# FOXGROUND AND BERRY BYPASS

## 2020 Post Construction Ecological, Aquatic, and Weed Monitoring Report

August 2021

**Project Number: 17-647**

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# DOCUMENT VERIFICATION

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| | | | | |

# TABLE OF CONTENTS

## FIGURES

## TABLE

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ANZECC | Australia and New Zealand Environment and Conservation |
| ARMCANZ 2000 | Agriculture and Resource Management Council of Australia and New Zealand 2000 |
| AUSRIVAS | Australian River Assessment System |
| Cwth | Commonwealth |
| CFFMP | Construction Flora and Fauna Management Plan |
| CoA | Conditions of Approval |
| DPI | Department of Primary Industries |
| DPIE | Department of Planning, Industry and Environment |
| EcMP | Ecological Monitoring Program |
| EA | Environmental Assessment |
| EEC | Endangered ecological community – as defined under relevant law applying to the proposal |
| TfNSW | Transport for New South Wales |
| GGBF | Green and Golden Bell Frog |
| ha | Hectares |
| km | Kilometres |
| m | Metres |
| NSW | New South Wales |
| RMS | Roads and Maritime |
| OEH | (NSW) Office of Environment and Heritage, formerly Department of Environment, Climate Change and Water |
| SoC | Statement of Commitments |
| sp/spp | Species/multiple species |

# EXECUTIVE SUMMARY

This document provides a summary of data collected as part of the Foxground and Berry Bypass Post Construction Ecological, Aquatic and Weed Monitoring Report throughout the 2020 calendar year. In addition, this final monitoring report provides a comparison of data over the three year post construction monitoring period from 2018- 2020, and the preconstruction data. Transport for New South Wales (TfNSW) (formerly Roads and Maritime Services) upgraded 12.5 km of the Princes Highway between Toolijooa Road north of Foxground, to Schofields Lane (the Foxground and Berry Bypass Project), and between Croziers Lane south of Berry (the Southern Extension). The three phases of this project in relation to biodiversity monitoring were pre-construction (2014-2015), construction (2016-2017) and operation (2018 to present). The elements of the Ecological Monitoring Program (EcMP) Parsons Brinkerhoff (PB) (2014) are outlined in the methods section of this document.

This report has been designed to provide quantitative information on post construction ecological monitoring at the Foxground and Berry Bypass across three types of monitoring programs and to compare to the requirements of the EcMP (PB 2014). Comparisons of captured data will be made with (baseline) preconstruction periods.

TfNSW contracted NGH to provide post-construction ecological services (2018-2020) with specific aims to provide monitoring programs and performance criteria comparisons for:

- Ecological monitoring (roadkill surveys, diurnal and nocturnal transect surveys (tracks, scats and signs, call playback) and automated camera detection).
- Aquatic monitoring (habitat assessments, water quality monitoring, macrophyte and emergent vegetation assessments, macroinvertebrate surveys and fish assessments).
- Nest box monitoring (bi-annual monitoring for a minimum 3-year period post construction)
- Weed monitoring (annual monitoring for a minimum of 3-year period)
- Review of mitigation measure and recommendations

Descriptive statistics of monitoring parameters were compared in accordance with Section 6.2 of the EcMP (PB 2014), annual reporting were completed for all monitoring surveys outlined in the EcMP. This includes monitoring during the pre-construction, construction and post-construction periods. The Baseline Ecological Monitoring Results Report (PB 2015) has been used to compare pre-construction monitoring results with post-construction monitoring results. Each monitoring program used performance criteria comparison to ensure EcMP objectives were met.

**Ecological Monitoring**

To date, ecological surveys have shown species diversity and abundance is higher across all post construction monitoring. Limitations of camera surveys were observed as the placement of cameras during the pre-construction phase was quite different, as no crossing structures were present at the time of initial monitoring. As such, some terrestrial species were recorded in initial monitoring which would not be recorded during post-construction monitoring of structures such as rope bridges. Performance criteria for ecological monitoring exceeded targets in five of the seven objectives. Furthermore, roadkill rates were similar or lower than pre-construction rates on the existing highway during the life of the monitoring program.

## Aquatic Monitoring

Aquatic monitoring habitat assessments demonstrated changes in substrate during monitoring surveys. 'Cobble' displayed the greatest substrate change with increased cover at the treatment sites during monitoring, whilst other substrates had little change and variability. Control sites displayed variation during each year of monitoring for 'Bedrock', while 'Pebble' had a sharp increase in the final year of monitoring. When compared to pre-construction data, there has been a downward trend of algae at all control sites and treatment sites.

Water quality varies across sites between surveys by more than 10% in some years. As such, the comparison of pre and post construction values may not be informative about the relative impact of the project, as the quality values of the whole waterway may change by more than 10% in any given season. The comparison to control sites allows for comparison upstream and downstream of the project, and it is suggested that this measure is more informative about the impacts of the project than comparison with conditions over time. The performance criteria and performance target in this case vary. The performance target should not solely be used as a guideline on the overall water quality assessment of the project. Rather, it should additionally include the comparison between control and treatment site data. This comparison would assess whether trends are consistent between treatment and control sites. We could suggest that although downstream treatment sites have decreased in water quality, if this is similarly seen in upstream control sites, disturbance would not be a result of the bypass' construction and use. The treatment sites are highly disturbed as a result of surrounding land uses. The water quality values at all the sites generally fell outside the ANZECC/ARMCANZ Guideline levels (ANZECC 2000) for disturbed aquatic ecosystems. This occurred during both preconstruction surveys and during construction and is therefore likely a reflection of the agricultural land uses in the catchment rather than the bypass' construction.

Performance targets for emergent vegetation and macrophyte dieback displayed by overall abundance was similar across survey years on all sites. Some sites experience some dieback with some species disappearing and reappearing and/or other species appearing. This could be due to natural temporal variations due to Winter surveys conducted in 2020 and not Autumn compared to previous years. Macroinvertebrate performance targets displayed signal scores and average number of taxa passed in all sites, only one site received a 'fail' score in EPT. Post construction native fish surveys found a decline in species diversity and abundance. Changes to the methodology by elimination fykes nets is cited as the likely possibility in declining survey numbers.

## Nest Box monitoring

Nest box monitoring results varied over the monitoring program surveys. Only one of the eight new nest boxes constructed from existing hollows had evidence of microbat use. Although this only translates to a low occupancy rate, the nest boxes were only recently installed and occupancy in the boxes may still increase over time as studies have shown further time is required for native fauna occupancy to occur. Having success early on is a good indication of the suitable habitat that has been provided.

## Weed monitoring

Weed management surveys display a trend of increasing weed species diversity during each yearly survey. Areas with prevalent weed cover continue to be highly disturbed with varying success of regeneration and revegetation. Mid storey species in most areas have successfully been established, however grass and herbaceous weeds continue to colonise most areas. Fireweed remains the most prevalent weed issue across the project alignment. Despite a small decline in

distribution and abundance, it is widespread throughout the alignment. Fireweed is a Priority Weed for the South-east region under the Biosecurity Act.

Review of the ecological mitigation measures suggest further action towards addressing exotic fauna species and implementing additional shelter structures are required to improve the decline of native reptile species. Variability with water quality monitoring will continue due to other terrestrial activities and runoff within proximity to the stream catchment. Increasing native revegetation efforts will provide shelter and habitat for native fauna and reduce the space for invasive weed species to establish and dominate ground cover.

# 1. INTRODUCTION

Transport for New South Wales (TfNSW) (formerly Roads and Maritime Services) upgraded 12.5 km of the Princes Highway between Toolijooa Road north of Foxground, to Schofields Lane (the Foxground and Berry Bypass Project), and between Croziers Lane south of Berry (the Southern Extension) (Figure 1-1). The three phases of this project in relation to biodiversity monitoring were pre-construction (2014-2015), construction (2016-2017) and operation (2018 to present).

TfNSW have contracted NGH to provide post-construction ecological services (2018-2020), with the scope of engagement including the following:

- nest box monitoring
- aquatic monitoring
- weed monitoring
- ecological monitoring
- specialist advice on ecological matters as required by TfNSW.

## 1.1. PURPOSE OF THE REPORT

The purpose of this report is to present monitoring data collected as part of the Foxground and Berry Bypass Post construction Monitoring throughout the 2020 calendar year. In addition, this final monitoring report provides a comparison of data over the three year post construction monitoring period from 2018- 2020, and the preconstruction data. The monitoring programs delivered in 2020 include:

- ecological monitoring (diurnal and nocturnal transect surveys, tracks, scats and signs, call playback, and camera surveys)
- aquatic monitoring (four 2020 surveys; two in Autumn, two in Spring)
- weed monitoring.

The annual report includes the following information:

- **Introduction** – background description and aims of the monitoring (this chapter)
- **Methodology** – description of methodology undertaken including personnel, project location and specific survey site locations for ecological, aquatic, and weed monitoring (refer to Section 2)
- **Results -** monitoring results (refer to Section 3)
- **Discussion** –comparison of results to performance indicators (refer to Section 4)
- **Review of mitigation measures** –the effectiveness of each mitigation measure will be reviewed (where appropriate) at the end of the monitoring period (refer to Section 5)
- **Recommendations** – suggestion of adaptive responses and contingency measures potentially required (where appropriate) based on the results of the monitoring session such as the implementation of contingency measures or modification of monitoring timing, frequency or methodology (refer to Section 6).

This report presents the third year of post-construction monitoring data (2020).


Figure 1-1 Location of the Foxground and Berry Bypass Project Map 1 of 4

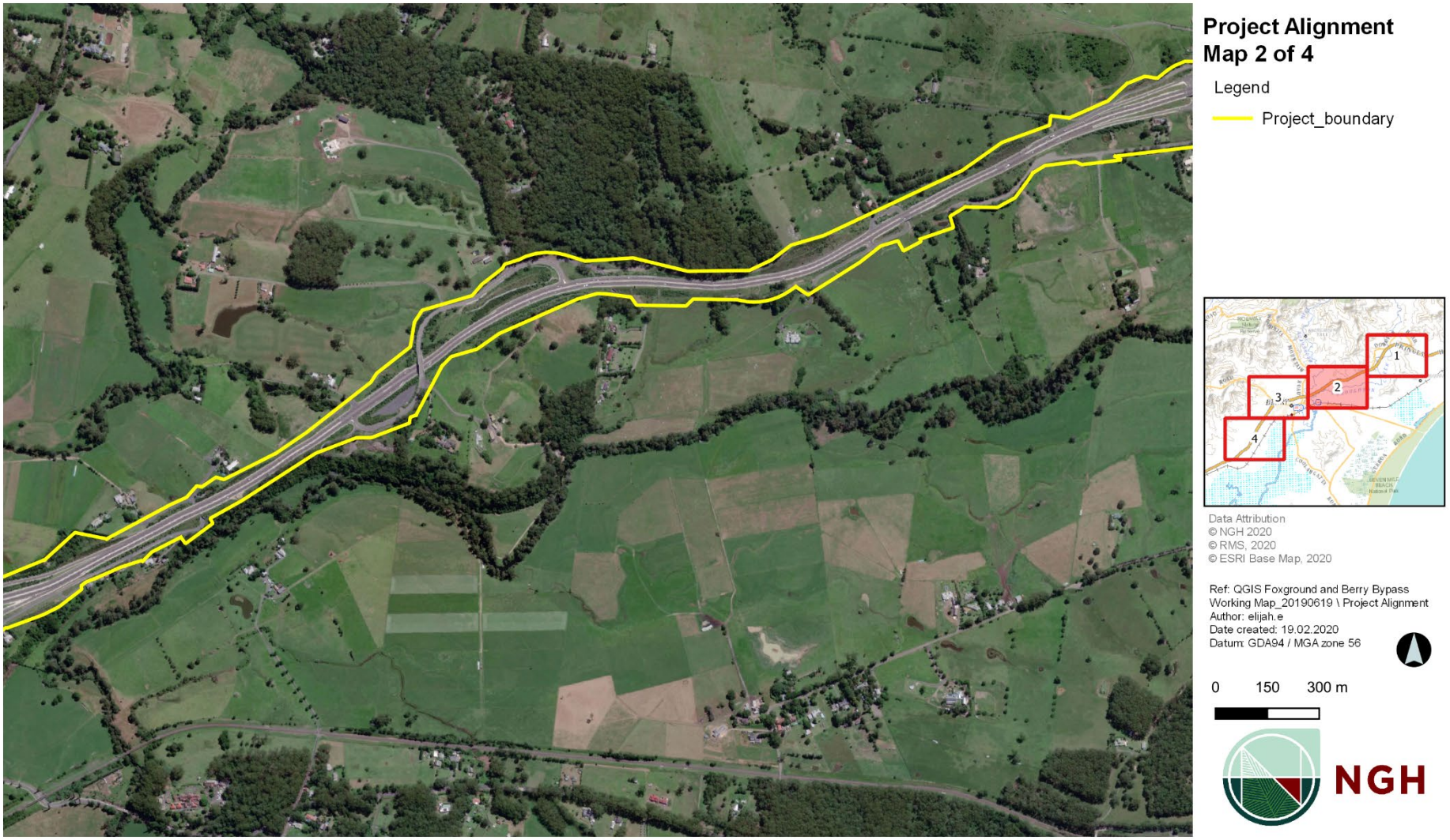


Figure 1-2 Location of the Foxground and Berry Bypass Project Map 2 of 4


Figure 1-3 Location of the Foxground and Berry Bypass Project Map 3 of 4


Figure 1-4 Location of the Foxground and Berry Bypass Project Map 4 of 4

### 1.1.1. Ecological Monitoring Requirements

Requirements for ecological monitoring during the post-construction period are outlined in the following documents:

- Minister's Condition of Approval (CoA) B9 whereby TfNSW are required to develop an Ecological Monitoring Program to monitor the effectiveness of the biodiversity mitigation measures implemented as part of the project.
- Roads and Maritime (RMS) and TfNSW Statement of Commitments (SoC)
- Construction Flora and Fauna Management Plan sub-plan (CFFMP) (Roads and Maritime 2014)
- Ecological Monitoring Program (EcMP) (PB 2014)
- The mitigation measures listed in the Foxground and Berry Bypass Environmental Assessment (EA) (AECOM 2012).

The CFFMP (Roads and Maritime 2014) and EcMP (PB 2014) prepared for the Project detail the actions that need to be taken to meet those requirements (see Table 1-1). Table 1-1 also cross references where each of these items is addressed in this report.

In accordance with Section 6.2 of the EcMP (PB 2014), annual reporting was completed for all monitoring surveys outlined in the EcMP. This includes monitoring during the pre-construction, construction and post-construction periods. The Baseline Ecological Monitoring Results Report (PB 2015) were to compare pre-construction monitoring results with post-construction monitoring results.

This present document represents the annual report for 2020.

Table 1-1 Conditions relevant to ecological monitoring requirements during the post-construction period

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| **Minister of Planning and Infrastructure - Conditions of Approval** | | | | |
| A1 | The proponent shall carry out the project generally in accordance with the: Major Project Application MP10_0240.<br><br>Princess Highway upgrade – Foxground and Berry bypass – Environmental Assessment (Volumes 1-2), prepared by AECOM Australia Pty Ltd for Roads and Maritime Services and dated November 2012<br><br>Princess Highway upgrade – Foxground and Berry bypass – Submissions Report, prepared by AECOM Australia Pty Ltd for Roads and Maritime Services and dated May 2013, including the revised Statement of Commitments contained therein Conditions of Approval | Discussed below | EcMP prepared in accordance with the documents outlined in A1 where applicable | EcMP - Section 1.1 |
| B9 | The proponent shall develop an **Ecological Monitoring Program** to monitor the effectiveness of the biodiversity mitigation measures implemented as part of the project. The program shall be developed by a suitably qualified and experienced ecologist in consultation with the OEH and DPI (Fishing and Aquaculture) and shall include but not necessarily be limited to: | Aspects of the EcMP are likely to be modified if changes in habitat usage are detected | The Ecological Monitoring Program (EcMP) was developed by a qualified and experienced ecologists and in consultation with OEH and DPI (Fishing and Aquaculture) | The EcMP |
| | (a) An adaptive monitoring program to assess the effectiveness of the mitigation measures identified in conditions B3 and B36 (b) and shall amendment to the measures as necessary. The monitoring program shall nominate performance parameters and criteria against which effectiveness of fauna crossings and exclusion fencing implemented as part of the project | - | An adaptive EcMP was prepared to monitor the effectiveness of the biodiversity mitigation measures in accordance with the conditions and commitments of the project. | EcMP - Sections 3, 4, 5 and 6<br>This report |
| | (b) Mechanisms for developing additional monitoring protocols to assess the effectiveness of any additional mitigation measures implemented to address additional impacts in the case of design amendments or unexpected threatened species finds during construction (where these additional impacts are generally consistent with the biodiversity impacts identified in the Project in the documents listed under Condition A1) | - | The EcMP provides monitoring methodologies, performance parameters, potential contingency measures and reporting requirements of the Project | EcMP - Sections 3, 4, 5 and 6<br>This report |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | (c) Monitoring shall be undertaken during construction (for construction-related impacts) and from opening of the project to traffic (for operation/ongoing impacts) until such time as the effectiveness of the mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods after opening of the project to traffic, unless otherwise agreed by the Director General. The monitoring period may be reduced with the agreement of the Director General in consultation with the OEH and DPI (Fishing and Aquaculture), depending on the outcomes of the monitoring | - | Monitoring to be undertaken pre- construction, during construction and post-construction as specified in this condition | EcMP - Sections 3, 4, 5 and 6<br><br>This report |
| | (d) Provision for the assessment of data to identify changes to habitat usage and whether this can be directly attributed to the project | - | The EcMP outlines data collection and assessment processes | EcMP - Sections 3, 4, 5 and 6 |
| | (e) Details of contingency measures that would be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the project | - | Contingency measures are outlined in the EcMP | EcMP - Section 5 |
| | (f) Provision for annual reporting of monitoring results to the Director General and the OEH and DPI (Fishing and Aquaculture), or as otherwise agreed by those agencies | - | This report is the second post-construction annual report of results that will be sent to the Director General and OEH and DPI (Fishing and Aquaculture) | EcMP - Section 6<br><br>This report |
| | The program shall be submitted to the Director General for approval no later than 6 weeks prior to the commencement of construction that would result in the disturbance of native vegetation (unless otherwise agreed by the Director General) | - | The EcMP program was submitted to the Director General over 6 weeks prior to commencement of construction resulting in disturbance of native vegetation | Not applicable. |
| B36 (b) | A **Construction Flora and Fauna Management Sub-plan (CFFMP)** to detail how construction impacts on ecology will be minimised and managed. The sub-plan shall be developed in consultation with the OEH and DPI (Fishing and Aquaculture) and shall include, but not necessarily be limited to | - | A separate CFFMP was prepared to address and manage the impacts of construction for the Project. The EcMP outlines monitoring requirements for the aspects specified below | EcMP - Section 2 |
| | Detail of pre-construction surveys undertaken by a suitably qualified and experienced ecologist to verify the construction boundaries/footprint of the project based on detailed design and to confirm the vegetation to be cleared as part of the project (including hollow, threatened flora and fauna species and riparian vegetation) | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | Updated sensitive area/vegetation maps based on (i) above and previous survey work | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| | Details of general work practices and mitigation measures to be implemented during construction to minimise impacts on native fauna and native vegetation (particularly threatened species and EECs) not proposed to be cleared as part of the project, including, but not necessarily limited to: fencing of sensitive areas, a protocol for the removal and relocation of fauna during clearing, engagement of a suitably qualified and experiences ecologist to identify locations where they would be present to oversee clearing activities and facilitate fauna recues and re-location, clearing timing with consideration to breeding periods, measures for maintaining existing habitat features (such as bush rock and tree branches etc.), seed harvesting and appropriate topsoil management construction worker education, weed management (including controls to prevent the introduction or spread of *Phytophthora cinnamomi*), erosion and sediment control and progressive re-vegetation | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| | Specific procedures to deal with EEC/threatened species anticipated to be encountered within the project corridor including re-location, translocation and/or management and protection measures | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| | A procedure for dealing with unexpected EEC/threatened species identified during construction including cessation of work and notification of the OEH, determination of appropriate mitigation measures in consultation with the OEH (including relevant re-location measures) and update of ecological monitoring and/or biodiversity offset requirements consistent with conditions B7 and B8 | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| **Revised Statement of Commitments – from within the Submissions Report** | | | | |
| **Manage impacts on flora and fauna** | | | | |
| BD2 | Pre-clearing fauna surveys, clearing procedures, including staged clearing where there are hollow trees, and methods to control noxious and environmental weeds and pests will be developed and implemented prior to clearing activities, in | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | consultation with a suitably qualified and experienced ecologist | | | |
| BD3 | Natural and artificial habitat features, such as bat roost and nest boxes, will be installed to replace hollow-bearing trees that are removed | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| BD4 | A fauna monitoring program will be developed in consultation with OEH. This program will allow the assessment of the effectiveness of fauna mitigation measures including nest boxes, bat roost boxes, fauna underpasses, rope bridges and fauna fencing | - | The EcMP addresses the fauna monitoring requirements of the project such that effectiveness of the mitigation measures can be assessed. It has been prepared in consultation with OEH and DPI (Fishing and Aquaculture) | EcMP - Section 3 |
| **Foxground and Berry Bypass Submissions Report Sections** | | | | |
| Section 2.10 (Page 152) | Vegetation clearing would be restricted to those areas where it is necessary and opportunities to minimise clearing would be considered during detailed design with a particular focus on retention of habitat trees. During construction, retained vegetation such as individual trees, stands of trees or patches of native vegetation would be fenced with highly visible temporary fencing. This would be undertaken in accordance with 'Guide 2 Exclusion zones' of Roads and Maritime' Biodiversity Guidelines: Protecting and managing biodiversity on Roads and Maritime projects (RTA 2011) | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| | The ancillary areas assessment methodology is detailed in Section 2.7 (pages F22 to F23) of Appendix F - Technical paper: Terrestrial Flora and Fauna to the environmental assessment. The assessment criteria for terrestrial biodiversity aim to identify ancillary areas where there would be:<br>n no substantial vegetation clearing (unless required for project alignment)<br>n low conservation significance for flora and fauna<br>n no removal of EECs, threatened species or threatened fauna habitat (unless required for project alignment) | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring. Ancillary sites are not expected to require any monitoring as they have been located in areas of low environmental significance, as per the requirements of the EA. Where any ancillary sites are located within the project footprint, and require staged vegetation removal, the monitoring and reporting proposed for all clearing as part of the project would apply. This is addressed in the first row of Table 3.2 in the EcMP | EcMP - Section 2 |
| | In addition no physical disturbance would occur outside the boundaries of the proposed ancillary sites. In accordance with 'Guide 2 – Exclusion Zones' (RTA 2011), buffers and temporary fencing would be installed to mark 'no-go' areas if ancillary sites | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | are located directly adjacent to EECs or areas of medium-high conservation significance. According to the ancillary facility assessment criteria, the definition of medium-high conservation significance includes:<br>n an area with native vegetation which may be EEC or not<br>n threatened (or migratory) flora or fauna records/occurrences<br>n moderate to good potential habitat for threatened (or migratory) species including intact soil profile, intact structural layers, mature fruiting trees, hollow- bearing trees and fallen woody debris in water source. | | | |
| | Further to the safeguards highlighted above, refinements may be made to the design features and construction methods to further minimise vegetation clearing during the detailed design phase of the project | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| | As detailed above, a vegetation management plan would be prepared to guide revegetation and restoration works. The vegetation management plan would be prepared in consultation with local Landcare groups, the Southern Rivers CMA and affected land owners and would consider the opportunities and constraints surrounding ownership and continuing management of specific parcels of land | - | Refer to separate Vegetation Management Plan for the project | Not Applicable |
| Section 2.10 (Page 154) | Mitigation measures such as fauna fencing, fauna underpasses and rope bridges have been located in areas with the greatest potential for impact based on existing constraints, movement patterns and fauna habitat utilisation (in areas with remnant vegetation). Some of these include: | Baseline monitoring limited to spring / summer. Post-construction monitoring methodology may require modification if any significant changes in habitat usage are detected | This EcMP addresses the fauna monitoring requirements of the project such that effectiveness of the mitigation measures can be assessed. | EcMP - Section 2 and Section 3<br><br>This report – Section 2.4 |
| | In areas along Broughton Mill Creek identified as potential dispersal habitat for the Green and Golden Bell Frog (*Litoria aurea*), a frog-proof fence would also be provided to encourage movement of this species beneath the bridge | - | EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 and Section 3<br>This report – not applicable |
| | Rope bridges would be provided to facilitate movement of arboreal mammals. Use of barbed wire in the vicinity of rope bridges and associated structures is not recommended due to the potential for gliders to become caught and killed in barbed | - | EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 and Section 3<br>This report |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | wire fences | | | |
| | Fauna fencing would be provided to avoid or minimise impacts to and improve the safety of native fauna by guiding fauna to crossing points. The current concept design generally includes wire rope safety barriers, except in locations were space is constrained (such as bridges) where concrete barriers would be required. In these locations, Roads and Maritime would use Type F concrete barriers to allow for movement of small mammals, amphibians and reptiles across these areas. Fauna fencing for the project would consist of a 1.8 metre high chain link fence. | - | EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 and Section 3 |
| | Farm boundary fencing will be provided in some areas. Roads and Maritime would encourage the use of fauna-friendly fencing design when fencing farm boundaries along the road corridor. The type of fencing used would be subject to agreements with landholders. In open agricultural land between areas of remnant vegetation the potential for small native mammals to occur is limited. Therefore, installing fauna fencing in these areas is not considered to be warranted | - | EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 and Section 3 |
| | Monitoring of fauna – vehicle collisions would be undertaken during the operation phase of the Project If road kill becomes an issue during the operational phase of the project additional fencing of these locations would be considered | - | The EcMP includes specific road kill monitoring requirements for the Project | EcMP - Section 2 and Section 3<br>This report – Section 2.3, 3.1 and 4.1 |
| Section 2.10 (Page 155) | In summary Roads and Maritime Biodiversity Guidelines (Guide 6 Weed management) outlines the requirements for management of terrestrial and aquatic environmental and noxious weeds during construction and suggests best practice methods for weed management during maintenance works. In addition to implementing the management practices recommended in Roads and Maritime' Biodiversity Guidelines: Protecting and managing biodiversity on Roads and Maritime projects (RTA, 2011), the following mitigation measure would be implemented:<br>• Control drainage that may contain weed seeds or high levels of nutrients.<br>• Use weed-free topsoil in landscaping and re-vegetate disturbed sites with locally indigenous species (local provenance). | - | The EcMP refers to the Weed Management Strategy in the CFFMP. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2.4, Section 3<br>See Weed Monitoring Reports (NGH) |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | • Monitor and control weed populations that establish in disturbed areas, with particular attention to eradication of noxious weeds. Weed invasions would be monitored and controlled by a person experienced in weed management.<br>• Incorporate weed management strategies into the vegetation management plan, detailing necessary weed control works, particularly in areas where the weeds may impact on threatened species and/or their habitats. | | | |
| **Environment Assessment Report – Biodiversity mitigation and management measures** | | | | |
| **Pre-construction** | | | | |
| General construction impacts on flora and | Conduct a hollow-bearing tree/stag watch survey prior to construction. Undertake stag-watching to identify the number and type of nest boxes required and where to install them. The optimal season for stag-watching is spring; a hollow-bearing tree/stag survey however, can be conducted any time of year | - | EcMP outlines methodology for undertaking hollow bearing tree and stag watching survey within full extent of the project. | EcMP - Sections 3, 4, 5 and 6 |
| Fauna | Install bat roost and nest boxes at a ratio of 1:1 for each hollow removed by the project | - | EcMP outlines surveys that would inform the number of bat roosts and nest boxes required to be installed at a 1:1 ratio for each hollow that will be removed. Nest box installation and management also discussed in accordance with Roads and Maritime Biodiversity Guidelines | EcMP - Sections 3, 4, 5 and 6<br>See Nest Box Monitoring Reports (NGH) |
| | Installation of bat roost and nest boxes would take place at least one month prior to the commencement of construction | - | EcMP outlines surveys that would inform the number of bat roosts and nest boxes required to be installed at a 1:1 ratio for each hollow that will be removed. Nest box installation and management also discussed in accordance with Roads and Maritime Biodiversity Guidelines | EcMP - Sections 3, 4, 5 and 6 |
| | Install nest boxes in accordance with Roads and Maritime 'Biodiversity Guidelines: Guide 8 – Nest Boxes' (RTA 2011) | - | EcMP outlines methodology for surveys of bridges and culverts to detect roosting microbats. Refers to the need of a Bat Management Plan if bats are detected during surveys | EcMP - Sections 3, 4, 5 and 6<br>See Nest Box Monitoring Reports (NGH) |
| | Prior to construction, conduct a survey of any bridges or culverts scheduled for removal in order to detect roosting microbats. If detected, prepare and implement a Bat Management Plan | - | EcMP outlines methodology for surveys of bridges and culverts to detect roosting microbats. Refers to the need of a Bat Management Plan if bats are | EcMP - Sections 3, 4, 5 and 6 |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | | | detected during surveys | |
| **Construction** | | | | |
| Mortality of individuals | Ensure that vegetation clearance complies with Roads and Maritime Biodiversity Guidelines: Guide 4 - Clearing of vegetation and removal of bushrock (RTA, 2011) | | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| **Monitoring - Monitoring impacts during pre-construction, construction and operational phases** | | | | |
| | Prepare pre-construction, construction and operational monitoring programs which would use the 'Before and After at Control and Impact sites' approach and set out the type and frequency of monitoring to be carried out, allocate responsibilities and monitoring parameters where relevant | Data likely to be highly qualitative therefore data analysis will be conducted where possible. Baseline monitoring limited to spring/ summer only | EcMP outlines the developed ecological monitoring program. A 'Before and After at Control and impact sites' (BACI) approach is not to be strictly applied, as outlined in Section 3. The type and frequency of monitoring, and monitoring parameters are also provided | EcMP - Section 3 and Section 4<br>This report |
| | Ensure a qualified ecologist is present for staged habitat removal in accordance with the Roads and Maritime' Biodiversity Guidelines (RTA 2011) and fauna rescue/relocation | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2 |
| | Undertake monitoring of edge effects and weed management measures as outlined in the Flora and Fauna Management Plan | - | Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring | EcMP - Section 2.4, Section 3<br>See Weed Monitoring Reports (NGH) |
| | Undertake bi-annual monitoring of nest boxes and bat roost boxes by a qualified and licensed ecologist during construction and annual monitoring for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring after the completion of three years monitoring | - | EcMP outlines a 3-year bi-annual monitoring program for nest boxes. | EcMP - Section 2.1. Section 2.3, Section 3 and Section 4<br>See Nest Box Monitoring Reports (NGH) |
| | Undertake bi-annual monitoring of dedicated fauna underpasses and rope bridges (using equipment such as remote cameras) by a qualified and licensed ecologist for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring for a further two years in the event a negative impact on species is detected | Baseline monitoring limited to spring only as a result of time restrictions<br>Due to inadequate planning for remote camera installation, post-construction monitoring | EcMP outlines a 3-year bi-annual monitoring program.<br>Discussions with Roads and Maritime confirmed that only annual monitoring would be required. | EcMP - Section 2.2, Section 3 and Section 4<br>This report – Sections 2.4, 3.2 and 4.2 |

| ID | Condition | Limitations | Fulfilment of commitments | Reference |
|---|---|---|---|---|
| | | was delayed until Spring 2018. | | |
| | Conduct road kill monitoring during operation of the project over a 12 month period at weekly intervals. The monitoring would include a record of the species (if possible) and the GPS location. The local council road cleansing teams or Wildlife Rescue South Coast may be contracted to undertake the monitoring or alternatively Roads and Maritime Southern Region would undertake the monitoring | Additional baseline monitoring will be limited to the number of weeks remaining until construction in approximately January 2015 | EcMP outlines the weekly road kill monitoring methodology. This has included pre-construction road kill monitoring on the existing Princes Highway section.<br>Weekly monitoring during the post-construction phase was completed by NGH for 52 weeks | EcMP - Section 3 and Section 4<br>This report – Section 2.1, 3.1 and 4.1 |
| | Conduct aquatic ecology monitoring during the pre-construction, construction and operational periods of the project in accordance with the aquatic ecology monitoring program outlined in Appendix G of the Aquatic Ecology and Water Quality Management Technical Paper provided at Appendix G of this environmental assessment. Sampling would be undertaken during Spring and Autumn, with the monitoring to continue for a minimum of one year after the project is opened to traffic. Monitoring locations would include the created diversion channel between Town Creek and Bundewallah Creek in order to provide an indication of the successful establishment of a natural creek ecosystem | Baseline monitoring limited to spring/ summer only as a result of time restrictions | EcMP outlines aquatic ecology monitoring program in accordance with the program outlined in the Environmental Assessment. Aquatic ecology monitoring to occur downstream of impact areas, with reference to upstream water quality monitoring results also to be provided | EcMP - Section 2.5, Section 3 and Section 4.<br>See Aquatic Monitoring Reports (NGH) |
| | In accordance with the aquatic ecology monitoring program, periodically review and evaluate the results of the monitoring to identify improvements to existing mitigation measures or maintenance regimes. Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity | - | EcMP outlines the requirement of periodic review of aquatic monitoring and the use of results to address unforeseen impacts on biodiversity, including consideration for the potential of additional mitigation requirements | EcMP - Section 2.5, Section 3 and Section 4.<br>See Aquatic Monitoring Reports (NGH) |
| | Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity | General responses to address unforeseen impacts provided only | EcMP outlines an adaptive ecological monitoring program, result assessment and recommends performance criteria and potential contingency measures to address unforeseen impacts on biodiversity | EcMP - Section 3 and Section 4 |

### 1.1.2. Aquatic Monitoring Requirements

A number of specific requirements regarding aquatic monitoring during the post-construction period are outlined in the following documents:

- Minister's CoA
- The TfNSW SoC
- CFFMP (Fulton Hogan, 2014)
- EcMP (PB 2014).

In accordance with Section 6.2 of the EcMP (PB 2014), annual reporting was completed for all monitoring surveys outlined in the EcMP. This includes aquatic monitoring post-construction.

The EcMP requires that the following aquatic monitoring be undertaken post construction:

Table 1-2 Aquatic monitoring requirements as stated in the EcMP

| Monitoring method | Data to be collected |
|---|---|
| **Habitat assessments** – at each creek to determine the suitability of the site to support listed species and based on AUSRIVAS protocols. | Identify habitat variables such as benthic substrate, water depth and vegetation/water % coverage (including shading). |
| **Water quality** – will be measured with a handheld multiparameter water quality meter at each site undertaken in accordance with the appropriate guidelines (AS/NZS 6557.1:1998, AS/NZS 5667.6:1998 and Australian Guidelines for Water Quality Monitoring and Reporting (2000). | pH, turbidity (NTU), conductivity (mS/cm), temperature (°C) and dissolved oxygen (% saturation and mg/L). |
| **Macrophyte and emergent vegetation –** will be identified and mapped at each site. Species abundance will also be quantitatively surveyed using five metre wide 25 m long transects. | Species identified, mapping and species abundance. |
| **Macroinvertebrates** – at each site following the AUSRIVAS protocols for NSW. | Macroinvertebrates would be sampled and identified to family species level and enumerated. |
| **Fish assessment** - at each site a single wing fyke net (12mm or 20mm) and six bait traps would be deployed and set to ensure a diversity of structural habitats are surveys where possible. Mesh seine nets (5-6mm bar) can also be used. | Fish would be identified to species, enumerated, weighed and measured. |

### 1.1.3. Nest Box Monitoring Requirements

A number of requirements regarding the installation and monitoring of nest boxes during the construction and operational period are outlined in the following documents:

- Minister's CoA
- TfNSW SoC
- CFFMP (Roads and Maritime 2014)
- The mitigation measures listed in the Foxground and Berry Bypass Environmental Assessment (EA) (AECOM, 2012)
- Foxground and Berry Bypass Princes Highway Upgrade Nest Box Management Plan (NBMP) (PB, 2014)
- EcMP (PB 2014).

The NBMP includes a three-year bi-annual monitoring program (this report).

In accordance with Section 6.2 of the EcMP (PB 2014), annual reporting was completed for all monitoring surveys outlined in the EcMP. This includes nest box monitoring during the construction and post-construction periods.

Table 1-3 Nest box monitoring requirements as stated in the EcMP

| Timing and frequency | Monitoring method | Data to be collected | Reporting |
|---|---|---|---|
| Monitoring on all nest boxes at least once during the construction phase and following construction in accordance with the NBMP and CFFMP. | A visual inspection of each nest box would be conducted.<br>ECMP outlines a 3 year bi annual monitoring program. NBMP (PB 2014) outlines monitoring will occur annually for 3 years post construction in addition to relevant monitoring requirements. | On visual inspection of the nest boxes the following data would be collected:<br>• Date of inspection<br>• Weather conditions<br>• Nest box ID<br>• Nest box type<br>• Nest box height and orientation<br>• Presence/absence of occupation<br>• If occupied, the species, age (juvenile/adult), number of individuals and whether it is native/feral.<br>• Signs of use if not occupied<br>• Condition of nest box and whether maintenance is required<br>• Changes in surrounding habitat | Results included in Annual Monitoring Report (this report) |

Annual nest box monitoring reports (NBMR) were prepared by NGH on behalf of Fulton Hogan in accordance with the EcMP and NBMP for the project during construction for the 2015, 2016 and 2017 monitoring periods (NGH 2015, 2017, 2018). Additionally, NGH prepared a 2018 NBMR (NGH 2019), where results were compared to the performance criteria and a monitoring scope change was agreed upon based on the recommendations provided in 2019. Funding was

redirected to a nest box monitoring study involving the construction, installation and monitoring of microbat boxes constructed from natural recycled hollows. A total of eight natural hollows were constructed and installed at two locations (four at each) as part of the scope change. Monitoring of these hollows was conducted in the final term of the post construction monitoring.

### 1.1.4. Weed Monitoring

A number of requirements regarding the management of weeds during the construction period are outlined in the following documents:

- Minister's CoA
- TfNSW SoC
- EA (AECOM, 2012)

The Construction Flora and Fauna Management sub-plan (CFFMP) (FH 2014) and Ecological Monitoring Program (EcMP) (PB 2014) prepared for the project details the actions that need to be taken to meet those requirements.

The EcMP requires that the following monitoring be undertaken post construction:

Table 1-4 Weed monitoring requirements as stated in the EcMP

| Timing and frequency | Monitoring method | Data to be collected | Reporting |
|---|---|---|---|
| Annual monitoring for a minimum 3 year period to commence at the start of the operational phase. Any time of year. | Conduct post-construction monitoring of re-vegetated areas and extent of study area for the introduction/spread of weed species. | On visual inspection of the study area the following weed data would be collected:<br>• Species of weeds identified<br>• Extent of infestations – cover and abundance<br>• Extent of previously identified weed infestations - map if possible. | Results included in Annual Weed Monitoring Report |

# 2. METHODOLOGY

## 2.1. PERSONNEL

The personnel involved in delivering the ecological monitoring project in 2020 are in Table 2-1.

