



## PACIFIC HIGHWAY UPGRADE: WOOLGOOLGA TO BALLINA

Sections 1 and 2 Giant Barred Frog (*Mixophyes iteratus*) Construction Monitoring: Year 1

February 2017




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...7<sup>th</sup> February 2017.....

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## 1.0 INTRODUCTION

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### 1.1 Project Overview and Background to this Monitoring

The Woolgoolga to Ballina Pacific Highway Upgrade comprises approximately 155 km of highway to achieve a four-lane divided road extending north of Woolgoolga at the northern extent of Sapphire to Woolgoolga Upgrade to south of Ballina where it ties into the southern extent of the Ballina bypass. The project includes grade separated interchanges, service roads and upgrades to local road connections and has the potential to be staged in 11 sections. The State Minister for Planning and Environment approved the project on 24<sup>th</sup> June 2014. On 14<sup>th</sup> August 2014, the Federal Minister for the Environment Greg Hunt approved the project in accordance with Part 9 of the *Environmental Protection and Biodiversity Conservation Act* (1999).

In order to enable commencement of construction in mid-2015, some key preconstruction survey tasks were to be undertaken as a priority. During preconstruction, baseline and targeted surveys of threatened species will enable the establishment of the monitoring program to be implemented on an ongoing basis to help manage and mitigate any potential impacts of the project on threatened species. Requirements for monitoring and mitigation measures throughout various stages of the project are outlined in a series of threatened species management plans.

The Threatened Frog Management Plan (RMS 2015) addresses the impacts of the upgrade and proposed mitigation on a number of threatened frog species including the Wallum Sedge Frog (*Litoria olongburensis*), Giant Barred Frog (*Mixophyes iteratus*) and Green-thighed Frog (*Litoria brevipalmata*). This management plan identifies both areas of known and potential habitat throughout the Project corridor and proposes a number of management actions to ensure the long-term survival of these species in the area of the project. In order to gauge the performance of these management actions, a pre-construction baseline monitoring survey was undertaken (Lewis 2014). The objective of this study was to identify known Giant Barred Frog sites and to collect baseline data on the population and habitat condition. This study identified three sites where the newly constructed carriageway would bisect known Giant Barred Frog habitat and located another three reference or control sites. In addition to this, some other locations were identified as containing suitable habitat.

With the commencement of construction in Sections 1 and 2 during mid 2015, the Roads and Maritime Services (RMS) engaged Lewis Ecological Surveys (Contract Identifier – 13.2544.0919.0023) on the 11<sup>th</sup> April 2016 to implement Year 1 BACI population monitoring surveys of the three paired sites. The following reports on these findings.

## 1.2 Subject Species – Giant Barred Frog (*Mixophyes iteratus*)

### 1.2.1 Description

The Giant Barred Frog (*Mixophyes iteratus*) is a large, dark-olive green to black coloured frog that grows to 115 mm. It has a pointed snout and a broad lateral band of dark spots dividing the dark dorsal surface from the white or pale yellow, ventral surface (underside). The limbs have dark crossbars. The hind side of the thighs are black with large yellow spots. Two joints of the fourth toe are free of web (Cogger 2000). The skin is finely granular above but smooth below. The call of the male Giant Barred Frog is a deep guttural grunt (OEH 2014).

Giant Barred Frog tadpoles are large and grow to over 100 mm in length. They are deep-bodied and ovoid, with a tail length twice that of the body. The tadpole's eyes are dorsolateral. The tadpoles are coloured yellow-brown above with dark spots and a dark patch at the base of tail. The underside is silver-white. The intestinal mass is obscured but the heart and lungs are visible from below (except near metamorphosis). The tail is thick and muscular (Anstis 2002). Fins are low and opaque with dark flecking (except the anterior half of the ventral fin; Meyer *et al.* 2001).



**Plate 1-1.** Giant Barred Frog (ad) from Corindi Creek.

### 1.2.2 Distribution

The species is currently known from mid to low altitudes below 610 m above sea level (Hines *et al.* 2004), along the Coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. North-eastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold whilst it appears to have disappeared south of the Hawkesbury and there are no recent records from the Blue Mountains (Hines and SEQTFRT 2002; DoE 2014).

### **1.2.3 Habitat and Ecology**

The Giant Barred Frogs forage and live amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m (DoE 2014). Whilst it has been observed to prefer a closed forest canopy with a relatively light cover of vegetation at ground level (Aland and Wood 2013), they have been found in cleared or disturbed areas, for example agricultural landscapes with vegetated riparian strips and regenerated logged areas (Ingram and McDonald 1993; Hero and Shoo n.d., cited in Hines *et al.* 2004; Lemckert and Brassil 2000; Lewis and Rohweder 2005). Giant Barred Frog are known from the lower reaches of streams which have been affected by major disturbances such as clearing, timber harvesting and urban development in their headwaters (Hines *et al.* 1999).

Giant Barred Frogs breed around shallow, flowing rocky streams and deeper slow moving rivers from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched (DoE 2014). Tadpoles grow to a length in excess of 100 mm and take up to 14 months before changing into frogs. They feed primarily on large insects and spiders, but have been known to consume small mammals (G. Madini pers. comm).

## 2.0 SURVEY METHODS

Field surveys were performed in accordance with the Threatened Frog Species Management Plan (RMS 2015). The following details the areas surveyed along with the timing of field surveys and how the data were treated or analysed.

### 2.1 Site Selection and Treatment Design

All three sampling sites known as Site 1A, 1B, 2A, 2B, 3A and 3B occur within Section 1 and 2 (Figure 2-1). Pre-clearing surveys as part of the clearing and grubbing works in Section 1 resulted in the capture of a Giant Barred Frog at Boneys Creek (ch. 13300; Sandpiper Ecological 2016). As this area had only been previously identified as potential habitat and now it had been confirmed, it was included in the monitoring program as Site 4A (Figure 2-1). To ensure consistency with the remainder of the program, a nearby site in the upper reaches of Halfway Creek was identified as paired monitoring Site 4B (Figure 2-1).

