/21	4/5/21	Active	26	0		11/6/21	Active	25	347		73	
North Martell's	Gound	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	3%	18978		11/6/21	Active	95	70		73	
North Martell's	Furniture	Reconyx	-	Autumn	30/3/21	4/5/21	Active	95	55		11/6/21	Active	5	20614		73	
Tyson's east	Ground	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	123		11/6/21	Active	95	119		73	
Tyson's east	Furniture	Reconyx	-	Autumn	30/3/21	4/5/21	Active	84	622		11/6/21	Active	88	2		73	
Tyson's east	Split ground	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	110		11/6/21	Active	95	129		73	
Tyson's west	Ground	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	64		11/6/21	Active	956	70		73	
Tyson's west	Furniture	Reconyx	-	Autumn	30/3/21	4/5/21	Active	11	261		11/6/21	Active	15	217		73	
Tyson's west	Split ground	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	161		11/6/21	Error	95	SD error		35	
Access G	Ground	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	38		11/6/21	Active	95	55		73	
Access G	Furniture	Reconyx	-	Autumn	30/3/21	4/5/21	Active	84	?		11/6/21	Active	80	158		73	
Access G	Split ground	Enduro (old)	-	Autumn	30/3/21	4/5/21	Active	95	1		11/6/21	Active	95	62		73	
Dalhousie east	Gound	Enduro (old)	-	Autumn	31/3/21	4/5/21	Active	95	131		11/6/21	Active	95	108		72	

Site	Location	Camera type	Cam ID	Sample	Install	Check	Status	Battery (%)	No. Vids	Date last vid	Retrieve	Status	Battery (%)	No.vids	Date last vid (if flat	Active days	Comments
Dalhousie east	Furniture	Reconyx	-	Autumn	16/4/21	4/5/21	Flat	0	no images	4/05/2021	11/6/21	Active	76	1317		38	Malfunction
Dalhousie West	Gound	Enduro (old)	-	Autumn	31/3/21	4/5/21	Active	95	100		11/6/21	Active	95	137		72	
Dalhousie West	Furniture	Reconyx	-	Autumn	16/4/21	4/5/21	Active	76	66		11/6/21	Active	76	296		56	
Martell's bridge	Ground	Enduro new	-	Autumn	16/4/21		Active	95	337		11/6/21	Active	95	70		56	
Martell's Bridge	Ground	Enduro new	-	Autumn	16/4/21		Active	95	87		11/6/21	Active	75	97		56	
Burke's	Gound	Enduro (old)	Ses161	Spring	16/8/21	20/9/21	Active	100	92		8/11/21	Active	95	77		84	
Burke's	Furniture	Reconyx	Ses 45	Spring	16/8/21	20/9/21	Active	54%	349		8/11/21	Active	66	330		84	
McGraths	North	Scout guard	-	Spring	16/8/21	20/9/21	Active	66	75		8/11/21	Flat	0	440	27/10/2021	72	
McGraths	South	Scout guard	-	Spring	16/8/21	20/9/21	Active	66	208		8/11/21	Active	66	595		84	
South Martell's	Gound	Enduro (old)	S 154	Spring	16/8/21	21/9/21	Active	90	103		8/11/21	Active	95	96		84	
South Martell's	Furniture	Reconyx	SES 5	Spring	16/8/21	21/9/21	Active	2	552		8/11/21	Active	11	456		84	
North Martell's	Gound	Enduro (old)	155	Spring	16/8/21	20/9/21	Active	100	118		8/11/21	Active	95	123		84	
North Martell's	Furniture	Reconyx	Ses 30	Spring	16/8/21	20/9/21	Active	26%	19041		8/11/21	Active	11	24390		84	On time lapse
Tyson's east	Ground	Enduro (old)	Ses177	Spring	16/8/21	21/9/21	Active	100	276		8/11/21	Active	95	935		84	
Tyson's east	Furniture	Reconyx	Ses87	Spring	16/8/21	21/9/21	Active	4	545		8/11/21	Active	45	276		84	
Tyson's east	Split ground	Enduro (old)	Ses176	Spring	16/8/21	21/9/21	Active	100	997		8/11/21	Active	95	918		84	
Tyson's west	Ground	Enduro (old)	Ses 172	Spring	16/8/21	21/9/21	Active	100	114		8/11/21	Active	95	214		84	
Tyson's west	Furniture	Reconyx	Ses16	Spring	16/8/21	21/9/21	Active	Low	1146		8/11/21	Active	11	156		84	
Tyson's west	Split ground	Enduro (old)	Ses 164	Spring	16/8/21	21/9/21	Active	90	165		8/11/21	Active	95	232		84	
Access G	Ground	Enduro (old)	S121	Spring	16/8/21	22/9/21	Active	100	56		8/11/21	Active	95	39		84	
Access G	Furniture	Reconyx	Ses79	Spring	16/8/21	22/9/21	Active	80	246		8/11/21	Active	77	106		84	
Access G	Split ground	Enduro (old)	Ses152	Spring	16/8/21	9/22/01	Active	100	123		8/11/21	Active	95	95		84	
Dalhousie east	Gound	Enduro (old)	Ses157	Spring	16/8/21	22/9/21	Active	100	215		8/11/21	Active	95	134		84	
Dalhousie east	Furniture	Reconyx	Ses 38	Spring	16/8/21	22/9/21	Active	80	1056		8/11/21	Active	25	21900		84	On time lapse
Dalhousie West	Gound	Enduro (old)	Ses 153	Spring	16/8/21	22/9/21	Active	100	180		8/11/21	Active	95	179		84	
Dalhousie West	Furniture	Reconyx	Ses 85	Spring	16/8/21	22/9/21	Active	76	1061		8/11/21	Active	48	215		84	
Martell's bridge	Ground	Enduro new	S269	Spring	16/8/21	23/9/21	Active	100	65		8/11/21	Active	95	375		84	
Martell's Bridge	Ground	Enduro new	S266	Spring	16/8/21	23/9/21	Active	100	87		8/11/21	Active	95	250		84	

Table B6: Summary of underpass image review data recorded by species/fauna groups during year five monitoring at NH2U, 2021.

Year	Season	Round	Site	Cell	Cam	Species	Complete	Incomplete	East C	West C	NDM	Comments
2021	Autumn	1/2	Access G		Furniture	Short-eared brushtail possum	20	4	10	10		
2021	Autumn		Access G		Furniture	Cat	0	1				Black small white patch chest
2021	Autumn		Access G		Furniture	Lace monitor	1			1		

2021	Autumn		Access G		Ground	Water rat	7		5	2		
2021	Autumn		Access G		Ground	Black rat	5		4	1		
2021	Autumn		Access G		Ground	Short-beaked echidna	6		5	1		
2021	Autumn		Access G		Split ground	Eastern water dragon	1			1		
2021	Autumn		Access G		Split ground	Fox	2		1	1		
2021	Autumn		Access G		Split ground	Water rat	7		4	3		
2021	Autumn		Access G		Split ground	Black rat	5		3	2		
2021	Autumn		Access G		split ground	Short-beaked echidna	4		2	2		
2021	Autumn		Access G		Split ground	House mouse	1		1			
2021	Autumn		Access G		Split ground	Northern brown bandicoot	1		1			
2021	Autumn		Burke's		Furniture	Short-eared brushtail possum	7		1	6		
2021	Autumn		Burke's		Ground	Long-nosed bandicoot	2	2	2			
2021	Autumn		Burke's		Ground	Coastal carpet python	1			1		
2021	Autumn		Burke's		Ground	Bandicoot spp.	8		8			
2021	Autumn		Burke's		Ground	Trichosurus spp.	4		2	2		51, 15.05.2021 12.40am - Fox attacking Possum
2021	Autumn		Burke's		Ground	Fox	13		12	1		
2021	Autumn		Burke's		Ground	Black rat	18		9	9		
2021	Autumn		Burke's		Ground	Northern brown bandicoot	6		6			
2021	Autumn		Burke's		Ground	House mouse	15		10	5		
2021	Autumn		Dalhousie	E	Furniture	Antechinus spp.	42	4	19	23		
2021	Autumn		Dalhousie	E	Furniture	Black rat	82	13	40	42		
2021	Autumn		Dalhousie	E	Furniture	Fawn-footed melomys	33		16	17		
2021	Autumn		Dalhousie	E	Ground	Black rat	46	3	26	20		
2021	Autumn		Dalhousie	E	Ground	Cat	1		1			
2021	Autumn		Dalhousie	E	Ground	Dog	19		8	11		
2021	Autumn		Dalhousie	E	Ground	Water rat	1	1		1		
2021	Autumn		Dalhousie	E	Ground	Fox	7		7			
2021	Autumn		Dalhousie	E	Ground	Bush rat	1		1			
2021	Autumn		Dalhousie	W	Furniture	Antechinus spp.	39	1	6	33		
2021	Autumn		Dalhousie	W	Furniture	Black rat	6	2	3	3		
2021	Autumn		Dalhousie	W	Ground	Black rat	45	3	15	30		
2021	Autumn		Dalhousie	W	Ground	Water rat	2		1	1		
2021	Autumn		Dalhousie	W	Ground	Dog	7		6	1		
2021	Autumn		Dalhousie	W	Ground	Rodent spp.	2			2		
2021	Autumn		Dalhousie	W	Ground	Eastern water dragon	2	1	1	1		
2021	Autumn		Dalhousie	W	Ground	Fox	3		3			
2021	Autumn		Martell's Bridge	N	Ground	Dog	4		2	2		
2021	Autumn		Martell's Bridge	S	Ground	Dog	9		3	6		At least 3 individuals
2021	Autumn		Martell's Bridge	S	Ground	Swamp wallaby	5		2	3		
2021	Autumn		McGraths	N	North	nil	0					
2021	Autumn		McGraths	S	South	Lace monitor	0	1				
2021	Autumn		North Martell's		Furniture	Egernia spp.	3		2	1		
2021	Autumn		North Martell's		Furniture	Antechinus spp.	5		2	3		
2021	Autumn		North Martell's		Ground	Cat	1			1		
2021	Autumn		North Martell's		Ground	Water rat	4	1	3	1		
2021	Autumn		North Martell's		Ground	Fox	2		2			
2021	Autumn		North Martell's		Ground	Dog	1		1			