Table 2-1 Personnel and their roles

| Name | Position | Role |
|---|---|---|
| Elijah Elias | Ecologist | Project manager, report preparation, data entry/analysis, ecological monitoring surveys, aquatic monitoring surveys, weed monitoring survey |
| Aleksei Atkin | Technical Lead - Ecology | Technical review and advice |
| Natascha Arens | Director – Sydney Office | Technical advice |
| Narawan Williams | Fauna Ecologist | Camera automated detection surveys |
| Amy Rowles | Fauna Ecologist | Camera automated detection surveys |
| Teah Wills | Graduate Ecologist | Report preparation, data entry/analysis, aquatic monitoring |
| Simon Lee | Graduate Ecologist | Aquatic monitoring |
| Sarah Downey | Graduate Ecologist | Ecological monitoring surveys |

## 2.2. ECOLOGICAL MONITORING

### 2.2.1. Post-Construction Monitoring Summary

Table 2-2 below provides a summary of the post-construction ecological monitoring requirements as stated in the EcMP. Any deviations from those requirements are also provided, including reasons for alterations.

Table 2-2 Post-construction ecological monitoring requirements as stated in the EcMP

| Survey Type | Post construction Monitoring -Location | Post construction monitoring - Timing and frequency | Monitoring requirements as per the EcMP | Departures from the EcMP |
|---|---|---|---|---|
| **Roadkill surveys** | Along the upgraded stretch of the Princes Highway between Toolijoola Road and O'Keefes Lane in Berry, NSW | Weekly basis for a period of up to 52 weeks to commence at the start of the operational phase (31 October 2017) | Conduct roadkill monitoring during operation of the project over a 12 month period at weekly intervals. The monitoring would include a record of the species (if possible) and the GPS location. The local council road cleansing teams or Wildlife Rescue South Coast may be contracted to undertake the monitoring or alternatively TfNSW Southern Region would undertake the monitoring | Roadkill monitoring was undertaken by Fulton Hogan from November 1 2017 to December 25 2017. Roadkill monitoring by NGH did not begin until 20 February 2018, at the time of contract award. NGH carried out 52 weeks of roadkill monitoring from February 2018 to February 2019.<br>The roadkill monitoring component was completed and additional roadkill monitoring surveys were not required for the remainder of the project. |
| **Camera – automated motion detection** | At locations where connectivity structures have been constructed (e.g. underpasses, rope crossings)<br>See Figures 2-1 to 2-10 below. | Annually (within spring/ summer) for a 3 year period to commence at the start of the operation al phase.<br>The monitoring session would involve 15 units, each recording constantly for one, 11 day session per year. | Cameras will be strategically placed in areas likely to be used as movement pathways by native wildlife such as:<br>• Above ephemeral waterways established animal tracks<br>• Existing bridges/culverts.<br>Cameras would be triggered by animal motion and would operate at day and night to record both nocturnal and diurnal animals. | Figure 2-1 of the EcMP map identified rope crossings and underpasses where cameras should be placed. Some locations are different to those identified within the EcMP due to those crossing structures being placed in different locations during the construction phase. TfNSW was consulted throughout and approved the locations monitored in this report. |
| **Transect surveys - Spotlighting** | Along each transect (Figures 2-1 to 2-10) | Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase. | Spotlighting would be completed after dusk along each transect at a rate of approximately one kilometre per hour using 50 watt spotlights. Animals observed, including arboreal, flying and ground-dwelling mammals as well as | None |

| Survey Type | Post construction Monitoring -Location | Post construction monitoring - Timing and frequency | Monitoring requirements as per the EcMP | Departures from the EcMP |
|---|---|---|---|---|
| | | | nocturnal amphibians, reptiles and birds will be identified by their distinctive vocalisations or by sight with the aid of binoculars and recorded. Spotlighting would be concentrated on areas that contain suitable habitat features for nocturnal species including trees, shrubbery, rock outcrops, water bodies/wet areas and the ground surface. | |
| **Transect surveys - Call Playback** | At one point along each transect (Figures 2-1 to 2-10) | Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase. Each monitoring session would involve one call playback session along each transect. | Call playback targeting threatened species of nocturnal bird (e.g. Bush Stone-curlew), mammals (e.g. Koala, Yellow-bellied Glider) and frogs (e.g. Green and Golden Bell Frog) would be conducted using standard methods as per below that are most often used for owls (Debus 1995). Calls for target species would be broadcast via megaphone after dusk.<br>The survey would involve an initial listening period of 5-10 minutes, followed by a spotlight search of 10 minutes to detect any animals in the vicinity. The calls of the targeted species would then be played intermittently for 5 minutes followed by a 10 minute listening period. After the calls are played, another 10 minutes of spotlighting would be done in the vicinity to check for animals attracted by the calls, but might not be vocalising<br>The direction and estimated distance of response calls will be recorded to provide data on the location of targeted species with respect to proposed structure locations. | None |
| **Transect surveys - Tracks, Scats, and signs searches** | Along each transect (Figures 2-1 to 2-10) | Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase. Each monitoring session will involve one, one hour search along each transect. | Searches will be conducted for signs of animal activity along each transect and would include searches of:<br>• tree trunks for scratches (e.g. Koala) and feeding wounds (e.g. Yellow-bellied Glider)<br>• the base of trees for scats of arboreal mammals<br>• the ground layer for scats of kangaroos, wallabies and the Common Wombat<br>• the soil surface for characteristic diggings of terrestrial mammals (e.g. Short-beaked Echidna, Long-nosed Potoroo) | None |

| Survey Type | Post construction Monitoring -Location | Post construction monitoring - Timing and frequency | Monitoring requirements as per the EcMP | Departures from the EcMP |
|---|---|---|---|---|
| | | | • sandy and muddy areas for animal tracks | |
| **Transect surveys - Herpetology searches** | Along each transect (Figures 2-1 to 2-10) | Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase.<br>Each monitoring session will involve one, one hour search along each transect. | Herpetofauna (frogs and reptiles) active searches would involve looking for active specimens and eye shine (frogs only) within suitable habitat within the study area. The survey would involve searches for:<br>• active or basking reptiles in sunlit areas<br>• sheltering frogs and reptiles:<br>• underneath logs and rocks<br>• in rock crevices<br>• under decorticating bark on trees<br>• amongst leaf litter.<br>Specimens would be identified visually, by aural recognition of call (frogs only) or collected by hand for identification.<br>Frogs and reptiles would also be surveyed during spotlighting and call playback events and opportunistically across the study area. | None |

### 2.2.2. Camera Automated Detection

Cameras were strategically placed at locations where connectivity structures have been constructed (e.g. underpasses and rope crossings), with locations shown in Figures 2-1- to 2-4. Cameras were set to burst photo mode, triggered by animal motion, and operated day and night to record both nocturnal and diurnal fauna utilising connectivity structures. Cameras were angled toward structures to detect furniture utilisation. The monitoring session involved the deployment of 15 Reconyx infrared motion detecting cameras. Each unit recorded constantly for a minimum 11-day session during December 2020. All cameras were retrieved on the 21st and 22nd of December 2020. Detailed locations and site notes are provided in Table 2-3.

In 2019 NGH was approached by a PhD student studying arboreal fauna utilising rope bridges. As part of her study, NGH/TfNSW granted semi-permanent solar motion detecting cameras be installed at certain rope bridges. For the purpose of NGH's 2020 study, the data from these cameras were utilised. Locations of these cameras have been included in Table 2-3, with the results included in Table 3-1 and 3-2.

Table 2-3 Deployed cameras and installation notes

| Site | Camera ID | Date installed | Easting | Northing | Notes | Crossing structure type | Crossing (from PB 2015) |
|---|---|---|---|---|---|---|---|
| **1** | 15 | 8-9/12/2020 | 289632 | 614986 | Bundewallah Creek, west of Woodhill Mountain Rd. Northbound. | Rope bridge | BABN |
| **2** | 1 | 8-9/12/2020 | 289627 | 6149930 | Broughton Mill Creek, east of Woodhill Mountain Rd. Southbound. | Rope bridge | BMCS |
| **3** | PhD Student Camera 1 | 8-9/12/2020 | 291875 | 6150926 | Northbound | Rope bridge | PH5N |
| **4** | 14 | 8-9/12/2020 | 291938 | 6150933 | Northbound | Fauna underpass | PH4N |
| **5** | PhD Student Camera 2 | 8-9/12/2020 | 292230 | 6150878 | Southbound | Rope bridge | PH3S |
| **6** | 2 | 8-9/12/2020 | 292290 | 6150916 | Southbound | Dual use underpass | PH2N |
| **7** | 12 | 8-9/12/2020 | 294140 | 6151765 | Broughton Creek. Southbound | Rope bridge | BCC3N |
| **8** | 8 | 8-9/12/2020 | 294157 | 6151729 | Broughton Creek. Southbound | Rope bridge | BCC3S |
| **9** | 13 | 8-9/12/2020 | 294393 | 6152199 | Broughton Creek. Southbound | Rope bridge | BCC2W |
| **10** | 10 | 8-9/12/2020 | 294826 | 6152825 | Broughton Creek. Northbound. | Rope bridge | BCC1N |
| **11** | 11 | 8-9/12/2020 | 294872 | 6152755 | Broughton Creek. Southbound | Rope bridge | BCC1S |
| **12** | 7 | 8-9/12/2020 | 296216 | 6152703 | Toolijooa. Southbound | Rope bridge | TR2S |
| **13** | 3 | 8-9/12/2020 | 294430 | 6152193 | Broughton Creek. Northbound | Rope bridge | BCC2E |

| Site | Camera ID | Date installed | Easting | Northing | Notes | Crossing structure type | Crossing (from PB 2015) |
|---|---|---|---|---|---|---|---|
| **14** | 9 | 8-9/12/2020 | 292797 | 6151078 | Broughton. Southbound | Dual use underpass | PH1S |
| **15** | 6 | 8-9/12/2020 | 296328 | 6152636 | Toolijooa. Northbound | Fauna underpass | TR1S |


Figure 2-1 Ecological Monitoring Summary 2019 (Camera, Transect and Call Playback locations) Map 1 of 4


Figure 2-2 Ecological Monitoring Summary 2019 (Camera, Transect and Call Playback locations) Map 2 of 4


Figure 2-3 Ecological Monitoring Summary 2019 (Camera, Transect and Call Playback locations) Map 3 of 4


Figure 2-4 Ecological Monitoring Summary 2019 (Camera, Transect and Call Playback locations) Map 4 of 4

## Limitations

The cameras were set to burst photo mode to ensure correct identification, and only one photo from each burst was added to the dataset tally to mitigate double counts of individual animals. Where animals were clearly the same animal triggering the camera with multiple bursts, a period of five (5) minutes from the detection of the first animal to the next count of the same species was implemented. As the camera time between bursts was set lower than expected to ensure all species/individuals were recorded, sightings of the same species within the same/similar time and location were only counted as one sighting. If an individual would return at a later time, there would be no definitive way of determining from this survey method if it is a new or returning individual.

In two of the 15 camera locations, more permanent solar cameras were installed as part of an ongoing PhD study. As such, data from these two locations have been collected from the PhD student's study rather than installing additional cameras in these locations. Although the cameras differ in brand, the cameras are still able to take infrared photos of fauna during the evenings similarly to the Reconyx cameras used. Therefore, this change is unlikely to compromise the camera detection monitoring component of the ecological monitoring.

### 2.2.3. Transect Surveys

Transect surveys were carried out in March 2020 and included including spotlighting, herpetological surveys, tracks, scats and signs searches, and call playback. Opportunistic observations were also recorded. The dates, weather conditions and survey effort for each transect survey session in 2020 is outlined in Table 2-4. The locations of each transect is presented in Figures 2-1- to 2-4.

Table 2-4 Transect survey dates, conditions (Foxground Road – 068197 Rainfall) (Kiama Bombo Headland – 068242 Temperature) and survey effort

| Date | Temp max (ºC) | Rainfall (mm) | Survey Type | Person hours (min) | Notes (e.g. transect number) |
|---|---|---|---|---|---|
| 02/03/2020 | 32.3 | 0.0 | Diurnal | 300 mins | T13, T14 |
| | | | Spotlight | 300 mins | T13, T14 |
| | | | Call Playback | 60 mins | T14- , BS Curlew, Squirrel glider, Masked Owl, Powerful Owl |
| 03/03/2020 | 20.8 | 0.0 | Diurnal | 570 mins (With T11)<br>450 mins (Without T11) | T4, T7, T8, T10, T11 |
| | | | Spotlight | 480 mins | T4, T7, T10, T11 |
| | | | Call Playback | 60 mins | T4- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl |
| 04/03/2020 | 22.5 | 12.0 | Diurnal | 180 mins | T9 |

| Date | Temp max (ºC) | Rainfall (mm) | Survey Type | Person hours (min) | Notes (e.g. transect number) |
|---|---|---|---|---|---|
| | | | Call Playback | 120 mins | T8- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl<br>T9- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl |
| | | | Spotlight | 360 mins | T8, T9 |
| 05/03/2020 | 23.2 | 20.8 | Call Playback | 60 mins | T2- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl |
| | | | Spotlight | 240 mins | T1, T2 |
| 06/03/2020 | 24.9 | 14.2 | Diurnal | 120 mins | T3 |
| 09/03/2020 | 20.5 | 15.2 | Diurnal | 300 mins | T5, T6 |
| | | | Spotlight | 120 mins | T5 |
| 10/03/2020 | 22.5 | 3.0 | Diurnal | 120 mins | T1 |
| | | | Call Playback | 60 mins | T6- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl |
| | | | Spotlight | 240 mins | T3, T6 |
| 11/03/2020 | 24.4 | 0 | Diurnal | 120 mins | T2 |

### 2.2.4. Spotlighting

Spotlighting was completed after dusk along each transect (Table 2-4, Figures 2-1- to 2-4) at a slow walking pace using Led Lenser H14R.2 headtorches. The fauna observed, which included arboreal, flying and ground-dwelling mammals as well as nocturnal amphibians, reptiles and birds were identified by their distinctive calls or by sight, and recorded. Spotlighting was concentrated in areas which contained suitable habitat features for nocturnal species including trees, shrubbery, rock outcrops, water bodies/wet areas and the ground surface.

### 2.2.5. Herpetological surveys

Active diurnal searches for frogs and reptiles were conducted along each transect (Figures 2-1- to 2-4).

The survey involved searches for:

- active or basking reptiles in sunlit areas
- sheltering frogs and reptiles: underneath logs and/or rocks, under decorticating bark on trees, or amongst leaf litter.

Specimens were identified visually, by call recognition (frogs only), or collected by hand for identification.

Frogs and reptiles were also surveyed for during spotlighting and call playback events and opportunistically across the study area.

### 2.2.6. Tracks, Scats and Signs Search

Diurnal searches were conducted for signs of animal activity along each transect (Figures 2-1- to 2-4) and included searches of:

- tree trunks for scratches (e.g. Koala) and feeding wounds (e.g. Yellow-bellied Glider)
- the base of trees for scats of arboreal mammals
- the ground layer for scats of kangaroos, wallabies, Common Wombats, and exotic mammals
- the soil surface for characteristic diggings of terrestrial mammals (e.g. Short-beaked Echidna, Long-nosed Potoroo)
- sandy and muddy areas for animal tracks.

### 2.2.7. Opportunistic

Opportunistic sightings were recorded during transect surveys. This included, but was not limited to, birds of prey flying overhead, birds, frog calls, fox sightings etc.

### 2.2.8. Call Playback

Call playback surveys were conducted in accordance with Table 3.3 of the EcMP. Species selected for call playback included, but was not limited to, those target species identified in the EcMP, and were tailored for the habitat of the transect and the likelihood of presence. The list included; Bush-stone Curlew, Squirrel Glider, Yellow Bellied Glider, Barking Owl, Masked Owl, Sooty Owl, Powerful Owl, and Koala. Species' calls were played in order from smaller/least territorial to larger/most territorial. This was essential especially for owls, for if a Powerful Owl call was played first, this may alarm gliders and smaller owls, impacting on results.

All call playback surveys occurred after dusk at a location along each transect for a minimum of 10 minutes, as per the EcMP. An initial listening period of 5-10 minutes was allowed, followed by a spotlight search of the area for 10 minutes to detect any animals in the area that had not vocalised their presence. Calls for target species were then broadcasted via megaphone. The calls of the targeted species were played intermittently for 5 minutes followed by a 10-minute listening period. After the calls were played, another 10 minutes of spotlighting was completed in the vicinity to check for animals attracted by the call playback but might not be vocalising.

### 2.2.9. Limitations

The weather during fieldwork can have an impact on fauna survey results. The rain experienced (Table 2-4) during the survey period may have caused terrestrial and arboreal mammals to shelter throughout the day and the night. In contrast, the weather would have provided enhanced activity in frog species.

Transect 12 was deemed inaccessible as the surveyors did not have permitted access by the land owner. Diurnal, spotlight and call play back surveys were therefore not conducted at this location.

The transects surveyed during the 2020 monitoring period aligned with those detailed within the EcMP (PB, 2014).

## 2.3. AQUATIC MONITORING

### 2.3.1. Aquatic Monitoring Sites

Aquatic monitoring was undertaken twice during Winter and twice during Spring in 2020 (Table 2-5). In accordance with AUSRIVAS aquatic monitoring protocols, Winter is considered to be between 16 June and 14 September, with Spring between 15 September & 15 December.

In accordance with the EcMP, the surveys were undertaken directly downstream of the creek crossings to monitor downstream impacts of construction. Upstream water quality monitoring via sampling control sites were also monitored to provide background water quality levels. Aquatic monitoring was conducted biannually (within Autumn and Spring) for a three year period which commenced at the start of the operational phase (2018). This monitoring is a continuation of surveys undertaken between 2014 (pre-construction) and 2015-2017 (Construction period). Post-construction monitoring involved four sessions per year; two in Autumn, and two in Spring. Previous years involved four sessions per year, two in Autumn and two in Spring. All results are included in this Annual Monitoring Report.

Six downstream aquatic monitoring sites, 100 metres in length, were monitored. It should be noted that while the site identification numbers have been kept from previous reports, the location of sites 13 and 25 have been modified compared to the pre-construction aquatic assessment undertaken by JSA Environmental in Spring 2014 (JSA 2016) to account for access restrictions. In addition, two control sites were monitored as per the recommendations in the 2015 annual report: Control Site 1 along Broughton Mill Creek (upstream of site 25) and Control Site 2 along Broughton Creek (upstream of site 13). Control Site 2 was not monitored until Spring 2016; as approval from Fulton Hogan to monitor the site was not received until Spring 2016.

Aquatic monitoring has been undertaken at eight sites (Figures 2-5 to 2-9)

- 13 – Broughton Creek
- 16 – Broughton Creek
- 17 – Broughton Creek
- 22 – Bundewallah Creek
- 25 – Broughton Mill Creek
- 27 – Bundewallah Creek
- Control 1 – Broughton Mill Creek
- Control 2 – Broughton Creek.

Table 2-5 Dates of aquatic monitoring

| | Post Construction (2018) | Post Construction (2019) | Post Construction (2020) |
|---|---|---|---|
| **Autumn** | Session 1: 16-18 April 2018 | Session 1: 2-3 April 2019 | Session 1: 5-6th August 2020 (late) |
| | Session 2: 5-7 June 2018 | Session 2: 15-17 April 2019 | Session 2: 25-26th August 2020 (late) |
| **Spring** | Session 1: 24-26 September 2018 | Session 1: 9-11 October 2019 | Session 1: 11-13th November 2020 |
| | Session 2: 20-22 November 2018 | Session 2: 28-29 October 2019 | Session 2: 7-8th December 2020 |

### 2.3.2. Habitat Assessment

The AUSRIVAS field data sheets were completed for each site to obtain an overview of the site attributes. The following was recorded:

- Riparian vegetation structure
- Shading of river
- Water levels
- Description of natural substrate
- Detritus cover
- Percentage cover of Algae/Moss/Macrophytes in 100 metre section
- Other instream habitats
- Land use
- Visual assessment of disturbance related to human activities

### 2.3.3. Water Quality

Water quality was monitored using a handheld multiparameter water quality meter. The following data was taken:

- Temperature ºC
- pH
- Conductivity mS/cm
- Turbidity NTU
- Dissolved oxygen in mg/L and %

### 2.3.4. Macrophyte and Emergent Vegetation

Macrophyte and emergent aquatic vegetation within the creek were identified within the 100 metre section of creek at each site. Furthermore, a 25 metre by 5 metre transect within the creek was surveyed at each site and abundance of macrophytes and emergent vegetation recorded. The

location of each transect is provided in Figures 2-5 to 2-9. A photograph of each transect was also taken for comparison purposes between monitoring sessions (Appendix F).

Cover/abundance assessments were based on visual estimates of foliage cover (after Carnahan 1997), scored using a modified Braun-Blanquet 6-point scale:

1. 1 to a few individuals present, less than 5% cover
2. many individuals present, but still less than 5% cover
3. 5 - < 20% cover
4. 20 - < 50% cover
5. 50 - < 75% cover
6. 75 - 100% cover


Figure 2-5 Aquatic Monitoring Sites Map 1 of 5


Figure 2-6 Aquatic Monitoring Sites Map 2 of 5

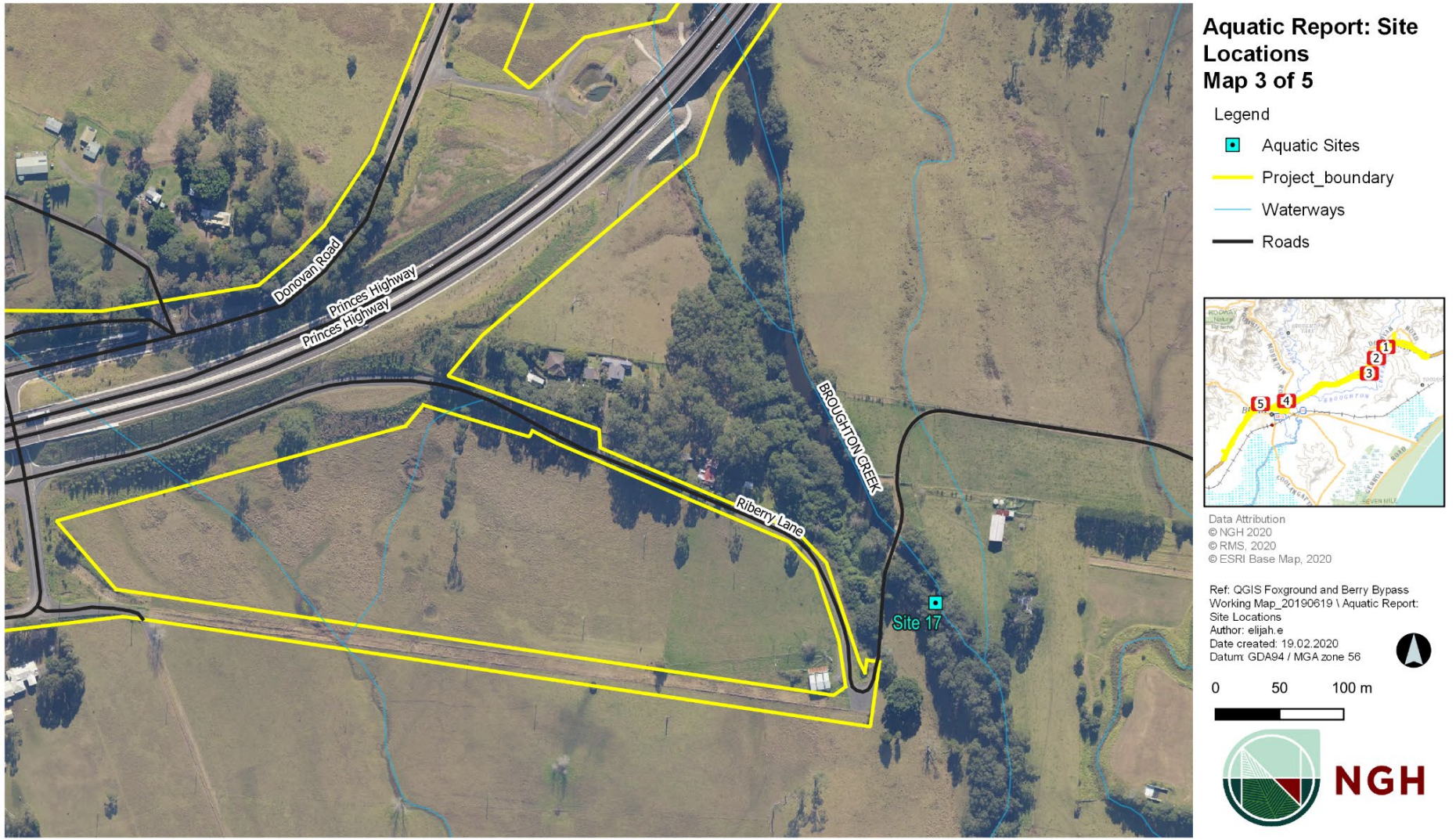


Figure 2-7 Aquatic Monitoring Sites Map 3 of 5

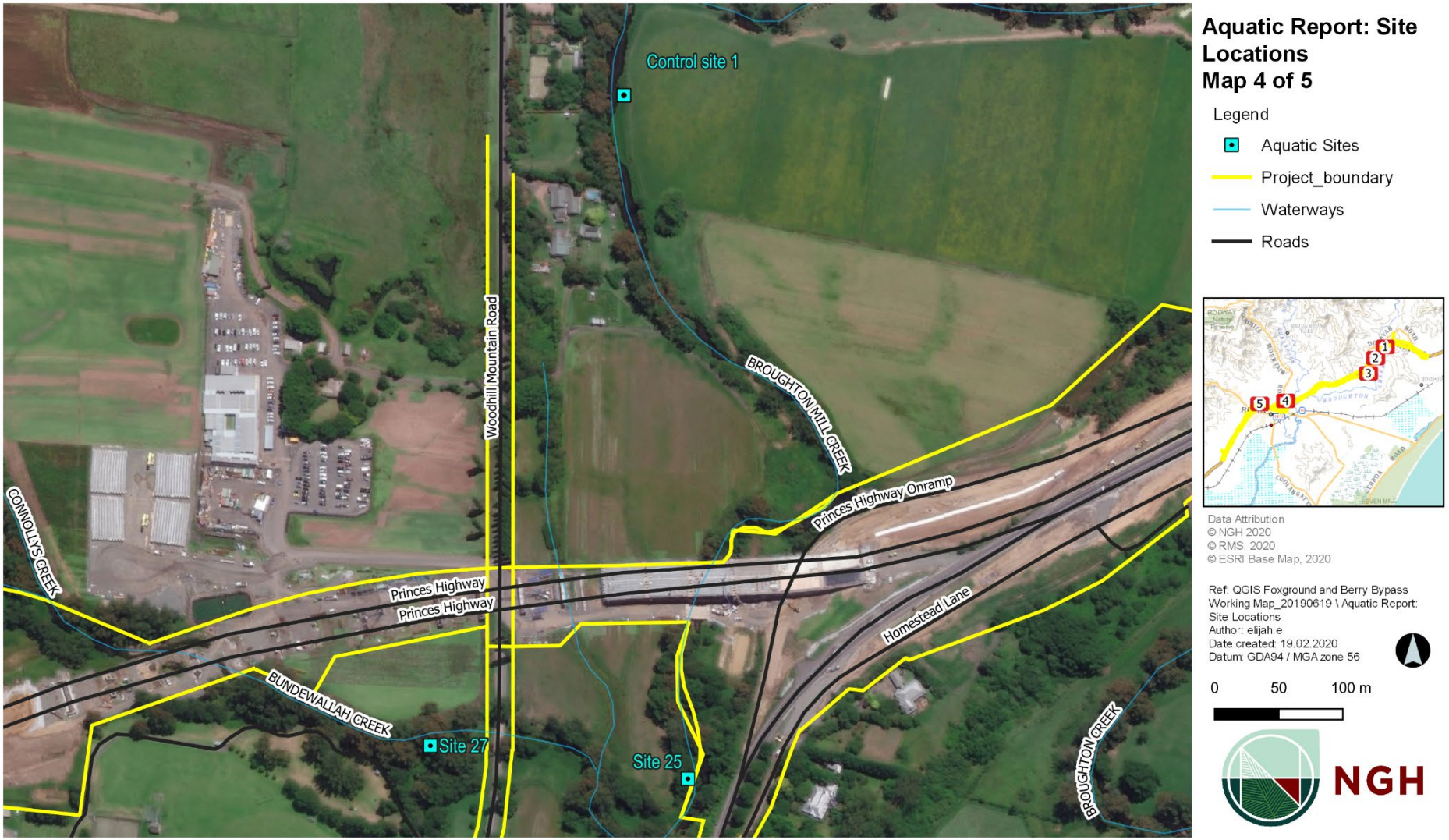


Figure 2-8 Aquatic Monitoring Sites Map 4 of 5

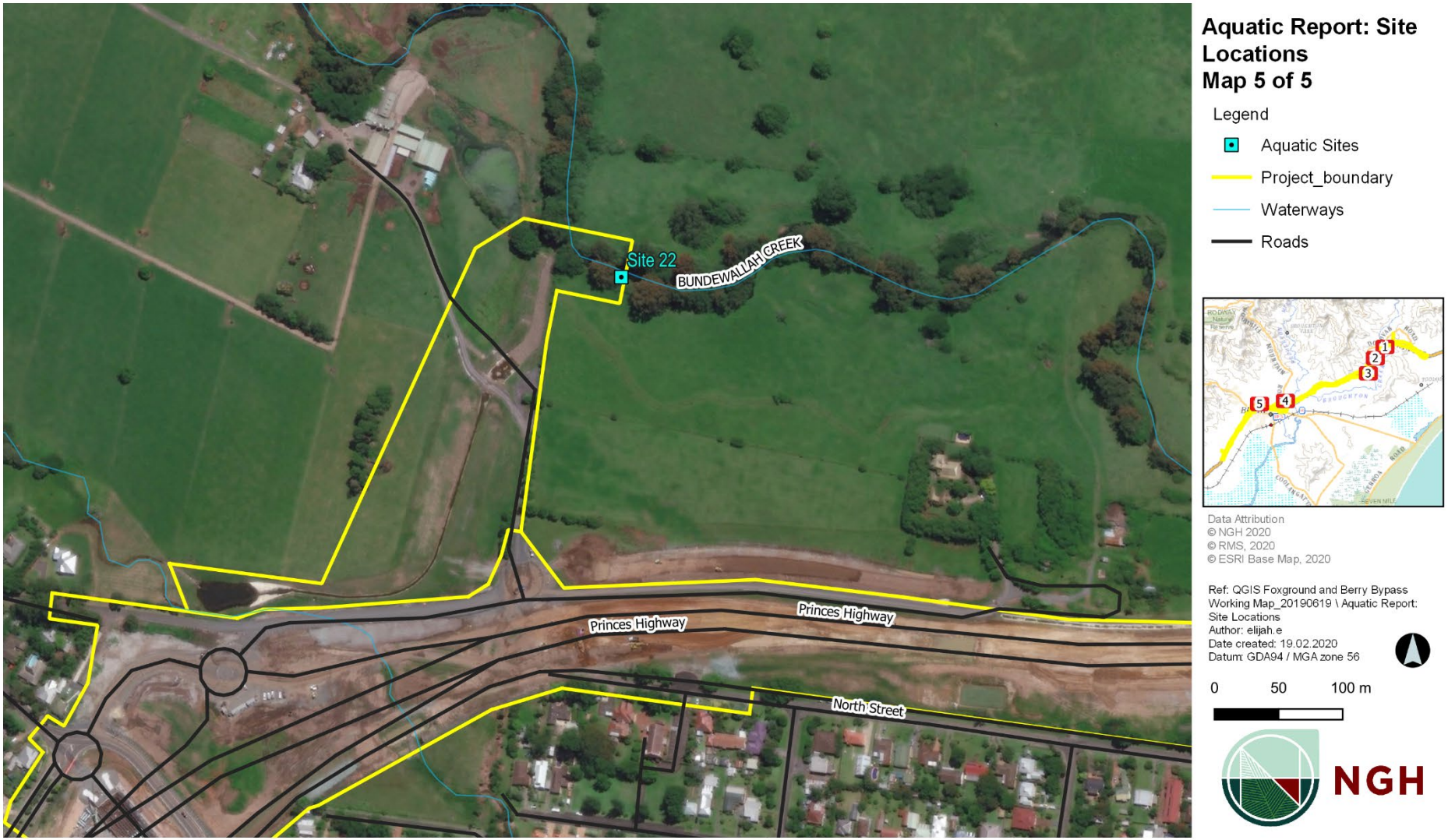


Figure 2-9 Aquatic Monitoring Sites Map 5 of 5

### 2.3.5. Macroinvertebrates

Macroinvertebrates were sampled in edge and riffle habitats in accordance with the NSW AUSRIVAS Sampling and Processing Manual (Department of Environment and Conservation, 2004). A kick net (250 micron mesh size) was used and a 10 m section of each type of habitat was sampled. The samples were then sorted in accordance with AUSRIVAS on site for a minimum of 40 minutes and preserved in 70% ethanol. Macroinvertebrate samples were identified to family. The resulting data was analysed using SIGNAL and EPT scores (see below) to provide an assessment of the existing 'health' of the waterway based on the water quality and abundance and diversity of the macroinvertebrate families present.

**SIGNAL score**

Families of aquatic invertebrates have been awarded sensitivity scores, according to their tolerance or intolerance to various pollutants. These scores have been determined by examining data from studies of various pollutants in south-eastern Australian streams. The scores are a compromise in cases where species within a family respond in different ways to a pollutant, and where the family responds differently to different types of pollutants. The index is calculated by totalling these scores and dividing by the number of graded families present (most, but not all, families have SIGNAL grades). Waterways with high SIGNAL scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorus.

**EPT score**

The EPT score is named for three orders of aquatic insects that are common in the benthic macroinvertebrate community: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). The EPT score is equal to the total number of families represented within these three orders in the sample (Mandaville 2002). Any loss of families in these groups usually indicates disturbance.

The grading guidelines for each score that are used to describe the health of a stream or river are provided in Table 2-6.

Table 2-6 Macroinvertebrate grading guidelines

| SIGNAL Score | Stream health | EPT Score | Stream health |
|---|---|---|---|
| <4 | Severe pollution | 0-6 | Poor |
| 4-5 | Moderate pollution | 7-13 | Fair |
| 5-6 | Mild pollution | 14-20 | Good-fair |
| 6-7 | Clean | 21-27 | Good |
| >7 | Excellent | >27 | Excellent |

### 2.3.6. Fish Assessment

Fish surveys were undertaken using passive trapping techniques. Six bait traps were deployed at each site. All nets were set to ensure a diversity of available fish habitat was sampled at each site. The surveys included:

- 6 x bait traps with a funnelled opening at each end were set close to emergent vegetation, submerged macrophytes and woody debris. Bait traps are a quick and easy method of sampling fish amongst woody debris, dense vegetation, steep banks and deep waters.

Fish were identified to species level and released.

In response to a recommendation in the 2018 aquatic monitoring report, and in consultation with TfNSW, the use of fyke nets was discontinued due to the ethical risks on animals associated with their use.

### 2.3.7. Limitations

Autumn 2020 surveys were conducted outside AUSRIVAS recommended Autumn survey period (between 15 March and 15 June) due to the delayed acquirement of a scoping variation.

Surveying in the colder season of winter may present some inconsistencies with some parameters for example, water temperature may average out less, weed densities may be reduced during winter months, or fish species may be less active in the colder water. However, it is unlikely to alter the results significantly that it cannot be utilised for comparison. Although some parameters may appear skewed during the season, general averaged trendlines would remain similar from what we would expect from an autumn survey.

Therefore, parameters collected have still been collated with other data collected as if an autumn survey was conducted. Surveys conducted during this period will however be referred to as ‘Winter 2020’.

## 2.4. NEST BOX MONITORING

### 2.4.1. Construction and Installation

Eight (8) microbat nest boxes were constructed using recycled natural hollows, wood offcuts, and steel plates. A total of three designs were constructed, and boxes were installed at two locations on 2$^{nd}$ December 2019. The details of nest box style and installation are found in the table below. An example of the nest boxes can be seen in Figure 2-10.

Figure 2-10 Installed recycled natural hollows for microbats

Table 2-7 Next box installation summary

| Nest Box ID | Design Type | Scat Plate | Height (m) | Orientation | Location |
|---|---|---|---|---|---|
| **NV1** | Horizontal | - | 5.0 | 165 SE | 1 |
| **NV2** | Horizontal | - | 5.35 | 65 NE | 2 |
| **NV3** | Horizontal | - | 5.0 | 217 SW | 1 |
| **NV4** | Vertical | Y | 4.1 | 220 SW | 2 |
| **NV5** | Vertical | Y | 4.0 | 265 W | 2 |
| **NV6** | Vertical | Y | 5.0 | 50 NE | 1 |
| **NV7** | 45 degree | - | 5.0 | 345 N | 1 |
| **NV8** | 45 degree | - | 5.0 | 238 SW | 2 |

### 2.4.2. Monitoring

An Apple iPad running GIS Pro was used to locate the eight (8) natural hollow microbat nest boxes. Nest boxes were inspected using a combination of methods. Firstly, a GoPro was secured to a 6 m extendable pole and linked via Bluetooth to the Apple iPad. A live feed was projected onto the iPad which enabled a thorough inspection of the scat plates (only relevant to some of the boxes). Additionally, a USB inspection camera with built in LEDs was secured to an extendable inspection pole. The end of the inspection camera was attached to wire enabling the first 0.3 m of the inspection cable and camera to be manipulated to suit the nest box design. The USB camera was connected to a laptop overriding the webcam and allowing a live feed to be viewed. The inspection camera was inserted into the next boxes to inspect its contents.

## 2.5. WEED MONITORING

A systematic weed survey was conducted at all survey locations by an ecologist on the 2nd of December 2020 (Figure 2-12 - Figure 2-15).

The aim of the survey was to determine weed species presence, abundances, and to map the distribution of weed infestations. Data was collected using a Global Positioning System (GPS) enabled tablet running GIS Pro mapping software. The tablet was pre-loaded with topographic, aerial imagery and the project boundary base layer. At each survey point a photograph was taken in order to capture any changes in land condition and weeds species composition from previous and future monitoring events. Polygons were drawn around areas of weeds observed during the survey to capture the identity of weed species present and their abundances. The polygons were saved directly to a GIS shapefile. Weed species targeted in this survey included:

- those listed as Priority Weeds for the South-east region under the *Biosecurity Act 2015* (Biosecurity Act)
- environmental weeds

Documented waypoints in this report signify the approximate location of each survey point where each site photograph was taken rather than the location of each individual weed. A brief site description was recorded where possible to aid with record keeping and as a basis for future management decisions.