This sampling design known as a BACI (Before-After-Control-Impact) consists of the following:

- Impact sites which are identified in this instance with an 'A' and may be potentially impacted by construction works or once the newly constructed carriageway is completed. Potential impacts may include but are not necessarily limited to habitat removal, a reduction in habitat connectivity, increased road strike, facilitating the distribution and increasing densities of exotic predators;
- Reference or control sites which are identified in this instance with an 'B' and possess similar geographic landscape and habitat traits as the impact sites, but are located a sufficient distance (>200 m) and ideally upstream of the Upgrade. If this was not possible, a nearby sub catchment with similar attributes was also considered sufficient.

### 2.2 Timing of Surveys

Frog surveys were performed in a manner that was consistent with the Threatened Frog Management Plan (RMS 2015). Sampling was restricted to the autumn and early winter period when there has been 10 mm of rainfall in 24 hours in the past 7 days and ambient air temperature was close to 18°C. Sampling was required during early winter to ensure some temporal independence in the sampling between the first and second survey, set here at 14 nights.



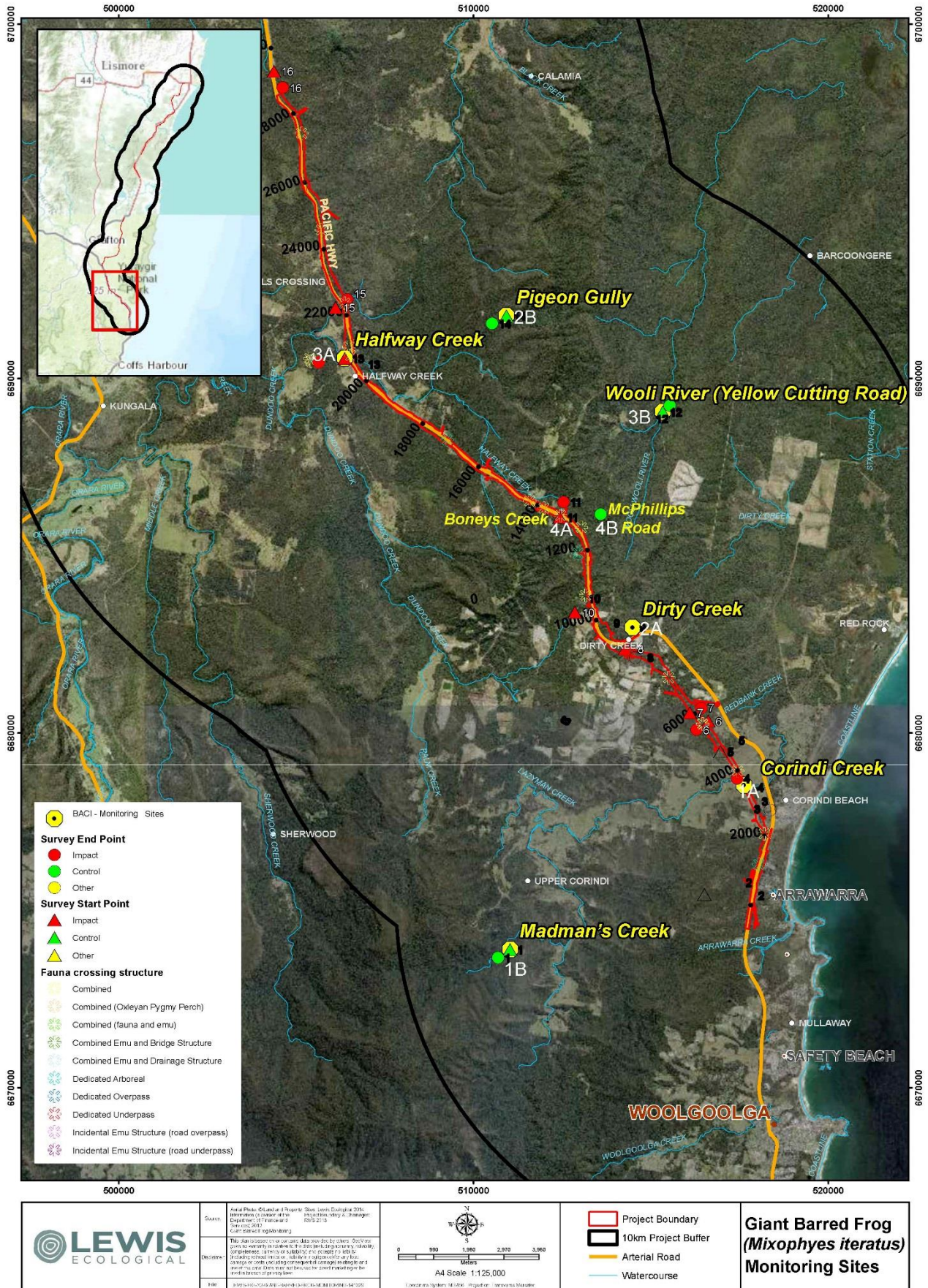


Figure 2-1. Locations of Giant Barred Frog BACI Monitoring Sites 1-4 in Sections 1 and 2 of Woolgoolga to Ballina Upgrade.

### 2.3 Frog Surveys

Frog surveys were performed in the manner outlined in the Threatened Frog Management Plan (RMS 2015). This involved:

- 500 m transect with 250 m either side of the Project corridor with the start and finish extent recorded using a hand held GPS in GDA94;
- Field surveys comprised spotlighting and call broadcast during the nocturnal transect;
- For each frog, the following information was collected:
  - Distance from the stream edge measured to the nearest 0.1 m;
  - Position within the microhabitat (i.e. under litter, above litter, exposed, on rock/log);
  - Sex (male, female, unknown) based on size of frog and inspection of nuptial pads present in male frogs;
  - Age class (adult = >60 mm; sub adult = 40-60 mm; juvenile = <40 mm)
  - Snout-vent length (mm);
  - Weight (grams); and
  - Breeding condition with:
    - males assessed on the colouration of their nuptial pads (i.e. no colour, light, moderate, dark) in accordance with a classification developed by Lewis Ecological Surveys (Table 2-1);
    - females based on whether they were gravid (i.e. typically adult weighing > 100 grams) or not gravid (egg bearing);
    - frogs with a snout vent length of <60 mm were classified as immature.
- Microchipped with Trovan™ nanotransponders to individually mark frogs.

