Green and Golden Bell Frog Monitoring, Arncliffe, Annual Report for 2021-2022

Prepared by AMBS Ecology & Heritage Pty Ltd for Transport for New South Wales

Final Report

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Cover Photo:	Green and Golden Bell Frog at Pond A in the M8 Marsh Street Habitat Area. Photo credit: Henry Cook.

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1 Introduction

1.1 Background

AMBS Ecology & Heritage Pty Ltd (AMBS) was commissioned by Transport for NSW (TfNSW) to undertake monitoring of the Green and Golden Bell Frog (*Litoria aurea*) (GGBF) at Arncliffe. This report describes the monitoring and other GGBF management actions undertaken between September 2021 and May 2022. The GGBF monitoring and management is being undertaken in response to consent conditions and management plans associated with project approvals for the recently constructed M8 motorway (previously referred to as the "New M5" motorway) and the previously constructed M5 East motorway.

Construction of the M5 East commenced in the late 1990's and the motorway was opened in 2001. The M5 East connects General Holmes Drive in Mascot to the M5 motorway at King Georges Road. There is a tunnel under the Cooks River and a second tunnel west of Marsh Street, Arncliffe. The section between the two tunnels is above-ground and passes between Kogarah Golf Course to the north and the Barton Park Driving Range and Eve Street Wetlands to the south.

Due to impacts on an area known as the "Marsh Street Wetland" (a habitat area for the GGBF), a management plan for the GGBF was prepared (White, 1998). Implementation of this management plan included the construction of two frog ponds on the northern side of the M5 East, adjacent to Kogarah Golf Course. These two ponds are generally referred to as the "RTA Ponds" (Figure 1.1), but have also been referred to as the "M5 East Ponds" (e.g., in DECC [2008]) and are referred to as "Habitat Area 1" in White (1998). In this report these ponds will be referred to as the RTA Ponds.

Construction of the M8 commenced in July 2016. This project was originally called the "New M5" and has since been re-named as the "WestConnex M8". Much of the documentation associated with the project, including the management plans and the infrastructure approval, still refer to the project as the New M5. In this report the project will be referred to as the M8.

The M8 involved the construction of twin underground tunnels between the M5 East at Kingsgrove to a new interchange at St Peters. A construction compound for the project was established on Kogarah Golf Course. The compound is approximately 7.8 ha in size and is located within 50 m of the RTA Ponds (Figure 1.1).

Consent conditions for the M8 included a requirement to prepare a Plan of Management (PoM) for the GGBF (EcoLogical 2018) and a Habitat Creation and Captive Breeding Plan (HCCBP) (EcoLogical 2017). Together these plans outline:

- measures to minimise impacts from construction works on GGBF habitat in the RTA Ponds and Kogarah Golf Course;
- the establishment of a new habitat area for the GGBF south of the M5 East, between Marsh Street and Eve Street (the "M8 Marsh Street habitat area"; Figure 1.1);
- the establishment of six small "stepping-stone" ponds along the southern boundary of Kogarah Golf Course, east of the RTA Ponds (the "Enhancement Area"; Figure 1.1); and
- the establishment of a captive breeding facility at Symbio Wildlife Park.

The M8 project included the installation of permanent infrastructure (ventilation towers and water treatment facilities) located north of the RTA Ponds. With the exception of the area occupied by these permanent facilities, most of the area currently occupied by the compound was intended to be re-instated after construction of the M8 was completed. However, the compound is now being used for the construction of the M6 Stage 1 and re-instatement has been delayed until that project is complete.

1.2 Study Area

The Study Area includes the following locations (Figure 1.1):

- the M8 Marsh Street habitat area (previously known as the "New M5 Marsh Street habitat area") – an area set aside for the establishment of potential GGBF habitat, including three ponds and surrounding terrestrial habitat, located south of the M5 between Marsh Street and Eve Street;
- the "Creek" area – a drainage line near the M8 Marsh Street habitat area, which runs eastwards from a stormwater outlet below Marsh Street to the Eve Street Wetland Reserve;
- the RTA Ponds – two ponds constructed as replacement habitat for the GGBF when the M5 was built (late 1990's to early 2000's), by the then NSW Roads and Traffic Authority (RTA), located near the Marsh Street/M5 intersection and adjacent to the Kogarah Golf Course;
- the Enhancement Area – six small ponds located near a drainage line that runs along the southern boundary of the Kogarah Golf Course, east of the RTA Ponds;
- Kogarah Golf Course – a golf course located between Marsh Street and the Cooks River, which contains a number of water features;
- Riverine Park surrounds* – parts of the area between the M5 and the Spring Street canal, where GGBFs have been recorded or potentially suitable habitat occurs;
- Barton Park* – parts of the area in the northern section of Barton Park;
- Underpass – a passageway below the M5 East, which contains a pedestrian/bicycle path and a fenced-off containment pond.