Figure 2-11 Weed Monitoring Locations Map 1 of 4

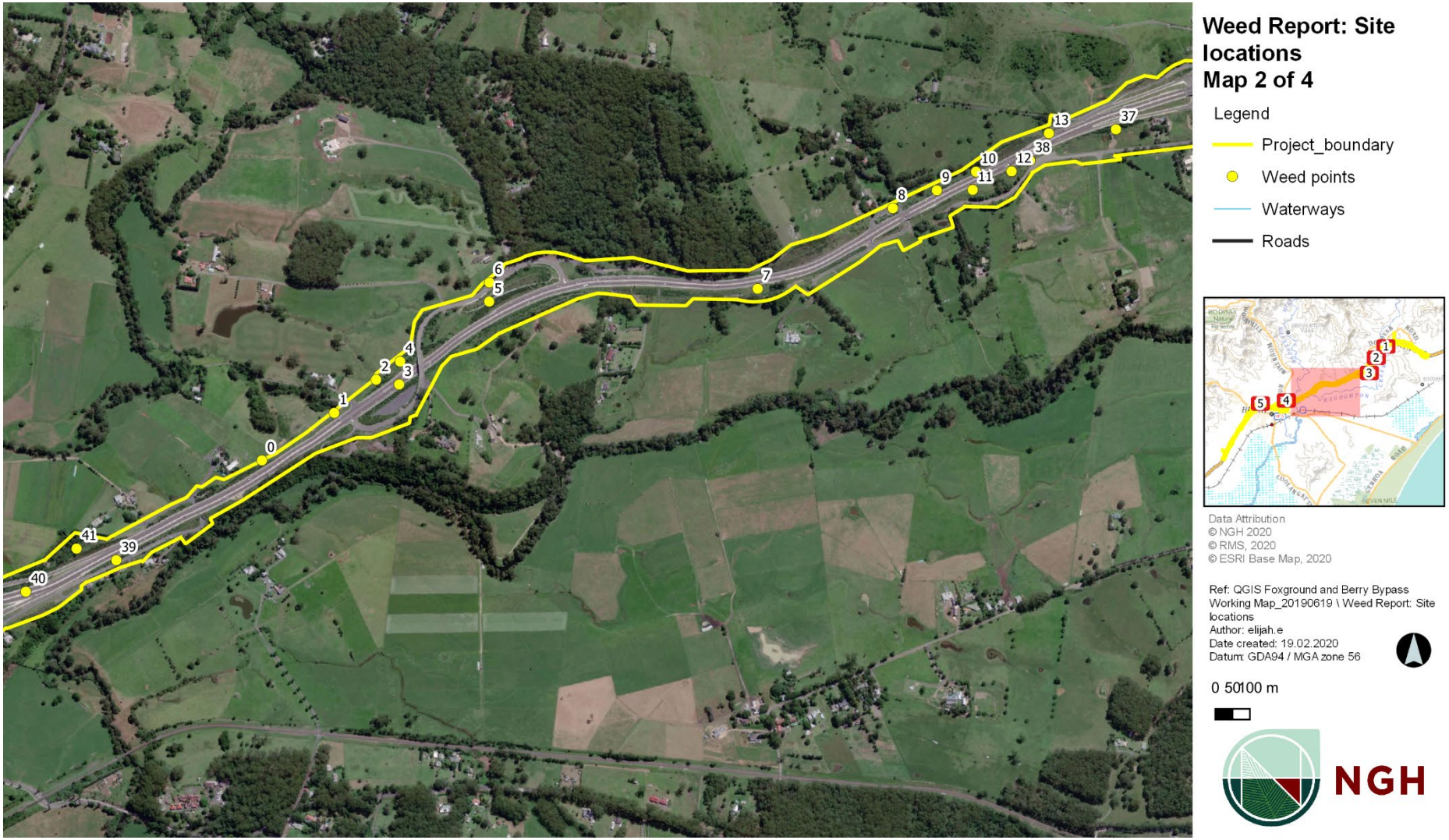


Figure 2-12 Weed Monitoring Locations Map 2 of 4


Figure 2-13 Weed Monitoring Locations Map 3 of 4


Figure 2-14 Weed Monitoring Locations Map 4 of 4

# 3. RESULTS

## 3.1. ECOLOGICAL MONITORING

### 3.1.1. Camera Automated Detection

A total of 449 sightings were recorded by the 13 deployed cameras and two PhD student cameras over the 11-day survey period. This includes a variety of bird, possum, glider, reptile and exotic fauna sightings. The camera with the most sightings recorded was camera 8 with 154 sightings, followed by cameras 12 and 13 with 82 and 63 sightings respectively (Table 3-1).

A total of 19 confirmed species were detected by the cameras over the 11-day survey period. Each camera varied in species richness detected from one to five species. The cameras which detected the greatest diversity (five species) were cameras 8 and 12. Two cameras (one deployed and one semi permanent) recorded no fauna. The number of species detected by each camera is detailed in Table 3-1. Locations of cameras are shown in Figures 2-1- to 2-4 above.

Table 3-1 Number of sightings and species richness per camera in 2020

| Site No. | Camera | Crossing Name | Number of sightings recorded | Number of species detected | Species type detected | Crossing structure type |
|---|---|---|---|---|---|---|
| **1** | 15 | BABN | 34 | 3 | Bird | Rope bridge |
| **2** | 1 | BMCS | 19 | 4 | Bird, arboreal mammal | Rope bridge |
| **3** | PhD Cam 1 | PH5N | 2 | 2 | Bird | Rope bridge |
| **4** | 14 | PH4N | 4 | 3 | Bird, reptile | Fauna underpass |
| **5** | PhD Cam 2 | PH3S | None recorded | None recorded | None recorded | Rope bridge |
| **6** | 2 | PH2N | 2 | 1 | Exotic mammal | Dual use underpass |
| **7** | 12 | BCC3N | 82 | 5 | Bird, arboreal mammal | Rope bridge |
| **8** | 8 | BCC3S | 154 | 5 | Bird, arboreal mammal | Rope bridge |
| **9** | 13 | BCC2W | 63 | 4 | Bird | Rope bridge |
| **10** | 10 | BCC1N | 9 | 3 | Bird | Rope bridge |
| **11** | 11 | BCC1S | 12 | 1 | Bird | Rope bridge |
| **12** | 7 | TR2S | 4 | 3 | Bird | Rope bridge |
| **13** | 3 | BCC2E | 53 | 3 | Bird | Rope bridge |
| **14** | 9 | PH1S | 11 | 4 | Bird, exotic mammal | Dual use underpass |
| **15** | 6 | TR1S | None recorded | None recorded | None recorded | Fauna underpass |

The most common species detected across the project by camera monitoring was the Magpie-lark (*Grallina cyanoleuca*) which was recorded by six different cameras. This was followed by Superb Fairy-wren (*Malurus cyaneus)* and Lewin's Honeyeater (*Meliphaga lewinii*) which were

recorded by five cameras each. The Australian Magpie (*Cracticus tibicen*) had the most records during the survey, with a total of 199 sightings recorded over 11 days on three cameras. This was followed by the Superb Fairy-wren (*Malurus cyaneus)* with 124 sightings.

Of the arboreal mammals, The Common Ringtail Possum (*Pseudocheirus peregrinus*) was detected more often than the Common Brushtail (*Trichosurus vulpecula*), by three cameras (1,8, 12) compared to only one (1). No Sugar Gliders (*Petaurus breviceps)* were recorded during 2020 surveys. These results confirm that the Common Ringtail Possums and Common Brushtails are using the rope bridges in these areas. See Table 3-2 below for detailed results.

Three exotic species were recorded during the survey: Black Rat (*Rattus rattus*), Red Fox (*Vulpes vulpes*), and Common Myna (*Acridotheres tristis*). The Common Myna was recorded six (6) times across three cameras, the Black Rat four (4) times at one camera, and the Red Fox four (4) times at three cameras.

Table-3-2 Species and individuals detected during 2020 camera surveys

| Common Name | Scientific Name | Individuals recorded by each camera | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PHD 1 | PHD 2 | C1 | C2 | C3 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | Total |
| Mammal | | | | | | | | | | | | | | | | | |
| Common Ringtail Possum | *Pseudocheirus peregrinus* | | | 3 | | | | | 14 | | | | 9 | | | | **26** |
| Common Brushtail Possum | *Trichosurus vulpecula* | | | 2 | | | | | | | | | | | | | **2** |
| Short-beaked Echidna | *Tachyglossus aculeatus* | | | | | | | | | 3 | | | | | | | **3** |
| Black Rat* | *Rattus rattus* | | | | | | | | | 4 | | 1 | | | | | **4** |
| Red Fox* | *Vulpes vulpes* | | | | 2 | | | | | 2 | | | | | | | **4** |
| Bird | | | | | | | | | | | | | | | | | |
| Satin Bowerbird | *Ptilonorhynchus violaceus* | | | | | | | 1 | | | | | | | | | **1** |
| Common Myna* | *Acridotheres tristis* | | | | | 2 | | | | | 2 | | | 2 | | | **6** |
| Grey Shrikethrush | *Colluricincla harmonica* | 1 | | | | | | | | | | | | | | | **1** |
| Australian Raven | *Corvus coronoides* | 1 | | 12 | | | | | | | | | | | | | **13** |
| Australian Magpie | *Cracticus tibicen* | | | | | | | 1 | 131 | | | | 67 | | | | **199** |
| Magpie Lark | *Grallina cyanoleuca* | | | | | 1 | | | 5 | | 6 | | 2 | 1 | | 31 | **46** |
| Superb Fairywren | *Malurus cyaneus.* | | | | | 50 | | | | 2 | | 12 | | 58 | 2 | | **124** |
| Lewin's Honeyeater | *Meliphaga lewinii* | | | 2 | | | | | 2 | | 1 | | 3 | 2 | | | **10** |
| Brown Gerygone | *Gerygone mouki* | | | | | | | | | | | | | | 1 | | **1** |
| Willy Wagtail | *Rhipidura leucophrys* | | | | | | | | 2 | | | | 1 | | | | **3** |

| Common Name | Scientific Name | Individuals recorded by each camera | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PHD 1 | PHD 2 | C1 | C2 | C3 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | Total |
| Laughing Kookaburra | *Dacelo novaeguineae* | | | | | | | | | | | | | | | 2 | **2** |
| Pied Currawong | *Strepera graculina* | | | | | | | | | | | | | | | 1 | **1** |
| Nankeen Kestrel | *Falco cenchroides* | | | | | | | 2 | | | | | | | | | **2** |
| **Reptile and Amphibian** | | | | | | | | | | | | | | | | | |
| Garden Skink | *Lampropholis guichenoti* | | | | | | | | | | | | | | 1 | | **1** |
| **Total** | | **2** | **0** | **19** | **2** | **53** | **0** | **4** | **154** | **11** | **9** | **12** | **82** | **63** | **4** | **34** | **449** |

*= exotic

### 3.1.2. Transect Surveys

## Spotlighting

A total of 24 different species were detected during spotlight surveys across all transects in the project alignment during 2020. Locations of transects are shown in Figure 2-1 to Figure 2-4. Spotlighting data plays a vital component in the dataset as it accounts for the detection of nocturnal fauna, in particular arboreal nocturnal fauna like the Common Brushtail Possum, the Common Ringtail Possum, and the Sugar Glider. Data on Grey-headed Flying-foxes (*Pteropus poliocephalus*) is also important as there is a known colony which populates Bundewallah Creek near Berry town centre.

The Grey-headed Flying-fox and the Common Ringtail Possum were the most frequently observed species during spotlighting, being detected at 5 and 4 different transects respectively. Additionally, microbats were detected in 5 different transects. Table 3-3 below summarises the species detected in each transect.

Table 3-3 Species and individuals detected during spotlight surveys in all transects 2020 (X=presence)

| Common Name | Scientific Name | Individuals recorded in each transect | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T13 | T14 |
| **Mammals** | | | | | | | | | | | | | | |
| Common Brushtail Possum | *Trichosurus vulpecula* | | | | | | | X | | | | | | X |
| Common Ringtail Possum | *Pseudocheirus peregrinus* | | | | X | | X (2) | | | | X | | | X |
| **Grey-headed Flying Fox** | ***Pteropus poliocephalus*** | X | X | X | X | | X | | | | | | | |
| Microbat (unidentified) | Microchiroptera | | | | X | X (12) | X | | X (2) | X (10) | | | | |
| Swamp Wallaby | *Wallabia bicolor* | | | | | | X | | | X (6) | | | | |
| European Rabbit* | *Oryctolagus cuniculus* | | | | | | | | | | | X | | |
| Eastern grey kangaroo | *Macropus giganteus* | | | | | | | | | X | | | | |

| Common Name | Scientific Name | Individuals recorded in each transect | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T13 | T14 |
| **Birds** | | | | | | | | | | | | | | |
| Domestic Goose* | *Anserina sp.* | | | | | | | X | | | | | | |
| Masked Lapwing | *Vanellus miles* | | | | | | X | | | | | | | |
| White-faced Heron | *Egretta novaehollandiae* | | | | | | | | | | | | | X |
| Swamphen | *Porphyrio porphyrio* | | | | | | | | | | | | | X |
| **Aquatic** | | | | | | | | | | | | | | |
| Common Eastern Froglet | *Crinia signifera* | X | X | X | | | X | X | | | | X | X | |
| Eastern Dwarf Tree Frog | *Litoria fallax* | X | X | X | | | X | | | | X | | X | |
| Short-Finned Eel | *Anguilla australis* | | | | | X | | | | | | | | |
| Bleating Tree Frog | *Litoria dentata* | | | | | X | X | X | | | | | | |
| Striped Marsh Frog | *Limnodynastes peronii* | X | X | X | | | | | | X | | X | | |
| Tyler's Tree Frog | *Litoria tyleri* | | | | | | | | | | X | | | |
| Common Yabby | *Cherax destructor* | | | | | | | | | X | | | | |
| Southern Leaf Green Tree | *Litoria nudidigita* | | | | | | X | X | | | | | | |
| Peron’s Tree Frog | *Litoria peronii* | X | X | X | | X | X | | | | X | | | X |
| Australian Bass | *Macquaria novemaculeata* | | | | | | | | | | | | | X |
| Cox's Gudgeon | *Gobiomorphus coxii* | | | | | X | | | | | | | | |
| **Reptiles** | | | | | | | | | | | | | | |
| Eastern Small-Eyed Snake | *Cryptophis nigrescens* | | | | | | | X | | | | | | |
| Water Skink | *Eulamprus quoyii* | | | | | | | | | | | | | X |

## Herpetological Surveys

A total of eight species were identified across all transects during herpetological diurnal surveys. Table 3-4 summarises the species found within each transect. The Garden Skink *Lampropholis guichenoti* was the most frequently identified reptile species during diurnal herpetological searches and the Eastern Dwarf Tree Frog *Litoria fallax* was the most observed amphibian species. A total of four lizard species and four frog species were observed.

Table 3-4 Herpetological survey observations within each transect

| Common Name | Scientific Name | Individuals recorded in each transect | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T13 | T14 |
| Eastern Water Dragon | *Intellagama lesueurii* | | | | | X | | | | | | | X | X |
| Eastern Water Skink | *Eulamprus quoyii* | | | | | X | | | | | | | | X |

| Common Name | Scientific Name | Individuals recorded in each transect | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T13 | T14 |
| Rainbow Skink | *Lampropholis delicata* | X | X | | | | | | | | | | | |
| Garden Skink | *Lampropholis guichenoti* | | | | | X | | | | | | X | X | X |
| Eastern Dwarf Tree Frog | *Litoria fallax* | X | X | X | | | X | X | X | | | | | |
| Striped Marsh Frog | *Limnodynastes peronii* | | | | | | X | X | | | | | | |
| Perons Tree Frog | *Litoria peronii* | X | X | | | | | | | | | | | |
| Common Eastern Froglet | *Crinia signifera* | | | X | | | X | X | | | | | | |

## Tracks, Scats, and Signs Search

Fifteen types of tracks, scats, and signs were observed in the project alignment across all transects however with none detected on transect 8. Fresh deer tracks were identified in transect 1 and 2. These transects are surrounded by a private property and Donovan Rd, both with barbed wire fencing. The area is a wet sclerophyll gully with dense *Lantana camara* throughout. Deer scat was also observed in these two transects, and deer are known to be present in the area from 2018 and 2019 monitoring. Underpasses were checked for Red Fox scats and macropod scats with no results.

Additional data collected from this survey method included wombat burrows and warrens, and macropod and fox scats. It is apparent that foxes occupy all areas in and around the alignment. Results of the searches are summarised in Table 3-5 below.

Table 3-5 Tracks, Scats, and Signs within each transect

| Common Name | Scientific Name | Observation Type | Individuals recorded in each transect | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T13 | T14 |
| Eastern Grey Kangaroo | *Macropus giganteus* | Scat | | | | | | | | | X | | | | |
| Eastern Grey Kangaroo | *M. giganteus* | Tracks | | | | | | | | | X | | | | |
| Red Fox* | *Vulpes vulpes* | Scat | X | X | | | X | X | X | | X | | X | X | X |
| Red Fox* | *V. vulpes* | Den | | | X | | | | | | X | | | | X |
| Red Fox* | *V. vulpes* | Tracks | | | | | | | | | X | | | | |
| European Rabbit* | *Oryctolagus cuniculus* | Burrows | | | | | | | | | X | X | | | |
| European Rabbit* | *O. cuniculus* | Scat | | | | | | | | | X | X | | | |
| Deer* | Species unknown | Tracks | X | X | | | | | | | | | | | |
| Deer* | Species unknown | Scat | X | X | | | | | | | | | | | |
| Deer* | Species unknown | Markings | | X | | | | | | | | | | | |

| Common Name | Scientific Name | Observation Type | Individuals recorded in each transect | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T13 | T14 |
| Common Wombat | *Vombatus ursinus* | Burrow/ Warren | | | | X | X | | X | | X | | | | X |
| Common Wombat | *V. ursinus* | Scat | | | | | X | | | | X | | | | |
| Swamp Wallaby | *Wallabia bicolor* | Scat | | | | | | X | X | | X | | | | |
| Common Yabby | *Cherax destructor* | Burrow | | X | | | | | | | | | | | |
| Macropod | Species unknown | Scat | | | | | X | | | | X | | | | |
| **Grey-headed Flying Fox** | ***Pteropus poliocephalus*** | Camp | | | | | | | | | | | | Absent | |

## Opportunistic Species Records

A total of 69 species across all transects were detected by opportunistic observation during diurnal transect surveys. These were species not originally targeted in the EcMP or FBB baseline monitoring (PB, 2014, PB 2015). As such, instances of species, though recorded during a transect, were considered incidental observations for the sake of comparison with previous survey data, and were not included in the species counts for survey techniques where they were not the target. These observations may however be useful for comparison during later years of monitoring.

Opportunistic observations included 66 species of birds, including three bird of prey species such as a Whistling Kite *Haliastur sphenurus*, Brown Falcon *Falco berigora*, and Black-shouldered Kite *Elanus axillaris.* The remaining non-avian species included a Short-finned Eel *Anguilla australis*, European rabbits *Oryctolagus cuniculus* and Grey-headed Flying-foxes.

Transect 7 had the largest diversity of the transects surveyed, with 21 species detected, all of which were birds (Table 3-6). Transect 5 had the next largest diversity with a total of 18 species detected. Transect 10 had the least diversity, with only eight species recorded.

Table 3-6 Opportunistic species diversity

| Transect | Number of species |
|---|---|
| 1 | 14 |
| 2 | 13 |
| 3 | 13 |
| 4 | 14 |
| 5 | 18 |
| 6 | 16 |
| 7 | 21 |
| 8 | 17 |
| 9 | 17 |
| 10 | 8 |
| 11 | 12 |
| 13 | 16 |

| Transect | Number of species |
|---|---|
| 14 | 17 |

### Call Playback

No threatened species were detected during call playback surveys in 2020. Additionally, surveys at other call playback points resulted in no responses being detected. Call playback locations can be seen in Figure 2-1 to Figure 2-4.

## 3.2. AQUATIC MONITORING

The results of the 2020 monitoring have been compared with the results of:

- pre-construction monitoring (2014)
- construction monitoring, where available and where meaningful comparisons can be made (refer to Section 2.7 for limitations)
- post construction 2019 and 2018 monitoring.

Two pre-construction surveys were undertaken in Spring 2014, with no Autumn surveys undertaken in that year (JSA 2016). This was due to a limited timeframe where monitoring was only possible in Spring 2014 (PB 2014). The following section therefore compares the results of the 2014 pre-construction monitoring (Spring 2014), the 2015 (Spring and Autumn) monitoring, the 2016 (Spring and Autumn) monitoring, the 2017 (Spring and Autumn) monitoring, the 2018 (Spring and Autumn) monitoring, the 2019 (Spring and Autumn) monitoring and the 2020 (Spring and Autumn) monitoring.

### 3.2.1. Habitat Assessment

Substrate levels of the six treatment sites (Site 13, 16, 17, 22, 25, and 27) can be seen below in Figure 3-1. ‘Cobble’ had the largest proportion across all sites (treatment and control) in most years surveyed. This trend continued in 2020. ‘Cobble’ average percentages in treatment sites increased from 46.67% in 2019 to 67.92% respectively. Control site ‘cobble’ averages declined from 46.88% in 2019 to 37.5% in 2020. In addition to this, similar percentage averages for ‘Boulder’, ‘Gravel’, and ‘Sand’ between treatment and control sites in 2019 and 2020 were observed. ‘Pebble’ increased from 17.5% (2019) to 35% (2020) at the treatment sites, while ‘Bedrock’ declined from 17.5% (2019) to 6.25% (2020) respectively. Most substrates were observed in similar proportions between treatment and control sites post-2016. The only exception to this is ‘Bedrock’ which is observed in highly varied proportions in the control sites. In 2017 and 2019 ‘Bedrock’ was observed in large proportions in control sites (28.75% and 18.13%) compared to treatment sites (0.21% and 0.42%). This may be due to the movement of substrate downstream from control sites.

Photographs of each site are provided in Appendix F. Substrate levels of the two control sites (CS1, CS2) are presented in Figure 3-2. Instream vegetation graphs below show the change in average algae, moss, and macrophytes percentage from 2016 onward at each of the sites (Figure 3-3 to Figure 3-10).

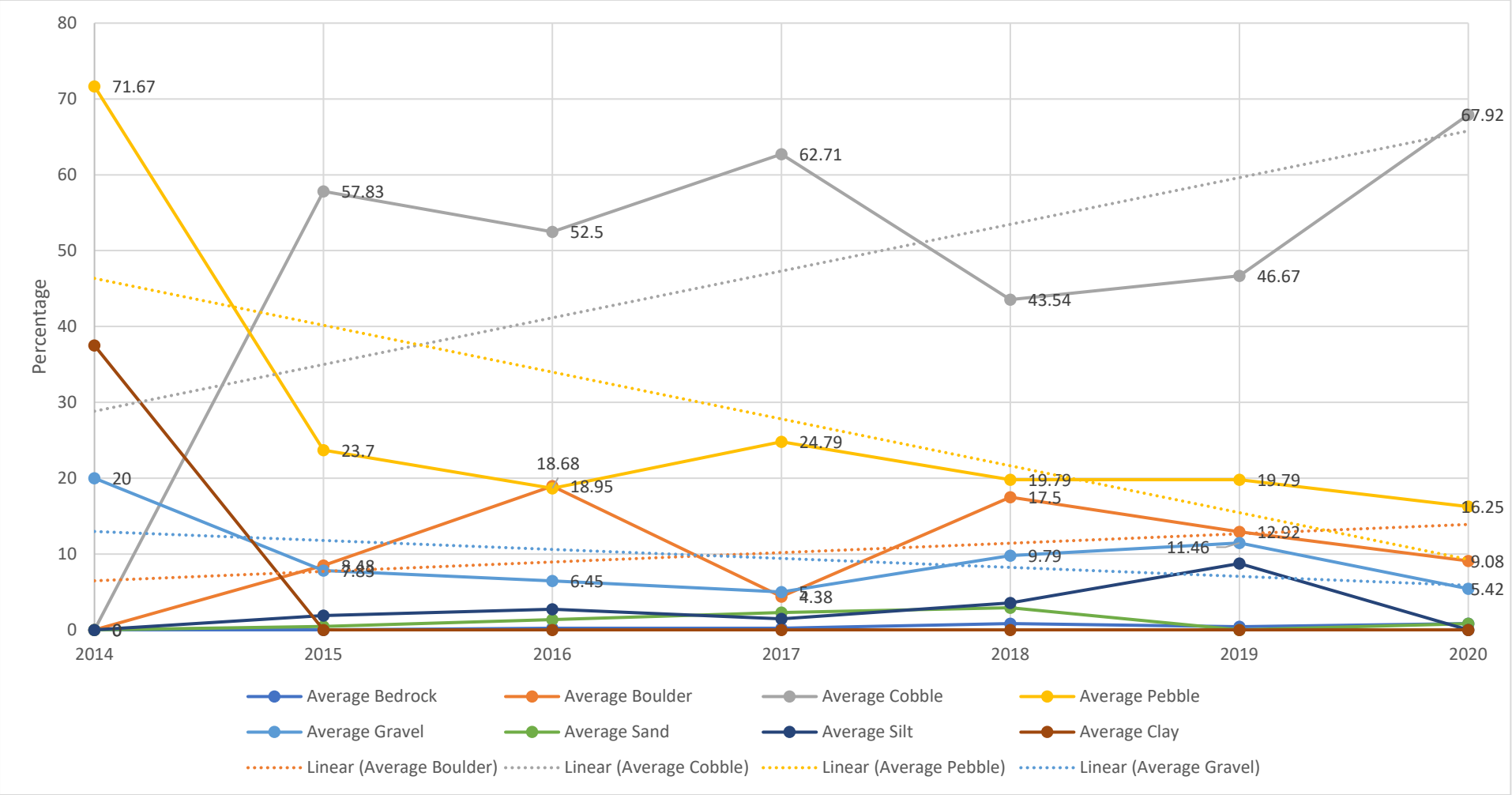


Figure 3-1 Substrate averages in treatment sites between 2014 and 2020

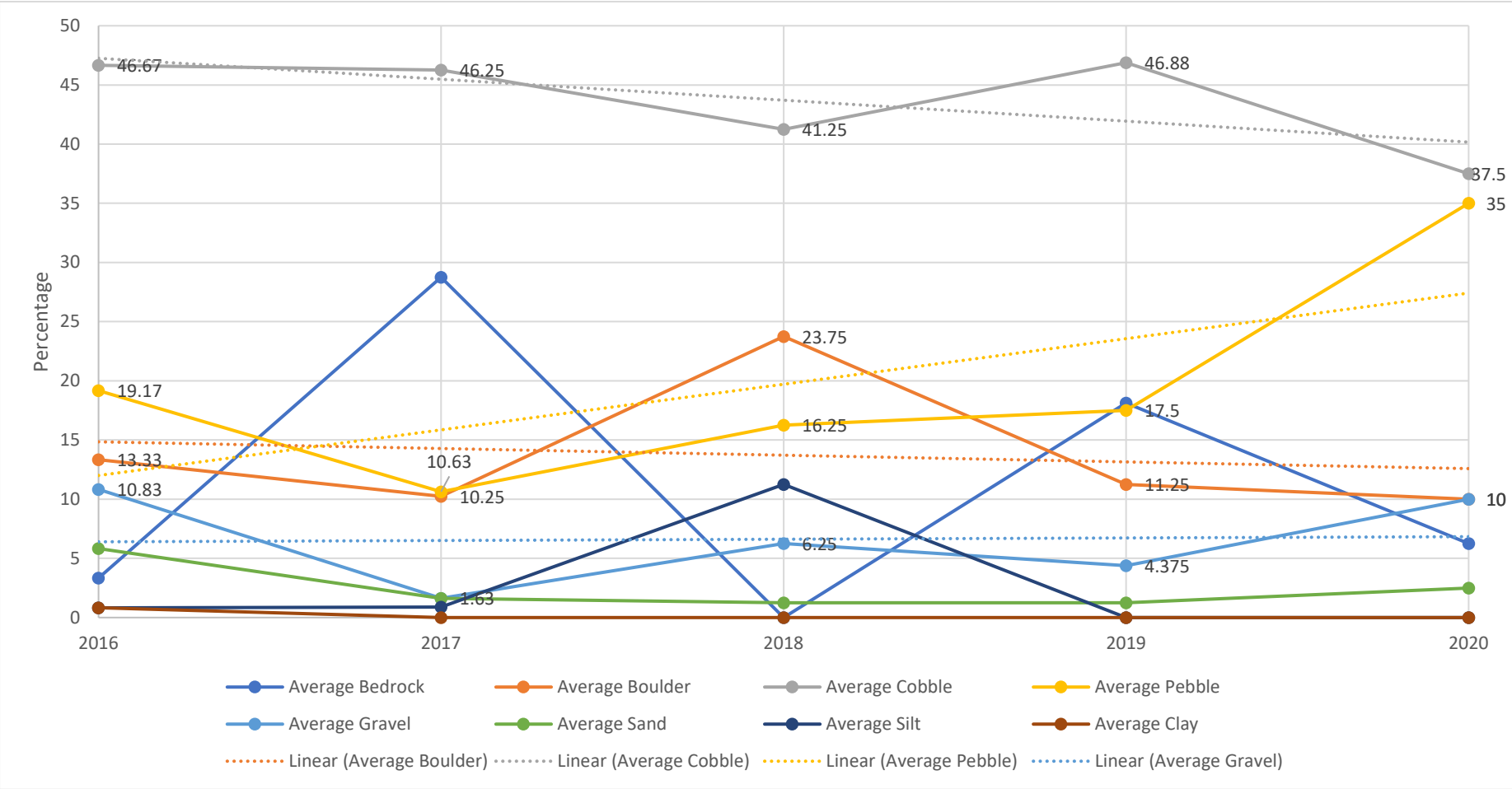


Figure 3-2 Substrate averages in control sites between 2016 and 2020

## Site 13

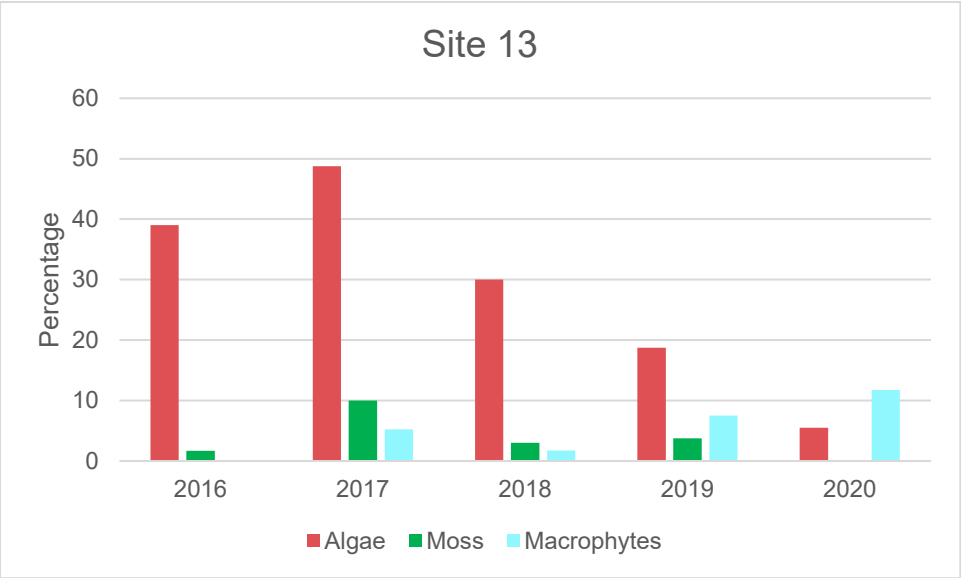


Figure 3-3 Site 13 Algae, moss and macrophyte percentages between 2016 and 2020.

## Site 16

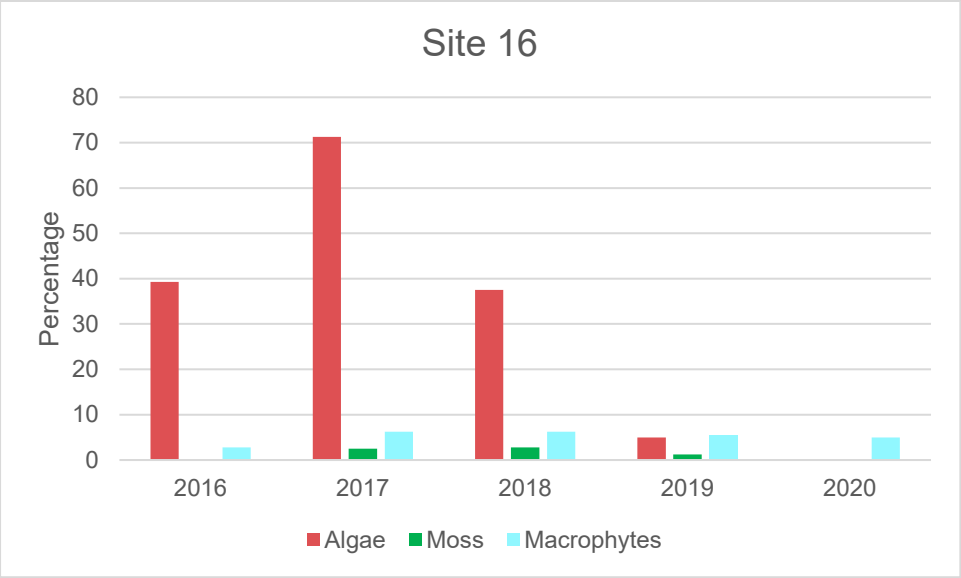


Figure 3-4 Site 16 Algae, moss and macrophyte percentages between 2016 and 2020.

## Site 17

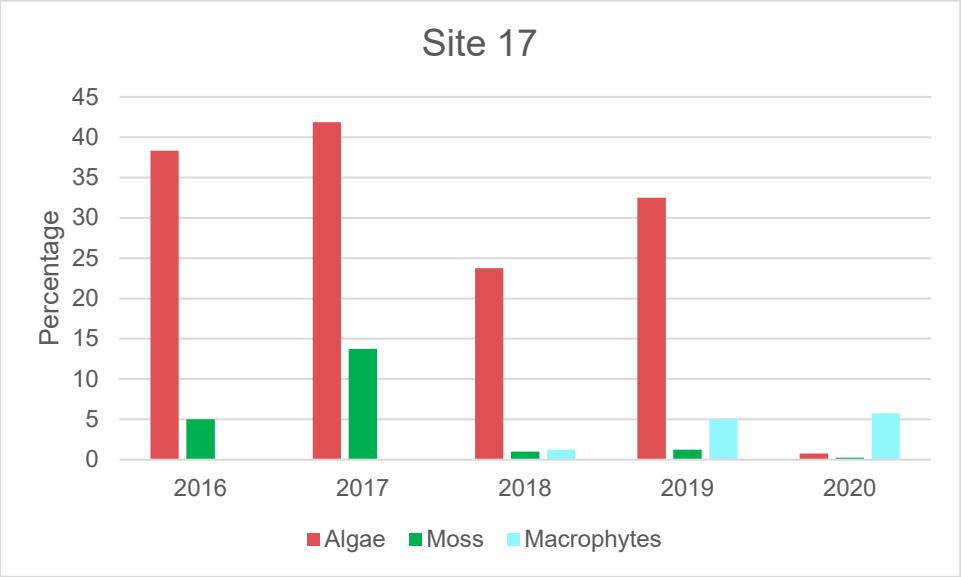


Figure 3-5 Site 17 Algae, moss and macrophyte percentages between 2016 and 2020.

## Site 22

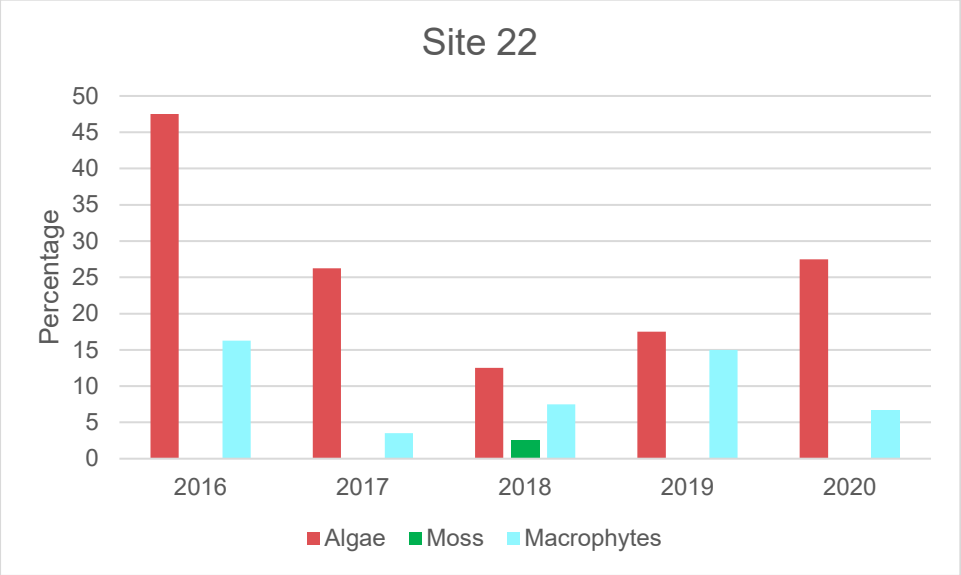


Figure 3-6 Site 22 Algae, moss and macrophyte percentages between 2016 and 2020.

## Site 25

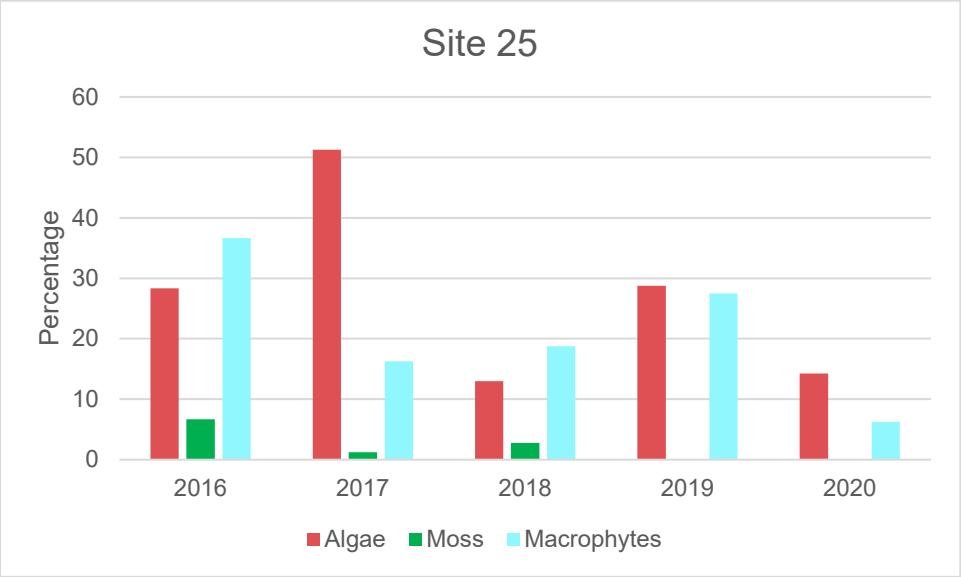


Figure 3-7 Site 25 Algae, moss and macrophyte percentages between 2016 and 2020.

## Site 27

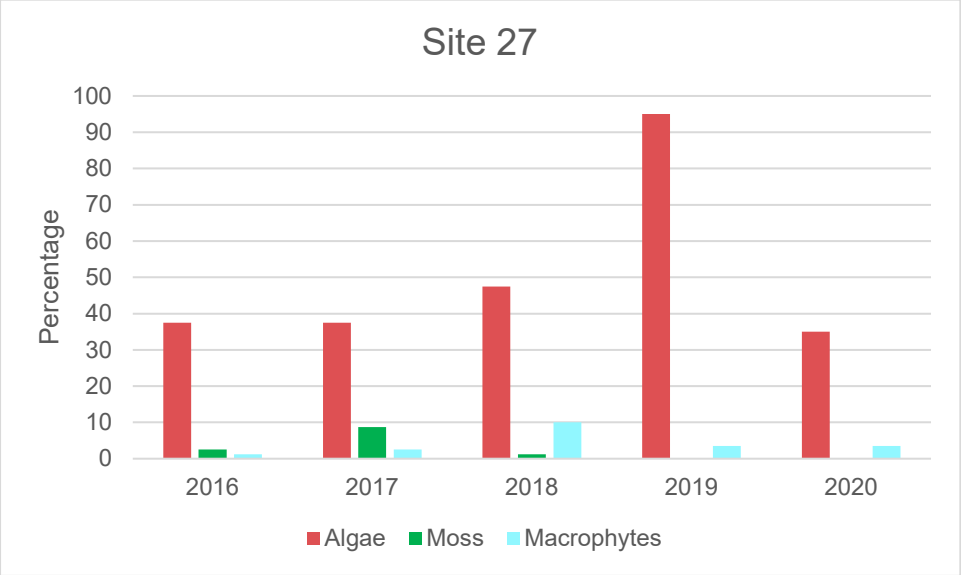


Figure 3-8 Site 27 Algae, moss and macrophyte percentages between 2016 and 2020.