2021	Autumn		North Martell's		Furniture	Fawn-footed melomys	1			1		
2021	Autumn		North Martell's		Ground	Short-beaked echidna	2		1	1		
2021	Autumn		South Martell's		Ground	Black rat	26	3	16	10		
2021	Autumn		South Martell's		Ground	Fox	6		6			
2021	Autumn		South Martell's		Ground	Eastern water dragon	1		1			
2021	Autumn		South Martell's		Ground	Short-eared brushtail possum	1		1			
2021	Autumn		South Martell's		Ground	Dog	1		1			
2021	Autumn		South Martell's		Ground	Water rat	1		1			
2021	Autumn		South Martell's		Ground	Bandicoot spp.	1		1			
2021	Autumn		South Martell's		Ground	Rodent spp.	2		2			
2021	Autumn		South Martell's		Furniture	Trichosurus spp.	27		18	9		
2021	Autumn		South Martell's		Furniture	Antechinus spp.	3			3		
2021	Autumn		South Martell's		Furniture	Spotted-tailed quoll	1			1		Img 271 - 276, 5.38pm, 25.05.2021
2021	Autumn		South Martell's		Ground	Short-beaked echidna	8		4	4		
2021	Autumn		Tyson's	East	Furniture	Black rat	15	3	7	8		
2021	Autumn		Tyson's	East	Furniture	Antechinus spp.	43	3	24	19		
2021	Autumn		Tyson's	East	Furniture	Trichosurus spp.	1			1		
2021	Autumn		Tyson's	East	Furniture	Eastern water dragon	4		2	2		
2021	Autumn		Tyson's	East	Furniture	Short-eared brushtail possum	2		1	1		
2021	Autumn		Tyson's	East	Ground	Black rat	31	6	16	15	1	
2021	Autumn		Tyson's	East	Ground	Short-beaked echidna	10		4	6		
2021	Autumn		Tyson's	East	Ground	Eastern water dragon	3		2	1		
2021	Autumn		Tyson's	East	Ground	Water rat	25	1	15	10	3	
2021	Autumn		Tyson's	East	Ground	Lace monitor	1		1			
2021	Autumn		Tyson's	East	Ground	Northern brown bandicoot	2			2		
2021	Autumn		Tyson's	East	Ground	House mouse	1		1			
2021	Autumn		Tyson's	East	Split ground	Black rat	34	13	18	16		
2021	Autumn		Tyson's	East	Split ground	Eastern water dragon	4		3	1		
2021	Autumn		Tyson's	East	Split ground	Water rat	13		7	6		Water often swims
2021	Autumn		Tyson's	East	Split ground	Northern brown bandicoot	4	1	3	1		
2021	Autumn		Tyson's	East	Split ground	Fox	1			1		
2021	Autumn		Tyson's	West	Furniture	Black rat	8		4	4		
2021	Autumn		Tyson's	West	Furniture	Antechinus spp.	2		1	1		
2021	Autumn		Tyson's	West	Furniture	Short-eared brushtail possum	5		1	4		
2021	Autumn		Tyson's	West	Ground	Black rat	18	4	12	6		
2021	Autumn		Tyson's	West	Ground	Antechinus spp.	1		1			
2021	Autumn		Tyson's	West	Ground	Australian brush turkey	1			1		
2021	Autumn		Tyson's	West	Ground	Lace monitor	1		1			
2021	Autumn		Tyson's	West	Ground	Northern brown bandicoot	7	1	5	2		
2021	Autumn		Tyson's	West	Ground	Short-beaked echidna	2		1	1		
2021	Autumn		Tyson's	West	Ground	Common brushtail possum	1		1			
2021	Autumn		Tyson's	West	Split ground	Black rat	8		6	2		
2021	Spring	1	Access G		Furniture	Antechinus spp.	1		1			
2021	Spring	1	Access G		Furniture	Lace monitor	2		1	1		
2021	Spring	1	Access G		Furniture	Black rat	1		1			
2021	Spring	1	Access G		Furniture	Short-eared brushtail possum	3	1	2	1		
2021	Spring	1	Access G		Ground	Antechinus spp.	3		1	2		

2021	Spring	1	Access G		Ground	Water rat	1		1			
2021	Spring	1	Access G		Ground	Eastern water dragon	3		3			
2021	Spring	1	Access G		Ground	House mouse	6	1	3	3		
2021	Spring	1	Access G		Ground	Black rat	4		2	2	1	
2021	Spring	1	Access G		Ground	Rodent spp.	2		2			
2021	Spring	1	Access G		Ground	Short-eared brushtail possum	1		1			
2021	Spring	1	Access G		Ground	Lace monitor	2		1	1		
2021	Spring	1	Access G		Ground	Long-nosed bandicoot	2		1	1		
2021	Spring	1	Access G		Ground	Swamp rat	3		2	1		
2021	Spring	1	Access G		Split ground	Water rat	3		1	2		
2021	Spring	1	Access G		Split ground	House mouse	5	3	4	1		
2021	Spring	1	Burke's		Furniture	Coastal carpet python	1			1		
2021	Spring	1	Burke's		Furniture	Black rat	1			1		
2021	Spring	1	Burke's		Furniture	Short-eared brushtail possum	11	1	6	5		Two individuals in one frame
2021	Spring	1	Burke's		Ground	Bandicoot spp.	14	1	14			
2021	Spring	1	Burke's		Ground	Fox	0	1				
2021	Spring	1	Burke's		Ground	Long-nosed bandicoot	4		4			
2021	Spring	1	Burke's		Ground	Black rat	3	2		3		
2021	Spring	1	Burke's		Ground	Short-eared brushtail possum	1			1		
2021	Spring	1	Dalhousie	East	Furniture	Antechinus spp.	26	2	8	18		Two antechinus daytime while bikes going through, suggest they are living in structure
2021	Spring	1	Dalhousie	East	Furniture	Egernia spp.	1		1			
2021	Spring	1	Dalhousie	East	Furniture	Fawn-footed melomys	16		7	9		
2021	Spring	1	Dalhousie	East	Furniture	Bush rat	7		2	5		Probable
2021	Spring	1	Dalhousie	East	Furniture	Black rat	40	6	16	24	1	
2021	Spring	1	Dalhousie	East	Furniture	Rodent spp.	36	3	19	17	1	
2021	Spring	1	Dalhousie	East	Ground	Antechinus spp.	15	2	4	11		Cameras good at detecting antechinus
2021	Spring	1	Dalhousie	East	Ground	Dog	4		2	2		Older cream coloured
2021	Spring	1	Dalhousie	East	Ground	Cat	0	1				
2021	Spring	1	Dalhousie	East	Ground	Eastern water dragon	3		1	2		
2021	Spring	1	Dalhousie	East	Ground	Koala	1			1		Date 15/09/2021, Appears heathy, potentially female heard during adjacent habitat surveys
2021	Spring	1	Dalhousie	East	Ground	Fawn-footed melomys	2		1	1		
2021	Spring	1	Dalhousie	East	Ground	Black rat	7	1	3	4	1	
2021	Spring	1	Dalhousie	East	Ground	Rodent spp.	16	1	6	10		Camera faces west
2021	Spring	1	Dalhousie	East	Ground	Short-eared brushtail possum	2			2		
2021	Spring	1	Dalhousie	East	Ground	Long-nosed bandicoot	2		1	1		
2021	Spring	1	Dalhousie	West	Furniture	Antechinus spp.	71	7	19	52		
2021	Spring	1	Dalhousie	West	Furniture	Egernia spp.	1		1			
2021	Spring	1	Dalhousie	West	Furniture	Black rat	5	2	2	3		
2021	Spring	1	Dalhousie	West	Furniture	Rodent spp.	2		1	1		
2021	Spring	1	Dalhousie	West	Furniture	Lace monitor	2	1	1	1		
2021	Spring	1	Dalhousie	West	Ground	Antechinus spp.	4	1	2	2		
2021	Spring	1	Dalhousie	West	Ground	Dog	5		2	3		
2021	Spring	1	Dalhousie	West	Ground	Cat	0					
2021	Spring	1	Dalhousie	West	Ground	House mouse	1			1		
2021	Spring	1	Dalhousie	West	Ground	Black rat	21	1	10	11		