* N.B. "Riverine Park surrounds" and "Barton Park" are referred to collectively in some previous reports as "Barton Park" and/or "the extended search area in Barton Park".

1.3 Scope

Monitoring and management of the GGBF at Arncliffe in 2021-2022 included:

- transfer of captive-bred tadpoles from the breeding facility and their release into the ponds in the M8 Marsh Street habitat area;
- regular checks of and support feeding of tadpoles in the M8 Marsh Street habitat area;
- nocturnal frog surveys in the M8 Marsh Street habitat area;
- support feeding of frogs in the M8 Marsh Street habitat area;
- removal of Striped Marsh Frogs (*Limnodynastes peronii*) from the M8 Marsh Street habitat area and their release into the adjacent creek (under a licence provided by the Office of Environment and Heritage [OEH]);
- nocturnal frog surveys in the RTA Ponds, Enhancement Area, Kogarah Golf Course, Perimeter, Creek, Underpass, Riverine Park surrounds and Barton Park;
- tadpole surveys and water quality measurements undertaken in the M8 Marsh Street Habitat area, RTA Ponds, Enhancement Area, Kogarah Golf Course, Riverine Park surrounds and Barton Park;
- salting of Pond B and building of refugia; and
- weed management in the M8 Marsh Street habitat area and RTA Ponds area (undertaken by Total Earth Care [TEC]).

1.4 Objectives

The objectives of the monitoring program as stated in the PoM are "to assess the ongoing survival of the Arncliffe population at the Kogarah Golf Course and within the RTA Ponds" and in the HCCBP as "to provide information for adaptive management on the effectiveness of the habitat created as part of the project."

Figure 1.1: Study Area.

1.5 Summary of Previous Monitoring Results

1.5.1 GGBF Monitoring for the M5 East

Monitoring of GGBFs at Arncliffe was undertaken by Dr Arthur White (Biosphere Environmental Consultants Pty Ltd) until 2017-2018. Surveys carried out in 1999-2000 and 2000-2001 showed an increase in the number of GGBFs in the RTA Ponds and a decrease in the Marsh Street Wetland (ELA 2018). Subsequent monitoring was mainly confined to the RTA Ponds and Kogarah Golf Course.

Each year between 2003-2004 and 2012-2013 the RTA Ponds and Kogarah Golf Course supported a population of GGBFs estimated to comprise a maximum of about 60 – 80 adults (except in 2011-2012, when the estimate was between 100 and 120 adults [numbers derived from Figure 2 in ELA 2018]). Breeding was recorded in the RTA Ponds in every year until 2014 (ELA 2017). GGBFs were regularly recorded on Kogarah Golf Course and tadpoles were recorded on a few occasions (the "pond to the east of the Crescent Lake on the Kogarah Golf Course in January / February 2003 and November 2005" [A Hamer, pers. comm. 2017 and A White, pers. comm. 2015 in ELA 2017]).

After 2012-2013 the population appears to have been in decline. In 2013-2014 the number of adult GGBFs captured was too low for a population estimate to be calculated (ELA 2018). In 2014-2015 the population was estimated to be a maximum of less than 40 adult frogs. In 2015-2016 only a few GGBFs were captured (six in November 2015 and eight in February 2016, the latter being over 5 consecutive nights of survey) (ELA 2017). However, a GGBF breeding event was recorded "in a large, ponded area between the RTA Ponds and the Kogarah Golf Course" in January 2016 (ELA 2017).

1.5.2 Implementation of the PoM and HCCBP and GGBF monitoring 2016-2017 and 2017-2018

In 2016-2017 surveys of the GGBF were expanded to include a number of areas south of the M5 as well as the RTA Ponds and Kogarah Golf Course (White 2017). Three juveniles were found in the RTA Ponds in September 2016, two were detected on Kogarah Golf Course in October 2016 (one in the "Southern Drain" and one in the Circular Pond), and between one and three GGBFs were observed on four occasions between October 2016 and March 2017 in the expanded survey area (White 2017).

In 2017 the HCCBP was implemented. Eighteen GGBFs found in the RTA Ponds, Kogarah Golf Course or the expanded survey area south of the M5 were transferred to Symbio Wildlife Park in February 2017 (Biosphere 2017a). Construction of the stepping-stone ponds in the Enhancement Area was completed by May-June 2017 (Biosphere 2017b, c) and construction of the M8 Marsh Street Habitat Area was completed over the following year.