## Control Site 1

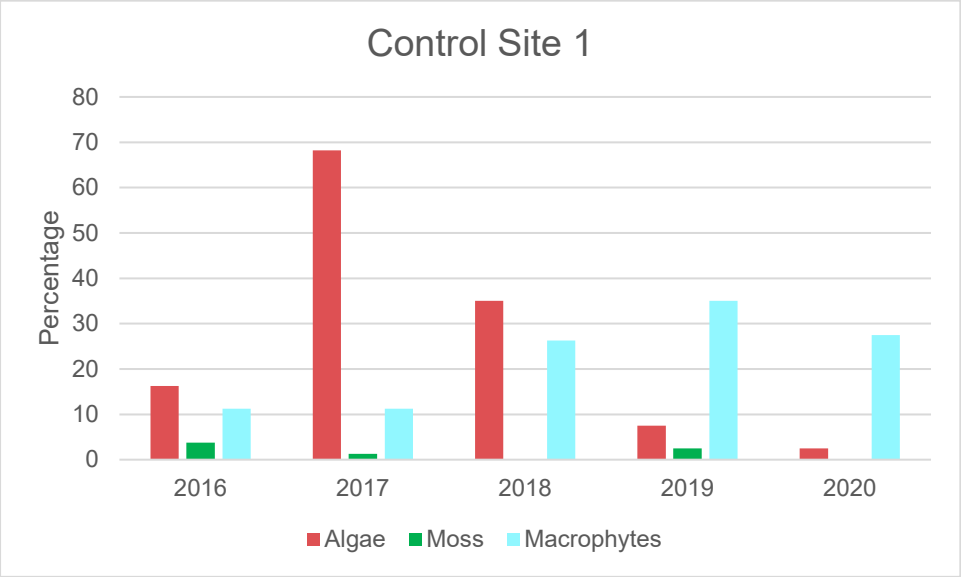


Figure 3-9 Control Site 1 Algae, moss and macrophyte percentages between 2016 and 2020.

## Control Site 2

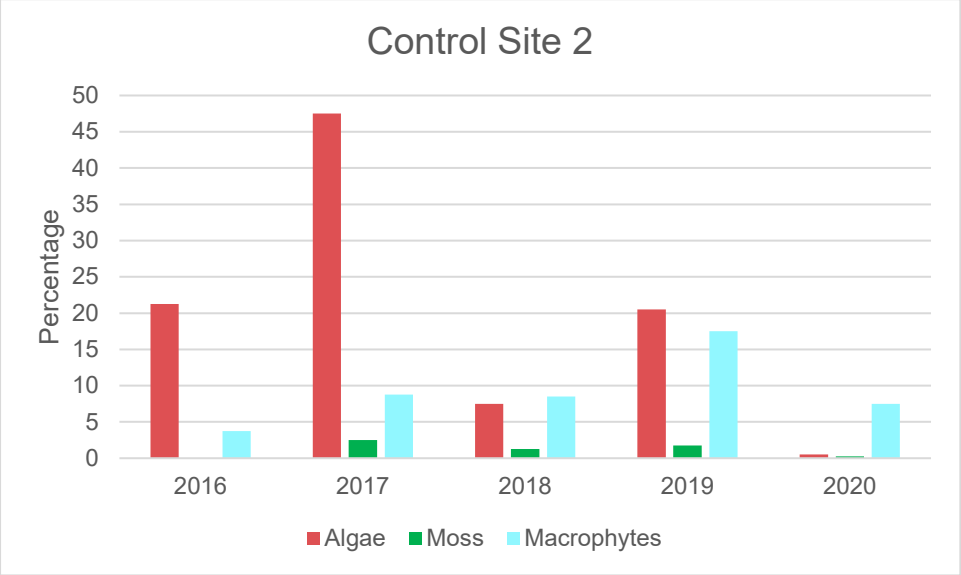


Figure 3-10 Control Site 2 Algae, moss and macrophyte percentages between 2016 and 2020.

### 3.2.2. Water Quality

The results of water quality monitoring from all sites are presented in Table 3-7 below.

Table 3-7 2020 Water quality results across sites 13,16,17,22,25,27, and control sites 1 and 2

| Site | Timing | Session | Temperature °C | pH | Conductivity mS/cm | Turbidity NTU | Dissolved oxygen % saturation |
|---|---|---|---|---|---|---|---|
| **ANZECC/AR MCANZZ Trigger value[1]** | | | NA | 6.5-8 | 200-300 | 6-50 | 85-110% |
| **Control site 1** | Winter 2020 | Session 1 | 10.0 | 6.68 | 89.7 | 5.4 | 89.6 |
| **Control site 1** | Winter 2020 | Session 2 | 11.6 | 6.41 | 92.0 | 2.4 | 99.7 |
| **Control site 1** | Spring 2020 | Session 1 | 18.2 | 6.09 | 102.5 | 3.0 | 110.0 |
| **Control site 1** | Spring 2020 | Session 2 | 20.0 | 5.99 | 130.4 | 2.2 | 94.6 |
| **Control Site 2** | Winter 2020 | Session 1 | 10.1 | 6.85 | 100.1 | 2.1 | 98.1 |
| **Control site 2** | Winter 2020 | Session 2 | 10.6 | 6.88 | 102.3 | 1.4 | 100.3 |
| **Control site 2** | Spring 2020 | Session 1 | 19.6 | 6.33 | 120.1 | 1.6 | 120.3 |
| **Control site 2** | Spring 2020 | Session 2 | 18.6 | 6.08 | 142.4 | 2.1 | 68.4 |
| **Site 13** | Winter 2020 | Session 1 | 10.8 | 6.37 | 102.6 | 2.3 | 95.9 |
| **Site 13** | Winter 2020 | Session 2 | 10.4 | 6.92 | 102.1 | 1.4 | 98.9 |
| **Site 13** | Spring 2020 | Session 1 | 19.4 | 6.21 | 120.3 | 1.9 | 120.1 |

[1] *Trigger values are concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' a management response (ANZECC/ARMCANZ Guidelines 2000). Green cells indicate results that are within the ANZECC/ARMCANZ trigger value range, where red cells are those results that have fallen outside the trigger value range and indicate a potential environmental problem. The results in Table 3-7 were recorded within a previously disturbed and degraded system which accounts for the prevalence of red cells.*

| Site | Timing | Session | Temperature °C | pH | Conductivity mS/cm | Turbidity NTU | Dissolved oxygen % saturation |
|---|---|---|---|---|---|---|---|
| **Site 13** | Spring 2020 | Session 2 | 17.4 | 6.32 | 141.4 | 2.4 | 87.5 |
| **Site 16** | Winter 2020 | Session 1 | 9.7 | 7.54 | 100.7 | 2.4 | 99.4 |
| **Site 16** | Winter 2020 | Session 2 | 10.7 | 6.67 | 103.9 | 1.6 | 101.1 |
| **Site 16** | Spring 2020 | Session 1 | 19.3 | 6.85 | 123 | 1.9 | 109.5 |
| **Site 16** | Spring 2020 | Session 2 | 23.4 | 5.45 | 161.8 | 2.5 | 104.5 |
| **Site 17** | Winter 2020 | Session 1 | 10.8 | 6.23 | 107.9 | 2.3 | 96.0 |
| **Site 17** | Winter 2020 | Session 2 | 9.7 | 7.01 | 103.8 | 1.4 | 95.1 |
| **Site 17** | Spring 2020 | Session 1 | 19.1 | 6.46 | 125.8 | 2.4 | 103.7 |
| **Site 17** | Spring 2020 | Session 2 | 20.8 | 5.60 | 158.7 | 1.8 | 65.3 |
| **Site 22** | Winter 2020 | Session 1 | 9.4 | 7.05 | 117.57 | 7.9 | 83.7 |
| **Site 22** | Winter 2020 | Session 2 | 12.2 | 7.13 | 118.1 | 3.0 | 109.0 |
| **Site 22** | Spring 2020 | Session 1 | 19.1 | 6.15 | 140 | 2.2 | 119.8 |
| **Site 22** | Spring 2020 | Session 2 | 20.3 | 5.19 | 180.6 | 2.5 | 83.2 |
| **Site 25** | Winter 2020 | Session 1 | 11.5 | 6.06 | 94.7 | 4.7 | 88.3 |
| **Site 25** | Winter 2020 | Session 2 | 10.6 | 6.15 | 101.6 | 2.2 | 98.4 |
| **Site 25** | Spring 2020 | Session 1 | 19.9 | 5.89 | 107.6 | 2.5 | 120.1 |
| **Site 25** | Spring 2020 | Session 2 | 23.0 | 5.30 | 145.8 | 4 | 82.6 |
| **Site 27** | Winter 2020 | Session 1 | 12.0 | 5.91 | 141 | 2.6 | 85 |

| Site | Timing | Session | Temperature °C | pH | Conductivity mS/cm | Turbidity NTU | Dissolved oxygen % saturation |
|---|---|---|---|---|---|---|---|
| **Site 27** | Winter 2020 | Session 2 | 11.7 | 6.46 | 131.2 | 4.1 | 98.9 |
| **Site 27** | Spring 2020 | Session 1 | 19.0 | 6.05 | 146.5 | 1.3 | 138.7 |
| **Site 27** | Spring 2020 | Session 2 | 20.9 | 5.26 | 176.2 | 2.2 | 86.7 |

The following was observed during the 2020 monitoring period:

- Water temperatures recorded at the treatment sites were between 9.4ºC and 23.4ºC for treatment sites and 10.1ºC and 20.0ºC at control sites. Temperatures varied according to the season and the conditions of the waterway. This variation was also consistent throughout the pre-construction and construction period.
- pH readings in 2020 were variable, ranging between 5.19 and 7.54 in treatment sites, and 5.99 and 6.88 in control sites. Soil and animal health will not generally be affected by water with pH in the range of 4-9, however values between 4 and 6 should be regarded with caution due to the potential for corrosion and fouling (ANZECC/ARMCANZ 2000). pH levels dropped below 6.0 in five of six treatment sites, and in one of two control sites. pH values fell within the ANZECC/ARMCANZ 2000 guidelines trigger value range seven out of 24 times (29%) for treatment sites, and three out of eight (37.5%) times for control sites in 2020.
- Conductivity had the equal lowest proportion of values fall within the guideline levels in 2020; zero out of 32 (0%) from all sites. Control sites did not achieve a single reading within the trigger value range in 2020. With all readings that fell outside of the trigger value range, conductivity was too low.
- Turbidity had the equal lowest proportion of values fall within the guideline levels in 2020; one out of 32 (3%) from all sites. All readings that fell outside the guideline range for turbidity were too low. In 2020 the highest value recorded was 7.9 NTU during Winter Session 1 Site 22.
- Dissolved oxygen was recorded within the ANZECC/ARMCANZ guideline range 17 out of 24 times (71%) in treatment sites in 2020, and six out of eight times (75%) in control sites. This parameter had the highest proportion of values recorded within the ANZECC/ARMCANZ guideline range.

Table 3-8 below show the comparison of water quality parameters between pre-construction data (2014) and the most current data (2020) at the treatment sites. Columns for +/- 10% as well as a pass/fail column have been included to address the performance target and criteria. This is discussed further in section 4.2.

Table 3-9 below shows the comparison of water quality parameters between during construction (2016-2017) and the most current data (2020) of control sites. Columns for +/- 10% as well as a pass/fail column have been included to address the performance target and criteria. This is discussed further in section 4.2. Trendlines of each water quality parameter across all years of survey are presented in the figures below (Figure 3-11 to Figure 3-15).

Table 3-8 Treatment site water quality comparison between pre-construction and 2020 results

| Site | Water Quality Parameters | 2014 average | 2020 average | Plus 10% | Minus 10% | Pass/Fail |
|---|---|---|---|---|---|---|
| Site 13 | Temperature ºC | 16.225 | 14.5 | 17.8475 | 14.6025 | Fail |
| | pH | 6.7725 | 6.455 | 7.44975 | 6.09525 | Pass |
| | Conductivity µs/cm | 104.225 | 116.6 | 114.6475 | 93.8025 | Fail |
| | Turbidity NTU | 48.13333333 | 2 | 52.94667 | 43.32 | Fail |
| | Dissolved oxygen % saturation | 76.34 | 100.6 | 83.974 | 68.706 | Fail |
| | | | | | | |
| Site 16 | Temperature ºC | 15.8 | 15.775 | 17.38 | 14.22 | Pass |
| | pH | 6.83 | 6.6275 | 7.513 | 6.147 | Pass |
| | Conductivity µs/cm | 121.025 | 122.35 | 133.1275 | 108.9225 | Pass |
| | Turbidity NTU | 3.2 | 2.1 | 3.52 | 2.88 | Fail |
| | Dissolved oxygen % saturation | 74.53 | 103.625 | 81.983 | 67.077 | Fail |
| | | | | | | |
| Site 17 | Temperature ºC | 15.975 | 15.1 | 17.5725 | 14.3775 | Pass |
| | pH | 6.93 | 6.325 | 7.623 | 6.237 | Pass |
| | Conductivity µs/cm | 118.325 | 124.05 | 130.1575 | 106.4925 | Pass |
| | Turbidity NTU | 11.3 | 1.975 | 12.43 | 10.17 | Fail |
| | Dissolved oxygen % saturation | 78.5225 | 90.025 | 86.37475 | 70.67025 | Fail |
| | | | | | | |
| Site 22 | Temperature ºC | 16.8 | 15.25 | 18.48 | 15.12 | Pass |
| | pH | 6.5875 | 6.38 | 7.24625 | 5.92875 | Pass |
| | Conductivity µs/cm | 206.475 | 139.0675 | 227.1225 | 185.8275 | Fail |
| | Turbidity NTU | 8.2 | 3.9 | 9.02 | 7.38 | Fail |
| | Dissolved oxygen % saturation | 57.0075 | 98.925 | 62.70825 | 51.30675 | Fail |
| | | | | | | |

| Site | Water Quality Parameters | 2014 average | 2020 average | Plus 10% | Minus 10% | Pass/Fail |
|---|---|---|---|---|---|---|
| Site 25 | Temperature °C | 16.675 | 16.25 | 18.3425 | 15.0075 | Pass |
| | pH | 6.34 | 5.85 | 6.974 | 5.706 | Pass |
| | Conductivity µs/cm | 103.625 | 112.425 | 113.9875 | 93.2625 | Pass |
| | Turbidity NTU | 4.666666667 | 3.35 | 5.133333 | 4.2 | Pass |
| | Dissolved oxygen % saturation | 69.0875 | 97.35 | 75.99625 | 62.17875 | Fail |
| | | | | | | |
| Site 27 | Temperature °C | 16.525 | 15.9 | 18.1775 | 14.8725 | Pass |
| | pH | 6.07 | 5.92 | 6.677 | 5.463 | Pass |
| | Conductivity µs/cm | 182.775 | 148.725 | 201.0525 | 164.4975 | Fail |
| | Turbidity NTU | 7.8 | 2.55 | 8.58 | 7.02 | Fail |
| | Dissolved oxygen % saturation | 53.525 | 102.325 | 58.8775 | 48.1725 | Fail |

Table 3-9 Control site water quality comparison between during construction and 2020 results

| Site | Water quality parameters | During Construction average (2016-2017) | During Construction average (2016-2017) Minus (-) 10% | During Construction average (2016-2017) Plus (+) 10% | 2020 Post constructio n average | Pass/Fail |
|---|---|---|---|---|---|---|
| Control site 1 | Temperature °C | 16.56875 | 14.911875 | 18.225625 | 14.95 | Pass |
| | pH | 6.8625 | 6.17625 | 7.54875 | 6.2925 | Pass |
| | Conductivity ms/cm | 142.875 | 128.5875 | 157.1625 | 103.65 | Fail |
| | Turbidity NTU | 2.875 | 2.5875 | 3.1625 | 3.25 | Fail |
| | Dissolved oxygen % saturation | 65.72625 | 59.153625 | 72.298875 | 98.475 | Fail |
| | | | | | | |
| Control site 2 | Temperature °C | 17.415 | 15.6735 | 19.1565 | 14.675 | Fail |
| | pH | 6.786666667 | 6.108 | 7.465333333 | 6.535 | Pass |
| | Conductivity ms/cm | 151.8333333 | 136.65 | 167.0166667 | 116.225 | Fail |
| | Turbidity NTU | 0.683333333 | 0.615 | 0.751666667 | 1.8 | Fail |
| | Dissolved oxygen % saturation | 59.26166667 | 53.3355 | 65.18783333 | 96.775 | Fail |

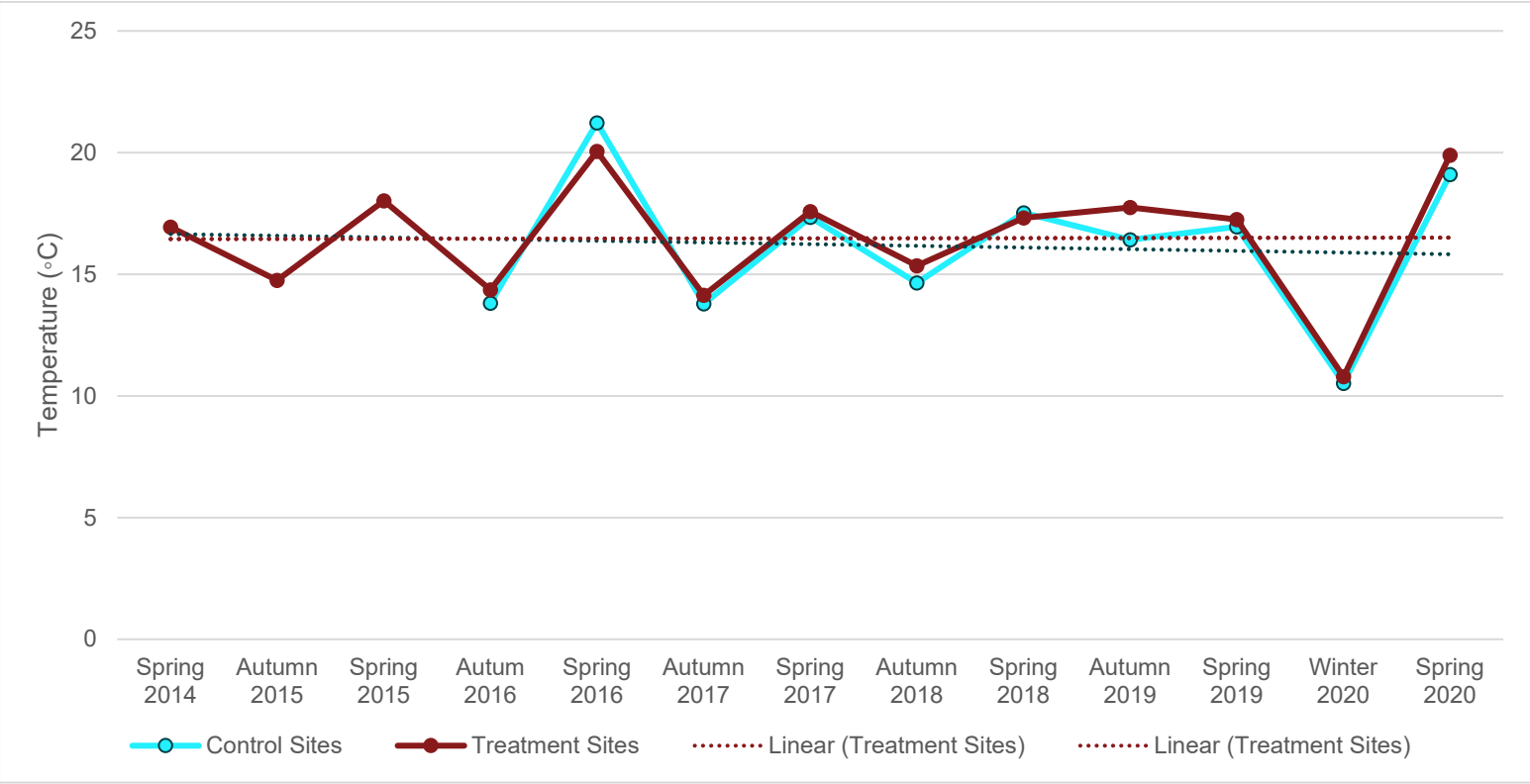


Figure 3-11 Water temperature across treatment and control sites between 2014 and 2020 surveys

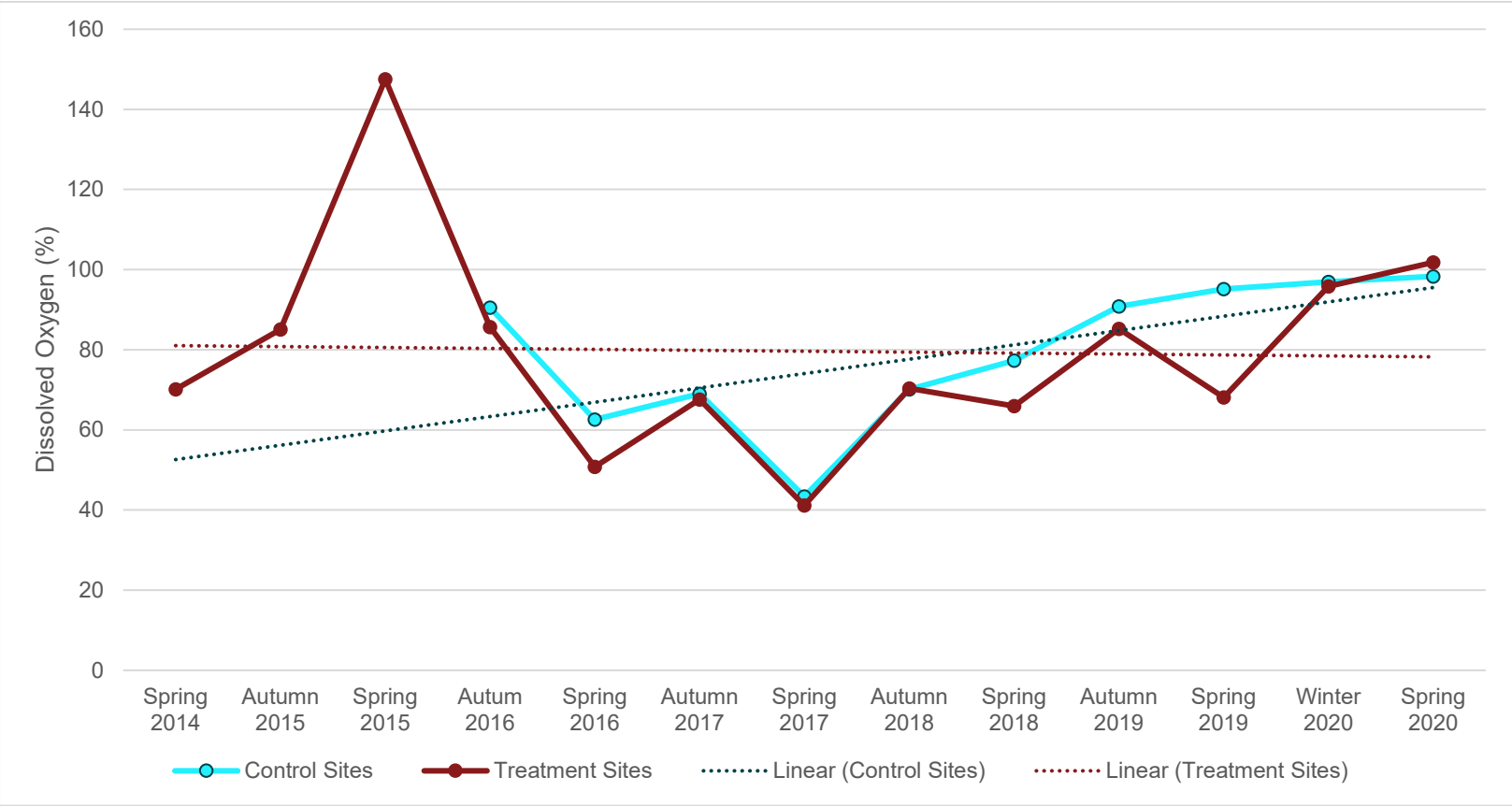


Figure 3-12 Water dissolved oxygen levels across treatment and control sites between 2014 and 2020 surveys

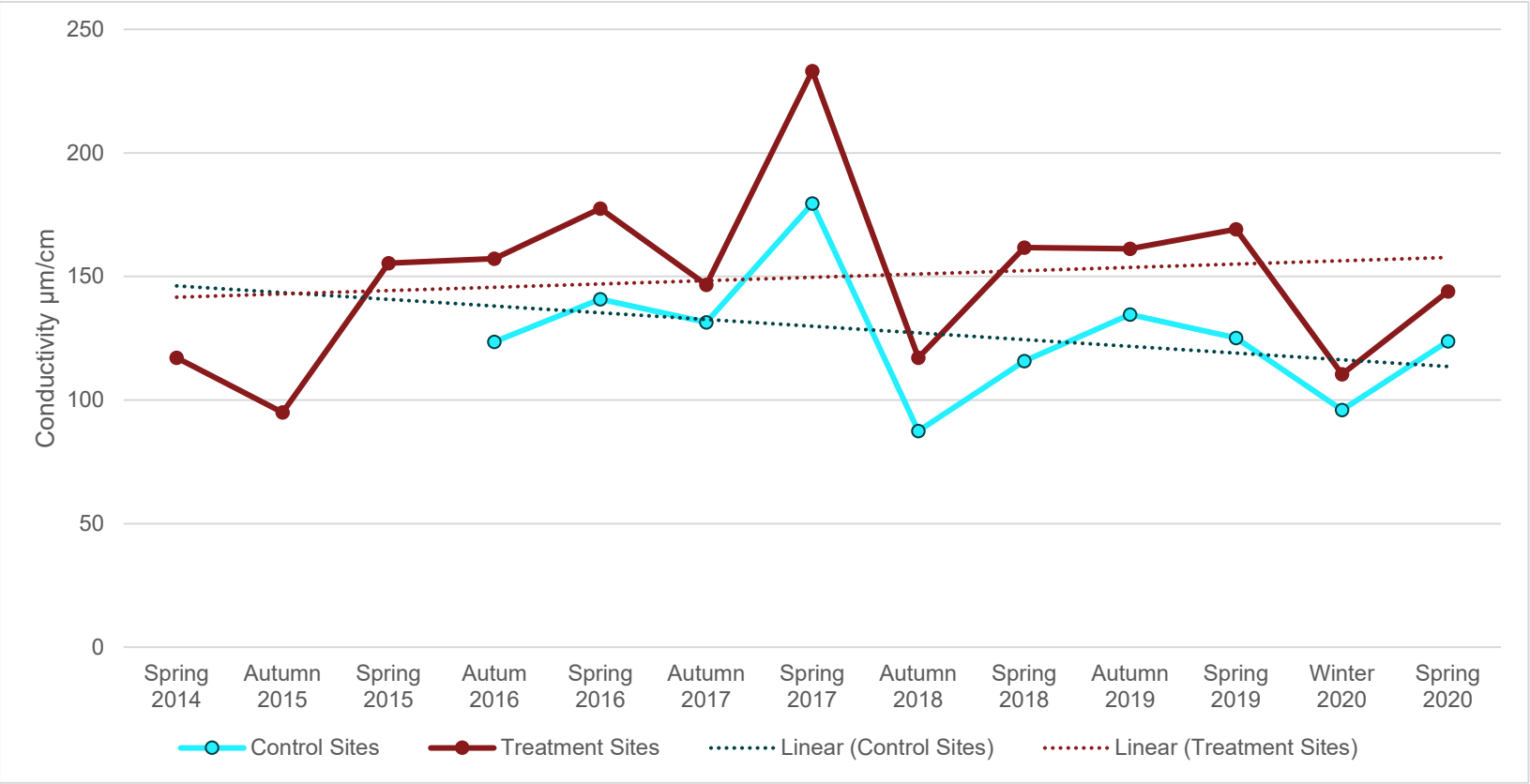


Figure 3-13 Water conductivity across treatment and control sites between 2014 and 2020 surveys

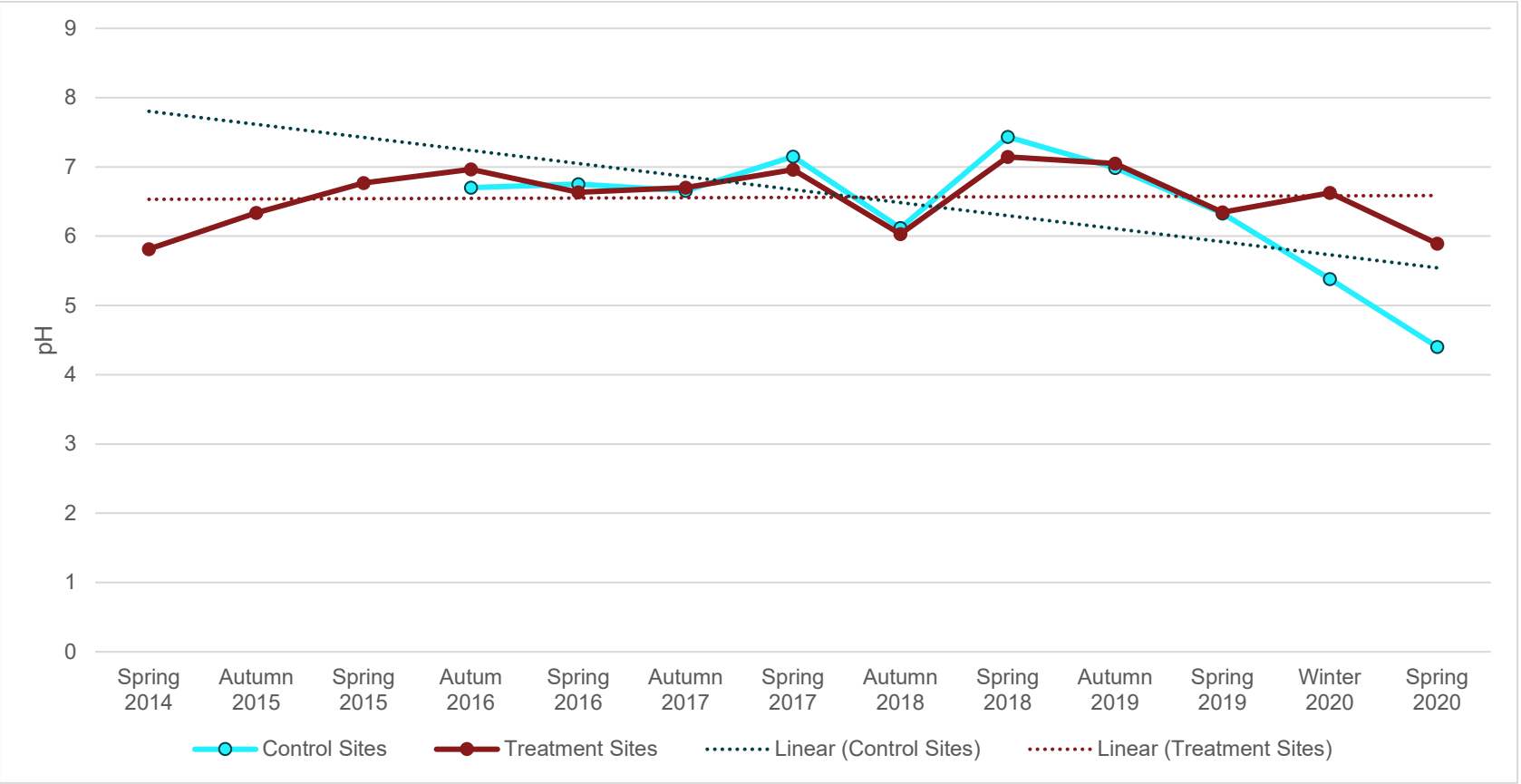


Figure 3-14 Water pH levels across treatment and control sites between 2014 and 2020 surveys

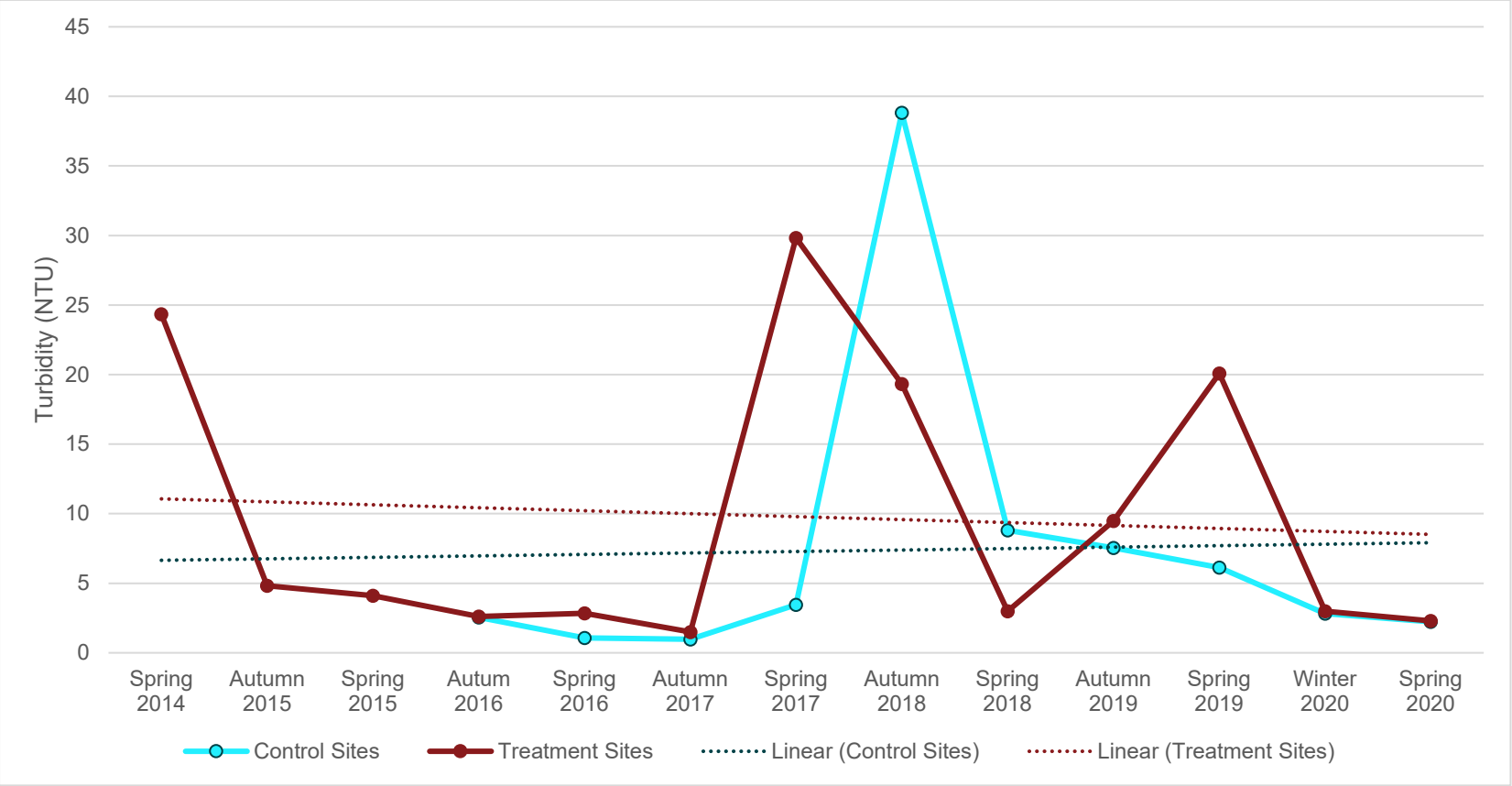


Figure 3-15 Water turbidity levels across treatment and control sites between 2014 and 2020 surveys

### 3.2.3. Macrophyte and Emergent Vegetation

The following presents the macrophyte and emergent vegetation of each site during 2020 as collected within the fixed quadrats.

Table 3-10 Macrophyte and emergent vegetation of each site in Winter Session 1 2020 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2)

| | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 |
|---|---|---|---|---|---|---|---|---|
| ***Persicaria hydropiper*** **Water pepper** | 0 | 2 | 0 | 0 | 0 | 2 | 3 | 1 |
| ***Baumea articulata*** **Jointed rush** | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| ***Sagittaria platyphylla**** **Sagittaria** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Colocasia sp.*** **Taro *** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ***Colocasia sp.**** **Elephants ear** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ***Juncus usitatus*** **Common rush** | 2 | 1 | 1 | 0 | 0 | 2 | 2 | 1 |
| ****Cyperus eragrostis*** **Umbrella Sedge** | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 1 |

Table 3-11 Macrophyte and emergent vegetation of each site in Winter Session 2 2020 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2)

| | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 |
|---|---|---|---|---|---|---|---|---|
| ***Persicaria hydropiper*** **Water pepper** | 2 | 2 | 0 | 0 | 2 | 2 | 2 | 2 |
| ***Sagittaria platyphylla**** **Sagittaria** | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| ***Colocasia sp.**** **Elephants ear** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ***Juncus usitatus*** **Common rush** | 2 | 2 | 1 | 0 | 0 | 2 | 2 | 2 |
| ****Rorippa nasturtium-aquaticum*** **Watercress** | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

Table 3-12 Macrophyte and emergent vegetation of each site in Spring Session 1 2020 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2)

| | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 |
|---|---|---|---|---|---|---|---|---|
| ***Persicaria hydropiper*** **Water pepper** | 3 | 2 | 2 | 3 | 2 | 2 | 5 | 2 |
| ***Baumea articulata*** **Jointed rush** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ***Sagittaria platyphylla**** **Sagittaria** | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| ***Colocasia sp.**** **Elephants ear** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ***Juncus usitatus*** **Common rush** | 2 | 2 | 2 | 0 | 0 | 2 | 3 | 0 |
| ****Cyperus eragrostis*** **Umbrella Sedge** | 1 | 0 | 1 | 3 | 0 | 0 | 2 | 0 |
| ****Rorippa nasturtium-aquaticum*** **Watercress** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Ageratina riparia*** **Mist flower** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ***Rumex obtusifolius*** **Curly-leaved Dock** | 1 | 0 | 0 | 1 | 1 | 0 | 2 | 1 |

Table 3-13 Macrophyte and emergent vegetation of each site in Spring Session 2 2020 according to the Braun-Blanquet 6-point scale

| | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 |
|---|---|---|---|---|---|---|---|---|
| ***Persicaria hydropiper*** **Water pepper** | 2 | 2 | 2 | 3 | 2 | 0 | 3 | 2 |
| ***Persicaria strigosa*** **Spotted Knotweed** | 2 | 2 | 0 | 0 | 2 | 0 | 1 | 0 |
| ***Baumea articulata*** **Jointed rush** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| ***Sagittaria platyphylla**** **Sagittaria** | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 |
| ***Colocasia sp.*** **Taro** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| ***Colocasia sp.**** **Elephants ear** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Juncus usitatus*** **Common rush** | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| ****Cyperus eragrostis*** **Umbrella Sedge** | 2 | 0 | 1 | 4 | 2 | 2 | 0 | 2 |
| ***Rumex obtusifolius*** **Curly-leaved Dock** | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |

### 3.2.4. Macroinvertebrates

The following tables summarise the macroinvertebrate survey results for each site in 2020. Signal and EPT scores have been given (refer to 2.3.5 for guidelines). Results from previous years can be found in Appendix E.