2021	Spring	1	Dalhousie	West	Ground	Rodent spp.	1			1		
2021	Spring	1	Dalhousie	West	Ground	Lace monitor	2		1	1		
2021	Spring	1	Martell's Bridge	North	North	Cat	1			1		Black cat
2021	Spring	1	Martell's Bridge	North	North	Dog	4		4			Stumpy tail and kelpie
2021	Spring	1	Martell's Bridge	North	North	Fox	3		2	1		
2021	Spring	1	Martell's Bridge	North	North	Swamp wallaby	1			1		
2021	Spring	1	Martell's Bridge	South	South	Dog	8		3	5		At least two individuals, one kelpie one cream coloured
2021	Spring	1	Martell's Bridge	South	South	Swamp wallaby	14		6	8		
2021	Spring	1	McGraths	North	North	Water rat	1			1		
2021	Spring	1	McGraths	North	North	Eastern water dragon	2		1	1		
2021	Spring	1	McGraths	North	North	Black rat	1		1			
2021	Spring	1	McGraths	North	North	Short-eared brushtail possum	26		15	11		Pouch young
2021	Spring	1	McGraths	North	North	Lace monitor	0	1				
2021	Spring	1	McGraths	South	South	Bandicoot spp.	0	1				
2021	Spring	1	McGraths	South	South	Fox	0				1	
2021	Spring	1	McGraths	South	South	Swamp wallaby	0				1	
2021	Spring	1	North Martell's		Furniture	Antechinus spp.	8	2	2	6		
2021	Spring	1	North Martell's		Furniture	Black rat	5	2	3	2	1	
2021	Spring	1	North Martell's		Ground	Antechinus spp.	2		2			
2021	Spring	1	North Martell's		Ground	Bandicoot spp.	2		2			
2021	Spring	1	North Martell's		Ground	Dog	1			1		
2021	Spring	1	North Martell's		Ground	Fox	4	1	4			
2021	Spring	1	North Martell's		Ground	Black rat	15	4	14	1		
2021	Spring	1	North Martell's		Ground	Water rat	2		2			
2021	Spring	1	North Martell's		Ground	Short-beaked echidna	8	1	5	3		
2021	Spring	1	South Martell's		Furniture	Short-eared brushtail possum	50	2	25	25		
2021	Spring	1	South Martell's		Ground	Black rat	3		3			
2021	Spring	1	South Martell's		Ground	Dog	1		1			
2021	Spring	1	South Martell's		Ground	Eastern water dragon	1		1			
2021	Spring	1	South Martell's		Ground	Fox	6		5	1		
2021	Spring	1	South Martell's		Ground	Lace monitor	9		5	4		
2021	Spring	1	South Martell's		Ground	Long-nosed bandicoot	3		3			
2021	Spring	1	South Martell's		Ground	Short-eared brushtail possum	2		2			
2021	Spring	1	South Martell's		Ground	Water rat	2		2			
2021	Spring	1	Tyson's	East	Ground	Short-beaked echidna	7		3	4		
2021	Spring	1	Tyson's	East	Ground	Short-beaked echidna	4		3	1		
2021	Spring	1	Tyson's	East	Ground	Lace monitor	5		4	1		
2021	Spring	1	Tyson's	East	Ground	Long-nosed bandicoot	2	1		2		
2021	Spring	1	Tyson's	East	Ground	Black rat	42	38	22	20	2	
2021	Spring	1	Tyson's	East	Ground	Snake spp.	1		1			
2021	Spring	1	Tyson's	East	Ground	Water rat	1	2	1			
2021	Spring	1	Tyson's	East	Furniture	Black rat	11	2	6	5	1	
2021	Spring	1	Tyson's	East	Furniture	Lace monitor	3		1	2		
2021	Spring	1	Tyson's	East	Furniture	Short-eared brushtail possum	5		3	2		
2021	Spring	1	Tyson's	East	Furniture	Antechinus spp.	11	2	7	4		
2021	Spring	1	Tyson's	East	Split Ground	Black rat	19	19	9	10	1	

2021	Spring	1	Tyson's	East	Split Ground	Water rat	1	2	1			
2021	Spring	1	Tyson's	West	Furniture	Antechinus spp.	4	2	1	3		
2021	Spring	1	Tyson's	West	Furniture	Black rat	8	9	4	4		
2021	Spring	1	Tyson's	West	Furniture	Short-eared brushtail possum	4		1	3		
2021	Spring	1	Tyson's	West	Ground	House mouse	2		1	1		
2021	Spring	1	Tyson's	West	Ground	Short-eared brushtail possum	16		5	11		
2021	Spring	1	Tyson's	West	Ground	Lace monitor	10		7	3		
2021	Spring	1	Tyson's	West	Ground	Eastern water dragon	2		1	1		
2021	Spring	1	Tyson's	West	Ground	Black rat	23	2	11	12		
2021	Spring	1	Tyson's	West	Split Ground	Eastern bearded dragon	1		1			
2021	Spring	1	Tyson's	West	Split Ground	Fox	1	1	1			
2021	Spring	1	Tyson's	West	Split Ground	House mouse	1	1		1		
2021	Spring	1	Tyson's	West	Split Ground	Lace monitor	6		4	2		
2021	Spring	1	Tyson's	West	Split Ground	Long-nosed bandicoot	1		1			
2021	Spring	1	Tyson's	West	Split Ground	Black rat	13	15	6	7		
2021	Spring	1	Tyson's	West	Split Ground	Short-eared brushtail possum	4		3	1		
2021	Spring	1	Tyson's	West	Split Ground	Marsh snake	1		1			
2021	Spring	2	Access G		Furniture	Eastern water dragon	3	2	3			
2021	Spring	2	Access G		Furniture	Lace monitor	1		1			
2021	Spring	2	Access G		Furniture	Short-eared brushtail possum	15	1	8	7		
2021	Spring	2	Access G		Ground	Black rat	3		2	1		
2021	Spring	2	Access G		Ground	Eastern water dragon	6		3	3		
2021	Spring	2	Access G		Ground	Lace monitor	2	1	1	1		
2021	Spring	2	Access G		Ground	Land mullet	1		1			
2021	Spring	2	Access G		Ground	White-faced heron	1		1			
2021	Spring	2	Access G		Split ground	Black rat	4	1	2	2		
2021	Spring	2	Access G		Split ground	Eastern water dragon	8	5	7	1	4	
2021	Spring	2	Access G		Split ground	House mouse	1		1			
2021	Spring	2	Access G		Split ground	Lace monitor	7	1	5	2		
2021	Spring	2	Access G		Split ground	Water rat	2		2			
2021	Spring	2	Burke's		Furniture	Short-eared brushtail possum	4		1	3		
2021	Spring	2	Burke's		Ground	Bandicoot spp.	9		8	1		
2021	Spring	2	Burke's		Ground	Black rat	1	1		1		
2021	Spring	2	Burke's		Ground	Bush rat	0	1				
2021	Spring	2	Burke's		Ground	Coastal carpet python	2		2			
2021	Spring	2	Burke's		Ground	Fox	5		3	2		
2021	Spring	2	Burke's		Ground	Long-nosed bandicoot	2	1	2			
2021	Spring	2	Dalhousie	East	Furniture	Fawn-footed melomys	5	1	1	4		
2021	Spring	2	Dalhousie	East	Furniture	Black rat	38	3	21	17		
2021	Spring	2	Dalhousie	East	Furniture	Lace monitor	1		1			
2021	Spring	2	Dalhousie	East	Furniture	Antechinus spp.	2		1	1		
2021	Spring	2	Dalhousie	East	Furniture	Rodent spp.	13	1	5	8		
2021	Spring	2	Dalhousie	East	Furniture	Egernia spp.	3	1	3			
2021	Spring	2	Dalhousie	East	Ground	Rodent spp.	4		4			
2021	Spring	2	Dalhousie	East	Ground	Cat	4			4		
2021	Spring	2	Dalhousie	East	Ground	Short-eared brushtail possum	2		1	1		
2021	Spring	2	Dalhousie	East	Ground	Eastern water dragon	2	1	1	1		

2021	Spring	2	Dalhousie	East	Ground	Lace monitor	3		1	2		
2021	Spring	2	Dalhousie	East	Ground	Dog	2		2			
2021	Spring	2	Dalhousie	East	Ground	Black rat	20	2	9	11		
2021	Spring	2	Dalhousie	West	Furniture	Egernia spp.	3		2	1		
2021	Spring	2	Dalhousie	West	Furniture	Antechinus spp.	23	3	13	10		
2021	Spring	2	Dalhousie	West	Furniture	Black rat	23	5	11	12		
2021	Spring	2	Dalhousie	West	Furniture	Lace monitor	5		4	1		
2021	Spring	2	Dalhousie	West	Furniture	Eastern water dragon	1		1			
2021	Spring	2	Dalhousie	West	Ground	Eastern water dragon	2		2			Faces West
2021	Spring	2	Dalhousie	West	Ground	Antechinus spp.	1		1			
2021	Spring	2	Dalhousie	West	Ground	Black rat	17		7	10		
2021	Spring	2	Dalhousie	West	Ground	Lace monitor	5		4	1		
2021	Spring	2	Dalhousie	West	Ground	Short-eared brushtail possum	5		5			
2021	Spring	2	Dalhousie	West	Ground	Cat	1			1		
2021	Spring	2	Dalhousie	West	Ground	Water rat	4		2	2		
2021	Spring	2	Dalhousie	West	Ground	Dog	1		1			
2021	Spring	2	Dalhousie	West	Ground	Fox	1		1			
2021	Spring	2	Dalhousie	West	Ground	Rodent spp.	3		1	2	1	
2021	Spring	2	Dalhousie	West	Ground	Eastern water dragon	1		1			
2021	Spring	2	Martell's Bridge	North	Ground	Dog	2		2			Stumpy Tail
2021	Spring	2	Martell's Bridge	South	Ground	Bandicoot spp.	1		1			
2021	Spring	2	Martell's Bridge	South	Ground	Dog	4	1		4		Kelpie, Black
2021	Spring	2	Martell's Bridge	South	Ground	Swamp wallaby	7		2	5		
2017	Spring	2	McGraths	North	North	Eastern water dragon	10	1	6	4	4	
2018	Spring	2	McGraths	North	North	Short-eared brushtail possum	15		8	7		
2019	Spring	2	McGraths	North	North	Lace monitor	0	2				
2021	Spring	2	McGraths	South	South	Swamp wallaby	0	1			10	
2021	Spring	2	North Martell's		Furniture	Black rat	4	1	2	2		
2021	Spring	2	North Martell's		Furniture	Lace monitor	1			1		
2021	Spring	2	North Martell's		Furniture	Antechinus spp.	15	1	9	6		
2021	Spring	2	North Martell's		Ground	Rodent spp.	3		1	2		
2021	Spring	2	North Martell's		Ground	Koala	1		1			Image 24, 29/9/2021, 0347am
2021	Spring	2	North Martell's		Ground	Eastern water dragon	1		1			
2021	Spring	2	North Martell's		Ground	Fox	6		4	2		Image 2/11/2021, fox carrying bandicoot
2022	Spring	3	North Martell's		Ground	Short-eared brushtail possum	2		1	1		
2022	Spring	3	North Martell's		Ground	Dog	1		1			
2021	Spring	2	North Martell's		Ground	Water rat	13	1	5	8		
2021	Spring	2	North Martell's		Ground	Black rat	17	1	7	10		
2021	Spring	2	South Martell's		Furniture	Short-eared brushtail possum	56	1	30	26		
2021	Spring	2	South Martell's		Furniture	Antechinus spp.	9		4	5		
2021	Spring	2	South Martell's		Furniture	Lace monitor	10		4	6		
2021	Spring	2	South Martell's		Furniture	Egernia spp.	1		1			
2021	Spring	2	South Martell's		Furniture	Fawn-footed melomys	6	1	3	3		
2021	Spring	2	South Martell's		Ground	Black rat	3		3			
2021	Spring	2	South Martell's		Ground	Dog	2		1			Stump tail Kelpie
2021	Spring	2	South Martell's		Ground	Eastern water dragon	4	2	1			
2021	Spring	2	South Martell's		Ground	Fox	4		5	1		