All handling procedures were undertaken in accordance with the *Hygiene Protocols for the Control of Disease in Frogs* (DECW 2008) and NSW Animal Care and Ethics Approval (Trim14/3786).

### 2.4 Abiotic Data

The following abiotic variables were collected during the survey:

- Air temperature (°C) measured with a thermometer at the start and finish of the frog survey and averaged;
- Relative humidity (%) measured with wet/dry bulb thermometer at the start and finish of the frog survey and averaged;
- Prevailing cloud cover was expressed as a percentage (%) coverage of the sky taken at the start and finish of the survey and averaged;
- Wind speed measured using a subjective scale (0 = no wind, 1 = light rustles of leaves on trees, 2 = leaves and branches moving and 3 = whole canopy moving); and
- Rain fall was also measured in a subjective scale (0 = no rain in past 24 hours, 1 = rain within 24 hours and 2 = rain during survey).

### 3.0 MONITORING RESULTS

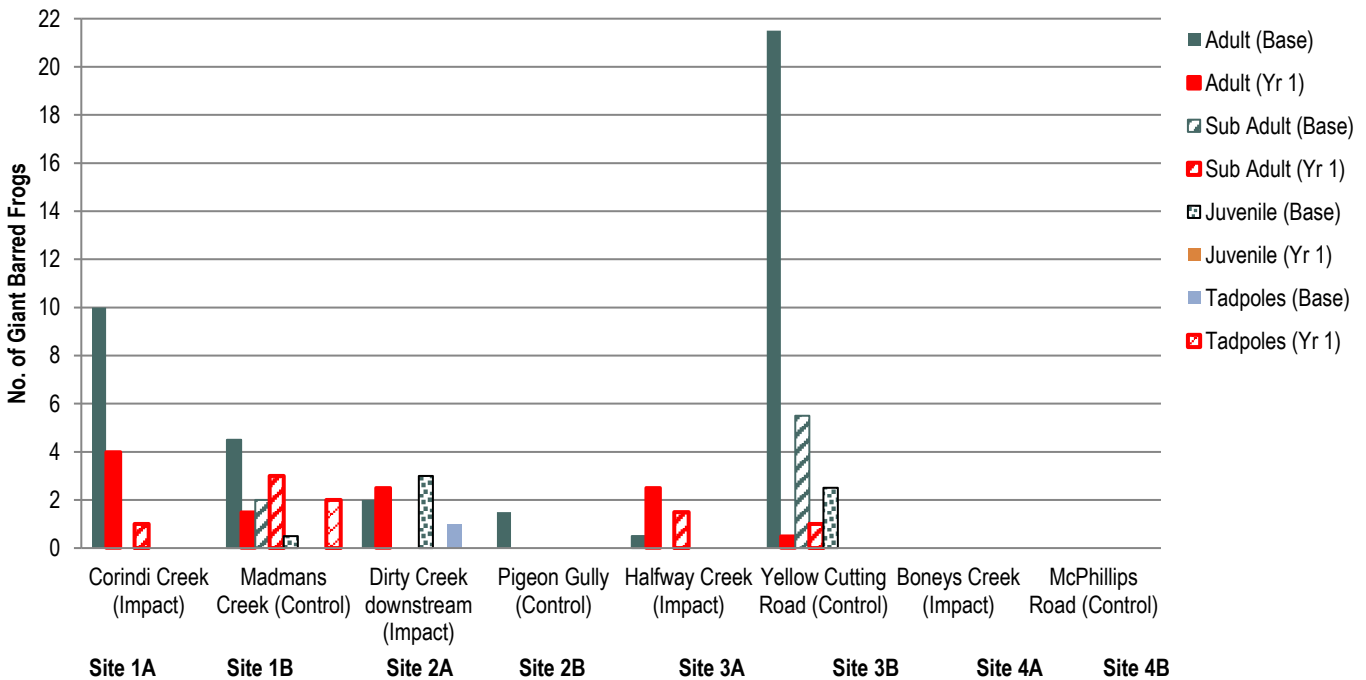
#### 3.1 Frog Surveys

Giant Barred Frogs were recorded at 5 (62.5%) of the 8 sites and specifically at Site 1A (Corindi Creek), 1B (Madmans Creek), 2A (Dirty Creek), 3A (Halfway Creek) and 3B (Yellow Cutting Road; Figure 3-1). Frogs were not recorded from the reference Site 2B (Pigeon Gully), or from either of the Site 4 treatments (Boneys Creek and McPhillips Road; Table 3-1).

Sampling recorded 35 frogs with:

- 10 frogs recorded from Corindi Creek (Site 1A);
- Nine frogs from Madmans Creek (Site 1B);
- Five frogs from Dirty Creek (Site 2A);
- Eight frogs from Halfway Creek (Site 3A); and
- Three frogs from Yellow Cutting Road (Site 3B).

In accordance with recommendations outlined in the baseline surveys, captured frogs were microchipped or alternatively toe-clipped for individual verification during later sampling. On two occasions at Corindi Creek, frogs were photographed as opposed to being toe clipped or PIT tagged as a means of managing animal welfare (i.e. no antiseptic available). Twenty-three frogs were micro-chipped, nine were toe-clipped and a further two were photographed to enable individual verification during subsequent monitoring events (Appendix A). One frog eluded marking at Dirty Creek.



**Figure 3-1.** The number of Giant Barred Frogs observed between baseline surveys (shaded) and Year 1 data compiled by Lewis (2015) - (unshaded).



**Plate 3-1.** Giant Barred Frog captures during Year 1 sampling: Halfway Creek (top), Madman's Creek (middle) and Corindi Creek (bottom).

Table 3-1. Summary of the Giant Barred Frog surveys for BACI Sites 1-4.