Table 3-14 Summary of 2020 macroinvertebrate data for treatment sites

| **Site 13** | | | | |
|---|---|---|---|---|
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 6.6 | 7.0 | 7.3 | 6.9 |
| EPT Score | 6 | 6 | 6 | 7 |
| Number of Taxa | 13 | 13 | 13 | 16 |
| **Site 16** | | | | |
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 6.6 | 7.3 | 7.7 | 6.9 |
| EPT Score | 6 | 9 | 8 | 4 |
| Number of Taxa | 14 | 18 | 16 | 11 |
| **Site 17** | | | | |
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 6.6 | 6.3 | 7.2 | 6.7 |
| EPT Score | 6 | 6 | 7 | 7 |
| Number of Taxa | 19 | 15 | 16 | 19 |
| **Site 22** | | | | |
| | Winter 2020 | | Spring 2020 | |

| | | | | |
|---|---|---|---|---|
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 5.1 | 7.0 | 6.7 | 6.2 |
| EPT Score | 5 | 6 | 6 | 8 |
| Number of Taxa | 15 | 16 | 22 | 19 |
| **Site 25** | | | | |
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 5.9 | 6.5 | 6.0 | 5.8 |
| EPT Score | 5 | 3 | 5 | 5 |
| Number of Taxa | 16 | 10 | 13 | 13 |
| **Site 27** | | | | |
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 6.2 | 6.6 | 7.1 | 6.7 |
| EPT Score | 4 | 5 | 6 | 7 |
| Number of Taxa | 11 | 13 | 18 | 18 |

Table 3-15 Summary of 2020 macroinvertebrate data for control sites

| **Control Site 1** | | | | |
|---|---|---|---|---|
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 5.8 | 6.5 | 6.3 | 6.4 |
| EPT Score | 6 | 8 | 7 | 6 |
| Number of Taxa | 19 | 18 | 22 | 17 |
| **Control Site 2** | | | | |
| | Winter 2020 | | Spring 2020 | |
| | Session 1 | Session 2 | Session 1 | Session 2 |
| Signal Score | 6.3 | 6.5 | 7.0 | 7.1 |
| EPT Score | 6 | 6 | 6 | 9 |
| Number of Taxa | 14 | 11 | 15 | 18 |

### 3.2.5. Aquatic Fauna Assessment

A total of 13 individuals were collected/observed across two common fish species in 2020 (see Figure 3-16). The only other aquatic species observed in 2020 were three (3) Short-finned Eels observed at Site 17, Site 27 and Control site 1 during Spring Session 2. No new aquatic species were recorded in 2020 surveys. Previous years data can be seen in Appendix C.

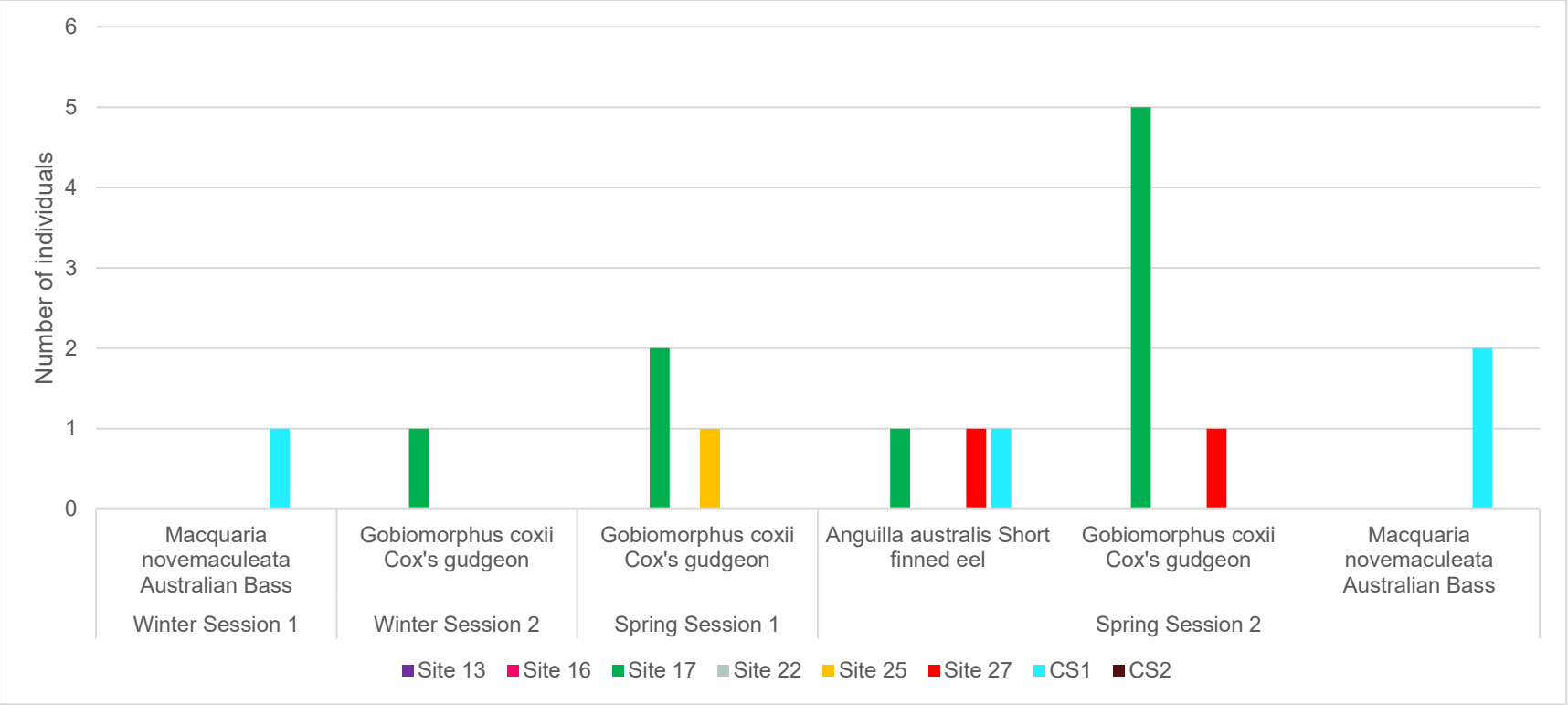


Figure 3-16 Aquatic fauna species observed across all sites and sessions in 2020

Aquatic fauna diversity at control sites was similar to 2019 records, with diversity increasing by from 3 (2019) to 4 (2020) and abundance remaining at 2 individuals across the two periods, see figure 3-17. These figures remain lower than control site surveys in 2017 (abundance 6, diversity 3). Treatment sites in 2020 had greater abundance of aquatic fauna (12) but a lower diversity (3) was recorded than in 2019 (abundance 4, diversity 4).

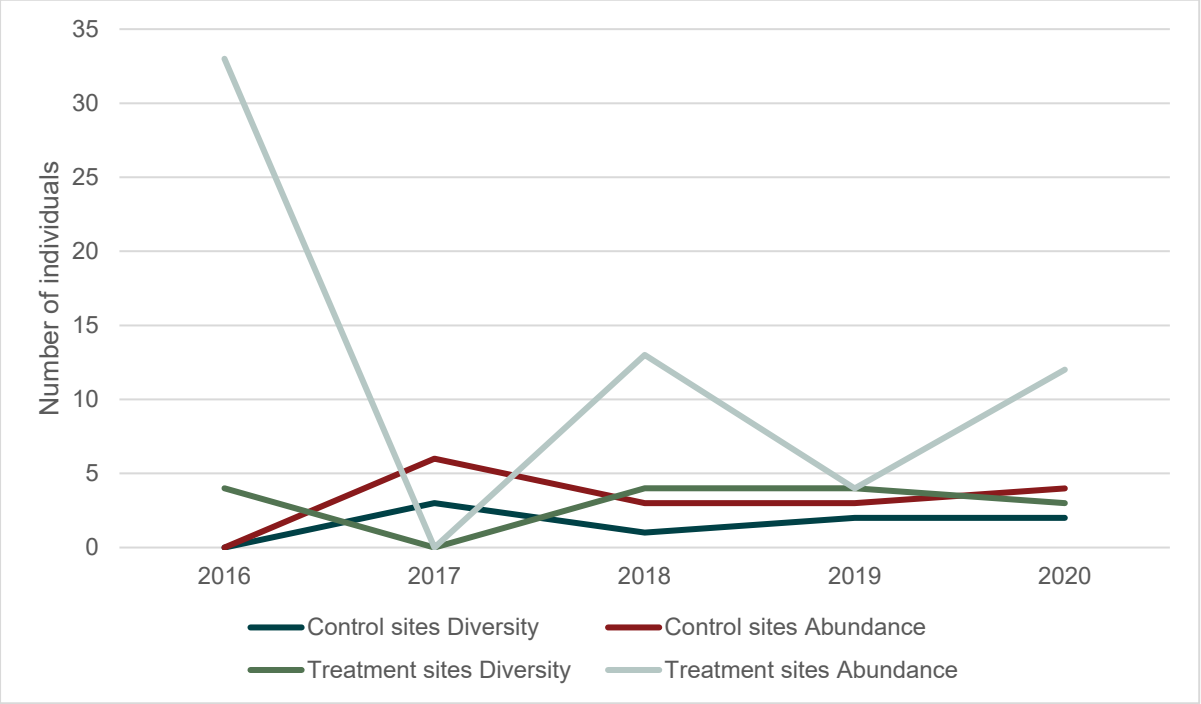


Figure 3-17 Diversity and abundance of aquatic fauna species (2016-2020)

## 3.3. NEST BOX MONITORING

The 2020 post-construction monitoring of 8 recycled hollow nest boxes found 1 containing signs of microbat use. Detailed results from the survey can be found in Table 3-16 below.

Table 3-16 Nest box monitoring results

| Nest Box ID | Design Type | Scat Plate | Height (m) | Orientation | Location | Method | Observation/Notes | Likelihood of Microbat utilisation | Repair |
|---|---|---|---|---|---|---|---|---|---|
| **NV1** | Horizontal | - | 5.0 | 165 SE | 1 | Inspection camera | Inside of nest box inspected, difficult to see last quarter due to minimal light. No signs of microbat use. Spider webs present in front entrance. | Unlikely | No repair required |
| **NV2** | Horizontal | - | 5.35 | 65 NE | 2 | Inspection camera | Inside of nest box thoroughly inspected, no signs of microbat use. | Unlikely | No repair required |
| **NV3** | Horizontal | - | 5.0 | 217 SW | 1 | Inspection camera | Inside of nest box thoroughly inspected, no signs of microbat use. | Unlikely | No repair required |
| **NV4** | Vertical | Y | 4.1 | 220 SW | 2 | Inspection camera and GoPro | Inside of nest box thoroughly inspected, no signs of microbat use. Spider webs present. Scat plate inspected, no signs of microbat use. | Unlikely | No repair required |
| **NV5** | Vertical | Y | 4.0 | 265 W | 2 | Inspection camera and GoPro | Inside of nest box inspected, difficult to see top quarter due to minimal light and bend in nest box. Microbat chatter was overheard, and inspection camera was removed. Scat plate inspected; no scats detected. | Likely | No repair required |
| **NV6** | Vertical | Y | 5.0 | 50 NE | 1 | Inspection camera and GoPro | Inside of nest box thoroughly inspected, no signs of microbat use. Scat plate inspected, no signs of microbat use. | Unlikely | No repair required |
| **NV7** | 45 degree | - | 5.0 | 345 N | 1 | Inspection camera | Inside of nest box inspected. Top quarter was difficult to see due to minimal light. No microbat use detected. Spider webs present | Unlikely | No repair required |

| Nest Box ID | Design Type | Scat Plate | Height (m) | Orientation | Location | Method | Observation/Notes | Likelihood of Microbat utilisation | Repair |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | in bottom entrance | | |
| **NV8** | 45 degree | - | 5.0 | 238 SW | 2 | Inspection camera | Inside of nest box inspected. Top quarter was difficult to see due to minimal light and angle of box. No microbat use detected. | Unlikely | No repair required |

## 3.4. WEED MONITORING

### 3.4.1. Weed Species Present

The 2020 post-construction weed monitoring of the 49 chainages identified 47 exotic weed species within the Foxground and Berry Bypass project area. with four (4) of the species listed as Priority Weeds under the *Biosecurity Act 2015.* Table 3-16 summarises the species identified and the Priority Weed Duty according to the Biosecurity Act.

Table 3-17 Priority and environmental weed species identified during 2020 weed monitoring

| Weed Species | Common Name | Environmental Weed | Priority Weed Duty (Biosecurity Act) |
|---|---|---|---|
| *Acetosa sagittata* | Turkey Rhubarb | x | |
| *Ageratina adenophora* | Crofton weed | x | |
| *Andropogon virginicus* | Whisky Grass | x | |
| *Araujia sericifera* | Moth Vine | x | |
| *Avena fatua* | Common Wild Oat | x | |
| *Bidens pilosa* | Cobbler's Pegs | x | |
| *Brassica oleracea* | Mustard | x | |
| *Briza maxima* | Quaking Grass | x | |
| *Briza minor* | Shivery Grass | x | |
| *Cenchrus clandestinus* | Kikuyu | x | |
| *Centaurea solstitialis* | St Barnaby's Thistle | x | |
| *Chenopodium album* | White Goosefoot | x | |
| *Chloris gayana* | Rhodes Grass | x | |
| *Cirsium vulgare* | Spear Thistle | x | |
| *Conyza bonariensis* | Fleabane | x | |
| *Cyperus eragrostis* | Tall flatsedge | x | |
| *Dactylis glomerata* | Cocksfoot | x | |
| *Erythrina sykesii* | Coral Tree | x | |

| Weed Species | Common Name | Environmental Weed | Priority Weed Duty (Biosecurity Act) |
|---|---|---|---|
| *Foeniculum vulgare* | Fennel | x | |
| *Gomphocarpus physocarpus* | Cottonbush | x | |
| *Grevillea robusta* | Silky Oak | x | |
| *Hypochaeris radicata* | Cat's Ear | x | |
| *Hyparrhenia hirta* | Coolatai Grass | x | |
| *Lantana camara* | Lantana | | Prohibition on dealings |
| *Lactuca seriiola* | Prickly Lettuce | x | |
| *Ligustrum sinense* | Small-leaved privet | x | |
| *Lolium perenne* | Perennial Ryegrass | x | |
| *Malva parviflora* | Mallow | x | |
| *Medicago sativa* | Alfalfa | x | |
| *Paspalum dilatatum* | Paspalum | x | |
| *Paspalum urvillei* | Vasey Grass | x | |
| *Phalaris aquatica* | Phalaris | x | |
| *Phytolacca octandra* | Inkweed | x | |
| *Plantago lanceolata* | Ribwort Plantain | x | |
| *Rubus fruticosus* | Blackberry | | Prohibition on dealings |
| *Rumex obtusifolius* | Curly Dock | x | |
| *Senecio madagascariensis* | Fireweed | | Regional Recommended Measure |
| *Setaria parviflora* | Pigeon Grass | x | |
| *Sida rhombifolia* | Paddy's Lucerne | x | |
| *Solanum mauritianum* | Wild Tobacco | x | |
| *Solanum nigrum* | Blackberry nightshade | x | |
| *Sonchus oleraceus* | Sow Thistle | x | |
| *Sporobolus fertilis* | Giant Parramatta grass | | Regional Recommended Measure |
| *Sporobolus africanus* | Parramatta grass | x | |
| *Tagetes minuta* | Stinking Roger | x | |
| *Trifolium repens* | White Clover | x | |
| *Verbena bonariensis* | Purpletop | x | |

Priority Weed Duty – as listed under the Biosecurity Act for the South-east Region

### 3.4.2. Cover and Abundances

Table 3-17 presents the weed species and relative abundance at each of the weed monitoring sites. Relative abundance is given by a cover abundance scale (modified Braun-Blanquet):

1. 1 to a few individuals present, less than 5% cover
2. many individuals present, but still less than 5% cover
3. 5 - < 20% cover
4. 20 - < 50% cover
5. 50 - < 75% cover
6. 75 - 100% cover

Table 3-18 Description of each survey location, dominant weeds and relative abundance

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 15 | 297055 | 6152294 | North of Toolijooa Rd | Batter | Mustard *Brassica oleracea* – 1<br>Kikuyu *Cenchrus clandestinus* – 5<br>Cobbler's Pegs Bidens p*ilosa* – 3<br>Paddy's Lucerne *Sida rhombifolia* – 2<br>Lantana *Lantana camara* – 1<br>Paspalum *Paspalum dilatatum* – 3<br>Fennel *Foeniculum vulgare* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Moth vine *Araujia sericifera* – 1<br>Sow thistle *Sonchus oleraceus* – 1<br>Common Wild Oat *Avena fatua* – 2<br>Rhodes Grass *Chloris gayana* – 2<br>Mallow *Malva parviflora* – 2 |  |
| 14 | 296835 | 6152244 | Near turn around bay south of Toolijooa Rd | Construction area, with bare soil areas | Kikuyu *Cenchrus clandestinus* – 5<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Paspalum *Paspalum dilatatum* – 4<br>Fennel *Foeniculum vulgare* - 3<br>White Clover *Trifolium repens* - 2<br>Cat's ear *Hypochaeris radicata*- 2<br>Paddy's Lucerne *Sida rhombifolia* – 2<br>Vasey Grass *Paspalum urvillei* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 16 | 296799 | 615239 | South of Toolijooa Rd | Roadside area | Kikuyu *Cenchrus clandestinus* – 5<br>Paspalum *Paspalum dilatatum* – 4<br>Purpletop *Verbena bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Sow thistle *Sonchus oleraceus* – 2<br>Fireweed *Senecio madagascariensis* – 1<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Common Wild Oat *Avena fatua* – 2<br>Cottonbush *Gomphocarpus physocarpus* – 1<br>Mallow *Malva parviflora* – 2<br>Cocksfoot *Dactylis glomerata* – 2<br>Shivery Grass *Briza minor – 2*<br>Fleabane *Conyza bonariensis* – 3<br>Ribwort Plantain *Plantago lanceolata – 2*<br>White Clover *Trifolium repens* – 2 |  |
| 17 | 296675 | 6152401 | South of Toolijooa Rd | Roadside batter | Cobbler's Pegs *Bidens pilosa* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Purpletop *Verbena bonariensis* – 3<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Kikuyu *Cenchrus clandestinus* – 5<br>Paspalum *Paspalum dilatatum* – 4<br>Sow thistle *Sonchus oleraceus* – 2<br>Moth vine Araujia sericifera – 1<br>Curly Dock *Rumex obtusifolius* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 18 | 296523 | 6152549 | South of Toolijooa Rd | Roadside batter | Kikuyu *Cenchrus clandestinus* – 6<br>Paspalum *Paspalum dilatatum* – 4<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Fireweed *Senecio madagascariensis* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Moth vine *Araujia sericifera* – 1<br>Fennel *Foeniculum vulgare* – 1<br>Cocksfoot *Dactylis glomerata* – 2<br>Common Wild Oat *Avena fatua* – 2<br>Mustard *Brassica oleracea* – 1<br>Perennial Ryegrass *Lolium perenne* – 2 |  |
| 19 | 296251 | 6152744 | Between BC1 and Toolijooa Rd | Roadside embankment | Lantana *Lantana camara*- 5<br>Kikuyu *Cenchrus clandestinus* – 5<br>Fleabane *Conyza bonariensis* – 3<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Stinking Roger *Tagetes minuta* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Sow thistle *Sonchus oleraceus* 2<br>Spear Thistle *Cirsium vulgare* – 1<br>Common Wild Oat *Avena fatua* – 2<br>White Clover *Trifolium repens* – 2<br>Mallow *Malva parviflora* – 2<br>Paddy's Lucerne *Sida rhombifolia* – 2<br>Curly Dock *Rumex obtusifolius* – 1<br>Ribwort Plantain *Plantago lanceolata* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Moth vine *Araujia sericifera* – 2<br>Crofton Weed *Ageratina adenophora* – 2<br>Perennial Ryegrass *Lolium perenne* – 1 | |
| 20 | 296157 | 6152704 | Between BC1 and Toolijooa Rd | Access track between Toolijooa Rd and BC1 | Kikuyu *Cenchrus clandestinus* – 4<br>Paspalum *Paspalum dilatatum* – 3<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Purpletop *Verbena bonariensis* – 2<br>Stinking Roger *Tagetes minuta* – 2<br>Fleabane *Conyza bonariensis* - 2<br>Ribwort Plantain *Plantago lanceolata* – 2<br>Curly Dock *Rumex obtusifolius* – 1<br>Common Wild Oat *Avena fatua* – 1 |  |
| 21 | 29593 | 6152819 | Between BC1 and Toolijooa Rd | Top of cut | Kikuyu *Cenchrus clandestinus* – 4<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Lantana *Lantana camara* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Fireweed *Senecio madagascariensis* – 2<br>Paspalum *Paspalum dilatatum* – 4<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Cottonbush *Gomphocarpus physocarpus* – 1<br>Fleabane *Conyza bonariensis* – 2<br>White Clover *Trifolium repens* – *1*<br>Alfalfa *Medicago sativa* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 22 | 295486 | 6152939 | Between BC1 and Toolijooa Rd | Light vehicle track | Fireweed *Senecio madagascariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 6<br>Spear Thistle *Cirsium vulgare* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Blackberry *Rubus fruiticosis* – 1<br>Paspalum *Paspalum dilatatum* – 3<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Paddy's Lucerne *Sida rhombifolia* – 4<br>Wild tobacco *Solanum mauritianum* - 1<br>Inkweed *Phytolacca octandra* – 3<br>Lantana *Lantana camara* – 1<br>St Barnaby's Thistle *Centaunea solstitialis*– 2 |  |
| 24 | 295121 | 6152887 | BC1 | Adjacent to compound | Kikuyu *Cenchrus clandestinus* – 6<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Purpletop *Verbena bonariensis* – 3<br>Fireweed *Senecio madagascariensis* – 2<br>Stinking Roger *Tagetes minuta* – 1<br>Crofton weed *Ageratina adenophora* – 2<br>Paddy's Lucerne *Sida rhombifolia* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Fleabane *Conyza bonariensis* – 2<br>Wild tobacco *Solanum mauritianum* - 1<br>Cat's Ear *Hypochaeris radicata* - 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Cocksfoot *Dactylis glomerata* – *3* |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 31 | 295126 | 6152978 | BC1 | Roadside batter | Fireweed *Senecio madagascariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 4<br>Paspalum *Paspalum dilatatum* – 4<br>Stinking Roger *Tagetes minuta* - 2<br>Paddy's Lucerne *Sida rhombifolia* – 4<br>Purpletop *Verbena bonariensis* – 3<br>Fleabane *Conyza bonariensis* – 3<br>Sow Thistle *Sonchus oleraceus* – 2<br>Alfalfa *Medicago sativa* - 1<br>Inkweed *Phytolacca octandra* - 2<br>Prickly Lettuce *Lactuca serriola – 1*<br>Cocksfoot *Dactylis glomerata – 1*<br>Perennial Ryegrass *Lolium perrene – 2*<br>Wild Oat *Avena fatua* – 1<br>Ribwort Plantain Plantago lanceolata – 2<br>Giant Paramatta Grass *Sporobolus fertilis – 1* |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 25 | 294923 | 6152794 | BC1 | BC1 | Fireweed *Senecio madagascariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 4<br>Cobbler's Pegs *Bidens Pilosa* – 2<br>Wild tobacco *Solanum mauritianum* – 3<br>Lantana *Lantana camara* – 4<br>Fleabane *Conyza bonariensis* – 2<br>Spear Thistle *Cirsium vulgare* – 3<br>Paspalum *Paspalum dilatatum* – 4<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Purpletop *Verbena bonariensis* – 4<br>Moth vine *Araujia sericifera* – 3<br>Wild Oat *Avena fatua* – 2<br>Prickly Lettuce *Lactuca serriola* – *2*<br>Ribwort Plantain *Plantago lanceolata* – 4 |  |
| 26 | 294695 | 6152708 | Between BC1 and BC2 | Road side | Lantana *Lantana camara*- 5<br>Kikuyu *Cenchrus clandestinus* – 6<br>Sow thistle *Sonchus oleraceus* – 2<br>Wild tobacco *Solanum mauritianum* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Paspalum *Paspalum dilatatum* – 3<br>Fleabane *Conyza bonariensis* - 2<br>Purpletop *Verbena bonariensis* – 2<br>Moth vine *Araujia sericifera* – 2<br>Spear Thistle *Cirsium vulgare* - 1<br>Silky oak *Grevillea robusta* - 3<br>Cobbler's Pegs *Bidens pilosa* - 3<br>White Clover *Trifolium repens* – 3 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Coral Tree *Erythrina sykesii* – 3<br>Quaking Grass *Briza maxima* – 3<br>Wild Oat *Avena fatua* – 2<br>Perennial Ryegrass *Lolium perrene – 2* | |
| 27 | 294623 | 6152587 | Between BC1 and BC2 | Road side | Sow thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Kikuyu *Cenchrus clandestinus* – 5<br>Paspalum *Paspalum dilatatum* – 4<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Purpletop *Verbena bonariensis* – 3<br>Alfalfa *Medicago sativa* – 2<br>Fleabane *Conyza bonariensis* – 3<br>Quaking Grass *Briza maxima* – 2<br>Cocksfoot *Dactylis glomerata –1*<br>Wild Oat *Avena fatua* – 1<br>Perennial Ryegrass *Lolium perrene – 2*<br>Cat's Ear *Hypochaeris radicata* - 2<br>Coolatai grass *Hyparrhenia hirta - 1*<br>Crofton Weed *Ageratina adenophora* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 30 | 294583 | 6152452 | Between BC1 and BC2 | Road side | Kikuyu *Cenchrus clandestinus* – 4<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Purpletop *Verbena bonariensis* – 3<br>White Clover *Trifolium repens* – 3<br>Cat's Ear *Hypochaeris radicata* - 3<br>Fleabane *Conyza bonariensis* – 2<br>Crofton weed *Ageratina adenophora* - 1<br>Paddy's Lucerne *Sida rhombifolia* – 2<br>Stinking Roger *Tagetes minuta* – 1<br>Sow thistle *Sonchus oleraceus* – 1<br>Moth vine *Araujia sericifera* – 1<br>Paspalum *Paspalum dilatatum* – 3 |  |
| 28 | 294296 | 6152021 | Between BC1 and BC2 | Road side | White Clover *Trifolium repens* – 3<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Purpletop *Verbena bonariensis* – 3<br>Kikuyu *Cenchrus clandestinus* – 4<br>Sow thistle *Sonchus oleraceus* – 3<br>Paspalum *Paspalum dilatatum* – 5<br>Fireweed *Senecio madagascariensis* – 2<br>Mustard *Brassica oleracea* - 2<br>Spear Thistle *Cirsium vulgare* – 2<br>Moth vine *Araujia sericifera* – 3<br>Paddy's Lucerne *Sida rhombifolia* - 4<br>Alfalfa *Medicago sativa* - 3<br>Cocksfoot *Dactylis glomerata* – 2<br>Phalaris *Phalaris aquatica* – *1* |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Perennial Ryegrass *Lolium perenne* – 2<br>Curly Dock *Rumex obtusifolius* – 2 | |
| 29 | 294250 | 6151865 | Between BC1 and BC2 | Road side | Kikuyu *Cenchrus clandestinus* – 5<br>Fireweed *Senecio madagascariensis* – 2<br>Blackberry *Rubus fruiticosis* – 1<br>Lantana *Lantana camara* – 1<br>Paspalum *Paspalum dilatatum* – 3<br>Crofton weed *Ageratina adenophora* – 3<br>Moth vine *Araujia sericifera* – 3<br>Purpletop *Verbena bonariensis* – 3<br>Cobbler's Pegs *Bidens pilosa* - 3<br>Spear Thistle *Cirsium vulgare* – 3<br>Fleabane *Conyza bonariensis* – 3<br>Wild tobacco *Solanum mauritianum* -1<br>White Clover *Trifolium repens* – 3<br>Stinking Roger *Tagetes minuta* – 1<br>Cocksfoot *Dactylis glomerata* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 32 | 294059 | 6151679 | Between Austral Park compound and BC3 | Access track | Fireweed *Senecio madagascariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 5<br>Paddy's Lucerne *Sida rhombifolia* – 2<br>Mallow *Malva parviflora* – 2<br>Stinking Roger *Tagetes minuta* – 1<br>Paspalum *Paspalum dilatatum* – 4<br>Whisky Grass *Andropogon virginicus* – 1<br>Fleabane *Conyza bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Perennial Ryegrass *Lolium perenne* – 2<br>Lantana *Lantana camara* – 1<br>Purpletop *Verbena bonariensis* – 2 |  |
| 33 | 293916 | 6151611 | Between Austral Park compound and BC3 | Batter | Stinking Roger *Tagetes minuta* – 1<br>Fireweed *Senecio madagascariensis* – 2<br>Paspalum *Paspalum dilatatum* – 4<br>Paddy's Lucerne *Sida rhombifolia* – 4<br>Kikuyu *Cenchrus clandestinus* – 6<br>Purpletop *Verbena bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Moth vine *Araujia sericifera* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 34 | 293975 | 6151579 | Between Austral Park compound and BC3 | Batter | Kikuyu *Cenchrus clandestinus* – 5<br>Paspalum *Paspalum dilatatum* – 5<br>Fleabane *Conyza bonariensis* – 3<br>Sow Thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Purpletop *Verbena bonariensis* – 2<br>Moth vine *Araujia sericifera* – 2<br>Fireweed *Senecio madagascariensis* – 2<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Cat's Ear *Hypochaeris radicata* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2 |  |
| 35 | 293661 | 6151517 | Between Austral Park compound and BC3 | Batter | Stinking Roger *Tagetes minuta* – 2<br>Lantana *Lantana camara* – 3<br>Crofton weed *Ageratina adenophora* – 4<br>Fleabane *Conyza bonariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 4<br>Purpletop *Verbena bonariensis* – 2<br>Fireweed *Senecio madagascariensis* – 2<br>Inkweed *Phytolacca octandra* – 2<br>Spear thistle *Cirsium vulgare* – 2<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Common Wild Oat *Avena fatua* – 3<br>Paspalum *Paspalum dilatatum* – 3 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 36 | 293699 | 6151420 | Between Austral Park compound and BC3 | Batter | Kikuyu *Cenchrus clandestinus* – 6<br>Paspalum *Paspalum dilatatum* – 6<br>Purpletop *Verbena bonariensis* – 3<br>Fireweed *Senecio madagascariensis* – 2<br>Crofton weed *Ageratina adenophora* – 4<br>Fleabane *Conyza bonariensis* – 3<br>Inkweed *Phytolacca octandra* – 2<br>Spear thistle *Cirsium vulgare* – 2<br>Mallow *Malva parviflora* – 2<br>Cobbler's Pegs *Bidens pilosa* – 3<br>White Clover *Trifolium repens* – 2<br>Moth Vine *Araujia sericifera* – 3<br>Wild tobacco *Solanum mauritianum* -1<br>Lantana *Lantana camara* - 1<br>Ribwort Plantain *Plantago lanceolata* – 2<br>Prickly Lettuce *Lactuca serriola* – 1 |  |
| 37 | 293391 | 6151342 | Between Austral Park compound and BC3 | Batter | Fireweed *Senecio madagascariensis* – 3<br>Inkweed *Phytolacca octandra* – 3<br>Purpletop *Verbena bonariensis* – 3<br>Kikuyu *Cenchrus clandestinus* – 6<br>Paspalum *Paspalum dilatatum* – 5<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Stinking Roger *Tagetes minuta* – 1<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Moth vine *Araujia sericifera* – 2<br>Crofton weed *Ageratina adenophora* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Spear thistle *Cirsium vulgare* – 1<br>Prickly Lettuce *Lactuca serriola – 1*<br>Ribwort Plantain *Plantago lanceolata* – 2 | |
| 13 | 293197 | 6151331 | Austral Park | Western side Princess Hwy | Lantana *Lantana camara* – 4<br>Crofton weed *Ageratina adenophora* – 3<br>Blackberry *Rubus fruiticosis* – 4<br>Moth vine *Araujia sericifera* – 3<br>Wild tobacco *Solanum mauritianum* – 1<br>Fireweed *Senecio madagascariensis* – 2<br>Inkweed *Phytolacca octandra* – 2<br>Purpletop *Verbena bonariensis* – 3<br>Kikuyu *Cenchrus clandestinus* - 6<br>Paspalum *Paspalum dilatatum* – 3<br>Paddy's Lucerne *Sida rhombifolia* – 4<br>Spear thistle *Cirsium vulgare* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Whisky grass *Andropogon virginicus* – 1<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Common Wild Oat *Avena fatua* – 2<br>Cat's Ear *Hypochaeris radicata* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 38 | 293143 | 6151252 | Austral Park | Western side Princess Hwy | Kikuyu *Cenchrus clandestinus* – 4<br>Paspalum *Paspalum dilatatum* – 5<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Fireweed *Senecio madagascariensis* – 2<br>Lantana *Lantana camara* – 3<br>Blackberry *Rubus fruiticosis* – 2<br>Crofton weed *Ageratina adenophora* – 2<br>Inkweed *Phytolacca octandra* – 2<br>Purpletop *Verbena bonariensis* – 3<br>Fleabane *Conyza bonariensis* – 2<br>Moth Vine Araujia sericifera – 2<br>Wild Tobacco *Solanum mauritianum* – 1<br>Spear Thistle *Cirsium vulgare* – 1<br>Common Wild Oat *Avena fatua* – 1<br>Cobbler's Pegs *Bidens pilosa* – 3 |  |
| 12 | 293089 | 6151221 | Austral Park | Western side Princess Hwy | Blackberry nightshade *Solanum nigrum* – 1<br>Fireweed *Senecio madagascariensis* – 1<br>Stinking Roger *Tagetes minuta* – 2<br>Paspalum *Paspalum dilatatum* – 5<br>Kikuyu *Cenchrus clandestinus* – 6<br>Paddy's Lucerne *Sida rhombifolia* – 4<br>Inkweed *Phytolacca octandra* – 1<br>Wild tobacco *Solanum mauritianum* – 2<br>Purpletop *Verbena bonariensis* – 3<br>Lantana *Lantana camara* – 2<br>Spear Thistle *Cirsium vulgare* – 3 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Moth Vine *Araujia sericifera* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Crofton weed *Ageratina adenophora* – 1<br>Cobbler's Pegs *Bidens pilosa* – 2 | |
| 10 | 292987 | 6151220 | Austral Park | Western side Princess Hwy | Fireweed *Senecio madagascariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 5<br>Purpletop *Verbena bonariensis* – 2<br>Paddy's Lucerne *Sida rhombifolia* – 3<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Fennel *Foeniculum vulgare* – 3<br>Spear Thistle *Cirsium vulgare* – 2<br>Quaking Grass *Briza maxima* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Moth Vine *Araujia sericifera* – 2<br>Common Wild Oat *Avena fatua* – 2<br>Perennial Ryegrass *Lolium perenne* – 3<br>Cocksfoot *Dactylis glomerata* – 3 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 11 | 292977 | 6151168 | Austral Park | Soil mound | Sow Thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens Pilosa* – 3<br>Fennel *Foeniculum vulgare* – 2<br>Kikuyu *Cenchrus clandestinus* – 5<br>Purpletop *Verbena bonariensis* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Patty's lucerne *Sida rhombifolia* - 3<br>Moth Vine *Araujia sericifera* – 2 |  |
| 9 | 292873 | 6151166 | Austral Park | Batter | Sow Thistle *Sonchus oleraceus* – 1<br>Fireweed *Senecio madagascariensis* – 1<br>Lantana *Lantana Camara* – 3<br>Purpletop *Verbena bonariensis* – 3<br>Paspalum *Paspalum dilatatum* – 3<br>Kikuyu *Cenchrus clandestinus* – 5<br>Fleabane *Conyza bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Patty's lucerne *Sida rhombifolia* – 3<br>White Clover *Trifolium repens* – 2<br>Common Wild Oat *Avena fatua* – 2<br>Ribwort Plantain *Plantago lanceolata* – 2<br>Blackberry nightshade *Solanum nigrum* – 1<br>Spear Thistle *Cirsium vulgare* – 2<br>Wild tobacco *Solanum mauritianum* – 3<br>Moth Vine *Araujia sericifera* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Turkey Rhubarb *Acetosa sagittata* – 3 | |
| 8 | 292746 | 6151115 | Austral Park | Road side | Fireweed *Senecio madagascariensis* – 2<br>Wild tobacco *Solanum mauritianum* – 3<br>Purpletop *Verbena bonariensis* – 3<br>Paspalum *Paspalum dilatatum* – 3<br>Small-leaved privet *Ligustrum sin*ense – 2<br>Fleabane *Conyza bonariensis* – 2<br>Tall flatsedge *Cyperus eragrostis* – 2<br>Kikuyu *Cenchrus clandestinus* – 3<br>Inkweed *Phytolacca octandra* – 1<br>Patty's Lucerne *Sida rhombifolia* – 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Blackberry *Rubus fruiticosis* – 3<br>Curly Dock *Rumex obtusifolius* – 2<br>Stinking Roger *Tagetes minuta* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 7 | 292355 | 6150882 | Central zone | Road side | Inkweed *Phytolacca octandra* – 1<br>Fireweed *Senecio madagascariensis* – 2<br>Kikuyu *Cenchrus clandestinus* – 6<br>Lantana *Lantana camara* – 3<br>Purpletop *Verbena bonariensis* – 2<br>Stinking Roger *Tagetes minuta* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Ribwort Plantain *Plantago laceolata* – 1<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Patty's lucerne *Sida rhombifolia* – 3<br>Fleabane *Conyza bonariensis* – 2<br>Spear Thistle *Cirsium vulgare* – 2 |  |
| 6 | 291579 | 6150900 | Tindell's Lane | Road side | Kikuyu *Cenchrus clandestinus* – 3<br>Blackberry *Rubus fruiticosis* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Lantana *Lantana camara* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Common Wild Oat Avena fatua – 1<br>Moth Vine Araujia sericifera – 1<br>White Clover Trifolium repens – 2<br>Quaking Grass Briza maxima – 3<br>Ribwort Plantain *Plantago laceolata* – 2<br>Small-leaved privet *Ligustrum sin*ense – 1<br>Cat's Ear *Hypochaeris radicata* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 5 | 291578 | 6150845 | Tindell's Lane | Batter | Kikuyu *Cenchrus clandestinus* – 5<br>Paspalum *Paspalum dilatatum* – 4<br>Patty's lucerne *Sida rhombifolia* – 4<br>Fireweed *Senecio madagascariensis* – 2<br>Moth vine *Araujia sericifera* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Spear Thistle *Cirsium vulgare* – 2<br>Quaking Grass *Briza Maxima* – 3<br>Ribwort Plantain *Plantago laceolata* – 2<br>Prickly Lettuce *Lactuca serriola* – 1 |  |
| 4 | 291320 | 6150671 | Central zone<br>Cut 6 | Batter | Kikuyu *Cenchrus clandestinus* – 6<br>Sow Thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Fleabane *Conyza bonariensis* – 2<br>Mallow *Malva parviflora* – 2<br>Patty's lucerne *Sida rhombifolia* – 2<br>Spear Thistle *Cirsium vulgare* – 1<br>Cat's Ear *Hypochaeris radicata* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 3 | 291317 | 6150605 | Central zone Cut 6 | Batter | Kikuyu *Cenchrus clandestinus* – 6<br>Paspalum *Paspalum dilatatum* – 3<br>Purpletop *Verbena bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Fireweed *Senecio madagascariensis* – 1<br>Patty's Lucerne *Sida rhombifolia* – 3<br>Fleabane *Conyza bonariensis* – 2<br>White Clover *Trifolium repens* – 2<br>Moth Vine *Araujia sericifera* – 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Prickly Lettuce *Lactuca serriola* – 1<br>Fennel *Foeniculum vulgare* – 1 |  |
| 2 | 291251 | 6150619 | Central zone Cut 6 | Batter | Kikuyu *Cenchrus clandestinus* – 6<br>Fireweed *Senecio madagascariensis* – 1<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Patty's lucerne *Sida rhombifolia* – 2<br>Fennel *Foeniculum vulgare* – 1<br>Spear Thistle *Cirsium vulgare* – 1<br>Cat's Ear *Hypochaeris radicata* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Moth Vine *Araujia sericifera* – 1<br>Prickly Lettuce *Lactuca serriola* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 1 | 291130 | 6150523 | Central zone Cut 6 | Batter | Kikuyu *Cenchrus clandestinus* – 6<br>Paspalum *Paspalum dilatatum* – 4<br>Purpletop *Verbena bonariensis* – 2<br>Fireweed *Senecio madagascariensis* – 1<br>Crofton weed *Ageratina adenophora* – 1<br>Mallow *Malva parviflora* – 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Patty's Lucerne *Sida rhombifolia* – 3<br>Fleabane *Conyza bonariensis* - 2<br>Inkweed *Phytolacca octandra* – 2<br>White clover *Trifolium repens* – 2 |  |
| 0 | 290920 | 6150386 | Central zone | Batter | Kikuyu *Cenchrus clandestinus* – 3<br>Paspalum *Paspalum dilatatum* – 3<br>Patty's Lucerne *Sida rhombifolia* – 3<br>Fennel Foeniculum vulgare – 2<br>Common Wild Oat- Avena fatua – 2<br>Spear Thistle Cirsium vulgare – 1<br>Purpletop Verbena bonariensis – 1<br>Moth Vine Araujia sericifera – 1<br>Quaking Grass Briza maxima – 3<br>Fleabane Conyza bonariensis - 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 39 | 290499 | 6150097 | Southern zone | Batter | Kikuyu *Cenchrus clandestinus* – 5<br>Paspalum *Paspalum dilatatum* – 4<br>Fireweed *Senecio madagascariensis* – 1<br>Patty's Lucerne *Sida rhombifolia* – 3<br>Crofton weed *Ageratina adenophora* – 1<br>Lantana Lantana *camara* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Fleabane *Conyza bonariensis* – 3<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Blackberry *Rubus fruticosus* – 2<br>Moth Vine *Araujia sericifera* – 2<br>Spear Thistle *Cirsium vulgare* – 1<br>Cocksfoot *Dactylis glomerata* – 1<br>Cat's Ear *Hypochaeris radicata* – 2 |  |
| 41 | 290384 | 6150131 | Southern zone | Batter | Mallow *Malva parviflora* – 1<br>Fireweed *Senecio madagascariensis* – 1<br>Kikuyu *Cenchrus clandestinus* – 4<br>Purpletop *Verbena bonariensis* – 1<br>Paspalum *Paspalum dilatatum* – 3<br>Sow Thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Patty's Lucerne *Sida rhombifolia* – 2<br>Common Wild Oat *Avena fatua* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 40 | 290237 | 6150006 | Southern zone | Embankment | Kikuyu *Cenchrus clandestinus* – 3<br>Fireweed *Senecio madagascariensis* – 1<br>Sow Thistle *Sonchus oleraceus* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Mallow *Malva parviflora* – 2<br>Fleabane Conyza bonariensis – 2<br>Paspalum *Paspalum dilatatum* – 2<br>Cocksfoot *Dactylis glomerata* – 2<br>Purpletop *Verbena bonariensis* – 1<br>Stinking Roger *Tagetes minuta* – 2 |  |
| 42 | 289262 | 6149761 | Southern zone | Batter | White Clover *Trifolium repens* – 2<br>Sow Thistle *Sonchus oleraceus* – 2<br>Mallow *Malva parviflora* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Pigeon Grass Setaria parviflora – 2<br>Paspalum *Paspalum dilatatum* – 2<br>Prickly Lettuce *Lactuca serriola* – 1<br>Fleabane Conyza bonariensis – 2<br>Fireweed *Senecio madagascariensis* – 1<br>Knotted Barley *Hordeum secalinum* – 1 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 43 | 288808 | 6149755 | Southern zone | Batter | Paspalum *Paspalum dilatatum* – 5<br>Fireweed *Senecio madagascariensis* – 1<br>Fleabane *Conyza bonariensis* – 2<br>White Clover *Trifolium repens* – 2<br>Ribwort Plantain *Plantago lanceolata* – 2<br>Cat's Ear *Hypochaeris radicata* – 1<br>Purpletop *Verbena bonariensis* – 1<br>Cobbler's Pegs Bidens *pilosa* – 1<br>Mallow *Malva parviflora* – 1 |  |
| 49 | 288598 | 6149960 | Southern zone | Town Creek Diversion, Rawling's Lane | Lantana *Lantana camara* – 3<br>Fireweed *Senecio madagascariensis* – 3<br>Patty's lucerne *Sida rhombifolia* – 3<br>Kikuyu *Cenchrus clandestinus* – 5<br>Curly Dock *Rumex obtusifolius* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Purpletop Verbena bonariensis – 2<br>White Clover Trifolium repens – 2<br>Ribwort Plantain *Plantago lanceolata* – 2 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| 44 | 288407 | 6149644 | Southern zone | Noise mound | Cobbler's Pegs *Bidens pilosa* – 4<br>Sow Thistle *Sonchus oleraceus* – 2<br>Paspalum *Paspalum dilatatum* – 2<br>Fireweed *Senecio madagascariensis* – 1<br>Purpletop Verbena bonariensis – 1<br>Fleabane *Conyza bonariensis* – 3<br>Blackberry nightshade *Solanum nigrum* – 1<br>Mustard *Brassica oleracea* – 1<br>White Clover Trifolium repens – 1<br>Curly Dock *Rumex obtusifolius* – 1<br>White goosefoot *Chenopodium album* – 1<br>Spear Thistle Cirsium vulgare – 1<br>Patty's lucerne *Sida rhombifolia* – 2<br>Prickly Lettuce *Lactuca serriola* – 1 |  |
| 45 | 288031 | 6149263 | Southern zone | Roadside | Fireweed *Senecio madagascariensis* – 1<br>Kikuyu *Cenchrus clandestinus* – 5<br>Blackberry nightshade *Solanum nigrum* – 2<br>Moth vine *Araujia sericifera* – 1<br>Patty's lucerne *Sida rhombifolia* – 2<br>Fleabane *Conyza bonariensis* – 2<br>Cobbler's Pegs *Bidens pilosa* – 3<br>Sow Thistle *Sonchus oleraceus* – 2<br>Blackberry *Rubus fruiticosis* – 2<br>Lantana *Lantana camara* – 3<br>Inkweed *Phytolacca octandra* – 2<br>Purpletop *Verbena bonariensis* – 2<br>Crofton weed *Ageratina adenophora* – 3 |  |