2021	Spring	2	South Martell's		Ground	Lace monitor	9		5	4		
2021	Spring	2	South Martell's		Ground	Long-nosed bandicoot	3		3			
2021	Spring	2	South Martell's		Ground	Short-eared brushtail possum	2		2			
2021	Spring	2	South Martell's		Ground	Water rat	2		2			
2021	Spring	2	South Martell's		Ground	Short-beaked echidna	7		3	4		
2021	Spring	2	Tyson's	East	Ground	Black rat	12	2	5	7		
2021	Spring	2	Tyson's	East	Ground	Short-beaked echidna	3		1	2		
2021	Spring	2	Tyson's	East	Ground	Trichosurus spp.	1		1			
2021	Spring	2	Tyson's	East	Ground	Bandicoot spp.	1		1			
2021	Spring	2	Tyson's	East	Ground	Lace monitor	1	1	1			
2021	Spring	2	Tyson's	East	Ground	Eastern water dragon	1		1		1	
2021	Spring	2	Tyson's	East	Furniture	Black rat	7	2	3	4		
2021	Spring	2	Tyson's	East	Furniture	Lace monitor	4		1	3		
2021	Spring	2	Tyson's	East	Furniture	Short-eared brushtail possum	14		6	8		Juvenile on back
2021	Spring	2	Tyson's	East	Furniture	Antechinus spp.	3	1	3			
2021	Spring	2	Tyson's	East	Furniture	Eastern water dragon	1	1		1		
2021	Spring	2	Tyson's	East	Split Ground	Short-eared brushtail possum	24		11	13		Back young on one individual
2021	Spring	2	Tyson's	East	Split Ground	Lace monitor	11	1	5	6		
2021	Spring	2	Tyson's	East	Split Ground	Eastern water dragon	7		2	5		
2021	Spring	2	Tyson's	East	Split Ground	Black rat	14	6	9	5		
2021	Spring	2	Tyson's	East	Split Ground	Rodent spp.	5		3	2		
2021	Spring	2	Tyson's	West	Furniture	Short-eared brushtail possum	10		4	6		
2021	Spring	2	Tyson's	West	Furniture	Egernia spp.	1			1		
2021	Spring	2	Tyson's	West	Furniture	Antechinus spp.	1		1			
2021	Spring	2	Tyson's	West	Furniture	Black rat	0	1				
2021	Spring	2	Tyson's	West	Furniture	Eastern water dragon	4	1	2	2		
2021	Spring	2	Tyson's	West	Ground	Black rat	18	4	7	11		
2021	Spring	2	Tyson's	West	Ground	Short-beaked echidna	2	2	1	1		
2021	Spring	2	Tyson's	West	Ground	Short-eared brushtail possum	3	1	2	1		
2021	Spring	2	Tyson's	West	Ground	Bandicoot spp.	1		1			
2021	Spring	2	Tyson's	West	Ground	Lace monitor	5		2	3		
2021	Spring	2	Tyson's	West	Ground	Eastern water dragon	9	1	4	5	2	
2021	Spring	2	Tyson's	West	Split Ground	House mouse	3	1	2	1	1	
2021	Spring	2	Tyson's	West	Split Ground	Short-eared brushtail possum	22		13	9		Back young on one individual
2021	Spring	2	Tyson's	West	Split Ground	Lace monitor	7		4	3		
2021	Spring	2	Tyson's	West	Split Ground	Eastern water dragon	2			2		
2021	Spring	2	Tyson's	West	Split Ground	Black rat	20	3	12	8		

Table B7: Underpass tracks/scats data during year five NH2U monitoring, 2021.

Site	Cell	Check no.	Season	Date	Scats/tracks	Comments
Tyson	**NE**	1	Autumn	10/05/2021	Antechinus	
		2	Autumn	12/05/2021	Rodent	
		3	Autumn	14/05/2021	Rodent	
	SE	1	Autumn	10/05/2021	Bandicoot and tree frog	
		2	Autumn	12/05/2021	Rodent	

Site	Cell	Check no.	Season	Date	Scats/tracks	Comments
		3	Autumn	14/05/2021	Nil	
	NW	1	Autumn	10/05/2021	Rodent	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
	SW	1	Autumn	10/05/2021	Nil	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
Access G	N	1	Autumn	10/05/2021	Nil	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
	S	1	Autumn	10/05/2021	Swallow	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
Nth Martell's	Single cell	1	Autumn	10/05/2021	Nil	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
Sth Martell's	Single cell	1	Autumn	10/05/2021	Btp spp	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
Dalhousie	E	1	Autumn	10/05/2021	Antechinus	
		2	Autumn	12/05/2021	nil	
		3	Autumn	14/05/2021	Rodent spp	
	W	1	Autumn	10/05/2021	Rodent	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
Burke's	Single cell	1	Autumn	10/05/2021	Swallow and large reptile	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
Martell's bridge	Bridge	1	Autumn	10/05/2021	Nil	
		2	Autumn	12/05/2021	Nil	
		3	Autumn	14/05/2021	Nil	
McGraths	S	1	Autumn	Under water	Under water	Under water
Tyson	NE	1	Spring	17/08/2021	Antechinus on rail, rodent on ground	
		2	Spring	21/09/2021	Rodent tracks, scat, lace monitor tracks	
		3	Spring	08/11/2021	Rodent, medium reptile scats	
	SE	1	Spring	17/08/2021	Bandicoot and tree frog	
		2	Spring	21/09/2021	Lace monitor tracks, rat tracks	
		3	Spring	08/11/2021	nil	
	NW	1	Spring	17/08/2021	Rodent	
		2	Spring	21/09/2021	Antechinus on ff, wallaby scat, lace monitor tracks, rodent tracks,	
		3	Spring	08/11/2021	nil	
	SW	1	Spring	17/08/2021	lace monitor (prob)	
		2	Spring	21/9/21	Rat scat and tracks, cat tracks, lace monitor tracks,	
		3	Spring	08/11/2021	nil	
Access G	N	1	Spring	17/08/2021	Nil	

Site	Cell	Check no.	Season	Date	Scats/tracks	Comments
		2	Spring	22/09/2021	Bird, reptile, Btposs scat, lace monitor, Btposs and rodent track	
		3	Spring	08/11/2021	nil	
	S	1	Spring	17/08/2021	Nil	
		2	Spring	22/09/2021	Bird scat, rodent and lace monitor track	
		3	Spring	08/11/2021	nil	
Nth Martell's	Single cell	1	Spring	17/08/2021	Nil	
		2	Spring	20/09/2021	Dog tracks, echidna tracks, rat tracks, fox tracks, small bird scat, rat scat	
		3	Spring	08/11/2021	nil	
Sth Martell's	Single cell	1	Spring	17/08/2021	Brushtail possum scat	
		2	Spring	21/09/2021	BtPoss scat, bat scat, lace monitor, echidna, cat, fox, dog, bandicoot, & rat tracks	
		3	Spring	08/11/2021	BtP on furniture and culvert apron	
Dalhousie	E	1	Spring	17/08/2021	nil	
		2	Spring	22/09/2021	Bird, rat scat, rat tracks	
		3	Spring	08/11/2021	Medium reptile and rodent scat	
	W	1	Spring	17/08/2021	nil	
		2	Spring	22/09/2021	Rodent, antechinus scat, lace monitor, rodent track	
		3	Spring	08/11/2021	Medium reptile and rodent scat	
Burke's	Single cell	1	Spring	17/08/2021	nil	
		2	Spring	20/09/2021	Wallaby tracks, small bird scat, bandicoot tracks, rat tracks, cat tracks, echidna tracks, lace monitor tracks	
		3	Spring	08/11/2021	Nil	
Martell's bridge	Bridge	1	Spring	17/08/2021	nil	
		2	Spring	23/09/2021	Canid tracks	
		3	Spring	08/11/2021	Wallaby scat, small reptile scat	
McGraths	S	1	Spring	Under water	Under water	Under water

Table B8: Underpass sand track data during year five NH2U monitoring, 2021. Prob = probably, poss = possible, Lit = Litoria, Btposs = brushtail possum, unid = unidentified.