BACI Site	Year 1 (Surveys)			Frog Management Mitigation Observed or Recorded	General Comments	Presence of Giant Barred Frogs Confirmed in Baseline Survey
	Date	Total Number Frogs Captured	Calculated Mean No. of Frogs Per 500 m			
1A ch.3600 (Corindi Creek)	30 <sup>th</sup> May 2016 9 <sup>th</sup> June 2016	10	5	i. Temporary frog fencing observed. ii. No frogs captured in this area as part of pre-clearing surveys. iii. Bridges installed to maintain habitat connectivity.	i. Frogs restricted to the upstream section of transect above the Upgrade works. ii. Early rehabilitation would assist habitat suitability, ensuring no over planting of <i>Lomandra</i> .	Yes
1B (Madmans Creek)	29 <sup>th</sup> May 2016 9 <sup>th</sup> June 2016	9	4.5	Outside works footprint.	i. Upper reaches of Corindi Creek catchment. Difficult to access, however, satisfies original brief to locate sites on public estate. ii. Site periodically dries up to series of deep pools.	Yes
2A ch. 8500 (Dirty Creek)	29 <sup>th</sup> May 2016 5 <sup>th</sup> June 2016	5	2.5	i. Temporary frog fencing observed. ii. No frogs captured in this area as part of pre-clearing surveys.	i. Sediment loads from site present in monitoring transect. ii. Habitat connectivity less of a concern as Project bisects edge of known habitat and may not isolate it.	Yes
2B (Pigeon Gully)	25 <sup>th</sup> May 2016 5 <sup>th</sup> June 2016	0	0	Outside works footprint.	i. Southerly aspect and high foliage cover create cool micro climate which made late season sampling difficult with cool temperatures. Frogs likely to be present at this site during Year 2.	Yes
3A ch.20800 (Halfway Creek)	20 <sup>th</sup> May 2016 26 <sup>th</sup> May 2016	8	4	i. Temporary frog fencing observed and in various states of repair. ii. No frogs captured in this area as part of pre-clearing surveys. iii. Bridges installed to maintain habitat connectivity iv. Some works associated with powerline easement on downstream side occur outside frog fence zone but within known frog habitat.	i. Frogs recorded on both sides of Upgrade. ii. Early rehabilitation would assist habitat suitability ensuring no over planting of <i>Lomandra</i> .	Yes
3B (Yellow Crossing Road)	20 <sup>th</sup> May 2016 26 <sup>th</sup> May 2016	3	1.5	Outside works footprint.	i. Numbers lower than baseline survey but more an artefact of late season sampling. ii. Some fires burning through area at time of field survey when it was raining.	Yes
4A ch.13300 (Boneys Creek)	20 <sup>th</sup> May 2016 6 <sup>th</sup> June 2016	0	0	i. Frog fencing observed. ii. No PIT tagging or marking of the frog prior to release. iii. Two cell box culvert installed.	i. Frogs likely to seasonal inhabit the bottom side of transect. ii. Captured frog was recorded on downstream side (SES 2016). iii. No frogs recorded on upstream side to date and not previously mapped as known habitat.	No
4B (McPhillips Road)	20 <sup>th</sup> May 2016 6 <sup>th</sup> June 2016	0	0	Outside works footprint.	i. Frogs are likely to be irregular inhabitants in this section of upper catchment.	No

## 4.0 DISCUSSION

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Year 1 monitoring recorded Giant Barred Frogs at most of the monitoring sites where they had been previously recorded during the baseline surveys. Frogs could not be located at Boneys Creek where pre-clearing surveys had captured and released an individual on the downstream side of the clearing footprint in spring 2015 (Sandpiper Ecological 2016). Similarly, frogs could not be located at the neighbouring control site which is also a tributary of Halfway Creek, albeit outside of the impact zone. Although a sedentary species, Giant Barred Frogs are thought to be somewhat uncommon inhabitant in the upper reaches of Halfway Creek due largely to the seasonal nature of the surface flows. This is reflected in the results of past surveys with unsuccessful sampling to inform the design package, although the area was thought to provide suitable habitat up to the proximity of the old carriageway, but importantly not further upstream (Lewis 2013). More recent surveys have included some successful sampling, including the collection of a sub adult frog from the control site along McPhillips Road which had been struck by a vehicle in December 2015 (R. Jago pers. comm). This record accords with the spring 2015 capture of a frog from within the clearing limits and based on the measurements provided in the report, it would indicate another sub adult frog, not an adult as reported. Monitoring over the next few years will prove useful in understanding the way Giant Barred Frogs use Boneys Creek, and in particular, the role of the newly constructed box culvert in maintaining habitat connectivity.

The continued presence of frogs at Corindi Creek, Dirty Creek and Halfway Creek is a positive outcome of Year 1 monitoring. Frogs were, however, only recorded on the upstream side of Corindi Creek and not the downstream side where frogs had been observed and heard in the past (Lewis 2013). Early establishment of riparian revegetation would be useful, and should focus on attributes that will facilitate frog movements under the newly constructed bridges. Although the reported mean number of frogs at this location for Year 1 is approximately half of the baseline survey, it was in fact comparable as the baseline data for this location was collected from a single survey used to inform the design package, not part of the November 2014 issued Professional Services Contract brief. Taking this into account, the June survey recorded 10 frogs and revealed two new insights into this frog population, firstly, the observation of sub adult frogs confirms breeding takes place in the vicinity of the Upgrade, and secondly, one of the captured female frogs had recently spawned following the heavy rains and receding floodwater in June. This is believed to be the first reported occurrence of the endangered Giant Barred Frog breeding in winter.

Sampling at Dirty Creek turned up adult frogs and these were restricted to the bottom reaches of this transect. The numbers of frogs differed from the baseline survey only in terms of age class, with no recent sign of breeding recorded. Sediment loads in excess of 200 mm depth were observed at the start or upper reaches of this transect. Frogs are expected to only periodically extend to the upper reaches of this transect and beyond. In this way, the population and its use of habitat around the Upgrade is expected to be similar to Boneys Creek. Any planned culvert or the upslope dedicated fauna underpass is likely to have limited success as frogs are less likely to extend more than 10-20 m from the

stream edge in this area and reliable stream flows emerge from the hillside within the clearing footprint, not upstream of it.