| Way point | Easting | Northing | General Location | Site Description | Weeds and abundances | Photograph |
|---|---|---|---|---|---|---|
| | | | | | Paspalum *Paspalum dilatatum* – 3 | |
| 48 | 287971 | 6149266 | Southern zone | Roadside | Kikuyu *Cenchrus clandestinus* – 4<br>Purpletop *Verbena bonariensis* – 2<br>Fireweed *Senecio madagascariensis* – 1<br>Patty's lucerne *Sida rhombifolia* – 2<br>Cobbler's Pegs *Bidens pilosa* – 2<br>Paspalum *Paspalum dilatatum* – 3<br>Sow Thistle *Sonchus oleraceus* – 2<br>White Clover Trifolium repens – 3<br>Fleabane *Conyza bonariensis* – 2<br>Quaking Grass *Briza maxima* – 3<br>Stinking Roger *Tagetes minuta* – 2 |  |
| 47 | 287054 | 6147773 | Southern zone | Roadside | Could not survey due to Berry to Bomaderry Construction | Could not survey due to Berry to Bomaderry Construction |
| 46 | 286918 | 6147524 | Southern zone | Roadside | Could not survey due to Berry to Bomaderry Construction | Could not survey due to Berry to Bomaderry Construction |

### 3.4.3. Landscape Maintenance Works

Works undertaken in accordance with the Landscape Maintenance Plan for the Foxground and Berry Bypass Project 2017 (LMP) include priority weed control as part of required maintenance activities. The following summarises the weed inspection requirements:

- All areas
    - Priority Weed Control – monthly inspections
- Grassland Areas
    - Weed control in Grassland – monthly inspections
- Landscape Bed Plantings
    - Weed garden beds prior to weed setting flower – yearly inspection
    - Removal/treatment of priority weeds – every 4 weeks.

A monthly and annual maintenance audit should have been completed by the Foxground and Berry Bypass Landscape Officer to ensure that landscape maintenance works are undertaken and to provide recommendations for future maintenance works. The landscape officer is also required to look at maintenance works records to ensure adequate works are being conducted in accordance with the timeframes outlined in the LMP. No evidence has been provided that these weed inspections or landscape audits have been conducted at the scheduled timeframes outlined in the LMP.

# 4. DISCUSSION

## 4.1. ECOLOGICAL MONITORING

### 4.1.1. Camera Automated Detection

#### Comparison with pre-construction data

In all post-construction monitoring (2018 onwards) species diversity and abundance has been higher than during pre-construction data (Figure 4-1 and Figure 4-2). It is important to note, that the placement of cameras during the pre-construction phase was quite different, as no crossing structures were present at the time of the pre-construction monitoring. As such, some terrestrial species were recorded in pre-construction monitoring which would not be recorded during post-construction monitoring of structures such as rope bridges. Six (6) species were detected during the pre-construction phase and 16 in 2018, 29 in 2019, and 19 in 2020. In 2020 Common Ringtail Possums and Common Brushtail Possums were detected at three and one locations respectively. The Common Brushtail Possum was not recorded in 2019. Sugar Gliders were an additional species detected in 2019, and have not been recorded in any other monitoring year. Mountain Brushtail Possums were detected in pre-construction monitoring but have been absent in surveys since. Presence of Mountain Brushtail Possums were however detected in 2019 by the PhD study on one of the rope bridges outside of NGH's survey time. Previously it was suggested that they may not have commenced utilising or traversing the rope bridges, however this evidence from 2019 suggests otherwise. Table 4-1 below provides a comparison of results pre- and post- construction at each crossing site for terrestrial and arboreal species only (birds have been excluded).

A number of fauna underpasses contain fauna furniture in the form of timber attached along the side of underpasses, however these poles are relatively isolated from adjacent vegetation, potentially reducing their efficacy for arboreal species that are less likely to move along the ground. In 2018 it was recommended that any revegetation efforts should target these areas to create vegetative connectivity to the crossings. The 2019 monitoring detected limited evidence of revegetation work. Similarly in 2020, revegetation works around furniture was predominantly absent and these areas were observed to be overgrown with weeds.

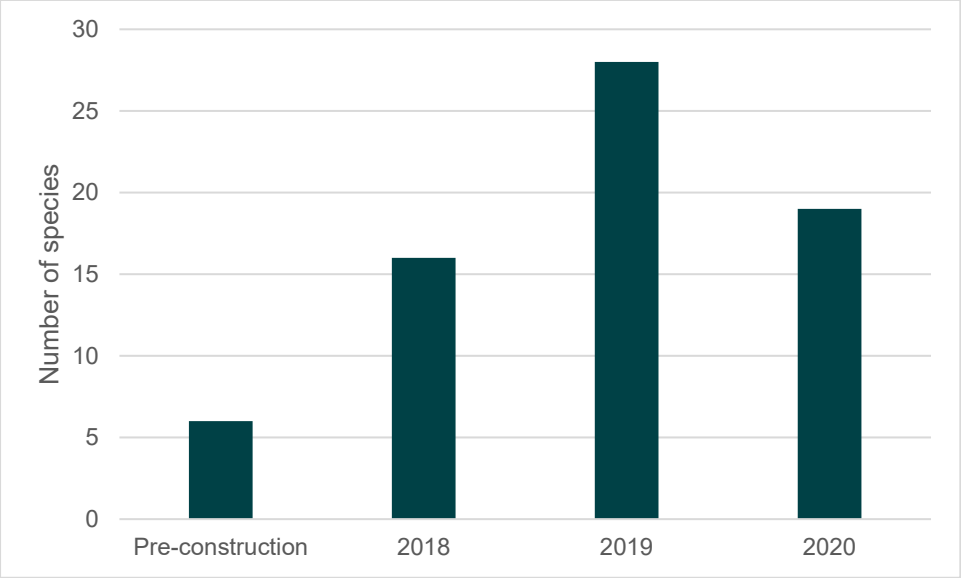


Figure 4-1 Pre-construction vs post-construction camera survey fauna diversity results

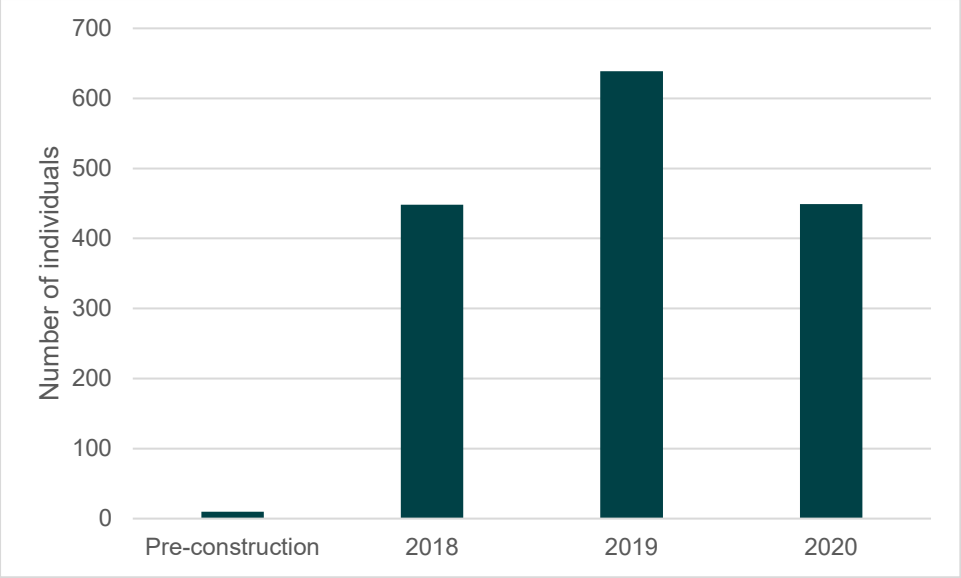


Figure 4-2 Pre-construction vs post-construction camera survey fauna abundance results

Table 4-1 Terrestrial and arboreal fauna recorded during camera surveys during pre-construction and post-construction

| Fauna mitigation structure locations | Structure code and type (PB 2015) | Fauna crossing main orientation | [1]Pre-construction | | [1]2018 | | [1]2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **North or east** | **South or west** | **North or east** | **South or west** | **North or east** | **South or west** | **North or east** | **South or west** |
| Toolijooa ridge 1 CH 8450 | TR1 Fauna underpass and fencing | North-South | Common Wombat Swamp Wallaby | - | - | Common Wombat | - | Common Ringtail Possum | - | None |
| Toolijooa ridge 2 CH 8500 | TR2 Rope bridge | North-South | Common Brushtail Possum | - | - | none | - | none | - | None |
| Broughton Creek 1 CH 9950 - CH 9990 | BCB1 Bridge | | - | Short-beaked Echidna | - | - | - | - | - | - |
| | BCC1 Rope bridge | | - | - | none | none | none | none | None | None |
| Broughton Creek 2 CH 10700 | BCB2 Bridge | East-West | Mountain Brushtail Possum | Eastern Water Skink | - | - | - | - | - | - |
| | BCC2 Rope bridge | | | | Common Ringtail Possum | Common Ringtail Possum | Common Ringtail Possum, Sugar Glider, Peron's Tree Frog | Common Ringtail Possum | None | None |
| Broughton Creek 3 CH 11200 | BCB3 Bridge | North-South | - | none | - | - | - | - | - | - |
| | BCC3 Rope bridge | | | | Common Ringtail Possum | Common Ringtail Possum | none | Common Ringtail Possum | Common Ringtail Possum | Common Ringtail Possum |

| Fauna mitigation structure locations | Structure code and type (PB 2015) | Fauna crossing main orientation | [1]Pre-construction | | [1]2018 | | [1]2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Princes Highway CH 12770 | PH1 Fauna underpass and fencing | North-South | - | Swamp Wallaby | - | Black Rat, Red Fox | - | Black Rat, Red Fox, Cat | - | Short-beaked Echidna, Red Fox |
| Princes Highway CH 13320 | PH2 Fauna underpass and fencing | North-South | Swamp Wallaby | - | none | - | Short-beaked Echidna, Red Fox | - | Red Fox | - |
| Princes Highway CH 13360 | PH3 Rope bridge | North-South | - | none | - | none | - | none | - | None |
| Princes Highway CH 13680 | PH4 Fauna underpass and fencing | North-South | - | Swamp Wallaby | none | - | Black Rat | - | Garden Skink | - |
| Princes Highway CH 13700 | PH5 Rope bridge | North-South | none | - | Possum? | - | none | - | None | - |
| Broughton Mill Creek CH 15900 | BMC Rope bridge | North-South | none | - | none | - | Common Ringtail Possum | - | - | Common Ringtail Possum, Common Brushtail Possum |
| Bridge at Berry CH 16000 | BAB Bridge | North-South | - | - | - | - | - | - | none | - |
| Bundewallah Creek (Connollys Creek) CH 16250 | BCCC Rope bridge | North-South | | | none | - | none | - | - | - |

*[1] ˜none" indicates that no species were recorded. ˜- " indicates that no camera was placed in this location due to monitoring program design

### 4.1.2. Transect Surveys

#### Comparison with pre-construction data

Figure 4-3 shows that more individuals and more species have been detected during post-construction spotlighting surveys than prior to construction. While fewer individuals (spotlight) were detected in 2019 and 2020 compared to 2018, there was a greater species diversity recorded. The number of individuals detected through scats, tracks and signs searches was similar from pre-construction to 2018, with an increase in 2019 and again in 2020. Herpetological surveys found a higher number of individuals and species during the pre-construction phase, possibly attributed to the conditions at the time of the survey which may have been more favourable for reptiles. Number of species (herp searches) were similar throughout post construction surveys.

No new mammal species were detected during 2020 transects. Overall, 10 native mammal species were detected during the pre-construction surveys, 11 native mammal species during 2018, 11 in 2019, and seven in 2020. One new species of snake was recorded in 2020; Small Eyed Snake *Cryptophis nigrescens*.

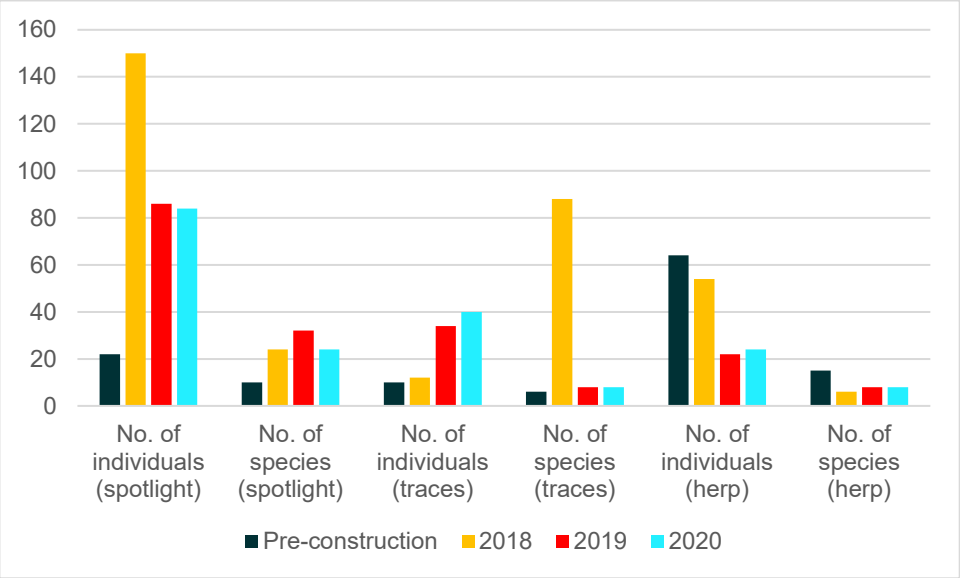


Figure 4-3 Transect abundance and diversity pre-construction vs post-construction (2018, 2019 and 2020)

### 4.1.3. Ecological Monitoring- Performance Criteria Comparison

Table 4-2 Performance Criteria Comparison

| Mitigation measure | Performance criteria | Performance target and timeframe | Are performance criteria being met? |
|---|---|---|---|
| **Targeted GGBF surveys** | If any Green and Golden Bell Frogs (GGBF) are detected during the pre- clearing surveys further investigations and reporting would be required (such as a GGBF Management Plan). This would identify the appropriate performance criteria. Generally, this would be likely to focus on the presence of GGBF continuing at the same or higher population levels | GGBF persist in areas identified during the life of the monitoring program. | Yes.<br>No GGBFs were detected during pre-clearing surveys, therefore no further targeted surveys were required during the post-construction period. No GGBFs were recorded during the transect surveys or call playback surveys conducted in 2018 to 2020. |
| **Connectivity mitigation measures (fauna exclusion fencing, underpasses and arboreal rope crossing)** | Low fauna mortality or injury due to road kill | Road kill rates similar or lower than rates recorded pre- construction on existing highway, during the life of the monitoring program. | No.<br>Road kill rates were 64 per cent higher during the post-construction period, when pre and post construction monitoring periods (March to November) are directly compared. No road kill monitoring was required during 2019 and 2020. |
| | Evidence of use of by arboreal, cover-dependent species with low mobility, dispersing (juvenile) or different age cohorts. | Demonstrated use of structure by native targeted fauna species within 3 years of start of operation phase | Yes.<br>Common Ringtail Possums and Sugar Gliders have been confirmed using the rope bridges 2019, with Common Ringtail Possums and Common Brushtail Possums also recorded during 2020 surveys |
| | High rates of native fauna movement and species diversity using structures. | Majority of structures show several native species using the structure within 3 years of start of operation phase | Yes.<br>A total of 19 different terrestrial and arboreal species were recorded using the rope bridges and fauna underpasses (52% decrease since 2019). The cameras recorded 449 terrestrial and arboreal individuals using the crossing structures in 2020 (a 42% decrease since 2019). |
| **Habitat Use** | Mammal species present within retained habitat is at similar levels to pre-construction | Mammal diversity of monitoring areas within 20% of pre-construction data during the life of the monitoring program. | Yes.<br>Native mammal diversity was 10% higher during both post-construction monitoring sessions when compared to pre-construction monitoring. |

| Mitigation measure | Performance criteria | Performance target and timeframe | Are performance criteria being met? |
|---|---|---|---|
| | Reptile species similar diversity as pre-construction | Reptile diversity of monitoring areas within 20% of pre-construction data during the life of the monitoring program. | No.<br>Fourteen reptile species were recorded during pre-construction surveys. Seven reptile species were recorded during 2018,eight reptile species during 2019 and six reptile species during 2020 post-construction surveys. This is a 50% (2018) ,43% (2019) and 58% (2020) decrease in reptile diversity when compared to pre-construction monitoring. Survey conditions may be a factor, and further monitoring may detect additional species. One new species of snake was recorded in 2020 transect surveys; Small Eyed Snake *Cryptophis nigrescens*. An increase in exotic predators may also be impacting reptile abundance. Foxes were recorded along three of the nocturnal transects, and a number of fox scats and burrows were detected opportunistically. |
| | Amphibians species similar diversity as pre-construction | Amphibians diversity of monitoring areas within 20% of pre-construction data during the life of the monitoring program. | Yes.<br>Seven species of frog were recorded during pre-construction surveys. Five species of frog were identified during 2018 (29% decrease), six species in 2019 (14% decrease) and seven in 2020. 2020 results show similar amphibian diversity compared to pre-construction surveys that are within the performance target range. |

## 4.2. AQUATIC MONITORING

### 4.2.1. Habitat Assessment

The substrate of a stream influences the type of organisms that are likely to occur. It is unlikely to vary greatly in healthy streams, however it is a valuable tool to detect changes such as siltation, which is a possibility in a rural/agricultural environment. An increase in the presence of bedrock, gravel, sand, silt and clay represents a decrease in habitat availability for aquatic organisms at a site. Substrate proportions in upstream control sites were similar to the downstream treatment sites. There was an increase in silt at the treatment sites since pre-construction, with a decrease at control sites since both 2018 and pre-construction. A possible explanation is that barriers and water catchment structures built during the installation of the bypass may be preventing some waterflow to downstream sites and therefore the potential substrates that may be dislodged during high flow events. An increased trend in cobble and boulder at treatment sites since pre-construction is an indication that habitat availability, while variable, has improved. Trendlines for cobble and boulder at the control sites are much less variable but this may be due to the comparison of only two control sites with six treatment sites.

A high proportion of cobble at both treatment sites and control sites, an increase compared to 2018 results, is likely to be impacted by water levels at the time of the surveys. Cobble at treatment sites has increased compared to pre-construction monitoring between 2015 to 2017, while there has been a decrease at the controlled site after 2019. Pebble, Bedrock, Boulder, Sand and Silt substrates at treatment sites showed a small degree of variability in 2020 when compared to 2019 results. At control sites there appeared to be a decrease in Bedrock, with an increase in Pebble and Gravel.

When compared to pre-construction data, there has been a downward trend of algae at all control sites and treatment sites, except for Site 27. There was a decrease in algae between 2019 and 2020 in all sites except for Site 20. There has been an increase in percentage cover of macrophytes at both control sites and Sites 13, 16, 17 and 27 since pre-construction. From 2019 to 2020 macrophytes decreased at all sites except at Sites 13 and 17. There have been no obvious changes since pre-construction at Site 22, and Site 25 shows a minor downward trend in macrophytes. Macrophytes provide habitat for aquatic fauna, reduce bank erosion, may improve water clarity, and may limit spread of invasive species. However, extensive macrophyte coverage also has the potential to limit stream flow. The highest percentage cover of macrophytes in 2020 was at Control Site 1 with 27.5%. There has been very little change in moss cover since pre-construction, except at Site 17 which has a downward trend. All sites failed to have any moss recorded in 2020. Moss can provide good habitat for aquatic invertebrates.

### 4.2.2. Water Quality

In comparison with the 2019 results, 2020 saw a lower minimum and a higher maximum recorded temperature (9.4ºC and 23.4ºC respectively in 2020 compared to 14.6ºC and 22.7ºC in 2019). The lower minimum water temperatures recorded is likely linked to surveys being conducted in the colder months of Winter for the first time. pH minimums and maximums

remained similar in 2020 to 2019 (5.31 to 7.71 in 2019 compared to 5.19 to 7.54 in 2020). Conductivity parameters were recorded in the ANZECC/ARMCANZ guideline range less often in 2020 than in 2019, zero compared to five of 32 readings across all sites. As water conductivity and other water quality parameters are correlated with changes in water temperature, it is likely that surveying during the colder winter months may have affected these results (Hayashi 2004, Dey *et al.* 2021). Similarly, turbidity was recorded within the ANZECC/ARMCANZ guideline range less in 2020 than in 2019, one compared to 13 of 32 readings across all sites. Dissolved oxygen was recorded within the ANZECC/ARMCANZ guideline range more in 2020 amongst both treatment and control sites compared to 2019; nine of 24 (37.5%) in 2019 treatment sites compared to 14 of 24 (58%) in 2020 and five of eight (62.5%) in 2019 control sites compared to six of eight (75%) in 2020.

Water quality parameters that varied more than 10% when compared to pre-construction values were temperature (Sites 13 and CS2), conductivity (Sites 13, 22, 27, CS1 and CS2), turbidity (Sites 13, 16, 17, 22, 27, CS1 and CS2), and dissolved oxygen (all sites). All other parameters passed the water quality performance criteria (See Table 3-8 and Table 3-9).

It is important to note that all dissolved oxygen parameters were higher than +10% of pre-construction readings, so although it fails the +/-10% variant assessment, dissolved oxygen has significantly improved consistently across the aquatic ecosystem between pre and post-construction. Dissolved oxygen is seen to increase slightly across all sites since 2019. Dissolved oxygen is the volume of oxygen contained in the water, however extreme levels (low and high) can have negative impacts on organisms. Dissolved oxygen was low during spring sampling events, however majority of the sites had levels that were within the recommended range (ANZECC 2000). This is consistent with previous studies that have shown that warmer water holds less dissolved oxygen (Michaud 1995). This may explain the higher dissolved oxygen values found in our colder water particularly during surveys winter months.

pH levels have decreased slightly across all sites since 2019. pH is a measure of acidity, and with increasingly acidic waters, numbers of species and individuals of aquatic organisms decrease. A pH reading of 6.5 to 7.5 is optimal. pH levels were below 6.5 at all treatment sites and are an indication of high photosynthetic growth. pH is directly linked to water temperature and is higher in warmer months and lowest in colder months (Dey *et al.* 2021). This is likely the case for the low pH values collected during the winter surveys.

Conductivity is seen to decrease since 2019 across all sites, with all sampling events below criteria <200ms/cm. Conductivity is a measure of the total ionic strength of the water and is used as an indication of the level of enrichment (i.e. nutrient content) of the water. There were no high readings of conductivity which could indicate unsuitable water quality. An increase in turbidity may inhibit plant growth. Overall, turbidity was significantly lower at both the treatment sites and control sites since 2019. Turbidity can be caused by soil erosion, waste discharge, urban runoff, algal growth and other disturbances in the water channel (Sydney Water 2010).

### 4.2.3. Macrophyte and Emergent Vegetation

In Winter Session 1 2020, Common Rush *Juncus usitatus* was the most common macrophyte observed. It was found in 4 sites; treatment sites 13, 16, 17 and 27, and control sites 1 and 2. Water Pepper *Persicaria hydropiper*, was found in the highest proportions of any macrophyte, with a reading of 3 and 2 (according to the Braun-Blanquet 6-point scale, refer to section 2.4.2)

on two (2) occasions. Sites 13 and 16 had the highest number of exotic species recorded (3), and control site 1 (6) during Winter Session 1.

In Winter Session 2 2020, Water pepper *Persicaria hydropiper* and Common Rush *Juncus usitatus* were the most common macrophytes observed, found in 6 sites each. Water pepper *Persicaria hydropiper,* Sagittaria *Sagittaria platyphylla,* Elephants ear *Colocasia sp* and Common Rush *Juncus usitatus*were were found in the highest proportions of any macrophyte, with a reading of 2 according to the Braun-Blanquet 6-point scale, on multiple occasions each (refer to section 2.4.2). Site 16 had the highest number of exotic species recorded (4) during Winter Session 2.

In Spring Session 1 2020, Water pepper *Persicaria hydropiper,* was the most common macrophyte observed, found in all 8 sites. Water pepper *Persicaria hydropiper* was found in the highest proportions of any macrophyte, with a reading of 5 according to the Braun-Blanquet 6-point scale, on one occasion each (refer to section 2.4.2). Site 13 and Control site 2 had the highest number of exotic species recorded (6) during Spring Session 1.

In Spring Session 2 2020, Water pepper *Persicaria hydropiper and* Common Rush *Juncus usitatus* were the most common macrophytes observed, found in 7 sites. Umbrella sedge *Cyperus eragrostis* was found in the highest proportions of any macrophyte, with a reading of 43 according to the Braun-Blanquet 6-point scale, on one occasion at Site 22 (refer to section 2.4.2). Treatment Sites 12, 25, Control site 1 and Control site 2 had the highest number of exotic species recorded (5) in Spring session 2.

Part of the 2020 surveys were conducted in Winter and not in Autumn. It is apparent that metabolic changes may occur to macrophytes and other plants during the colder months. "Fundamental aspects of the life history of plants, including the phenology of flowering and germination, seed dormancy mechanisms and their related seed bank dynamics, are strongly dependent of seasonal temperature changes" (Keith 2017). These changes are anticipated during the colder months and may have affected the survey results. For example, plant species may be lying dormant in seed banks during winter. We do not however foresee this greatly affecting the survey results regarding macrophyte abundance despite this being a limitation of the survey. Macrophytes that were place and present during Winter surveys would of likely been present in Autumn.

The "strong correlation between flowering and temperature" (Keith 2017) presents another limitation by which the identification of certain macrophytes and thus potentially the diversity results collected during winter may be impacted. Again, we do not anticipate this to greatly affect our overall results. It is likely that if species were missed during winter months, they were recorded during spring surveys if still present. Moreover, although the identification of macrophytes can be slightly affected by the lack of flowering material available in winter, this was not an issue given the types of aquatic flora observed in our surveys.

A data comparison between current values and pre-construction survey data with regards to the performance criteria is provided in Table 4.4 below. Data from previous years can be found in Appendix B.

### 4.2.4. Macroinvertebrates

Overall, Sites 13, 16, 22, 25, 27 and Control Site 1 had an improved signal score based on a comparison of the 2020 average with the preconstruction average. Site 27 had the largest

performance increase of 450% compared to the pre-construction average, followed by Site 16 with a performance increase of 350%. Control Site 2 had no data from the pre-construction surveys, therefore no post construction comparisons can be made.

Site 17 had a decrease of 8% in the EPT richness score compared to the pre-construction EPT score average. This was the only site to receive a FAIL in the scoring criteria. No taxa data was recorded for Site 17. Control Site 2 had no data from the pre-construction surveys, therefore no post construction comparisons can be made. Results from water quality monitoring at Site 17 are inconclusive to determine if this is the result of a decrease in EPT richness. The 2020 surveys were conducted in Winter and Spring, differing from previous years when surveys were conducted in Autumn and Spring. This might be a variable that could explain the decline in EPT at Site 17.

Number of taxa at Sites 13, 16, 22, 25, 27 and Control Site 1 had increased compared to pre-construction average. Site 17 and Control Site 2 had no data from the pre-construction surveys, therefore no post construction comparisons can be made.

Table 4-3 Pre and post construction signal, EPT scores and taxa number comparison

| | Parameter | Pre- Construction Average | Pre- Construction Average minus 20% | 2020 Average | PASS/FAIL |
|---|---|---|---|---|---|
| Site 13 | SIGNAL score | 3.75 | 3 | 7 | PASS |
| | EPT score | 6 | 4.8 | 6.3 | PASS |
| | Number of taxa | 6 | 4.8 | 13.8 | PASS |
| | | | | | |
| Site 16 | SIGNAL score | 3.55 | 2.84 | 7.1 | PASS |
| | EPT score | 1.5 | 1.2 | 6.8 | PASS |
| | Number of taxa | 6 | 4.8 | 14.8 | PASS |
| | | | | | |
| Site 17 | SIGNAL score | 2.9 | 2.32 | 6.7 | PASS |
| | EPT score | 7 | 5.6 | 6.5 | PASS (Not lower than 20% less of pre-construction average) |
| | Number of taxa | No Data | No Data | 17.3 | NA |
| | | | | | |
| Site 22 | SIGNAL score | 3.6 | 2.88 | 6.3 | PASS |
| | EPT score | 3 | 2.4 | 6.3 | PASS |
| | Number of taxa | 6 | 4.8 | 18 | PASS |
| | | | | | |
| Site 25 | SIGNAL score | 3.4 | 2.72 | 6..0 | PASS |
| | EPT score | 2.5 | 2 | 4.5 | PASS |
| | Number of taxa | 8.5 | 6.8 | 13 | PASS |
| | | | | | |

| | Parameter | Pre- Construction Average | Pre- Construction Average minus 20% | 2020 Average | PASS/FAIL |
|---|---|---|---|---|---|
| Site 27 | SIGNAL score | 3.25 | 2.6 | 6.7 | PASS |
| | EPT score | 1 | 0.8 | 5.5 | PASS |
| | Number of taxa | 5.5 | 4.4 | 15 | PASS |
| | | | | | |
| Control Site 1 | SIGNAL score | 5.285 | 4.228 | 6.3 | PASS |
| | EPT score | 5 | 4 | 6.8 | PASS |
| | Number of taxa | 16.5 | 13.2 | 19 | PASS |
| | | | | | |
| Control Site 2 | SIGNAL score | No Data | No Data | 6.8 | NA |
| | EPT score | No Data | No Data | 6.8 | NA |
| | Number of taxa | No Data | No Data | 14.5 | NA |

### 4.2.5. Aquatic Fauna Assessment

Overall, there has been a dramatic decline in the abundance of aquatic fauna species since 2016. This is likely due to a change in methodology. Previously in 2016 fyke nets were left out overnight. From 2018, fish trapping has been limited to daytime only. In late 2018, the decision was made in consultation with TfNSW to discontinue use of fyke nets during aquatic surveys due to the presence of platypus, and the safety risks associated with flash flooding events. As a result, the results of monitoring from 2016 through to 2020 are not directly comparable.

Control sites in 2020 had the same diversity compared to 2019, and an abundance that increased by one (1). Treatment sites had the same diversity in 2020 and 2019, and an increased abundance by eight (8). Although abundance recorded during 2020 amongst treatment sites was higher than that observed in control sites, it is important to note that this is an aggregate tally of individuals across 6 treatment sites compared to an aggregate of 2 control sites. Nonetheless, this is comparable to other treatment site data from 2019, but not conclusively comparable to control site figures in this regard, particularly with significant methodology change over the years prior. With general trendlines remaining similar between control and treatment sites in 2020 compared to 2019, change is reasonably consistent across the board and not dissimilar between control and treatment sites. This may indicate that factors affecting species diversity and abundance are not necessarily a result of construction activities but may be attributed to conditions of this generally disturbed aquatic ecosystem. Factors that typically influence aquatic ecosystems include water supply, water quality, turbidity, pollution levels, nutrient loads, and exotic aquatic species.

We anticipated both the diversity and abundance of species reducing in winter due to decreased aquatic fauna activity in colder water (Bartolini *et al.* 2014). However, as Winter 2020 results observed 2 species across 2 sites (Control site 1 and Site 17), and Autumn 2019 results found 2 species in 1 site, we suggest that seasonality did not greatly impact the limitations of the survey in this regard. Therefore, the increased abundance in treatment sites with no reduction in diversity suggests a positive change for aquatic fauna between 2020 and 2019.

### 4.2.6. Aquatic Monitoring – Performance Criteria Comparison

The following performance criteria relevant to aquatic monitoring are taken from the EcMP (PB 2014). It should be noted that these do not relate specifically to the post-construction period monitoring rather they relate to the lifetime of the monitoring program, including post construction.

Of note is the fact that the water quality varies across sites between surveys by more than 10% in some years. Examples of this include turbidity changing from approximately 25 NTU to 5 NTU between 2014 Spring and 2015 Autumn, and Dissolved Oxygen changing from approximately 70 to 130 between Spring 2014 and Spring 2015. As such, the comparison of pre and post construction values may not be informative about the relative impact of the project, as the quality values of the whole waterway may change by more than 10% in any given season. The comparison to control sites allows for comparison upstream and downstream of the project, and it is suggested that this measure is more informative about the impacts of the project than comparison with conditions over time.