Site	Cell	Date	Check no.	Tracks (no. of/direction of travel)	Comments
Tyson's	NE	10/05/2021	Install	Monday, May 10, 2021	**2 bags each (8 bags)**
		11/05/2021	1	Nil	
		12/05/2021	2	Echidna 1e, water rat 1 e	
		13/05/2021	3	Water rat 1e1w, rodent 1e1w	
		14/05/2021	4	Rodent 1e1w	
	SE	10/05/2021	Install	Monday, May 10, 2021	
		11/05/2021	1	nil	
		12/05/2021	2	nil	
		13/05/2021	3	bandicoot 1e1w, rodent 1e1w	
		14/05/2021	4	Bandicoot 1e	
	NW	10/05/2021	Install	Monday, May 10, 2021	
		11/05/2021	1	Nil	water flowing in culvert

Site	Cell	Date	Check no.	Tracks (no. of/direction of travel)	Comments
		12/05/2021	2	Rodent 1e	partial washout restored
		13/05/2021	3	Washout	
		14/05/2021	4	Washout	
	SW	10/05/2021	Install	Monday, May 10, 2021	
		11/05/2021	1	Nil	water flowing in culvert
		12/05/2021	2	nil	partial washout restored
		13/05/2021	3	washout	
		14/05/2021	4	washout	
Access G	**N**	10/05/2021	Install	Monday, May 10, 2021	**2 bags each (4 bags)**
		11/05/2021	1	Nil	water flowing in culvert
		12/05/2021	2	Nil	partial washout restored
		13/05/2021	3	Washout	
		14/05/2021	4	Washout	
	S	10/05/2021	Install		
		11/05/2021	1	Nil	
		12/05/2021	2	Nil	partial washout restored
		13/05/2021	3	washout	
		14/05/2021	4	washout	
Nth Martell's	**Single**	10/05/2021	Install		**2 bags**
		11/05/2021	1	Nil	
		12/05/2021	2	Nil	Rebuilt
		13/05/2021	3	Washout	
		14/05/2021	4	Washout	
Sth Martell's	**Single**	10/05/2021	Install		**2 bags**
		11/05/2021	1	Rodent 1e	
		12/05/2021	2	Rodent 1e1w	partial washout restored
		13/05/2021	3	Washout	
		14/05/2021	4	Washout	
Dalhousie	**E**	10/05/2021	Install		**2 bags each (4 bags)**
		11/05/2021	1	rodent 1 e	
		12/05/2021	2	rodent 1 e	
		13/05/2021	3	Washout	
		14/05/2021	4	Washout	
	W	10/05/2021	Install		
		11/05/2021	1	Rodent 2e2w	
		12/05/2021	2	Nil	partial washout restored
		13/05/2021	3	Washout	
		14/05/2021	4	Washout	
Burke's	**Single**	10/05/2021	Install		**3 bags**
		11/05/2021	1	rodent 1e1w	
		12/05/2021	2	nil	
		13/05/2021	3	washout	Rebuilt
		14/05/2021	4	nil	
Martell's bridge	**N**	11/05/2021	Install		**6 bags**
		12/05/2021	1	nil	
		13/05/2021	2	nil	

Site	Cell	Date	Check no.	Tracks (no. of/direction of travel)	Comments
		14/05/2021	3	nil	
		15/05/2021	4	nil	no check
	S	10/05/2021	Install		
		11/05/2021	1	Nil	
		12/05/2021	2	Nil	
		13/05/2021	3	Nil	
		14/05/2021	4	Nil	
Mcgrath	**S**		Install	**underpass submerged**	**underpass submerged**
Tyson's	**NE**	17/08/2021	Install		**2 bags each (8 bags)**
		18/08/2021	1	Water rat 2e2w	
		19/08/2021	2	Rodent 3e3w	
		20/08/2021	3	Rodent 2e1w	
		21/08/2021	4	Antechinus prob 1 east rodent 1e1w	
	SE	17/08/2021	Install		
		18/08/2021	1	Rodent 2w1e	
		19/08/2021	2	Nil	
		20/08/2021	3	Rodent 2e2w	
		21/08/2021	4	Small bird meandering	
	NW	17/08/2021	Install		
		18/08/2021	1	Rodent 1e1w	
		19/08/2021	2	Nil	
		20/08/2021	3	Rodent 2e1w	
		21/08/2021	4	Rodent 1e1w, antechinus 1e1w	
	SW	17/08/2021	Install		
		18/08/2021	1	Lace monitor 1e	
		19/08/2021	2	Nil	
		20/08/2021	3	Lace monitor 1w , small rodent meandering w and e	
		21/08/2021	4	Mil	
Access G	**N**	17/08/2021	Install		**2 bags each (4 bags)**
		18/08/2021	1	Water rat 1e	
		19/08/2021	2	House mouse1w antechinus 1w	
		20/08/2021	3	Antechinus 1w1e	
		21/08/2021	4	Antechinus meandering	
	S	17/08/2021	Install		
		18/08/2021	1	Nil	
		19/08/2021	2	House mouse 1e1w	
		20/08/2021	3	Antechinus 2e	
		21/08/2021	4	Antechinus 1e1w	
Nth Martell's	**Single**	17/08/2021	Install		**2 bags**
		18/08/2021	1	Rodent 1e1w	
		19/08/2021	2	Nil	
		20/08/2021	3	Rodent 1e1w	
		21/08/2021	4	Echidna m1e	
Sth Martell's	**Single**	17/08/2021	Install		**2 bags**
		18/08/2021	1	Nil	

Site	Cell	Date	Check no.	Tracks (no. of/direction of travel)	Comments
		19/08/2021	2	Echidna 1e1w	
		20/08/2021	3	Echidna 1e, prob antechinus 1e1w	
		21/08/2021	4	Nil	
Dalhousie	**E**	17/08/2021	Install		**2 bags each (4 bags)**
		18/08/2021	1	Nil	
		19/08/2021	2	Dog w and e rodent sp. wand e pr antechinus sp. w	
		20/08/2021	3	Rodent 3w1e	
		21/08/2021	4	Antechinus 3e3w	
	W	17/08/2021	Install		
		18/08/2021	1	Water rat 1w	
		19/08/2021	2	Dog w pr antechinus sp. w	
		20/08/2021	3	Nil	
		21/08/2021	4	Nil	
Burke's	**Single**	17/08/2021	Install		**3 bags**
		18/08/2021	1	Nil	
		19/08/2021	2	Nil	
		20/08/2021	3	Nil	
		21/08/2021	4	Nil	
Martels bridge	**N**	17/08/2021	Install		**6 bags**
		18/08/2021	1	Nil	
		19/08/2021	2	Nil	
		20/08/2021	3	Nil	
		21/08/2021	4	Nil	
	S	17/08/2021	Install		
		18/08/2021	1	Wallaby spp	
		19/08/2021	2	Dog	
		20/08/2021	3	Nil	
		21/08/2021	4	Nil	
McGraths	**S**		Install	**underpass submerged**	**underpass submerged**

Table B9: Frog survey data during year five NH2U monitoring, 2021. Lit = Litoria spp., C. = Crinia spp., Pseud. = Pseudophryne spp., Lim. = Limnodynastes spp., M. fasciolatus = Mixophyes fasciolatus.

Location	Obs. No.	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
Tyson's	1	27/03/2021	LA/DW	2235	2240	Lim. peroni within SW culvert moving west	nil	nil	good	20	90	Lukes phone photo
	2	29/03/2021	LA/DW	2115	2120	Nil	RL	nil	good	19.5	88	-
	3	31/03/2021	LA/NM	2140	2147	Nil						-
Access G	1	27/03/2021	DR	2030	2050	Crinia signifera (scour protection), Ps coriaciea(ad hab), Lit. fallax (ad hab, sed basin)	nil	nil	good	21	83	-
	2	29/03/2021	LA/DW	2023	2028	Nil	RL	nil	good	19.5	88	-
	3	31/03/2021	LA/NM	2155	2200	Nil	Nil	Nil	Good	18.6	78	-