More frogs were recorded at Halfway Creek during the Year 1 compared to the baseline study. There were a number of contributing factors in this, including the sampling during the baseline had been hampered by floods in early 2013, a time when individuals tend to move away from the stream and take refuge whilst the males are less likely to call. Importantly, frogs were recorded on both the upstream and downstream side of the Upgrade with several individuals recorded in close proximity to the works. With the implementation of PIT tagging into the program, continued monitoring will provide useful insights on how these frogs respond to the installed management actions of frog fencing and structures to maintain habitat connectivity.

The following section compares the Year 1 data against the prescriptions outlined in the Threatened Frog Species Management Plan.

## 5.0 PERFORMANCE INDICATORS AND CORRECTIVE ACTIONS

A series of performance indicators and corrective actions have been outlined in Section 7.2.3 of the Threatened Frog Species Management Plan (RMS 2015). This plan states that *should it become clear that sites that were occupied prior to road construction (i.e. established impact monitoring sites) have become unoccupied, or abundance (estimated using the transect counts) has declined beyond the identified thresholds (i.e. 25%) relative to control/reference sites, corrective actions must be implemented in accordance with those provided in Table 7-1.*

Year 1 monitoring is mainly tied into the population monitoring component outlined in Table 5-1 as the culverts, bridges, ponds and revegetation works are not yet complete. The performing factor for the population monitoring is the number of Giant Barred Frogs per 500 m of habitat, however, this unit of measure doesn't explicitly state if mean or cumulative data requires comparison. In the absence of this, mean data has been used and is considered the standardised format.

Both declines and increases were recorded across the monitoring sites and this has been summarised in Table 5-2. The reported decline in the number of Giant Barred Frogs at Corindi Creek can be explained via a single survey in early summer to inform the baseline data set whilst the Year 1 sampling was undertaken late in the season during difficult sampling conditions. This in itself created greater variability with the first survey recording no frogs whilst the second survey recorded 10 frogs, and represents the same number of frogs as the baseline survey. Mean data requires both survey results be considered and is ultimately the causation of the 50% reported decline. Regardless, the paired monitoring site (1B) known as Madmans Creek also recorded a decline and the relative difference between the decline of both the impact and control treatment was 14.29% and within the acceptable 25%. At this reference site, very little water was present along the transect, however, following the east coast low in early June, sampling thereafter recorded nine frogs in various age classes.

Dirty Creek and its paired control site of Pigeon Gully also recorded declines when compared to the baseline data. The 50% decline recorded at Dirty Creek reflects the results of the first survey where no frogs were recorded, however, later sampling in early June recorded five adults and was comparable to the baseline. Again, the use of mean data results in this being presented as 2.5 frogs over the 500 m. No frogs were recorded at Pigeon Gully during either of the Year 1 surveys and whilst this signifies some form of absence, it has more to do with late season sampling at a site with a very cool micro climate due to its southern aspect and high canopy cover. Sampling in late summer at this location has only ever yielded a maximum of two adults over 500 m and frogs are likely to still inhabit this transect.



**Table 5-1.** Performance indicators and corrective actions from the Threatened Frog Species Management Plan (RMS 2015).

Triggers for corrective actions	Corrective actions	Relevance to Year 1 Giant Barred Frog Monitoring	Results of Year 1 Giant Barred Frog Monitoring	Potential Contributing Factors	Corrective Action Required
<b>Population Monitoring</b>					
<p>The absence of threatened frogs at impact sites identified as occupied in the baseline monitoring surveys.</p> <p>A relative decline in abundance of 25% or more at an impact site than its relative control site over 3 consecutive monitoring periods. Frog abundance determined by standardised transect counts:</p> <ul style="list-style-type: none"> <li>• Number of Wallum Sedge Frogs per 100 m<sup>2</sup> of habitat;</li> <li>• Number of Giant Barred Frogs per 500 m of habitat;</li> <li>• Number of adult male Green-thighed Frog per Stage 1 survey (breeding survey) (as outlined in Section 4.3).</li> </ul>	<p>Review monitoring methods immediately, considering further monitoring and assessment if there is a decline in population abundance.</p> <p>Investigate effectiveness of frog exclusion fencing immediately.</p> <p>Closely monitor habitat conditions over a period of three months to ensure they are suitable, in particular hydrology (hydro-period), water quality and vegetation.</p> <p>Assess the requirement for additional offsets where a threatened frog population is no longer present in a previously occupied area, and this habitat is deemed unsuitable for the target species.</p>	Relevant	<p>Giant Barred Frogs recorded from Site 1A (Corindi Creek), 2A (Dirty Creek), 3A (Halfway Creek) but not Site 4A (Boneys Creek).</p> <p>Declines at Corindi Creek and Dirty Creek are within the acceptable threshold and causation of the declines explained in the sampling regime.</p>	<p>Sampling results meet the general overall intent of the monitoring program with frogs detected at sites where they had been recorded during the baseline surveys.</p> <p>The variability in frog abundance from one survey to the next can be attributed to late season sampling making opportunities to conduct meaningful surveys difficult.</p>	<p>No.</p> <p>RMS implement the unexpected finds procedure as per the TFMP for Boneys Creek if not already done so.</p>
<b>Underpass Structure Monitoring</b>					
<p>The use of the structure by less than 1% of the estimated population size.</p> <p>Connectivity structures not maintained (i.e. culverts clogged with debris or sedimentation). Frog exclusion fencing damaged or ineffective.</p>	<p>Review monitoring methods where goals are not achieved, by increasing frequency, intensity and duration, to ensure individuals are identified.</p> <p>Survey habitat adjoining the connectivity structures and undertake Landscape improvement (planting, weed removal) to improve habitat functionality.</p> <p>Survey and monitor crossing structures and frog fencing to ensure they are functional (i.e. are adequately maintained, including fencing is not damaged, and connectivity structure is operating correctly). Monitor twice per year.</p> <p>Assess the need for offsets if connectivity structures are identified as ineffective over three consecutive monitoring periods.</p>	No relevant at this point in time. Structures are not operational.	Not Applicable	Not applicable	Not Applicable