As can be seen from Table 3-8 and Table 3-9, conductivity is the only measure where control sites have consistently better values than treatment sites. It is suggested that this may be as a result of the importation of fill and rocks for the construction of the project, and potentially from inorganic compounds resulting from the construction and use of the road.

Table 4-4 Performance criteria Comparison

| Measure | Performance criteria | Performance target | Comment |
|---|---|---|---|
| Aquatic and riparian monitoring | Water quality maintained between impact sites and control sites as a result of the Project's operations | Water quality is maintained at preconstruction data levels or increases. Any decrease in water quality does not exceed 10% difference when compared to preconstruction data levels. | The performance criteria and performance target in this case vary. The performance target should not solely be used as a guideline on the overall water quality assessment of the project. Rather, it should additionally include the comparison between control and treatment site data. This comparison would assess whether trends are consistent between treatment and control sites. We could suggest that although downstream treatment sites have decreased in water quality, if this is similarly seen in upstream control sites, disturbance would not be a result of the bypass' construction and use. A discussion of the water quality analysis is given below.<br><br>The treatment sites are highly disturbed as a result of surrounding land uses. The water quality values at all the sites generally fell outside the ANZECC/ARMCANZ Guideline levels (ANZECC 2000) for disturbed aquatic ecosystems. This occurred during both preconstruction surveys and during construction and is therefore likely a reflection of the agricultural land uses in the catchment rather than the bypass' construction.<br>An analysis (Table 3-8 and Table 3-9) has been conducted to assess whether the performance target of water quality has been met, which is summarised below.<br>• Site 13: FAIL for Temperature, Conductivity, Turbidity and Dissolved Oxygen<br>• Site 16: FAIL for Turbidity and Dissolved Oxygen<br>• Site 17: FAIL for Turbidity and Dissolved Oxygen |

| Measure | Performance criteria | Performance target | Comment |
|---|---|---|---|
| | | | • Site 22: FAIL for Conductivity, Turbidity and Dissolved Oxygen<br>• Site 25: FAIL for Dissolved Oxygen<br>• Site 27: FAIL for Conductivity, Turbidity and Dissolved Oxygen<br>• Control Site 1: FAIL for temperature, Conductivity, Turbidity and Dissolved Oxygen<br>• Control Site 2: FAIL for Temperature, Conductivity, Turbidity and Dissolved Oxygen<br>Although no control site data was obtained pre-construction, a comparison has been made between control site data during construction and post-construction (above).<br>As mentioned above, this performance target should not solely be used as a determining factor of the overall water quality assessment of the project. Rather, trends between treatment sites and control sites additionally need to be compared before overall conclusions can be made.<br>Temperature: Only failed at Site 13 and Control Site 2. Figure 3-11 shows a very similar trend between treatment sites and control sites between surveys.<br><br>pH: Passed in both control and treatment sites. Figure 3-14 shows a linear trend in pH at treatment sites since pre-construction, and little change at control sites, despite seasonal /yearly variations.<br><br>Conductivity: Failed in both control sites and in site 13, 22, 27. Figure 3-13 shows a similar trend in control and treatment sites. However, treatment sites always had a higher recorded conductivity than control sites throughout the survey times. Important to note, average trendlines in the graph are different to actual trendlines as treatment sites included pre-construction data, where none was recorded for control sites.<br><br>Turbidity: Failed in all sites and control sites except for site 25. Figure 3-15 shows a similar trend line except for Spring 2017 where a much higher turbidity was recorded in treatment sites than control sites. This change was not permanent as from Autumn 2018 trend lines restored to similar levels. Spring 2019 recorded higher turbidity levels at treatment sites than control sites. Overall, changes cannot be attributed to construction activities or operation when compared to pre-construction data.<br><br>Dissolved oxygen: Failed in all sites and control sites. Figure 3-12 shows a downward trend for treatment sites since pre-construction and an upward trend at control sites since pre-construction. There is a similar trendline between treatment and control sites across surveys. |
| | No emergent vegetation or macrophyte | None observed during the life of the monitoring program. | The overall abundance was similar across survey years, with 13 different species recorded in 2020 across all sites and seasons compared to 14 species in 2019, 11 |

| Measure | Performance criteria | Performance target | Comment |
|---|---|---|---|
| | dieback | | in 2018, 13 species in 2017, 10 species in 2016, and 14 species during 2015. Overall, emergent vegetation and macrophytes were at pre-construction levels during 2020. Some sites experience dieback with some species disappearing and reappearing and/or other species appearing. This could be due to natural temporal variations due to Winter surveys conducted in 2020 and not Autumn compared to previous years.<br>Five exotic species were observed in 2020, reduced from seven detected in 2019. The most abundant species at any one site was *Persicaria hydropiper* at Control Site 1.<br>Treatment Site 22 had the largest recorded abundance of any exotic macrophyte identified, *Cyperus eragrostis 3* (5 - < 20% modified Braun-Blanquet 6-point scale). A total of 12 species, including four exotic species were recorded at the control sites in 2020.<br>As upstream control sites also contained similar abundance and richness of macrophytes to the downstream sites, this suggests results may not necessarily be construction caused. |
| | Macroinvertebrates maintained | Macroinvertebrates are maintained at preconstruction data levels or increase during the life of the monitoring program. Any decrease in macroinvertebrates does not exceed 20% difference when compared to preconstruction data levels. | Table 4-2 and Table 4-3 shows the comparison between EPT and SIGNAL scores and number of macroinvertebrate taxa observed between pre-construction data and post construction data. A column for Pre-construction averages minus 20% has been included to specifically address performance targets/indicators. Furthermore, a PASS/FAIL column has been added.<br>PASS: Signal Scores at all sites passed. No data was recorded for number of taxa site 17 pre-construction which means no comparison can be made. EPT scores passed for treatment sites 13, 16, 22, 25, and 27 between pre and post construction. That is, the EPT score either increased since, or decreased by less than 20% of the pre-construction recordings.<br>PASS: Site 17 had a decline of 8% in the EPT score compared to pre construction average. All other sites increased EPT scores compared to pre construction, the largest increase of more than 550% was recorded at Site 27.<br>PASS: Average number of taxa at all sites passed. No data comparison can be made at Site 17 and Control Site 2. |
| | Native fish species diversity maintained | Fish species diversity is maintained at preconstruction data levels, or increases during the life of the monitoring program. Any decrease in fish species diversity does not exceed | A small number of fish (16) were collected/observed from three (3) common fish species throughout 2020. Species diversity was five (5) during pre-construction monitoring. Site 17 had the greatest species diversity three (3) of all sites. The greatest number of a single species was five (5) *Gobiomorpus coxii* at Site 17.<br>FAIL: There is a 40% difference in species diversity for 2020 when compared to pre-construction data, however |

| Measure | Performance criteria | Performance target | Comment |
|---|---|---|---|
| | | 20% difference when compared to preconstruction data levels. | fyke nets were no longer used in 2019 for ethical reasons; the risks to fauna, primarily the platypus were too high despite the implementation of safeguards. The change in technique is a likely cause for this reduction, and not a true reflection of fish diversity when compared to previous years. |

## 4.3. NEST BOX MONITORING

The performance criteria relevant to the nest boxes outlined in the EcMP (PB 2014). Table 4-5 below, is no longer relevant due to the nest box monitoring change of scope.

Table 4-5 Assessment of performance criteria based on 2018 Nest Box monitoring results

| Performance criteria | Performance target | Meeting Target | Comment |
|---|---|---|---|
| High use of bat roost boxes by targeted species | >60% of installed bat boxes used by bats during the life of the monitoring program. | No | Bats were detected in 2017, however none were detected in 2018.<br>Irvine and Bender (1995) found that bat boxes were not occupied within 30 months of installation in regenerating woodland. Goldingay and Stevens (2009) found that bat box occupancy at the same site (Organ Pipes National Park) increased from 15% occupancy in 1994-1995 to >100% occupancy in 2004-2005. Similarly, Boyd and Stebbings (1989) reported a doubling over a 10-year period in a population of brown long-eared bats (*Plecotus auritus*) supported by roost boxes in managed forest in Great Britain.<br>Installing more boxes wouldn't necessarily increase proportions of bat boxes being used, rather this may make the proportion worse. Besides changing microbat nest box designs or creating/restoring more suitable habitat, not much more can be done about this. Emphasis should be placed on researching microbat box design and only using proven designs for Australian bats in future projects. |
| High durability of bat roost boxes, with low maintenance requirements. | >90% of installed bat nest boxes persist during the life of the monitoring program. | Yes | None of the bat roost boxes monitored showed any signs of damage. All boxes are serviceable and available for use by microchiropteran bats. |
| High species diversity and abundance of hollow dependant native fauna occupying nest boxes | >80% of installed nest boxes occupied by target species or other native fauna within 3 years. | No | Of the 290 nest boxes monitored, 109 (38%) were either used or showed signs of use by native fauna with 34 adult individuals from 9 different species being recorded. This is a decrease from the previous surveys, including the first year results where 42 individuals were detected.<br>It is considered unlikely that these results are an accurate reflection of the actual utilisation rate, and that additional survey in different season would generate a significant increase in utilisation results. |
| High durability of nest boxes | >90% of next boxes installed persist through monitoring program life | Yes | By the end of Year 4, 22 (7%) of the nest boxes installed and monitored were either missing or showed signs of damage. |

Only one of the eight new nest boxes constructed from recycled hollows had evidence of microbat use. Although this only translates to a 12.5% occupancy rate, the nest boxes were only recently installed and occupancy in the boxes may still increase over time. Having success early on is a good indication of the suitable habitat that has been provided.

## 4.4. WEED MONITORING

### 4.4.1. Comparison with 2019 Monitoring

The 2020 annual weed monitoring identified a total of 47 weed species across the 49 survey locations, including 43 environmental weeds, and four (4) species listed as Priority Weeds for the South-East region under the Biosecurity Act. This is up from the 39 exotic species observed in 2019.

An additional nine (9) environmental weed species were identified in 2020 that were not recorded in 2017, 2018, and/or 2019 (red in Table 4-4). Seven (7) species observed in 2017, 2018 and/or 2019 were not recorded in 2020.

Table 4-6 Priority weeds and environmental weed species recorded in the project area: 2017-2020 comparison

| Weed Species | Common name | Weed listing | Detected during 2017 surveys | Detected during 2018 surveys | Detected during 2019 surveys | Detected during 2020 surveys |
|---|---|---|---|---|---|---|
| *Acetosa sagittata* | Turkey Rhubarb | Environmental | | | | X |
| *Ageratina adenophora* | Crofton Weed | Environmental | X | X | X | X |
| *Andropogon virginicus* | Whiskey Grass | Environmental | X | X | X | X |
| *Araujia sericifera* | Moth Vine | Environmental | | X | X | X |
| *Aster subulatus* | Wild Aster | Environmental | X | | | |
| *Avena fatua* | Wild Oats | Environmental | X | | X | X |
| *Bidens pilosa* | Cobbler's Pegs | Environmental | X | X | X | X |
| *Brassica oleracea* | Mustard | Environmental | | X | X | X |
| *Briza maxima* | Quaking Grass | Environmental | | | X | X |
| *Briza minor* | Shivery Grass | Environmental | | | | X |
| *Cenchrus clandestinus* | Kikuyu Grass | Environmental | X | X | X | X |
| *Centaurea melitensis* | Maltese star-thistle | Environmental | | | X | |
| *Centaurea solstitialis* | St Barnaby's Thistle | Environmental | | | | X |
| *Chenopodium album* | White Goosefoot | Environmental | | | | X |
| *Chloris gayana* | Rhodes Grass | Environmental | | | | X |
| *Cirsium vulgare* | Spear Thistle | Environmental | X | X | X | X |
| *Conyza bonariensis* | Fleabane | Environmental | X | X | X | X |
| *Cyperus eragrostis* | Tall flatsedge | Environmental | | X | X | X |
| *Dactylis glomerata* | Cocksfoot | Environmental | | | | X |
| *Erythrina x sykesii* | Coral Tree | Environmental | X | | X | X |
| *Foeniculum vulgare* | Fennel | Environmental | X | X | X | X |
| *Gomphocarpus physocarpus* | Cottonbush | Environmental | | | X | X |
| *Grevillea robusta* | Silky Oak | Environmental | | X | X | X |

| Weed Species | Common name | Weed listing | Detected during 2017 surveys | Detected during 2018 surveys | Detected during 2019 surveys | Detected during 2020 surveys |
|---|---|---|---|---|---|---|
| *Hypochaeris radicata* | Cat's Ear | Environmental | | | X | X |
| *Hyparrhenia hirta* | Coolatai Grass | Environmental | | | | X |
| *Lantana camara* | Lantana | Priority Weed | X | X | X | X |
| *Ligustrum lucidum* | Large-leaved Privet | Environmental | | X | | |
| *Ligustrum sinense* | Small-leaved Privet | Environmental | X | X | X | X |
| *Lolium perenne* | Perennial Ryegrass | Environmental | | | | X |
| *Malva parviflora* | Mallow | Environmental | | X | X | X |
| *Medicago sativa* | Alfalfa | Environmental | | | X | X |
| *Morus alba* | White Mulberry | Environmental | | | X | |
| *Paspalum dilatatum* | Paspalum | Environmental | X | X | X | X |
| *Paspalum urvillei* | Vasey Grass | Environmental | | | | X |
| *Phalaris aquatica* | Phalaris | Environmental | | | X | X |
| *Phytolacca octandra* | Inkweed | Environmental | X | X | X | X |
| *Plantago lanceolata* | Plantain | Environmental | X | | X | X |
| *Rubus fruticosus* | Blackberry | Priority Weed | X | X | X | X |
| *Rumex crispus* | Curly Dock | Environmental | X | X | X | X |
| *Senecio madagascariensis* | Fireweed | Priority Weed | X | X | X | X |
| *Setaria parviflora* | Pigeon Grass | Environmental | | X | X | X |
| *Sida rhombifolia* | Paddy's Lucerne | Environmental | X | X | X | X |
| *Solanum mauritianum* | Wild Tobacco | Environmental | X | X | X | X |
| *Solanum nigrum* | Deadly Nightshade | Environmental | X | X | X | X |
| *Sonchus oleraceus* | Sow Thistle | Environmental | X | X | X | X |
| *Sporobolus fertilis* | Giant Paramatta Grass | Priority Weed | X | X | X | X |
| *Tagetes minuta* | Stinking Roger | Environmental | X | X | X | X |

| Weed Species | Common name | Weed listing | Detected during 2017 surveys | Detected during 2018 surveys | Detected during 2019 surveys | Detected during 2020 surveys |
|---|---|---|---|---|---|---|
| *Taraxacum officinale* | Dandelion | Environmental | X | X | | |
| *Trifolium pratense* | Pink Clover | Environmental | X | | | |
| *Trifolium repens* | White Clover | Environmental | X | X | X | X |
| *Verbena bonariensis* | Verbena | Environmental | X | X | X | X |
| *Xanthium occidentale* | Nagoora burr | Environmental | | X | | |

Priority Weed- Listed as a Priority weed under the Biosecurity Act 2015 for the South-east region.
Environmental – Environmental weeds.

There were no new Priority Weeds detected during 2020. Fireweed is the most prevalent priority weed, detected at the same number of sites in 2020 as 2019 (42 sites). This is lower than the 44 sites observed in 2018 and 45 sites in 2017 (Figure 4-3). There has also been a decrease in average relative abundance of Fireweed across the project alignment (according to modified Braun-Blanquet) 2.17 in 2019 to 1.55 in 2020 (Figure 4-4). Blackberry was found at the same number of sites in 2020 as 2019. The average relative abundance reduced from 2.5 in 2019 to 2.13 in 2020. Lantana was observed in one additional site in 2020; 19 sites in 2020 compared to 18 in 2019. There was however an overall reduction in Lantana in the alignment, with an average of 2.58 being observed compared to 3.06 in 2019. As Blackberry and Lantana are both dense monoculture species and are highly prevalent in the project's surrounds, these species are expected to spread across the project alignment without appropriate control. Giant Parramatta Grass was observed at just one (1) site in this years' survey, similarly to 2019, with abundance staying the same between the years with an average of 1 being observed. See Figure 4-3 and Figure 4-4 below.

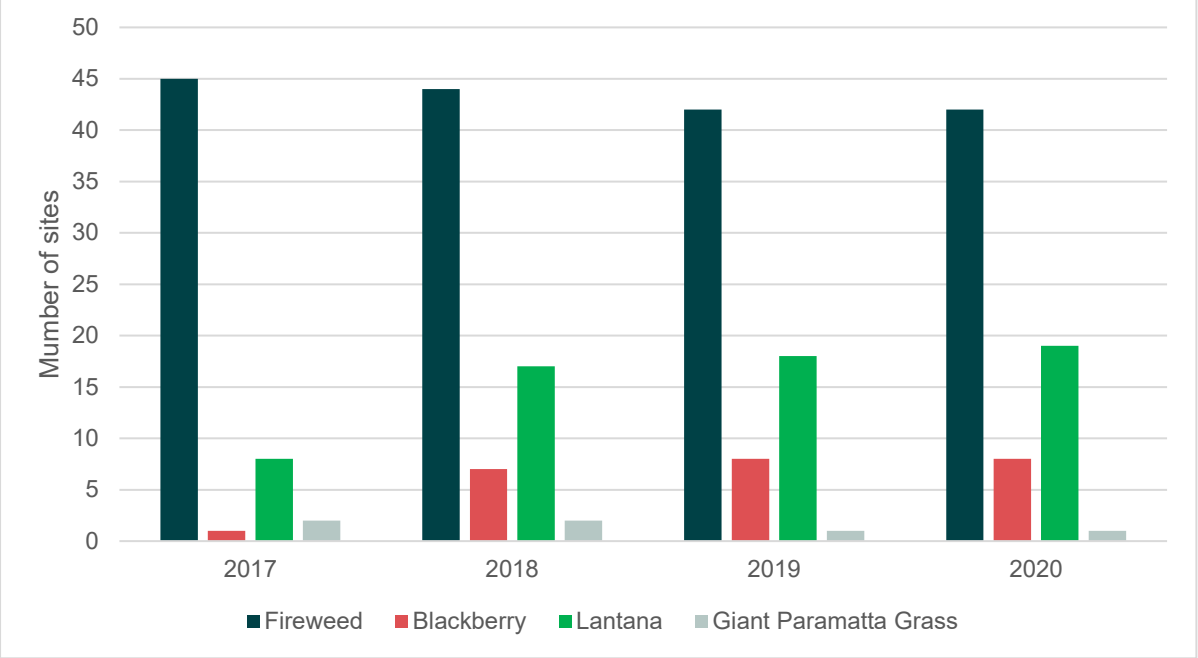


Figure 4-4 Priority weed occurrence 2017-2020

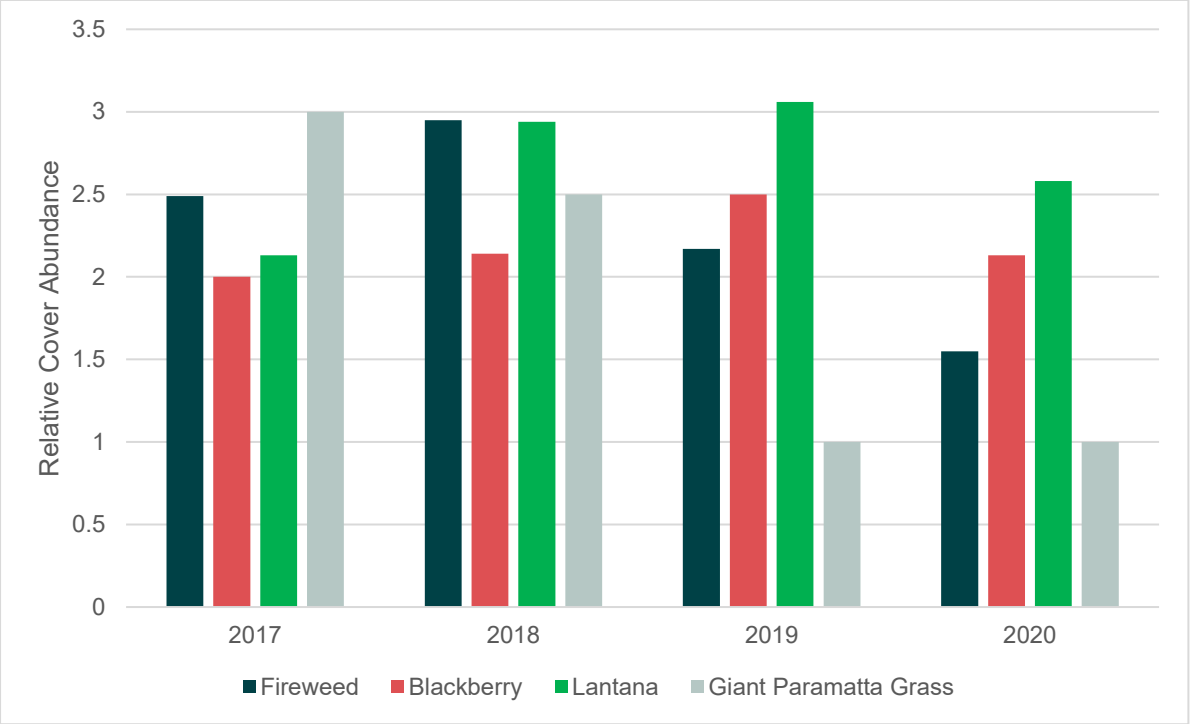


Figure 4-5 Priority Weeds relative cover abundance 2017 - 2020 comparison

Kikuyu and Paspalum were the most prevalent environmental weeds, observed in 44 and 45 sites respectively. In 2019 Kikuyu was observed in 45 sites, with Paspalum being observed in 43 sites.

The 2020 survey recorded an average relative abundance for Kikuyu at 4.91 which has increased from 4.82 in 2019. An increase was also observed between 2018 (4.59) and 2019.

There was a reduction in Paspalum abundance from 4.06 in 2018 to 3.84 in 2019. This trend has continued with a reduced average of 3.56 being observed in 2020.

Although only minor changes have been observed in the spread and abundance of these two species, they can act as a good mechanism to supress other more invasive weed species.

Appendix A provides photographic comparisons between the 2018 and 2019 surveys.

### 4.4.2. Weed Monitoring- Performance Criteria Comparison

Table 4-7 Performance Criteria Comparison

| Measure | Performance Criteria | Performance Target | 2019 Assessment | 2020 Assessment |
|---|---|---|---|---|
| Weed management | No evidence of weed invasion or spread to adjacent areas | No new weed species become problematic within 12 months post-construction | There has been an increase in weed species diversity compared to previous years. An additional eight species were identified in the project alignment in 2019. None of these weeds should be considered problematic as they are common environmental weeds.<br>Areas with prevalent weed cover are those that have been highly disturbed and have limited revegetation activities (e.g. roadsides). Mid storey species establishment has overall been a success, however grass and herbaceous weeds have colonised many areas.<br>Two of the four priority weeds identified have spread to new areas since 2018; Blackberry and Lantana. Weed control measures are recommended immediately to stop these weeds from spreading to more areas.<br>Fireweed remains the most prevalent weed issue across the project alignment. Despite a small decline in distribution and abundance, it is widespread throughout the alignment. Fireweed is a Priority Weed for the South-east region under the Biosecurity Act. Fireweed is difficult to control due to its widespread presence in private lands surrounding the project alignment, placing more of an emphasis on control of spread to new areas than eradication. | There has been an increase in weed species diversity compared to previous years with an additional nine (9) species being observed in 2020. Important to note, seven (7) of the species previously recorded were not observed in 2020. None of the new weed species should be considered problematic as they are common environmental weeds.<br>Areas with prevalent weed cover continue to be highly disturbed with varying success of regeneration and revegetation. Mid storey species in most areas have successfully been established, however grass and herbaceous weeds continue to colonise most areas.<br>The same four priority weeds were identified in 2020; Lantana, Blackberry, Fireweed, and Giant Parramatta Grass. Lantana was found in one additional site in 2020 than in 2019, however the overall abundance for the species has reduced. Blackberry, Fireweed and Giant Parramatta Grass were all found in the same number of sites as 2019 in 2020. Abundance remained the same for Giant Parramatta Grass, whereas a reduction was observed in both Blackberry (2.13) and Fireweed (1.55) in 2020 compared to 2019.<br>Fireweed remains the most prevalent weed across the project alignment. Despite the decline of abundance it is still widespread throughout the alignment (observed in 42 of 47 surveyable sites in 2020). Fireweed is difficult to control and manage particularly in agricultural area, where large private lands surround the project alignment. This places more emphasis on controlling the spread to new areas than overall eradication. |

# 5. REVIEW OF MITIGATION MEASURES

## 5.1. ECOLOGICAL MONITORING

According to the results of ecological monitoring, only one mitigation measure is not meeting the performance criteria; twelve reptile species were recorded during pre-construction transect surveys, with seven reptile species in 2018, eight reptile species during 2019 and six reptile species in 2020. This is a 50% (2018), 43% (2019) and 58% (2020) decrease in reptile diversity when compared to pre-construction monitoring. Survey weather conditions and an increase in predation may be factors. Further monitoring may detect additional species. Ongoing monitoring and potentially managing fox populations in the locality should be considered.

Road kill rates above the performance target were evident in 2018, but NGH was not contracted to undertake road kill monitoring in 2019 and 2020.

## 5.2. AQUATIC MONITORING

The EcMP and the CFFMP, including the Weed Management Plan, include a number of mitigation measures and actions from the environmental assessment and Statement of Commitments to be undertaken to avoid and/or minimise water quality and aquatic biodiversity impacts during construction. These are detailed in Table 5-1 along with notes on whether these have been implemented.

Table 5-1 Mitigation measures

| Mitigation measure | Implementation |
|---|---|
| **EcMP** | |
| Consider lopping or relocation of large woody debris in streams as a first priority before removal. Should removal of large woody debris be necessary, consider the introduction of engineered woody debris as compensation within the offset strategy for residual impacts. | Cut stump methodology has been used to retain root balls in situ around waterways. Coarse woody debris has been salvaged and has been re-introduced to the project during stream rehabilitation works. |
| Consult with the DPI (Fishing and Aquaculture) for input in relation to matters relevant to Fisheries, where appropriate | DPI and Fisheries attended the project four times in 2015 and on at least three occasions in 2016. They have also been consulted periodically via email and on the telephone for all creek works. |
| Where feasible use low hollow-core bridges or short lengths of pipe culverts for temporary crossings to maintain fish passage with reference to guidelines for the design and construction of waterway crossings to maintain fish passage. | Fish passage in the major creeks of the project has been maintained through the construction of temporary bridges. These bridges allow for full connectivity of upstream and downstream flows and have been installed at;<br>Broughton Creek 1,<br>Broughton Creek 2,<br>Broughton Mill Creek,<br>The other main creek on the project Bundewallah Creek had piped culverts installed below the waterline so passage for fish is maintained. This crossing was approved by NSW DPI Fisheries. |

| Mitigation measure | Implementation |
|---|---|
| | All other waterways on the project are ephemeral. |
| Manage weeds where identified | Current results indicate that weed control measures should be continued across the project as they have been ineffective thus far for certain exotic species. |
| Minimise impacts to water quality during operation of the project through the combination of swales, water quality basins and biofiltration. | The operational design includes the following water quality features:<br>• Basins<br>• Bioswales<br>• Vegetated swales<br>Hard rock scour protection<br>The effectiveness of these design features will continue to be assessed during the operational phase of the project. |
| Implement erosion and scour protection in the design and construction of bridges and culverts. Manage erosion and sedimentation impacts and conduct surface water quality monitoring during construction of the project to monitor water quality | A PESCP has been prepared and implemented across the site. EWMS's have been prepared and implemented during works within and adjacent to waterways.<br>All bridge structures have scour protection designed around them.<br>Surface water quality monitoring completed throughout 2020 did not show any impacts on the receiving waterways which can be attributed to the operation of the bypass. |
| Design transverse drainage structures to allow unrestricted passage of most natural flows and allow for changes in the natural flow regime as a result of climate change. This would be achieved by designing bridges and culverts to provide flood immunity from the 100 year flood event and the 50 year flood event respectively. | This has been completed and is included in the design at Broughton Creek, Bundewallah Creek and Broughton Mill creek. |
| In areas close to or upstream from sensitive receiving waters, implement additional treatment measures to ensure no net increase in pollutant load from road runoff. | Pollution control basins and attenuation swales have been designed to manage long term road runoff pollutants. |
| Conduct regular water quality monitoring in accordance with the Foxground and Berry Bypass Water Quality Monitoring Program (GHD, 2014). | Ongoing. Monitoring completed to date. |
| Conduct aquatic ecology monitoring during the pre-construction, construction and operational periods. | Ongoing. Monitoring completed to date. |
| Periodically review and evaluate the results of the monitoring to identify improvements to existing mitigation measures or maintenance regimes. Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity. | Ongoing. Refer to this annual report and the 2015, 2016, 2017, 2018, 2019 and 2020 annual reports. |
| **CFFMP** | |
| Periodically review and evaluate the results of the monitoring to identify improvements to | Additional controls will be put in place where monitoring shows they are required. |

| Mitigation measure | Implementation |
|---|---|
| existing mitigation measures or maintenance regimes. Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity. | Current results indicate that continued weed control measures should be continued across the project as they have been ineffective thus far. |
| Retain stumps in riparian zones and aquatic habitats where practicable to reduce the potential for bank erosion. Even dead stumps and root systems may act to reduce erosion during construction and operation periods. | Cut stump clearing has been undertaken across the project within 5 m of waterways as a minimum. |
| Subject to consultation with NOW and DPI (Fishing and Aquaculture), utilise trees removed as a consequence of the project for fish habitat and bank stability within the creeks of the project area. | Coarse woody debris has been salvaged and has been re-introduced to the project as part of the creek rehabilitation works. Riparian rehabilitation was carried out in consultation with DPI (fisheries) and NSW Office of Water. |
| For temporary water crossings over all Class 1 and 2 waterways install temporary bridge structures instead of box culverts to reduce the potential for scouring. | Temporary bridge structures were installed over Broughton Creek crossing one and two, and Broughton Mill creek. |
| Follow the relevant EWMS and PESCP for the construction of all temporary bridges to minimise the potential of erosion and sedimentation impacts. | Adhered to. |
| Locate all refuelling areas at least 50 metres away from waterways. | Refuelling of mobile plant was undertaken more than 50 m from a waterway.<br>Cranes, pilling rigs and other less mobile plant was refuelled closer than 50 m to the waterway in accordance with the Fulton Hogan refuelling procedure. |
| Progressively revegetate batters and other disturbed areas with cover crop species to stabilise the soil and provide vegetation cover as a method to minimise sedimentation of waterways and impacts on fish. Use Rye Corn during the months of April to August or Japanese Millet during the months of September to March. Also refer to the UDLP where necessary. | Cover crops were applied to temporarily stabilise batters, design seed was applied as efficiently as construction allowed in all areas. |

## 5.3. WEED MONITORING

There is one mitigation measure for weed management which states that there should be ‘no evidence of weed invasion or spread to adjacent areas’. There has been an increase in weed species diversity since 2017. This mitigation measure has not been met, however during construction, areas were stripped of vegetation, and continue to recolonise. There were no new priority weed species in 2020.

Lantana was found in one additional site in 2020 than in 2019, however the overall abundance for the species has reduced. Blackberry, Fireweed and Giant Parramatta Grass were all found in the same number of sites as 2019 in 2020. Abundance remained the same for Giant Parramatta Grass, whereas a reduction was observed in both Blackberry (2.13) and Fireweed (1.55) in 2020 compared to 2019.

# 6. RECOMMENDATIONS

## 6.1. ECOLOGICAL MONITORING

The CoA require the development of potential contingency measures that would be implemented if circumstances arise where there are changes in habitat usage patterns as a result of the construction or operation phase of the Project, or where performance criteria are not met.

Table 6-1 and Table 6-2 below provide a list of mitigation and contingency measures in response to the performance criteria results and in accordance with Section 5 of the EcMP.

Table 6-1 Mitigation measures and contingency measures

| Area of concern | Recommendation/Mitigation Measure |
|---|---|
| Roadkill rates – fauna fencing | • In 2019 it was recommended that a fauna fence assessment should be conducted along the project alignment, to assess the current level of damage to fauna fences, and determine if installation of new areas of fauna fencing is feasible, and whether the installation of fauna escape features is feasible in fenced areas<br>• Restore damaged fauna fencing<br>• Replace severely damaged fauna fencing<br>• Where feasible, install fauna fencing in areas where roadkill hotspots are high, and no fence is present. Installation areas should focus on the terrestrial roadkill hotspots identified in Section 4.1.1 and within figures 3-2 to 3-11 |
| Roadkill rates - Landscape Maintenance | • Plant non-preferred clumping species or non-desirable species to reduce grazing potential for macropods near the roadside in areas with no fencing. Examples include:<br>  • Spiny-head Mat-rush *Lomandra longifolia*<br>  • Coastal Rosemary *Westringia fruticosa*<br>• Mowing these areas will also reduce habitat for small rodents and reptiles, reducing the foraging habitat for birds of prey and owls.<br>• Supplement the loss of foraging habitat by implementing Weed Management recommendations by creating more suitable locations for foraging further from the road.<br>• Control fruit-bearing vegetation which may attract birds/Flying Foxes adjacent to the road. |
| Reptile species diversity | • Reptile species diversity continues to decline. Recommend implementing additional shelter structures in proximity to crossings. Fox control (baiting) is also recommended. |

Two additional recommendations not triggered by the EcMP criteria are provided below.

Table 6-2 Additional measures

| Area of concern | Recommendation/Mitigation Measure |
|---|---|
| Rope Bridges | A collaboration of data sets suggests that some rope bridges are being |

| Area of concern | Recommendation/Mitigation Measure |
|---|---|
| | utilised by Ringtail Possums, Brush-tail Possums, Mountain Brushtail Possums, Sugar Gliders and roosting birds. The areas surrounding crossing structures would benefit from additional revegetation. It is understood that replanting has been undertaken around these areas, thus additional time will be required before surrounding vegetation grows to the height of crossing structures. This may increase the use of these structures by arboreal fauna. |
| Underpasses/ underpass bridges<br>Wooden structures have been installed without connecting ropes | The areas surrounding crossing structures would benefit from additional revegetation. Ensure adequate connectivity of underpass structures to surrounding vegetation to enable use by fauna. It is understood that some revegetation has taken place surrounding structures, and this will take time to grow to a height useable by fauna. It will also enhance safety for native fauna to cross given the presence of exotic predators. |

## 6.2. AQUATIC MONITORING

The safeguards detailed below should continue to be implemented. Additionally, regular and systematic aquatic weed control should commence immediately across all sites. Please refer to the below guidelines.

| Mitigation Measure | Implementation |
|---|---|
| Control aquatic weeds in riparian zones and aquatic habitats to prevent further spread. | Undertake aquatic weed management in accordance with the DPI guidelines (2008; 2018) and the 2019 FBB Weed Monitoring Report recommendations, across the project. This includes:<br>• Mechanically or physically removing plants when they first appear;<br>• Treating any remnants with spot applications of a recommended herbicide;<br>• Diverting nutrient run off away from the riparian zones as nutrient rich waters encourage aquatic weed growth;<br>• Plant trees to shade the riparian zones and reduce available light to the weeds;<br>• Use biological control agents if they are available and are suitable to the particular situation;<br>• Strategic placement of barriers or booms to contain the weeds and to prevent them from spreading;<br>• Continual weed monitoring of the sites. |

## 6.3. WEED MONITORING

The 2020 weed monitoring recorded a slight decrease in average weed cover across most sites, which indicates that the spread of weeds has been controlled. However, an increase in weed species diversity in 2020 indicates that ongoing weed control remains a priority.

Priority weed diversity remained unchanged between 2019 and 2020, where abundance was seen to decrease in 3 of 4 species.

The following sites provide examples where revegetation attempts have been effective in the suppression of weed abundance and diversity across the project alignment:

- 5 – mid-storey revegetation improved between 2018 and 2019, and continued in 2020
- 9 – mid-storey revegetation improved between 2018 and 2019, and continued in 2020
- 15- mid-storey revegetation improved between 2018 and 2019, and continued in 2020. Relative abundance of weeds has seen a decrease in most species.
- 32 – landscape plantings in this area improved considerably between 2018 and 2019, and their establishment has continued in 2020 and are still providing a good suppressant for weed establishment and spread
- 33 - landscape plantings in this area improved considerably between 2018 and 2019, and their establishment has continued in 2020 and are still providing a good suppressant for weed establishment and spread
- 40 - landscape plantings in this area improved considerably between 2018 and 2019, and their establishment has continued in 2020 and are still providing a good suppressant for weed establishment and spread
- 43– landscape plantings in this area improved considerably between 2018 and 2019, and their establishment has continued in 2020 and are still providing a good suppressant for weed establishment and spread
- 44 - landscape plantings in this area improved considerably between 2018 and 2019, and their establishment has continued in 2020 and are still providing a good suppressant for weed establishment and spread

The overall revegetation attempts seem more successful in 2020 than in 2019. However, there was still evidence of die-back and with empty tubes, stakes and mats observed in some areas. The LMP states that all dead or dying plant material would be removed during maintenance activities. Furthermore, that replacement planting would be conducted in failed or damaged plantings. It is important to note that species selection in revegetation attempts can considerably affect the success rate. Revegetation attempts should continue to further aid the prevention of spread and invasion of weed species. The TfNSW Landscape Officer should look at maintenance work records to ensure works are being completed and in accordance with the timeframes agreed upon in the LMP. Cleaning up after failed revegetation attempts across all chainages, and particularly on large stockpiles and slopes across the site should be an initial priority.

Suppression of Fireweed and other priority weeds remains an ongoing issue. As Fireweed occurs throughout most of the project area and in the presence of various other weeds, targeted control measures are not yet required. Fireweed should be treated as routine weed control and conducted in all areas. Blackberry and Lantana have larger ecological impacts and should be controlled immediately across sites where present. TfNSW should consider engaging with land owners in the project surrounds to assist in overall weed control as they too have a General Biosecurity Duty under the Biosecurity Act 2015.

Areas of concern:

- 9 – Although mid storey revegetation attempts have been successful in this area, it is recommended that immediate weed control is conducted to reduce this risk of exotic vines suffocating native mid storey.
- 12 – Area was previously dominated by exotic grasses however and was observed with establishing thistles and emerging abundances of lantana and exotic vines. With

proximity to remnant trees, and successful revegetation, immediate weed control is recommended to prevent the spread and further establishment of these weeds. If left untreated, it poses a risk of invasion and establishment in other areas within the alignment.

- 13 - An area impacted by runoff. This area still contains a large diversity of weeds. Immediate control is recommended for this area to reduce the risk of spread to neighbouring sites.
- 19 – An area on the fringe of wet sclerophyll forest and landscape grasses. It contains large native trees and is also a possum rope bridge access point. It is recommended that immediate weed control is implemented in this area; primarily on *L. camara* and perennial grasses to better utilise the habitat available for possums, gliders, and birds. Native revegetation may assist in weed suppression.
- 26 – Immediate weed control is recommended for L. camara as it occurs in a large abundance
- 35 – Revegetation attempts are yet to be successful in this area. More revegetation attempts are recommended. Due to the location in the landscape, ground covers including rushes and grasses are recommended to avoid line of sight issues for vehicles. These will also help supress exotic weeds from establishing and spreading.
- 36 – Although revegetation attempts with the mid storey have been effective in some part. Exotic groundcovers, and vines continue to be prevalent in the area. Immediate weed control is recommended in this area to avoid the suffocation of native mid storey by exotic vines.