Location	Obs. No.	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
Nth Martell's	1	29/03/2021	DR/NM	2030	2040	Lit fallax (ad hab)	RL	nil	good	20	81	-
	3	31/03/2021	NM/LA	2045	2050	Nil	Nil	Nil	Good	14.5	74	-
Sth martells	1	27/03/2021	LA/DW	2139	2144	Nil	nil	nil	good	20	90	-
	2	29/03/2021	LA/DW	2023	2128	Nil	RL	nil	good	19.5	88	-
	3	31/03/2021	NM/LA	2126	2132	Nil	Nil	Nil	Good	18.6	78	-
	4					Nil						-
Dalhousie	1	27/03/2021	DR	1000	1020	Ps coriacea (ad hab, sed basin), Lit fallax (sed basin)	nil	nil	good	20	90	-
	2	29/03/2021	LA/DW	2310	2315	Nil						-
	3	31/03/2021	NM/LA	2206	2213	Nil	Nil	Nil	Good	18.6	78	-
	4					Nil						-
Burke's	1	27/03/2021	LA/DW	2010	2015	Nil	nil	nil	good	20	90	-
	2	29/03/2021	DR/NM	2210	2220	Nil	RL	nil	good	19.5	88	-
	3	31/03/2021	NM/LA	19:40	19:51	Nil	Nil	Nil	Good	18.6	78	-
	4					Nil						-
Martell's bridge	1	10/05/2021	GR/LA	1815	1825	Nil	Nil	Nil	Good	15.8	90	-
McGraths	1	27/03/2021	LA/DW	2040	2045	Nil	nil	nil	good	20	90	-
	2	29/03/2021	DR/NM	2125	2135	Nil	RL	nil	good	20	85	-
	3	31/03/2021	NM/LA	2003	2010	Nil	Nil	Nil	Good	18.6	78	-
												-
Tyson's	1	16/08/2021	LA/AE	1917	1927	Nil	Nil	Nil	Good	14.5	74	-
	2	18/08/2021	LA/AE	2005	2010	Nil	Nil	Nil	Good	15.5	75	-
	3	21/9/21	NM/AE	2222	2227	Nil	Msb	Nil	Good	13.1	49	-
	4	22/09/2021	NM/AE	2045	2050	Nil	RL	Nil	Good	12	81	-
	5	23/09/2021	NM/AE	2025	2030	L. fallax, L. tyleri, L. peronii	Rl	Nil	Good	17	69	-
Access G	1	16/08/2021	LA/AE	1929	1939	Nil	Nil	Nil	Good	14.5	74	-
	2	18/08/2021	LA/AE	2058	2103	Litoria fallax, Crinia signifera (ad Hab)	Nil	Nil	Good	15.5	75	-
	3	21/09/2021	NM/AE	2240	2245	Lit. fallax ad hab	Msb	Nil	Good	13.1	49	-
	4	22/9/21	NM/AE	2150	2155	Lit. fallax adhab	Rl	Nil	Good	12	81	-
	5	23/9/21	NM/AE	2100	2105	Lit fallax, lit tyleri, lit peronii	Rl	Nil	Good	18	61	-
Nth Martell's	1	16/08/2021	AE/LA	1856	1906	Lit fallax ad hab	Nil	Nil	Good	14.5	74	-
	2	18/08/2021	LA/AE	18:50	19:00	Nil	Nil	Nil	Good	16.8	68	-
	3	21/09/2021	NM/AE	2125	2130	Nil	Msb	Nil	Good	12.9	43	-
	4	22/09/2021	NM/AE	1852	1857	Lit. fallax ad hab	Rl	Nil	Good	17.2	65	-
	5	23/09/2021	NM/AE	1905	1910	Lit. fallax ad hab	Rl	Nil	Good	18.4	60	-
Sth martells	1	16/08/2021	LA/AE	2022	2032	Nil (ad hab lit peronii, lit revelata, Crinia signifera)	Nil	Nil	Good	16.8	68	-
	2	18/08/2021	LA/AE	2159	2209	Nil culvert. Crinia signifera and lit fallax in ad hab	Nil	Nil	Good	15.5	75	-
	3	21/09/2021	NM/AE	2205	2210	Nil culvert, Lit fallax ad hab	Msb	Nil	Good	13	46	-
	4	22/09/2021	NM/AE	1920	1925	Lit. fallax, lit. peronii ad hab	Rl	Nil	Good	16.5	66	-
	5	23/09/2021	NM/AE	1952	1957	Lit. fallax, lit. peronii ad hab	Rl	Nil	Good	18.4	60	-
Dalhousie	1	16/08/2021	LA/AE	2006	2016	Nil	Nil	Nil	Good	14.5	74	-
	2	18/08/2021	LA/AE	2142	2152	Nil culvert. Crinia signifera and lit fallax in ad hab	Nil	Nil	Good	15.5	75	-

Location	Obs. No.	Date	Observers	Start	Finish	Species	Wind	Rain	Visibility	Air Temp	Humidity	Comment
	3	21/09/2021	NM/AE	2315	2320	Lit fallax adhab	Msb	Nil	Good	12.7	55	-
	4	22/09/2021	NM/AE	2205	2210	Lit fallax adhab	Rl	Nil	Good	13.8	75	-
	5	23/09/2021	NM/AE	2255	2300	Nil	Rl	Nil	Good	13	82	-
Burke's	1	16/08/2021	LA/AE	1800	1810	Crinia signifera ad hab	Nil	Nil	Good	16.8	68	-
	2	18/08/2021	LA/AE	17:50	1800	Nil	Nil	Nil	Good	16.5	69	-
	3	21/09/2021	NM/AE	1900	1905	Nil	Msb	Nil	Good	13.2	46	-
	4	22/09/2021	NM/AE	1820	1825	Nil	Rl	Nil	Good	17.1	65	-
	5	23/09/2021	NM/AE	1825	1830	Nil	Rl	Nil	Good	18.8	58	-
Martell's bridge	1	16/08/2021	LA/AE	1941	1951	Nil culvert. Crinia signifera and lit fallax in ad hab	Nil	Nil	Good	16.8	68	-
	2	18/08/2021	LA/AE	2107	2117	Nil culvert. Crinia signifera and lit fallax in ad hab	Nil	Nil	Good	15.5	75	-
	3	21/09/2021	NM/AE	2300	2305	Nil	Msb	Nil	Good	12.7	55	-
	4	22/09/2021	NM/AE	2150	2155	L.fallax, l.peronii ad hab	RL	Nil	Good	14.2	75	-
	5	23/09/2021	NM/AE	2210	2215	L.fallax, l.peronii ad hab	RL	Nil	Good	14	77	-
McGraths	1	16/08/2021	LA/AE	1816	1826	Fallax in ad hab	Nil	Nil	Good	16.8	68	-
	2	18/08/2021	LA/AE	1833	1843	Nil	Nil	Nil	Good	16.5	69	-
	3	21/09/2021	NM/AE	2010	2015	Nil	Msb	Nil	Good	13.1	44	-
	4	22/09/2021	NM/AE	1835	1840	Nil	Rl	Nil	Good	17.1	65	-
	5	23/09/2021	NM/AE	1842	1847	Nil	Rl	Nil	Good	18.8	58	-

Table B10: Underpass hair funnel data during year five monitoring at NH2U, 2021.

Funnel ID	Autumn 2021				
	Location	Install Date	Collect date	Fauna	Active days
Dalhousie E	**Ground**	31/03/2021	10/05/2021		40
Dalhousie E	**Furniture**	31/03/2021	10/05/2021		40
Dalhousie W	**Ground**	31/03/2021	10/05/2021		40
Dalhousie W	**Furniture**	31/03/2021	10/05/2021		40
South Martells E	**Ground**	30/03/2021	10/05/2021		41
South Martells W	**Furniture**	30/03/2021	10/05/2021		41
Burke's E	**Ground**	30/03/2021	10/05/2021	Rattus sp.	41
Burke's W	**Furniture**	30/03/2021	10/05/2021	Trichosurus sp.	41
North Martells E	**Ground**	30/03/2021	10/05/2021		41
North Martells W	**Furniture**	30/03/2021	10/05/2021		41
Tysons W	**Ground**	30/03/2021	10/05/2021		41
Tysons W	**Furniture**	30/03/2021	10/05/2021		41
Tysons E	**Ground**	30/03/2021	10/05/2021		41
Tysons E	**Furniture**	30/03/2021	10/05/2021		41
Access G W	**Ground**	30/03/2021	10/05/2021	Trichosurus sp.	41

Access G E	**Furniture**	30/03/2021	10/05/2021		41
Martells Bridge N	**Ground**	16/04/2021	10/05/2021		24
Martells Bridge S	**Ground**	16/04/2021	10/05/2021		24
Dalhousie E	**Ground**	17/08/2021	22/09/2021	Antechinus stuartii	36
Dalhousie E	**Furniture**	17/08/2021	22/09/2021	Antechinus stuartii	36
Dalhousie W	**Ground**	17/08/2021	22/09/2021	Antechinus stuartii	36
Dalhousie W	**Furniture**	17/08/2021	22/09/2021	Antechinus stuartii	36
South Martells E	**Ground**	17/08/2021	22/09/2021	Antechinus flavipes/swainsonii	36
South Martells W	**Furniture**	17/08/2021	22/09/2021		36
Burke's E	**Ground**	17/08/2021	22/09/2021		36
Burke's W	**Furniture**	17/08/2021	22/09/2021		36
North Martells E	**Ground**	17/08/2021	22/09/2021		36
North Martells W	**Furniture**	17/08/2021	22/09/2021		36
Tysons W	**Ground**	17/08/2021	22/09/2021		36
Tysons W	**Furniture**	17/08/2021	22/09/2021	Antechinus flavipes/swainsonii	36
Tysons E	**Ground**	17/08/2021	22/09/2021	Rattus sp.	36
Tysons E	**Furniture**	17/08/2021	22/09/2021	Antechinus stuartii(probable)	36
Access G W	**Ground**	17/08/2021	22/09/2021	Mus musculus	36
Access G E	**Furniture**	17/08/2021	22/09/2021		36
Martells Bridge N	**Ground**	17/08/2021	22/09/2021	Mus musculus	36
Martells Bridge S	**Ground**	17/08/2021	22/09/2021	Mus musculus	36

Table B11: Exclusion fence camera effort during year five monitoring at NH2U, 2021.