Triggers for corrective actions	Corrective actions	Relevance to Year 1 Giant Barred Frog Monitoring	Results of Year 1 Giant Barred Frog Monitoring	Potential Contributing Factors	Corrective Action Required
<b>Riparian Habitat Revegetation</b>					
<p>Greater than 10% of riparian plants have died after first 12 months of maintenance.</p> <p>Greater than 20% of riparian plants have died after three years of maintenance.</p> <p>Total weed coverage is more than 30% in revegetation areas.</p> <p>Bank erosion causes unforeseen revegetation area instability.</p>	<p>Review maintenance schedule for revegetated areas immediately after trigger.</p> <p>Replace dead plants within one month of issue being identified.</p> <p>Increase weed control if required as soon as practicable or review control methods being used.</p> <p>Install physical measures to halt bank erosion within one month of issue being identified.</p>	<p>Not relevant at this point in time. Landscape and habitat rehabilitation is expected to commence during Year 2 of the Giant Barred Frog monitoring program</p>	<p>Not Applicable</p>	<p>Not Applicable</p>	<p>Not Applicable</p>

**Table 5-2.** Mean number of Giant Barred Frogs (inclusive of adults, sub adults, juvenile) from the monitoring sites.

Sampling Year	Corindi Creek (Impact)	Madmans Creek (Control)	Dirty Creek downstream (Impact)	Pigeon Gully (Control)	Halfway Creek (Impact)	Yellow Cutting Road (Control)	Boneys Creek (Impact)	McPhillips Road (Control)
GBF Base	10	7	5	1.5	0.5	29.5	0	0
GBF Year 1 (mean count)	5	4.5	2.5	0	4	1.5	0	0
Increase (%)	-	-	-	-	700	-	no change	no change
Decline (%)	50	35.71	50	absent	-	95	-	-

Year 1 sampling at Halfway Creek returned a seven fold increase in the number of frogs. This was due to only one frog being found during the baseline survey compared to the eight individuals found in Year 1. In contrast, very few frogs were recorded from the control site at Yellow Crossing Road in the headwaters of Wooli River. The reported 95% decline at this control site has more to do with the difficulties of late season sampling conditions than any real change in the population size. This statement is supported by the fact that sub adult frogs were recorded during the current round of monitoring thus indicating adult frogs have successfully bred at this site.

The absence of frogs from Boneys Creek and its adjacent control site on McPhillips Road is comparable to the baseline survey where no frogs could be located during sampling to inform design (Lewis 2013). Only the pre-clearing surveys have managed to locate a frog at this location in September 2015 (Sandpiper Ecological 2016) and similarly, a road killed individual was collected from the McPhillips Road site in December 2015 (R. Jago pers. comm). From a BACI monitoring perspective, there has been no overall change at this site.

In regard to other construction related mitigation goals and mitigation measures for threatened frog species, and their associated corrective actions as outlined in Table 5-4 of the TFMP they include:

- No injuries or mortality to threatened frogs during clearing works.
- No injuries to or mortality of threatened frogs during construction as a result of vehicle collisions.
- No injuries to frogs that need to be handled.
- No movement of chytrid fungus between sites.
- Low rate injuries or mortality of threatened frogs as a result of dewatering activities.
- No loss of habitat beyond what is identified in construction footprint as a result of dewatering activities
- No adverse effects to Giant Barred Frog and Green-thighed Frog populations resulting from impacts to water quality.

The performance of these management actions would be addressed in the post clearing reports for Sections 1 and 2.

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

Year 1 population monitoring surveys were able to demonstrate that Giant Barred Frog populations continue to inhabit areas bisected to accommodate the Woolgoolga to Ballina Upgrade and in doing so have met the intent of the Threatened Frog Management Plan. The use of early management prescriptions such as pre-clearing surveys have proved useful in confirming the presence of frogs at other locations which has allowed for adaptive management actions such as the inclusion of temporary frog fencing, habitat connectivity considerations and the addition of further sites into the BACI population monitoring program.

Sampling revealed a comparable number of frogs to the baseline sampling. The difficulties associated with late season sampling created greater variability in the data set than what would have otherwise been expected and ultimately contributed to the calculated declines. In reality, the population count data taken from one but not both sampling events suggests there has been no change in the number of frogs at both Corindi Creek and Dirty Creek, but rather some changes in the way frogs use each site with no frogs recorded downstream of the newly constructed bridges at Corindi Creek and no frogs using the top half of Dirty Creek. Sampling at Halfway Creek revealed frogs inhabit both sides of the Upgrade and at densities markedly higher than recorded in the baseline survey. Sampling at Boneys Creek was unable to locate frogs which is the same result as the baseline sampling. Continued monitoring at this location will provide an understanding on how frogs use seasonal creeks in the upper Halfway Creek catchment.

In light of the Year 1 findings, the following recommendations are considered important:

1. Updates to the Threatened Frog Species Management Plan (RMS 2015) to include.
  - a. The Performance indicators and corrective actions outlined in Section 7.2.3 of the Threatened Frog Species Management Plan should read mean number of frogs per 500m.
  - b. Section 7.2.2 be updated to read:
    - i. Sampling for Giant Barred Frog be seasonally limited to Spring through to Autumn (October-May). Other species considered in the plan should be updated accordingly.
2. Prioritise rehabilitation works at Corindi Creek and Halfway Creek to assist in the restoration of habitat connectivity for Giant Barred Frog.
3. Ensure any connectivity structures which are planned for monitoring are reviewed for consideration as part of Year 2.
4. Give due consideration to developing access agreements via a leasing arrangement at sites where private property may need to be accessed; Corindi Creek (both sides), Dirty Creek (both sides), Boneys Creek (both sides), McPhillips Road (both sides), Halfway Creek (downstream side). This will provide greater certainty in the program being delivered in its existing survey design.