The hierarchy of weed control: Prevention, Eradication, Control, Asset protection; can be used as a guide to control infestations. As priority weeds are already present and are spread throughout multiple sites, controlling the spread of these species and invasion into other areas is the main mitigation method. Targeting these species during routine weed control in addition to educating weed control officers on these species will assist in their suppression. Avoiding their establishment in new areas is paramount in controlling them throughout the project alignment.

# 7. REFERENCES

AECOM (2012) Foxground and Berry Bypass Environmental Assessment, prepared for Roads and Maritime Services, from https://www.rms.nsw.gov.au/documents/projects/south-coast/foxground-and-berry-bypass/foxground-berry-bypass-environmental-assessment-main-report.pdf

ANZECC/ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 Chapters 1-7.

Bartolini, T., Butail, S. & Porfiri, M. (2015) Temperature influences sociality and activity of freshwater fish. *Environ Biol Fish* 98**,** 825–832. https://doi.org/10.1007/s10641-014-0318-8

Biggs, B.J.F., Kilroy, C., Mulcock, C.M., Scarsbrook, M.R., Ogilvie, S.C. (2002) New Zealand Stream Health Monitoring and Assessment Kit. Stream Monitoring Manual. Version 2K – A tool for Kaitiaki. *NIWA Technical Report* 111-1.

Dey, S. Botta, S. Kallam, R. Andugala, J. (2021) Seasonal variation in water quality parameters of Gudlavalleru Engineering College pond. Available at https://doi.org/10.1016/j.crgsc.2021.100058.

Fulton Hogan (2014) Construction Flora and Fauna Management Sub-plan, Foxground and Berry bypass.

Fulton Hogan (2017) Landscape Maintenance Plan.

Keith, D. A. (2017) Australian Vegetation (Cambridge University Press, Cambridge).

JSA (2016) Berry to Foxground Princes Highway upgrade pre-construction aquatic assessment.

Mandaville, S.M. (2002) Benthic Macroinvertebrates in Freshwaters – Taxa Tolerance Values, Metrics and Protocols. Project H-1, Soil & Water Conservation Society of Metro Halifax.

Masaki Hayashi, (2004) Temperature-Electrical Conductivity Relation of Water for Environmental Monitoring and Geophysical Data Inversion. Environmental Monitoring and Assessment V96 Pages 119 - 128. From https://link.springer.com/article/10.1023/B:EMAS.0000031719.83065.68

Michaud, J. P. (1995) A citizens Guide to Understanding and Monitoring Lakes and Streams. Washington State Department of Ecology & administered by Puget Sound Water Quality Authority. Available at https://apps.ecology.wa.gov/publications/documents/94149.pdf

New South Wales Department of Primary Industries (2014) http://weeds.dpi.nsw.gov.au/Weeds/Details/53 accessed 19/01/2016

Parsons Brinkerhoff (PB) (2014) Princes Highway Upgrade - Foxground and Berry Bypass Project - Ecological Monitoring Program, Sydney.

Parsons Brinkerhoff (PB) (2015) Princes Highway Upgrade - Foxground and Berry Bypass Project Baseline Ecological Monitoring Results Report, Sydney.

Roads and Maritime Services (2011) Biodiversity Guidelines, Roads and Maritime Services.

Roads and Maritime Services (2014) Construction Flora and Fauna Management Sub-plan, Foxground and Berry bypass, NSW Government.

RTA Environmental Branch (2011) Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects, Transport Roads and Traffic Authority, NSW Government, from https://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/guides-manuals/biodiversity_guidelines.pdf

Sydney Water (2010) City of Ryde Report: Biological and Water Quality Monitoring in Spring 2010.

# APPENDIX A WEED MONITORING PHOTO COMPARSION 2019/2020

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 15 | 297055 | 6152294 | North of Toolijooa Rd | Batter |  |  |
| 14 | 296835 | 6152244 | Near turn around bay south of Toolijooa Rd | Construction area, with bare soil areas |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 16 | 296799 | 615239 | South of Toolijooa Rd | Roadside area |  |  |
| 17 | 296675 | 6152401 | South of Toolijooa Rd | Roadside batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 18 | 296523 | 6152549 | South of Toolijooa Rd | Roadside batter |  |  |
| 19 | 296251 | 6152744 | Between BC1 and Toolijooa Rd | Roadside embankment |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 20 | 296157 | 6152704 | Between BC1 and Toolijooa Rd | Access track between Toolijooa Rd and BC1 |  |  |
| 21 | 29593 | 6152819 | Between BC1 and Toolijooa Rd | Top of cut |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 22 | 295486 | 6152939 | Between BC1 and Toolijooa Rd | Light vehicle track |  |  |
| 24 | 295121 | 6152887 | BC1 | Adjacent to compound |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 31 | 295126 | 6152978 | BC1 | Roadside batter |  |  |
| 25 | 294923 | 6152794 | BC1 | BC1 |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 26 | 294695 | 6152708 | Between BC1 and BC2 | Road side |  |  |
| 27 | 294623 | 6152587 | Between BC1 and BC2 | Road side |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 30 | 294583 | 6152452 | Between BC1 and BC2 | Road side |  |  |
| 28 | 294296 | 6152021 | Between BC2 and BC3 | Road side |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 29 | 294250 | 6151865 | Between BC2 and BC3 | Road side |  |  |
| 32 | 294059 | 6151679 | Between Austral Park compound and BC3 | Access track |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 33 | 293916 | 6151611 | Between Austral Park compound and BC3 | Batter |  |  |
| 34 | 293975 | 6151579 | Between Austral Park compound and BC3 | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 35 | 293661 | 6151517 | Between Austral Park compound and BC3 | Batter |  |  |
| 36 | 293699 | 6151420 | Between Austral Park compound and BC3 | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 37 | 293391 | 6151342 | Between Austral Park compound and BC3 | Batter |  |  |
| 13 | 293197 | 6151331 | Austral Park | Western side Princess Hwy |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 38 | 293143 | 6151252 | Austral Park | Western side Princess Hwy |  |  |
| 12 | 293089 | 6151221 | Austral Park | Western side Princess Hwy |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 10 | 292987 | 6151220 | Austral Park | Western side Princess Hwy |  |  |
| 11 | 292977 | 6151168 | Austral Park | Soil mound |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 9 | 292873 | 6151166 | Austral Park | Batter |  |  |
| 8 | 292746 | 6151115 | Austral Park | Road side |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 7 | 292355 | 6150882 | Central zone | Road side |  |  |
| 6 | 291579 | 6150900 | Tindell's Lane | Road side |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 5 | 291578 | 6150845 | Tindell's Lane | Batter |  |  |
| 4 | 291320 | 6150671 | Central zone<br>Cut 6 | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 3 | 291317 | 6150605 | Central zone<br>Cut 6 | Batter |  |  |
| 2 | 291251 | 6150619 | Central zone<br>Cut 6 | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 1 | 291130 | 6150523 | Central zone<br>Cut 6 | Batter |  |  |
| 0 | 290920 | 6150386 | Central zone | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 39 | 290499 | 6150097 | Southern zone | Batter |  |  |
| 41 | 290384 | 6150131 | Southern zone | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 40 | 290237 | 6150006 | Southern zone | Embankment |  |  |
| 42 | 289262 | 6149761 | Southern zone | Batter |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 43 | 288808 | 6149755 | Southern zone | Batter |  |  |
| 49 | 288598 | 6149960 | Southern zone | Town Creek Diversion, Rawling's Lane |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 44 | 288407 | 6149644 | Southern zone | Noise mound |  |  |
| 45 | 288031 | 6149263 | Southern zone | Roadside |  |  |

| Way point | Eastings | Northings | General Location | Site Description | 2019 Photograph | 2020 Photograph |
|---|---|---|---|---|---|---|
| 48 | 287971 | 6149266 | Southern zone | Roadside |  |  |
| 47 | 287054 | 6147773 | Southern zone | Roadside | Could not survey due to Berry to Bomaderry Construction | Could not survey due to Berry to Bomaderry Construction |
| 46 | 286918 | 6147524 | Southern zone | Roadside |  | Could not survey due to Berry to Bomaderry Construction |

# APPENDIX B MACROPHYTE DATA 2016-2019

| Site13 – Broughton Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Ottelia ovalifolia* Swamp lily | | | | | | | | 1 | | | | | | | | | | | | |
| *Sagittaria platyphylla** Sagittaria | | | | | | | | 1 | | | | | | | | | | | | |
| *Colocasia sp.** Elephants ear | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| *Lemna disperma* Duckweed | 1 | | 1 | 2 | | 1 | 1 | | | | | | | | | | | | | |
| *Altenanthera philoxeroides** Aligator weed | | | | | | | | | 2 | | | | | | | | | | | |
| **Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | 2 | | | | 2 | 1 | | 1 | 2 |

| Site13 – Broughton Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Juncus usitatus* Common rush | | | | | | | | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | 2 | 2 | | 1 | | 2 | 3 | 2 |
| *Colocasia* sp.* Taro | | | | | | | | | | | | | 1 | 1 | | | | | | |
| *Rorippa nasturtium-aquaticum** Watercress | | | | | | | | | | | | | | 1 | 2 | | | | 1 | |
| *Rumex crispus** Curly dock | | | | | | | | | | | | | | | 1 | | | | 1 | |
| *Persicaria strigose* Knotweed | | | | | | | | | | | | | | | | | | | | 2 |

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| Site 16 – Broughton Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | | | | | 2 | 2 | 2 | 2 |
| *Lemna disperma* Duckweed | | 1 | | | | | | | | | | | | | | | | | | |
| *Sagittaria platyphylla** Sagittaria | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | | | 1 | 2 | | |
| *Colocasia sp.** Elephants ear | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | |
| *Damasonium minus* Starfruit | 1 | 1 | | | | | | | | | | | | | | | | | | |
| **Rorippa nasturtium-aquaticum* Watercress | | | | | | 1 | 1 | 1 | | | | | | | | | | 1 | | |
| *Juncus usitatus* | | | | | | | | | | | 3 | 2 | 1 | 2 | | 2 | 1 | 2 | 2 | 2 |

| Site 16 – Broughton Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc | Session 1 Abundanc | Session 2 Abundanc |
| Common rush | | | | | | | | | | | | | | | | | | | | |
| **Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | 2 | | 1 | 3 | 2 | | | | |
| *Persicaria strigose* Knotweed | | | | | | | | | | | | | | | | | | | | 2 |

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| Site 17 – Bundewallah Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Lemna disperma* Duckweed | | | 2 | 3 | | 2 | | | | | | | | | | | | | | |
| *Juncus usitatus* Common rush | | | | | | | 1 | 1 | | | | 1 | 2 | | | 2 | 1 | 1 | 2 | 2 |
| *Maidenii rubra* Maidenii | 1 | | 1 | 2 | | 1 | | 1 | | | | | | | | | | | | |
| *Sagittaria platyphylla** Sagittaria | | | | | | | | | 2 | | | 1 | | | | | | | 1 | |
| *Colocasia sp.** Elephants ear | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | |
| **Myriophyllum aquaticum* Parrots feather | | | | | | | | | | | 1 | | | | | | | | | |
| **Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | 1 | 2 | 1 | | 2 | 1 | | 1 | 1 |

| Site 17 – Bundewallah Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Colocasia sp.** Taro | | | | | | | | | | | | | 1 | 1 | 1 | 1 | | | | |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | | 1 | | | | | 2 | 2 |
| *Cypress gracilis* Slender flat sedge | | | | | | | | | | | | | | | 1 | 1 | | | | |
| **Rorippa nasturtium-aquaticum* Watercress | | | | | | | | | | | | | | | | | | 1 | | |

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| Site 22 – Bundewallah Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | 1 | 2 | | | | | 3 | 3 |
| *Lemna disperma* Duckweed | 2 | 1 | 2 | 1 | | 3 | 1 | | | | | | | | | | | | | |
| *Ludwigia peploides* Water primrose | | | | | | | | | | | | | | | 1 | 1 | | | | |
| *Rorippa palustris** Marsh watercress | | 1 | | | | | | | | | | | | | | | | | | |
| *Eleocharis acuta* Common Spike Rush | | | | | | | | | | | | | | | | | | | | |
| *Vallisneria australis* Ribbonweed | | 1 | 1 | 3 | 1 | 1 | 1 | | | | | | | | | | | | | |

| Site 22 – Bundewallah Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Nasturtium officinale** Watercress | | | | | | | | | | | | | | | | | | | | |
| *Maidenii rubra* Maidenii | 1 | | 1 | 1 | | 1 | | | | | | | | | | | | | | |
| **Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | 4 | 2 | 3 | 3 | 3 | 2 | | 3 | 4 |
| *Alternathera philoxeroides** Alligator weed | | | | | | | | | | | | | 1 | 1 | | | | | | |
| *Rumex crispus** Curly dock | | | | | | | | | | | | | | | 1 | 1 | | | 1 | |
| *Juncus usitatus* Common rush | | | | | | | | | | | | | | | | | | | | 2 |

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| Site 25 – Broughton Mill Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Ottelia ovalifolia* Swamp lily | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | | | | | | | | | | | | |
| *Sagittaria platyphylla** Sagittaria | | | 2 | 3 | 3 | 3 | 3 | 3 | | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 1 | 2 |
| *Glyceria maxima** Reed sweetgrass | | | | | | | | | | | | | | | | | | | | |
| *Potamogeton crispus* Curly Pond Weed | 3 | | | | | | | | | | | | | | | | | | | |
| **Elodea canadensis* Elodea | 3 | 2 | 3 | 5 | 4 | 4 | 2 | 2 | | 2 | 2 | 3 | 3 | 3 | 3 | 3 | | | | |
| *Vallisneria australis* | | | 3 | 2 | 2 | 2 | 2 | 1 | | | | | | | | | | | | |

| Site 25 – Broughton Mill Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| Ribbonweed | | | | | | | | | | | | | | | | | | | | |
| *Alternanthera philoxeroides** Alligator weed | | | | | | | | | 2 | | | | | | | | | | | |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | | | 2 | 2 | | 2 | 2 | 2 |
| *Rumex crispus** Curly dock | | | | | | | | | | | | | | | | | | | 1 | 2 |
| *Persicaria strigose* Knotweed | | | | | | | | | | | | | | | | | | | | 2 |
| **Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | | | | | | | | | 2 |

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| Site 27 – Bundewallah Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Persicaria despectans* Slender knotweed | | | | | | | | | | | | | | | | | | | | |
| *Ludwigia peploides* Water primrose | | | | | | | | | | | | | | | | 1 | | | | |
| *Lemna disperma* Duckweed | 1 | 2 | 1 | 2 | 2 | 1 | 1 | | | | | | | | | | | | | |
| *Juncus usitatus* Common rush | | | | | | | | | | | | | | | 1 | | 2 | 2 | 2 | 2 |
| **Rorippa palustris* Marsh Watercress | | 1 | | | | | | | | | | | | | | | | | | |

| Site 27 – Bundewallah Creek | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| *Alternanthera philoxeroides** Alligator weed | | | | | | | | | | 1 | 1 | | 1 | | 1 | 1 | | | | |
| *Azolla pinnata* Mosquito fern | | | | | | | | | | | 3 | | | | | | | | | |
| **Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | 2 | | | | 1 | | | | 2 |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | 2 | | | 2 | 2 | 2 | 2 | |
| *Rorippa nasturtium-aquaticum** Watercress | | | | | | | | | | | | | | 2 | 1 | 1 | | | | |
| *Rumex crispus** Curly dock | | | | | | | | | | | | | | | | 1 | | | | |

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| Control Site 1 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | | Winter 2020 | | Spring 2020 |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| **Sagittaria platyphylla* Sagittaria | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | 1 |
| *Persicaria strigose* Knotweed | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | | | | | | | | | | | | 1 |
| *Ottelia ovalifolia* Swamp Lily | 1 | 1 | | | | | | | | | | | | | | | | | | |
| *Maidenii rubra* Maidenii | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | |
| **Myriophyllum aquaticum* Parrots feather | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | |
| *Vallisneria australis* Ribbonweed | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 2 | | | | | | | | | | |
| *Triglochin procerum* | 1 | 1 | | | | | | | | | | | | | | | | | | |

| Control Site 1 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | | Winter 2020 | | Spring 2020 |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| Water ribbon | | | | | | | | | | | | | | | | | | | | |
| *Eleocharis acuta* Common Spike-rush | | 3 | 2 | 2 | 2 | 2 | 2 | 1 | | | | | | | | | | | | |
| **Elodea canadensis* Elodea | | | | | | | | | 3 | | 2 | | 3 | 4 | 4 | 4 | | | | |
| *Baumea articulata* *Jointed rush* | | | | | | | | | 2 | | 1 | 2 | 2 | | 2 | 2 | 2 | | | 1 |
| *Persicaria hydropiper* Water pepper | | | | | | | | | | | | | 3 | 2 | 3 | 3 | 3 | 2 | 5 | 3 |
| *Cyperus eragrostis* Umbrella Sedge | | | | | | | | | | | | | | 2 | | | | | 2 | 2 |
| *Juncus usitatus* Common Rush | | | | | | | | | | | | | | | | | 2 | 2 | 3 | 2 |
| *Rumex crispus** | | | | | | | | | | | | | | | | | | | 2 | |

| Control Site 1 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| Curly dock | | | | | | | | | | | | | | | | | | | | |

*Exotic

| Control Site 2 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| **Species** | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance | Session 1 Abundance | Session 2 Abundance |
| **Sagittaria platyphylla* Sagittaria | | | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | | | 2 | |
| *Eleocharis acuta* Common Spike-rush | | | 1 | | | | | | | | | | | | | | | | | |

| Control Site 2 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| *Eleocharis sphacelata*<br>Tall Spike-rush | | | | 2 | | 1 | 1 | 1 | | | | | | | | | | | | |
| **Colocasia sp.*<br>Elephant's Ear | | | | 1 | | | | | 2 | | 1 | | | | 1 | 1 | 1 | | 1 | |
| *Ottelia ovalifolia*<br>Swamp Lily | | | | 3 | 2 | | 1 | | | | 1 | | | | | | | | | |
| *Baumea articulata*<br>*Jointed rush* | | | | | | | | | 2 | | | | 2 | 1 | 2 | 2 | 2 | | 2 | |
| *Alternanthera philoxeroides**<br>Alligator weed | | | | | | | | | 2 | | | | | | | | | | | |
| **Cyperus eragrostis*<br>Umbrella Sedge | | | | | | | | | | | | 2 | | 1 | | 2 | 1 | | | |
| *Persicaria hydropiper*<br>Water pepper | | | | | | | | | | | | | 2 | 1 | | | 1 | | 2 | |
| *Colocasia sp.**<br>Taro | | | | | | | | | | | | | 1 | 1 | 1 | | 1 | | | |
| *Rorippanasturtium-aquaticum**<br>Watercress | | | | | | | | | | | | | | 1 | 2 | 1 | | | | |
| *Ageratina riparia**<br>Mistflower | | | | | | | | | | | | | | 1 | | | | | 1 | |
| *Rumex crispus**<br>Curly dock | | | | | | | | | | | | | | | | 1 | | | | |

| Control Site 2 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | | Winter 2020 | | Spring 2020 | |
| *Juncus usitatus*<br>Common rush | | | | | | | | | | | | | | | | | 1 | | | |
| *Rumex crispus**<br>Curly dock | | | | | | | | | | | | | | | | | | | 1 | |

*Exotic

# APPENDIX C AQUATIC FAUNA ASSESSMENT RAW DATA 2016-2020

| | | | 2016 | | | | | | 2017 | | | | | | | | 2018 | | | | | | | | 2019 | | | | | | | | 2020 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Taxa | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 | Site 13 | Site 16 | Site 17 | Site 22 | Site 25 | Site 27 | CS1 | CS2 |
| Preconstruction | Spring session 1 | *Atherinosoma microstoma* Small-mouthed Hardyhead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Gobiomorphus coxii* Cox's Gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Hypseleotris galli* Firetail Gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Macquaria novemaculeata* Australian Bass | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | Spring session 2 | *Anguilla australis* Short-finned Eel | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | 2016 | | | | | | 2017 | | | | | | | | 2018 | | | | | | | | 2019 | | | | | | | | 2020 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Atherinosoma microstoma* Small-mouthed Hardyhead | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Gobiomorphus coxii* Cox's Gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Macquaria novemaculeata* Australian Bass | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| Construction | Autumn Session 1 | *Macquaria novemaculeata* Australian bass | 0 | 0 | 0 | 0 | 3 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Gobiomorphus australis* Striped gudgeon | 0 | 0 | 1 | 2 | 1 | 1 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | 2016 | | | | | | 2017 | | | | | | | | 2018 | | | | | | | | 2019 | | | | | | | | 2020 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Philypnodon grandiceps* Flathead gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | Autumn Session 2 | *Gobiomorphus australis* Striped gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | Spring session 1 | *Macquaria novemaculeata* Australian bass | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Gobiomorphus australis* Striped gudgeon | 0 | 0 | 0 | 2 | 0 | 3 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Philypnodon grandiceps* Flathead gudgeon | 1 | 1 | 0 | 0 | 1 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Anguilla australis* Short finned eel | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | 2016 | | | | | | 2017 | | | | | | | | 2018 | | | | | | | | 2019 | | | | | | | | 2020 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring session 2 | *Macquaria novemaculeata* Australian bass | 0 | 0 | 2 | 0 | 2 | 0 | | | | | | | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Gobiomorphus australis* Striped gudgeon | 3 | 0 | 1 | 2 | 1 | 1 | | | | | | | 1 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Anguilla australis* Short finned eel | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 2 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Gobiomorphus coxii* Cox's Gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Philypnodon grandiceps* Flathead gudgeon | 0 | 1 | 1 | 0 | 1 | 0 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | *Atherinosoma microstoma* Small-mouthed Hardyhead | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | 2016 | | | | | | 2017 | | | | | | | | 2018 | | | | | | | | 2019 | | | | | | | | 2020 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Post Construction | Autumn Session 1 | *Macquaria novemaculeata* Australian Bass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | *Gobiomorphus coxii* Cox's gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Anguilla australis Short finned eel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | *Philypnodon grandiceps* Flathead gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Autumn Session 2 | *Philypnodon grandiceps* Flathead gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | *Anguilla australis* Short finned eel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | *Ornithorhynchus anatinus* Platypus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | Spring Session 1 | *Gobiomorphus coxii* Cox's gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | *Anguilla australis* Short finned eel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |

| | | | 2016 | | | | | | 2017 | | | | | | | | 2018 | | | | | | | | 2019 | | | | | | | | 2020 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring Session 2 | *Anguilla australis* Short finned eel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| | | *Gobiomorphus coxii* Cox's gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | *Philypnodon grandiceps* Flathead gudgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 0 |

# APPENDIX D MACROINVERTEBRATE RAW DATA

| Site 13 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 39 | 27 | 47 | 54 | 45 | 51 | 54 | 70 |
| TAXA RICHNESS | 14 | 12 | 13 | 12 | 12 | 14 | 15 | 17 |
| SIGNAL2 | 6.6923 | 6.5556 | 7.2128 | 6.8333 | 7.5111 | 7.0784 | 7.0926 | 6.6857 |
| EPT | 6 | 6 | 5 | 7 | 5 | 6 | 6 | 8 |

| Site 16 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 42 | 38 | 92 | 55 | 61 | 92 | 100 | 41 |
| TAXA RICHNESS | 13 | 15 | 19 | 16 | 15 | 16 | 12 | 10 |
| SIGNAL2 | 6.0952381 | 7.05263158 | 7.1196 | 7.4000 | 7.4754 | 7.9348 | 5.9000 | 7.9512 |
| EPT | 5 | 7 | 9 | 8 | 6 | 10 | 3 | 5 |

| Site 17 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 172 | 125 | 126 | 61 | 129 | 84 | 142 | 69 |
| TAXA RICHNESS | 17 | 20 | 18 | 11 | 15 | 16 | 16 | 19 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SIGNAL2 | 6.2442 | 6.9520 | 5.7222 | 6.7869 | 6.4961 | 7.8690 | 5.9859 | 7.4638 |
| EPT | 3 | 8 | 6 | 6 | 3 | 10 | 4 | 9 |

| Site 22 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 72 | 57 | 74 | 44 | 86 | 90 | 79 | 105 |
| TAXA RICHNESS | 18 | 11 | 20 | 11 | 25 | 18 | 19 | 19 |
| SIGNAL2 | 5.7778 | 4.5088 | 6.8243 | 7.2500 | 6.4535 | 7.0444 | 6.1772 | 6.1238 |
| EPT | 4 | 5 | 6 | 5 | 6 | 6 | 7 | 8 |

| Site 25 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | riffle | edge | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 52 | 62 | 44 | 57 | 89 | 28 | 44 | 40 |
| TAXA RICHNESS | 16 | 15 | 11 | 10 | 13 | 13 | 10 | 16 |
| SIGNAL2 | 5.7692 | 5.9677 | 7.2500 | 6.3333 | 5.5618 | 6.3571 | 5.5909 | 6.0750 |
| EPT | 4 | 6 | 5 | 3 | 5 | 5 | 2 | 7 |

| Site 27 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 48 | 34 | 82 | 70 | 65 | 63 | 72 | 58 |
| TAXA RICHNESS | 11 | 10 | 15 | 11 | 19 | 16 | 18 | 18 |
| SIGNAL2 | 6.6667 | 5.6765 | 6.4756 | 6.8000 | 7.2923 | 6.9365 | 6.3333 | 7.1379 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EPT | 3 | 5 | 4 | 6 | 5 | 6 | 4 | 10 |

| Control Site 1 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 149 | 122 | 148 | 83 | 231 | 71 | 115 | 69 |
| TAXA RICHNESS | 18 | 19 | 18 | 18 | 27 | 16 | 20 | 14 |
| SIGNAL2 | 5.8322 | 5.6803 | 6.1351 | 6.9398 | 6.3636 | 6.1690 | 6.0870 | 6.6377 |
| EPT | 4 | 8 | 5 | 10 | 7 | 6 | 5 | 7 |

| Control Site 2 - Broughton Macroinvertebrate Raw Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Winter Session 1 | | Winter Session 2 | | Spring Session 1 | | Spring Session 2 | |
| HABITAT | edge | riffle | edge | riffle | edge | riffle | edge | riffle |
| TAXA ABUNDANCE | 75 | 51 | 40 | 44 | 129 | 71 | 84 | 122 |
| TAXA RICHNESS | 16 | 12 | 10 | 11 | 19 | 10 | 20 | 16 |
| SIGNAL2 | 6.2000 | 6.3529 | 6.9000 | 6.0000 | 6.5039 | 7.5211 | 6.3571 | 7.8607 |
| EPT | 6 | 6 | 5 | 6 | 6 | 5 | 7 | 10 |

# APPENDIX E MACROINVERTEBRATE DATA 2014-2019

Table 7-1 Site 13 – Broughton Creek macroinvertebrates

| Site13 – Broughton Creek | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Preconstruction survey[1]** | | **Autumn 2015** | | **Spring 2015** | | **Autumn 2016** | | **Spring 2016** | | **Autumn 2017** | | **Spring 2017** | |
| | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** |
| **SIGNAL score[2]** | Approx. 3.3 Severe | Approx. 4.2 Moderate | 4.94 Moderate | 4.75 Moderate | 5.17 Mild | 5.66 Mild | 5.1 Mild | 5.27 Mild | 4.89 Moderate | 4.49 Moderate | 5.04 Mild | 5.07 Mild | 4.76 Moderate | 5.13 Mild |
| | 8 Fair | 4 Poor | 8 Fair | 6 Poor | 8 Fair | 9 Fair | 9 Fair | 9 Fair | 9 Fair | 11 Fair | 6 Poor | 8 Fair | 8 Fair | 5 Poor |
| **Number of taxa** | 6 | 6 | 21 | 18 | 25 | 20 | 22 | 24 | 31 | 29 | 23 | 23 | 26 | 23 |

Note 1 Site 13 during preconstruction was located upstream of 2015 surveys

Note 2 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

| Site13 – Broughton Creek | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Autumn 2018** | | **Spring 2018** | | **Autumn 2019** | | **Spring 2019** | |
| | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** |
| **SIGNAL score[2]** | 5.09 Mild | 3.5 Severe | 4.26 Moderate | 4.81 Moderate | 4.97 Moderate | 4.52 Moderate | 5.46 Moderate | 5.91 Moderate |
| **EPT score** | 8 Fair | 4 Poor | 4 Poor | 6 Poor | 6 Poor | 6 Poor | 6 Poor | 7 Poor |

| Site13 – Broughton Creek | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Number of taxa** | 20 | 20 | 12 | 10 | 10 | 24 | 13 | 21 |

Table 7-2 Site 16 – Broughton Creek macroinvertebrates

| **Site 16 – Broughton Creek** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Preconstruction survey** | | **Autumn 2015** | | **Spring 2015** | | **Autumn 2016** | | **Spring 2016** | | **Autumn 2017** | | **Spring 2017** | |
| | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** |
| **SIGNAL score[1]** | Approx. 4.2 Moderate | Approx. 2.9 Severe | 4.47 Moderate | 4.99 Moderate | 4.66 Moderate | 4.55 Moderate | 4.84 Moderate | 5.30 Mild | 4.58 Moderate | 4.63 Moderate | 5.07 Mild | 5.18 Mild | 5.37 Mild | 4.72 Moderate |
| **EPT score** | 3 Poor | 0 Poor | 8 Fair | 11 Fair | 9 Fair | 6 Poor | 8 Fair | 9 Fair | 11 Fair | 9 Fair | 8 Fair | 8 Fair | 8 Fair | 6 Poor |
| **Number of taxa** | 8 | 4 | 20 | 22 | 30 | 15 | 16 | 24 | 37 | 26 | 28 | 26 | 17 | 19 |

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

| **Site16 – Broughton Creek** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Autumn 2018** | | **Spring 2018** | | **Autumn 2020** | | **Spring 2020** | |
| | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** | **Session 1** | **Session 2** |
| **SIGNAL score[2]** | 4.43 Moderate | 5.39 Mild | 4.61 Moderate | 4.42 Moderate | 5.17 Moderate | 5.59 Moderate | 5.14 Moderate | 4.51 Moderate |
| **EPT score** | 9 Fair | 9 Fair | 7 Fair | 8 Fair | 5 Poor | 6 Poor | 8 Fair | 6 Poor |
| **Number of taxa** | 24 | 24 | 20 | 21 | 25 | 21 | 25 | 15 |

Table 7-3 Site 17 – Broughton Creek macroinvertebrates

| Site 17 – Broughton Creek | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Preconstruction survey | | Autumn 2015 | | Spring 2015 | | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[1] | N/A | Approx.2.9 Severe | NA | 5.28 Mild | 4.88 Moderate | 4.74 Moderate | 4.96 Moderate | 5.08 Mild | 4.88 Moderate | 4.24 Moderate | 5.03 Mild | 5.43 Mild | 4.76 Moderate | 4.86 Moderate |
| EPT score | N/A | 7 Fair | NA | 8 Fair | 10 Fair | 6 Poor | 9 Fair | 8 Fair | 8 Fair | 10 Fair | 7 Fair | 9 Fair | 6 Poor | 5 Poor |
| Number of taxa | N/A | N/A | NA | 16 | 29 | 19 | 23 | 20 | 31 | 28 | 21 | 21 | 18 | 23 |

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

| Site17 – Broughton Creek | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | 4.18 Moderate | 4.39 Moderate | 4.11 Moderate | 4.15 Moderate | 4.21 Moderate | 4.22 Moderate | 4.54 Moderate | 4.26 Moderate |
| EPT score | 7 Fair | 6 Poor | 5 Poor | 5 Poor | 5 Poor | 4 Poor | 5 Poor | 4 Poor |
| Number of taxa | 25 | 17 | 23 | 19 | 12 | 15 | 15 | 13 |

Table 7-4 Site 22 – Bundewallah Creek macroinvertebrates

| Site 22 – Bundewallah Creek | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Preconstruction survey | | Autumn 2015 | | Spring 2015 | | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[1] | Approx. 4.2 Moderate | Approx. 3 Severe | 4.64 Moderate | 4.26 Moderate | 4.44 Moderate | 3.71 Severe | 5.27 Mild | 4.23 Moderate | 4.49 Moderate | 3.63 Severe | 4.05 Moderate | 4.27 Moderate | 3.82 Severe | 3.11 Severe |
| EPT score | 2 Poor | 4 Poor | 7 Fair | 6 Poor | 6 Poor | 6 Poor | 6 Poor | 8 Fair | 6 Poor | 1 Poor | 7 Fair | 7 Fair | 4 Poor | 4 Poor |
| Number of taxa | 4 | 8 | 24 | 17 | 27 | 17 | 21 | 25 | 28 | 10 | 23 | 22 | 17 | 17 |

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

| Site22 – Bundewallah Creek | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | 4.32 Moderate | 3.83 Severe | 3.08 Severe | 3.06 Severe | 3.35 Severe | 2.93 Severe | 3.42 Severe | 2.97 Severe |
| EPT score | 4 Poor | 4 Poor | 1 Poor | 2 Poor | 2 Poor | 1 Poor | 1 Poor | 3 Poor |
| Number of taxa | 19 | 21 | 6 | 17 | 16 | 6 | 10 | 13 |

Table 7-5 Site 25 – Broughton Mill Creek macroinvertebrates

| Site 25 – Broughton Mill Creek | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Preconstruction survey[1] | | Autumn 2015 | | Spring 2015 | | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | Approx. 3.5 Severe | Approx. 3.3 Severe | 4.46 Moderate | 4.93 Moderate | 4.70 Moderate | 3.57 Severe | 4.96 Moderate | 5.03 Mild | 4.88 Moderate | 4.53 Moderate | 4.93 Moderate | 5.19 Mild | 4.05 Moderate | 4.01 Moderate |
| EPT score | 4 Poor | 1 Poor | 7 Fair | 8 Fair | 8 Fair | 5 Poor | 6 Poor | 10 Fair | 10 Fair | 10 Fair | 8 Fair | 12 Fair | 7 Fair | 3 Poor |
| Number of taxa | 13 | 4 | 22 | 22 | 25 | 20 | 15 | 28 | 33 | 31 | 29 | 32 | 28 | 24 |

Note 1 Site 25 during preconstruction was located upstream of 2015 surveys

Note 2 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

| Site25 – Broughton Mill Creek | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2018 | | Spring 2018 | | Autumn 2018 | | Spring 2018 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | 5.02 Mild | 3.77 severe | 5.24 Mild | 4.8 Poor | 5.17 Moderate | 4.26 Moderate | 5.08 Moderate | 5.08 Moderate |
| EPT score | 7 Fair | 5 Poor | 4 Poor | 3 Poor | 1 Poor | 1 Poor | 4 Poor | 4 Poor |
| Number of taxa | 28 | 14 | 15 | 17 | 11 | 11 | 21 | 21 |

Table 7-6 Site 27 – Bundewallah Creek macroinvertebrates

| Site 27 – Bundewallah Creek | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Preconstruction survey | | Autumn 2015 | | Spring 2015 | | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[1] | Approx. 3.6 Severe | Approx. 2.9 Severe | 4.96 Moderate | 4.98 Moderate | 4.79 Moderate | 4.75 Moderate | 4.98 Moderate | 4.64 Moderate | 4.63 Moderate | 3.32 Severe | 5.07 Mild | 5.54 Mild | 4.51 Moderate | 4.61 Moderate |
| EPT score | 2 Poor | 0 Poor | 9 Fair | 8 Fair | 9 Fair | 6 Poor | 5 Poor | 9 Fair | 8 Fair | 3 Poor | 9 Fair | 10 Fair | 6 Poor | 5 Poor |
| Number of taxa | 7 | 4 | 25 | 20 | 25 | 17 | 18 | 28 | 27 | 18 | 31 | 25 | 20 | 26 |

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

| Site 27 – Bundewallah Creek | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | 4.78 Moderate | 4.10 Moderate | 4.75 Moderate | 4.22 Moderate | 5.57 Moderate | 4.1 Moderate | 5.47 Moderate | 4.63 Moderate |
| EPT score | 7 Fair | 3 Poor | 1 Poor | 3 Poor | 3 Poor | 2 Poor | 3 Poor | 2 Poor |
| Number of taxa | 32 | 15 | 16 | 18 | 17 | 10 | 19 | 21 |

Table 7-7 Control Site 1 macroinvertebrates

| Control Site 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2016 | | Spring 2016 | | Autumn 2017 | | Spring 2017 | |
| | Session 1 | Session 2[2] | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL 2 score[1] | 4.9 Moderate | 5.67 Mild | 4.95 Moderate | 4.55 Moderate | 4.63 Moderate | 5.46 Mild | 4.44 Moderate | 4.71 Moderate |
| EPT score | 3 Poor | 7 Fair | 10 Fair | 9 Fair | 6 Poor | 11 Fair | 7 Fair | 6 Poor |
| Number of taxa | 6 | 27 | 37 | 33 | 27 | 28 | 28 | 20 |

Note 1 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores

| Control Site 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | 4.08 Moderate | 4.13 Moderate | 4.11 Moderate | 3.91 Severe | 5.39 Moderate | 5.16 Moderate | 4.53 Moderate | 4.54 Moderate |
| EPT score | 2 Poor | 4 Poor | 4 Poor | 3 Poor | 4 Poor | 5 Poor | 4 Poor | 4 Poor |
| Number of taxa | 20 | 21 | 20 | 19 | 21 | 20 | 13 | 18 |

Table 7-8 Control Site 2 macroinvertebrates

| Control Site 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2016[2] | | Spring 2016 | | Autumn 2017 | | Spring 2017 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL 2 score[1] | N/A | N/A | 4.7 Moderate | 4.3 Moderate | 4.74 Moderate | 5.25 Mild | 5.03 Mild | 4.56 Moderate |
| EPT score | N/A | N/A | 8 Fair | 9 Fair | 8 Fair | 8 Fair | 8 Fair | 5 Poor |
| Number of taxa | N/A | N/A | 32 | 29 | 25 | 28 | 23 | 23 |

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores

Note 2 Access to Control Site 2 was not granted until Spring 2016

| Control Site 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Autumn 2018 | | Spring 2018 | | Autumn 2019 | | Spring 2019 | |
| | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 | Session 1 | Session 2 |
| SIGNAL score[2] | 4.71 Moderate | 4.19 Moderate | 4.52 Moderate | 4.58 Moderate | 5.31 Moderate | 5.1 Moderate | 4.51 Moderate | 4.5 Moderate |
| EPT score | 6 Poor | 4 Poor | 7 Fair | 5 Poor | 3 Poor | 5 Poor | 5 Poor | 5 Poor |
| Number of taxa | 25 | 12 | 17 | 12 | 11 | 16 | 22 | 22 |

# APPENDIX F AQUATIC MONITORING PHOTOS 2020

| Site 13 | |
|---|---|
| Winter Session 1 | Winter Session 2 |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

| Site 16 | |
|---|---|
| Winter Session 1 | Winter Session 2 |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

## Site 17

| Winter Session 1 | Winter Session 2 |
| --- | --- |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

| Site 22 | |
|---|---|
| Winter Session 1 | Winter Session 2 |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

| Site 25 | |
|---|---|
| Winter Session 1 | Winter Session 2 |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

Site 27

| Winter Session 1 | Winter Session 2 |
| --- | --- |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

## Control Site 1

| Winter Session 1 | Winter Session 2 |
| --- | --- |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |

## Control Site 2

| Winter Session 1 | Winter Session 2 |
| --- | --- |
|  |  |

| Spring Session 1 | Spring Session 2 |
| --- | --- |
|  |  |