Site	Easting	Northing	Season	Install	Retrieval	Status	Date last vid	Pics	Days Active
Dalhousie NW	499667	6621992	Autumn	29/03/2021	30/04/2021	Active	-	35	32
Dalhousie SW	499678	6621921	Autumn	29/03/2021	30/04/2021	Flat	30/04/2021	1536	32
Dalhousie NE	499741	6622021	Autumn	29/03/2021	30/04/2021	Flat	24/04/2021	15	26
Dalhousie SE	499776	6621970	Autumn	29/03/2021	30/04/2021	Active	-	510	32
South Martell's NW	498535	6622868	Autumn	28/03/2021	30/04/2021	Active	-	39	33
South Martell's SW	498544	6622855	Autumn	28/03/2021	30/04/2021	Flat	21/04/2021	1879	24
South Martell's NE	498595	6622902	Autumn	28/03/2021	30/04/2021	Flat	6/04/2021	2	9
South Martell's SE	498601	6622894	Autumn	28/03/2021	30/04/2021	Active	-	54	33
Burke's NW	500278	6616806	Autumn	16/04/2021	14/05/2021	Active	-	9142	28
Burke's SW	500267	6616778	Autumn	16/04/2021	14/05/2021	Active	-	122	28
Burke's NE	500351	6616837	Autumn	29/03/2021	30/04/2021	Flat	11/04/2021	33	13
Burke's SE	500337	6616740	Autumn	29/03/2021	30/04/2021	Active	-	15	32
North Martell's NW	498309	6623380	Autumn	29/03/2021	30/04/2021	Flat	18/04/2021	7	20
North Martell's SW	498324	6623341	Autumn	29/03/2021	30/04/2021	Active	-	43	32
North Martell's NE	498378	6623430	Autumn	29/03/2021	30/04/2021	Flat	3/04/2021	9	5
North Martell's SE	498374	6623404	Autumn	29/03/2021	30/04/2021	Active	-	0	32
Tyson's NW	498685	6627459	Autumn	28/03/2021	30/04/2021	Flat	-	874	33
Tyson's SW	498629	6627430	Autumn	28/03/2021	30/04/2021	Flat	-	777	33
Tyson's NE	498718	6627410	Autumn	28/03/2021	30/04/2021	Active	-	38	33
Tyson's SE	498697	6627318	Autumn	28/03/2021	30/04/2021	Active	-	9	33

Site	Easting	Northing	Season	Install	Retrieval	Status	Date last vid	Pics	Days Active
Access G NW	497927	6626258	Autumn	28/03/2021	30/04/2021	Active	-	23	33
Access G SW	497900	6626205	Autumn	28/03/2021	30/04/2021	Flat	5/04/2021	4	8
Access G NE	497983	6626218	Autumn	28/03/2021	30/04/2021	Flat	11/04/2021	6	14
Access G SE	497962	6626183	Autumn	28/03/2021	30/04/2021	Active	-	0	33
Martell's bridge NW	NR	NR	Autumn	16/04/2021	14/05/2021	Active	-	101	28
Martell's bridge SW	NR	NR	Autumn	16/04/2021	14/05/2021	Active	-	26	28
Martell's bridge NE	NR	NR	Autumn	16/04/2021	14/05/2021	Active	-	32	28
Martell's bridge SE	NR	NR	Autumn	16/04/2021	14/05/2021	Active	-	14	28
							-		
Dalhousie NW	499667	6621992	Spring	17/08/2021	22/09/2021	Active	-	4622	36
Dalhousie SW	499678	6621921	Spring	17/08/2021	22/09/2021	Active	-	6	36
Dalhousie NE	499741	6622021	Spring	17/08/2021	22/09/2021	Flat	27/08/2021	9	10
Dalhousie SE	499776	6621970	Spring	17/08/2021	22/09/2021	Flat	18/08/2021	91	1
South Martell's NW	498535	6622868	Spring	17/08/2021	21/09/2021	Flat	-	0	0
South Martell's SW	498544	6622855	Spring	17/08/2021	21/09/2021	Active	-	107	35
South Martell's NE	498595	6622902	Spring	17/08/2021	21/09/2021	Active	-	81	35
South Martell's SE	498601	6622894	Spring	17/08/2021	21/09/2021	Active	-	13	35
Burke's NW	500278	6616806	Spring	17/08/2021	21/09/2021	Active	-	61	35
Burke's SW	500267	6616778	Spring	17/08/2021	21/09/2021	Active	-	247	35
Burke's NE	500351	6616837	Spring	17/08/2021	21/09/2021	Active	-	206	35
Burke's SE	500337	6616740	Spring	17/08/2021	21/09/2021	Active	-	128	35
North Martell's NW	498309	6623380	Spring	17/08/2021	21/09/2021	Flat	-	0	0
North Martell's SW	498324	6623341	Spring	17/08/2021	21/09/2021	Flat	-	0	0
North Martell's NE	498378	6623430	Spring	17/08/2021	21/09/2021	Active	-	223	35
North Martell's SE	498374	6623404	Spring	17/08/2021	21/09/2021	Flat	28/08/2021	481	11
Tyson's NW	498685	6627459	Spring	17/08/2021	21/09/2021	Active	-	893	35
Tyson's SW	498629	6627430	Spring	17/08/2021	21/09/2021	Active	-	274	35
Tyson's NE	498718	6627410	Spring	17/08/2021	21/09/2021	Active	-	383	35
Tyson's SE	498697	6627318	Spring	17/08/2021	21/09/2021	Flat	6/09/2021	7	20
Access G NW	497927	6626258	Spring	17/08/2021	22/09/2021	Active	-	10	36
Access G SW	497900	6626205	Spring	17/08/2021	22/09/2021	Flat	4/09/2021	6	18
Access G NE	497983	6626218	Spring	17/08/2021	22/09/2021	Active	-	0	36
Access G SE	497962	6626183	Spring	17/08/2021	22/09/2021	Flat	19/08/2021	5	2
Martell's bridge NW	NR	NR	Spring	17/08/2021	23/09/2021	Active	-	1	37
Martell's bridge SW	NR	NR	Spring	17/08/2021	23/09/2021	Active	-	4	37
Martell's bridge NE	NR	NR	Spring	17/08/2021	23/09/2021	Flat	28/08/2021	14	11
Martell's bridge SE	NR	NR	Spring	17/08/2021	23/09/2021	Active	-	11	37

Table B12: Exclusion fence image review data during year five monitoring at NH2U, 2021. TB = Towards Bush, TR = Towards Road, TU- Towards Underpass, AFU = Away from Underpass, NDM = No Directional Movement.

Site	Season	Side	Species	TB	TU	TF	AFU	NDM	Comments
Dalhousie	Autumn	NW	House mouse			8		2	Overall vegetation obscured view and cause numerous flase triggers
Dalhousie	Autumn	NW	Bandicoot spp.					1	
Dalhousie	Autumn	NW	Rodent spp.					2	
Dalhousie	Autumn	SE	Antechinus spp.		1				
Dalhousie	Autumn	SE	Black rat			1	1	1	
South Martells	Autumn	NW	Nil						
South Martells	Autumn	SW	Nil						
South Martells	Autumn	SE	Rodent spp.					1	
Burkes	Autumn	NW	Nil						
Burkes	Autumn	NE	Nil						
Burkes	Autumn	SE	Nil						
Burkes	Autumn	SW	Cat		1				
Burkes	Autumn	SW	Black rat			4			
Burkes	Autumn	SE	Nil						
Tysons	Autumn	NW	Nil						
Tysons	Autumn	NE	Australian brush turkey				1		
Tysons	Autumn	NE	Black rat			1	1	1	
Tysons	Autumn	NE	Rodent spp.			1			
Tysons	Autumn	NE	Fox					1	
Tysons	Autumn	SE	Rodent spp.			2			
Tysons	Autumn	SE	Black rat					1	
Tysons	Autumn	SE	Northern brown bandicoot		1				
Tysons	Autumn	SW	Rodent spp.		1				
Tysons	Autumn	NE	Swamp wallaby					1	
Tysons	Autumn	NE	Rodent spp.			1			
Martells Bridge	Autumn	NW	Swamp wallaby				1		
Martells Bridge	Autumn	NW	Dog				3		
Martells Bridge	Autumn	SW	Black rat			4			
Martells Bridge	Autumn	NE	Black rat			2		2	
Martells Bridge	Autumn	NE	Rodent spp.			1			
Martells Bridge	Autumn	SE	Rodent spp.				1		
Martells Bridge	Autumn	SE	Bandicoot spp.		2			1	
Martells Bridge	Autumn	SE	Black rat			3			
Access G	Autumn	SW	Black rat	1		6		1	
Access G	Autumn	SW	Black rat			1		1	
Access G	Autumn	NE	Black rat	1		1			
Access G	Autumn	SW	Cat		1				
Access G	Autumn		Fox		1				
Access G	Autumn	0	House mouse				1		
Access G	Autumn	SW	Nil						
Access G	Autumn	SW	Nil						
Access G	Autumn	NE	Nil						

Site	Season	Side	Species	TB	TU	TF	AFU	NDM	Comments
Access G	Autumn	SW	Nil						
Access G	Autumn	SE	Nil						
North Martells	Autumn	NW	Rodent spp.			1			
North Martells	Autumn	NW	Short-beaked echidna				1		
North Martells	Autumn	NW	Swamp wallaby	1	1		1		
Dalhousie	Spring	NW	Short-beaked echidna		1				
Dalhousie	Spring	NW	Rattus spp.			2			
Dalhousie	Spring	SW	Nil						
Dalhousie	Spring	NE	fox	1	1				
Dalhousie	Spring	NE	Rattus spp.			1			
Dalhousie	Spring	SE	Short-beaked echidna		1				
South Martells	Spring	NW	Nil						
South Martells	Spring	SW	Nil						
South Martells	Spring	NE	Australia brush turkey	1					
South Martells	Spring	NE	fox		1				
South Martells	Spring	NE	Rattus spp.				1		
South Martells	Spring	NE	Swamp wallaby	2	1		1	1	
South Martells	Spring	SE	Australia brush turkey		1		1		
South Martells	Spring	SE	Swamp wallaby	1					
South Martells	Spring	SE	Rattus spp.			1			
South Martells	Spring	SE	dog		1				
Burkes	Spring	NW	Nil						
Burkes	Spring	SW	Nil						
Burkes	Spring	NE	Rattus spp.				1		
Burkes	Spring	NE	Eastern water dragon	1	1			1	
Burkes	Spring	NE	Bandicoot spp.		1				
Burkes	Spring	SE	Rattus spp.			3			
North Martells	Spring	NW	Nil						
North Martells	Spring	SW	Nil						
North Martells	Spring	NE	Nil						
North Martells	Spring	SE	Rattus spp.			1			
Tysons	Spring	NW	fox	1					
Tysons	Spring	NW	Rattus spp.			1			
Tysons	Spring	NW	Short-eared brushtail possum		2				
Tysons	Spring	NW	Swamp wallaby		3				
Tysons	Spring	NW	Short-eared brushtail possum		1				
Tysons	Spring	SW	Swamp wallaby		2			1	
Tysons	Spring	SW	Rattus spp.	1					
Tysons	Spring	SW	Short-beaked echidna		1				
Tysons	Spring	SW	Northern brown bandicoot		1		1		
Tysons	Spring	NE	Bandicoot spp.	1	1		1		
Tysons	Spring	NE	Rattus spp.	1	1	1			
Tysons	Spring	SE	Rattus spp.			1			
Access G	Spring	NW	Short-beaked echidna		1		1		
Access G	Spring	NW	Rattus spp.			1			