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## 8.0 APPENDIX A – GIANT BARRED FROG SURVEY SUMMARY DATA

Table A1. Summary of Giant Barred Frog surveys in Sections 1 and 2: Year 1 (2016).

BACI Site	Site	Sample Date	Start Time	Finish Time	Mean Air Temperature oC	Mean Water Temperature oC	Mean Cloud Cover (%)	Mean Humidity (%)	Mean Wind (0-4)	Mean Rainfall (0-3)	Stream Depth (Description)	Sex	Age Class	Reprod Status/Age Class	Length (mm SV)	Weight (g)	PIT Tag Ref Number	Zone	Distance to Water (m)	Last Known Recapture Point	Activity at Time of Capture	Microhabitat	Notes/Comments
1A	Corindi Creek	30/05/2016	1840	1940	12.8	15	0	77	0	0	Mainly confined to pools with reduce flows through riffles due to dry season and extraction of water												
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Unknown	Sub adult	Sub adult	49.1	17.75	000735B928	Upstream of Upgrade	6	First Time Captured	Above Litter/Observed	Above Litter	1st year cohort frog
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Just Spawned	94.5	107	0007356B7A	Upstream of Upgrade	9	First Time Captured	Above Litter/Observed	On Bare Ground	Spawning membrane still attached to frog rear end and legs after oviposition
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Gravid	112.9	203	000735C574	Upstream of Upgrade	9	First Time Captured	Above Litter/Observed	On Bare Ground	Just emerged. Still had sand covering it
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Unknown	Sub adult	Sub adult	48.2	15.5	000735B844	Upstream of Upgrade	2	First Time Captured	Above Litter/Observed	Above Litter	Close to other adult females
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Partly gravid	101.3	145	000735758F	Upstream of Upgrade	10	First Time Captured	Above Litter/Observed	On flood debris	Close to other adult females
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Partly gravid	114.5	157	00073524F5	Upstream of Upgrade	7	First Time Captured	Observed but partially buried	Partially buried in sand under litter	Missing right hand. Considered very old frog given weight
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Male	Adult	No colour	90.5	105	000735C5A3	Upstream of Upgrade	6	First Time Captured	Observed	On Bare Ground	Bulging eyes and among largest males caught in recent times doing GBF surveys
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Not Gravid	99.8	125	00073536B4	Upstream of Upgrade	7	First Time Captured	Observed	On bare sandy loam	Captured from southern bank where bare conditions following floods
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Not Gravid	100.8	132	PhotoLogID	Upstream of Upgrade	8	First Time Captured	Observed	On log	Pictures as had nanotransponders on backorder
1A	Corindi Creek	9/06/2016	1745	2050	19.4	15	0	55	0	0	Stream receding from flood flows	Female	Adult	Partly gravid	109	161	PhotoLogID	Upstream of Upgrade	10	First Time Captured	Observed on bare dirt	On bare dirt	Pictures as had nanotransponders on backorder
1B	Madmans Creek	29/05/2016	1800	1930	9.5	13	0	58	0	0	Very dry with only largest pools containing water												
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Unknown	Sub adult	Immature	51.5	17.5	Right hand 1st finger	10 m downstream bridge north bank	5	First Time Captured	Observed	Above litter on scoured sandy bank	North bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Unknown	Sub adult	Immature	50.6	17	Right hand 2nd finger	60 m downstream on south bank	10	First Time Captured	Observed	Above litter sheltering under Lomandra on secondary bank	South bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Male	Adult	Light Nuptials	76.9	63	Right hand 3rd finger	110 m downstream south bank	5	First Time Captured	Observed	Above ground using undercut bank	South bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Unknown	Sub adult	Immature	57.5	24	Right hand 4th finger	105 m downstream north bank	0.5	First Time Captured	Observed	Using rocky area of primary bank	South bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Female	Adult	Not Gravid	104.5	145	Left hand 1st finger	250 m downstream north bank	8	First Time Captured	Observed	Above litter on top of debris	North bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Unknown	Sub adult	Immature	20.5	55	Left hand 2nd finger	320 m downstream north bank	2.5	First Time Captured	Observed	Using scoured area of primary bank with overhang	South bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Male	Adult	No Colour	90.1	100	Left hand 3rd finger	At bridge/start of transect south bank	7	First Time Captured	Observed	Partially buried under litter	South bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Unknown	Sub adult	Immature	49.7	16.5	Left hand 4th finger	350 m downstream south bank	2	First Time Captured	Observed	Above litter	South bank
1B	Madmans Creek	9/06/2016	2140	2324	16.1	14	0	66	0	0	Stream receding with full flow pools and riffle zones	Unknown	Sub adult	Immature	52.5	17	Left leg top 1st toe	420 m downstream south bank	4	First Time Captured	Observed	Above litter	South bank
2A	Dirty Creek	29/05/2016	2053	2229	9.4	11	0	68	0	0	Limited to pools with no obvious flows through riffles												
2A	Dirty Creek	5/06/2016	1816	2015	17.9	13	90	66	0	1	Flowing pools and riffles. Upstream section of transect has a lot of sediment through whole transect	Female	Adult	Not Gravid	104.5	127	0007359786	Downstream of old highway below culvert	1	First Time Captured	Above Litter/Observed	Above Litter	Post flooding emergence which is suggestive of frogs may go on to spawn in winter

BACI Site	Site	Sample Date	Start Time	Finish Time	Mean Air Temperature oC	Mean Water Temperature oC	Mean Cloud Cover (%)	Mean Humidity (%)	Mean Wind (0-4)	Mean Rainfall (0-3)	Stream Depth (Description)	Sex	Age Class	Reprod Status/Age Class	Length (mm SV)	Weight (g)	PIT Tag Ref Number	Zone	Distance to Water (m)	Last Known Recapture Point	Activity at Time of Capture	Microhabitat	Notes/Comments
2A	Dirty Creek	5/06/2016	1816	2015	17.9	13	90	66	0	1	Flowing pools and riffles. Upstream section of transect has a lot of sediment through whole transect	Female	Adult	Not Gravid	103.5	121	0007356CF0	Downstream of old highway below culvert	3	First Time Captured	Above Litter/Observed	Above Litter	Post flooding emergence which is suggestive of frogs may go on to spawn in winter
2A	Dirty Creek	5/06/2016	1816	2015	17.9	13	90	66	0	1	Flowing pools and riffles. Upstream section of transect has a lot of sediment through whole transect	Female	Adult	Not Gravid	102.1	124	0007355E9A	Downstream of old highway below culvert	8	First Time Captured	Above Litter/Observed	Above Litter	Post flooding emergence which is suggestive of frogs may go on to spawn in winter
2A	Dirty Creek	5/06/2016	1816	2015	17.9	13	90	66	0	1	Flowing pools and riffles. Upstream section of transect has a lot of sediment through whole transect	Female	Adult	Not Gravid	110.8	135	0007358F1F	Bottom end of transect	9	First Time Captured	Above Litter/Observed	Above Litter	Post flooding emergence which is suggestive of frogs may go on to spawn in winter
2A	Dirty Creek	5/06/2016	1816	2015	17.9	13	90	66	0	1	Flowing pools and riffles. Upstream section of transect has a lot of sediment through whole transect	Female	Adult	Not Gravid	106.5	131	Frog not PIT tagged	Bottom end of transect	8	First Time Captured	Above Litter/Observed	Above Litter	Post flooding emergence which is suggestive of frogs may go on to spawn in winter
2B	Pigeon Gully	25/05/2016	1918	2103	11.5	12	0	63	0	0	Series of pool riffles through the entire transect. Water levels diminish in upper reaches of transect												
2B	Pigeon Gully	5/06/2016	2040	2230	15	13	40	72	0	0	Pool riffles running through transect following heavy flooding rain a few days beforehand												
3A	Halfway Creek	20/05/2016	2324	51	13	15	0	82	0	0	Pools with predominantly sub surface riffle flows												
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Unknown	Sub adult	Immature	53.7	17	0007352344	Downstream of Upgrade	9	First Time Captured	Above Litter/Observed	Among low ground covers	
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Male	Adult	No Colour	74.5	46.5	0007355BE0	Downstream of Upgrade	8	First Time Captured	Above Litter/Observed	Among sparse shrubs	
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Unknown	Sub adult	Immature	55	15	0007358ECB	Downstream of Upgrade	6	First Time Captured	Above Litter/Observed	On sand among exposed roots	
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Male	Adult	No Colour	76.8	51	0007356B83	Upstream of Upgrade	13	First Time Captured	Above Litter/Observed	Among sparse shrubs	
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Unknown	Sub adult	Immature	55.1	15.5	0007358CED	Upstream of Upgrade	7	First Time Captured	Above Litter/Observed	Above Litter	
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Female	Adult	Not Gravid	105.9	131.5	0007359E45	Upstream of Upgrade	14	First Time Captured	Above Litter/Observed	Above Litter	Close proximity (4m2) to two frogs below
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Female	Adult	Not Gravid	109.9	139.5	00073593F8	Upstream of Upgrade	17	First Time Captured	Above Litter/Observed	Above Litter	Close primary (4m2) to frog above and frog below
3A	Halfway Creek	26/05/2016	2128	0010	14.1	15	75	97	0	1	Pools with predominantly sub surface riffle flows	Male	Adult	No Colour	63.1	25	0007352F79	Upstream of Upgrade	15	First Time Captured	Above Litter/Observed	Above Litter	Close proximity (4m2) to two frogs above
3B	Yellow Crossing Road (Wooli River Catchment)	20/05/2016	2113	2255	15.5	15	0	79	0	0	Lowest observed in recent few years with just pool section and no obvious flows through riffle zones												
3B	Yellow Crossing Road (Wooli River Catchment)	26/05/2016	1838	2108	15	14	100	100	0	2	Lowest observed in recent few years with just pool section and no obvious flows through riffle zones	Unknown	Sub adult	Immature	50.5	15	000735258F	Road Verge	6	First Time Captured	Above Litter/Observed	Above Litter	On Eastern Edge of rain emerged from litter during rainfall
3B	Yellow Crossing Road (Wooli River Catchment)	26/05/2016	1838	2108	15	14	100	100	0	2	Lowest observed in recent few years with just pool section and no obvious flows through riffle zones	Unknown	Sub adult	Immature	54.7	16.5	000735907A	Road Verge	6	First Time Captured	Above Litter/Observed	Above Litter	On western edge of road
3B	Yellow Crossing Road (Wooli River Catchment)	26/05/2016	1838	2108	15	14	100	100	0	2	Lowest observed in recent few years with just pool section and no obvious flows through riffle zones	Male	Adult	No Colour	67.1	37	0007358B9B	Below road	4	First Time Captured	Above Litter/Observed	Above Litter	On northern bank 15 m downstream of road
4A	Boneys Creek	20/05/2016	1810	2037	16.7	15	0	77	0	0	Dry in upstream 1/3, few permeant pool in middle												



BACI Site	Site	Sample Date	Start Time	Finish Time	Mean Air Temperature oC	Mean Water Temperature oC	Mean Cloud Cover (%)	Mean Humidity (%)	Mean Wind (0-4)	Mean Rainfall (0-3)	Stream Depth (Description)	Sex	Age Class	Reprod Status/Age Class	Length (mm SV)	Weight (g)	PIT Tag Ref Number	Zone	Distance to Water (m)	Last Known Recapture Point	Activity at Time of Capture	Microhabitat	Notes/Comments	
4A	Boneys Creek	6/06/2016	1805	2011	12.9	14	0	50	0	0	reaches, continuous pools downstream of Upgrade Pool riffles running through transect following heavy flooding rain a few days beforehand													



Plate A-1. Giant Barred Frog female (100.8 mm Snout-vent) markings and female (109 mm snout-vent) markings to be used to verify Year 1 capture. Photos used due to no transponder tags.