Site	Season	Side	Species	TB	TU	TF	AFU	NDM	Comments
Access G	Spring	SW	Rattus spp.				1		
Access G	Spring	NE	Long-nosed bandicoot	1	1				
Access G	Spring	SE	Long-nosed bandicoot		1				
Martells Bridge	Spring	NW	nil						
Martells Bridge	Spring	SW	dog	1					
Martells Bridge	Spring	SW	Swamp wallaby					2	
Martells Bridge	Spring	NE	dog	1					
Martells Bridge	Spring	NE	Swamp wallaby				1		
Martells Bridge	Spring	NE	Rattus spp.			1			
Martells Bridge	Spring	SE	nil						

Table B13: Road-kill survey data recorded during year five monitoring at NH2U, 2021. RB Finch = red browed finch, TF = tawny frogmouth, SB = Southern boobook, Med = medium, UnID = Unidentified.

Table B14: Effort of vegetated median cameras during year five NH2U monitoring, 2021.

Cam	Easting	Northing	Install	Check	No. of Vids	Status	Battery	No. days active	Check	No. of Vids	Status	Battery	Date of last vid if flat	Collect	Status	Battery	No. vids	Date of last vid if flat	Active days	Total active days
TVM1	498624	6627381	29/3/21	11/5/21	56	A	95%	43	18/8/21	20	Active	95		26/11/21	active	80	46		100	242
TVM2	498588	6627297	29/3/21	11/5/21	26	A	95%	43	18/8/21	58	Active	95		26/11/21	active	95	29		100	242
TVM3	498340	6626988	29/3/21	11/5/21	11	A	95%	43	19/8/21	6	Active	95		26/11/21	active	75	44		99	242
TVM4	498305	6626882	29/3/21	11/5/21	30	A	95%	43	19/8/21	51	Active	95		26/11/21	active	95	17		99	242
DVM1	499673	6622011	30/3/21	11/5/21	23	A	95%	42	19/8/21	175	Flat	0	22/7/21	26/11/21	flat	0	14	27/09/2021	39	153
DVM2	499885	6621801	30/3/21	11/5/21	27	A	95%	42	19/8/21	901	Active	80		26/11/21	flat	0	32	1/11/2021	74	216
DVM3	500036	6621513	30/3/21	11/5/21	8	A	95%	42	18/8/21	667	Active	80		26/11/21	flat	0	5	5/09/2021	18	159
DVM4	500131	6621439	30/3/21	11/5/21	23	A	95%	42	18/8/21	35	Active	80		26/11/21	flat	0	142	24/09/2021	37	178

Table B15: Image review data of fauna detected using the vegetated medians during year five NH2U monitoring, 2021.

Median	Season	Camera	Species	No.visitations	Date	Image No's	Comments
Tysons	Autumn/winter	TVM1	Sugar glider	9	29/3/2021-18/8/2021		
Tysons	Autumn/winter	TVM1	Acrobates spp.	1	""		
Tysons	Autumn/winter	TVM1	Antechinus spp.	7	""		
Tysons	Autumn/winter	TVM2	Sugar glider	12	""		
Tysons	Autumn/winter	TVM2	Acrobates spp.	9	""		
Tysons	Autumn/winter	TVM2	Antechinus spp.	2	""		
Tysons	Autumn/winter	TVM3	Sugar glider	8	""		
Tysons	Autumn/winter	TVM3	Acrobates spp.	1	""		

Tysons	Autumn/winter	TVM4	Sugar glider	33	""		
Dalhousie	Autumn/winter	DVM1	Sugar glider	35	""		
Dalhousie	Autumn/winter	DVM1	Antechinus spp.	5	""		
Dalhousie	Autumn/winter	DVM2	Sugar glider	95	""		
Dalhousie	Autumn/winter	DVM2	Acrobates spp.	2	""		
Dalhousie	Autumn/winter	DVM2	Antechinus spp.	23	""		
Dalhousie	Autumn/winter	DVM3	Sugar glider	137	""		
Dalhousie	Autumn/winter	DVM3	Acrobates spp.	4	""		
Dalhousie	Autumn/winter	DVM3	Antechinus spp.	1	""		
Dalhousie	Autumn/winter	DVM4	Sugar glider	28			
Dalhousie	Autumn/winter	DVM4	Acrobates spp.	4			
Tysons	Spring	TVM1	Sugar glider	11	18/08/2021-26/11/2021		
Tysons	Spring	TVM1	Acrobates spp.	4	""		
Tysons	Spring	TVM1	Antechinus spp.	3	""		
Tysons	Spring	TVM2	Sugar glider	7	""		
Tysons	Spring	TVM2	Acrobates spp.	1	""		
Tysons	Spring	TVM2	Antechinus spp.	4	""		
Tysons	Spring	TVM3	Sugar glider	11	""		
Tysons	Spring	TVM3	Acrobates spp.	9	""		
Tysons	Spring	TVM4	Sugar glider	5	""		
Dalhousie	Spring	DVM1	Antechinus spp.	3	""		
Dalhousie	Spring	DVM2	Sugar glider	5	""		
Dalhousie	Spring	DVM2	Antechinus spp.	2	""		
Dalhousie	Spring	DVM3	Sugar glider	2	""		
Dalhousie	Spring	DVM3	Acrobates spp.	1	""		
Dalhousie	Spring	DVM3	Antechinus spp.	1	""		
Dalhousie	Spring	DVM4	Sugar glider	32	""		
Dalhousie	Spring	DVM4	Acrobates spp.	11	""		

Table B16: Site habitat assessment. Eucs = eucalypts, MoF = moist open forest, DoF = dry open forest, McF = moist closed forest.

Site	Side	Hab class	Dominant canopy spp.	Dominant sub canopy spp.	Dominant Ground cover	Comments	
McGraths	East	MOF	Flooded Gum, blackbutt, Pink Bloodwood, brushbox, Tallowwood	Vine spp, Rainforest spp, Bangalow palms, cheese tree	Gahnia spp, Cordyline spp, blady grass, Lantana, leaf litter		
	West		Pints radiata, blackbutt, Rainforest spp,	Vine spp, Rainforest spp, camphor laurel	Agricultural grasses, Lantana, bracken, pine needles		
Burke's	East	MOF/DOF	Blackbutt, Tallowwood, swamp Mahogany	Bamboo, emergent eucs, acacia spp, casuarina spp, cheese tree	Blady grass, lantana, scetaria, cordyline spp		
	West	DOF	Tallowwood, blackbutt, Flooded Gum, Grey Ironbark	Emergent eucs, acacia spp, casuarina spp, vine spp	Cordyline, blady grass		
South Martell's	East	MOF	Blackbutt, Flooded Gum, grey ironbark	Vine spp, emergent eucs, acacia spp, some Rainforest spp, casuarina spp	Cordyline, gahnia, blady grass, vine spp		
	West	MOF	Flooded Gum, Grey Ironbark, small fruited grey gum	Vine spp, emergent eucs, acacia spp, some Rainforest spp, casuarina spp	Cordyline, vine spp		
Tyson's	West	MOF	Swamp Mahogany, melaleuca quin,	Melaleuca spp, emergent eucs, acacia spp, cheese story	Cordyline, blady grass, gahnia		
	East	MCF/MOF	Flooded Gum, Grey Ironbark, turpentine,	Casuarina spp, emergent eucs, vine spp	Cordyline, gahnia, leaf litter		
Access G	West	MCF	Grey Ironbark, brushbox, small fruited grey gum,	Bangalow palms, Rainforest spp, vine spp	Cordyline spp, emergent Rainforest spp,		
	East	MCF	Grey Ironbark, flooded Gum,	Melaleuca spp, emergent eucs, casuarina spp	Cordyline spp, gahnia, leaf palms		
Dalhousie	West	DOF	Blackbutt, pink Bloodwood, Flooded Gum, turpentine	Casuarina spp, emergent eucs, vine spp, Rainforest spp	Various grasses, blady grass, leaf litter		
	East	MOF	Blackbutt, pink Bloodwood, Flooded Gum, turpentine	Casuarina spp, emergent eucs, vine spp, Rainforest spp	Various grasses, blady grass, gahnia spp, Cordyline spp, leaf litter, Acacia spp.		
North Martell's	West	MOF/DOF	Blackbutt, Red Mahogany	Melaleuca spp, emergent eucs, acacia spp	Cordyline, gahnia, small shrubs	Heavily logged, heavy regen	
	East	MOF/DOF	Blackbutt, Red Mahogany	Melaleuca spp, emergent eucs, acacia spp	Cordyline, gahnia, small shrubs	Heavily logged, heavy regen	
Martell's bridge	East	MOF	flooded gum. ironbark, pink blood wood	Calisatomen spp., melaleuca spp., rainforest spp. Acacia app.	Cordyline, lantana, gahnia		
	West	MOF	Pink Bloodwood, ironbark, turpentine	emergent rainforest spp, Casuarina spp., Acacia spp	blady grass, leaf litter		