In 2017-2018, after the transfer of animals to the captive breeding facility, only two GGBFs were detected; one in the south-eastern corner of Kogarah Golf Course and one in "Barton Park".

1.5.3 GGBF monitoring 2018-2019

AMBS commenced monitoring of the GGBFs at Arncliffe in September 2018, by which time the construction of the M8 Marsh Street habitat area was complete. Captive breeding of the GGBFs at Symbio Wildlife Park commenced. Approximately 3,500 captive-bred tadpoles were released into the ponds in the M8 Marsh Street habitat area over February and March 2019. Juvenile GGBFs began to be observed almost immediately. Surveys in March and April 2019 recorded well over 100 animals and sometimes more than 200 animals. The average size and weight of the animals increased over time and by April 2019 a small proportion of the animals were large enough to be implanted with a PIT tag. By early June, 16 GGBFs had been tagged.

Two juvenile GGBFs were observed outside the boundary fence during surveys conducted in May 2019.

Outside of the M8 Marsh Street habitat area, monitoring in 2018-2019 included surveys of the RTA Ponds, Enhancement Area, a selection of waterbodies on Kogarah Golf Course and a range of sites south of the M5. No GGBFs were detected in any of these sites. It should be noted that this season marked the commencement of a period of very low rainfall across NSW.

1.5.4 GGBF monitoring 2019-2020

The 2019-2020 season was characterised by extreme weather events, with an extended period of hot, dry conditions followed by heavy rainfall. Conditions between mid-October 2019 and mid-January 2020 were particularly poor, with most of south-eastern Australia in the midst of a drought and a severe bushfire season. There was a short period of heavy rain and thunderstorms in the middle of January 2020 (16-18 January); however, in general the month was characterised by extreme heat, low rainfall, bushfires and poor air quality.

An extreme rainfall event in February 2020 marked the end of this period of extreme heat and dry weather. Approximately 390 mm of rain fell in a 4-day period from 7 to 10 February 2020 (recorded at Observatory Hill by the Bureau of Meteorology). Over those 4 days many parts of Greater Sydney were subject to local flooding and some sites received their highest February rainfall on record. The heavy rain caused a large tree in Eve Street to fall, which landed across the frog fence surrounding the M8 Marsh Street habitat area.

During the drought, the habitat within the M8 Marsh Street habitat area was managed by using water from an on-site tank to top up the ponds and to dampen some of the terrestrial vegetation. A survey in October 2019 was undertaken prior to the release of captive-bred tadpoles in 2019-2020 and counted 110 GGBFs, approximately a third of which were large enough to be tagged. Male GGBFs were heard calling, but no other evidence of breeding was observed and no GGBF tadpoles were recorded in September or October.

Between the end of October 2019 and January 2020, a total of approximately 4,500 captive-bred GGBF tadpoles were released into the M8 Marsh Street habitat area. Juvenile GGBFs were observed in or adjacent to the ponds in November, December and January, shortly after the tadpole releases. At the end of the season a population estimate obtained from mark-recapture data indicated approximately 680 adult GGBFs (the 95% confidence interval being 336-1022 individuals).

No GGBFs were recorded anywhere outside of the M8 New M5 Marsh Street habitat area in the latter half of 2019. However, after the rain in January 2020, GGBFs began appearing outside of this area, mainly in nearby locations. Some of these frogs contained microchip codes confirming that they had escaped from the M8 Marsh Street habitat area.

A GGBF breeding event was recorded in the RTA Ponds in January 2020.

After the heavy rain event in February and the tree falling on the perimeter fence, dispersal to other areas was rapid. GGBFs appeared in a number of locations both south and north of the M5 East, including the RTA Ponds, the Enhancement Area, Riverine and Barton Parks and some of the ponds on the Kogarah Golf Course. However, none of the GGBFs that were found north of the M5 East had been tagged in the M8 Marsh Street habitat area; it was therefore unclear whether the animals recorded north of the M5 East had originated from the M8 Marsh Street habitat area, or from the breeding event in the RTA Ponds, or both.

1.5.5 GGBF monitoring 2020-2021

A survey of the M8 Marsh Street habitat area and the RTA Ponds in October 2020 found GGBFs in all ponds in the M8 Marsh Street habitat area, including calling males in Pond B and Pond C, and one GGBF in the Western RTA Pond.

Between the end of October 2020 and January 2021 a total of approximately 4,500 captive-bred GGBF tadpoles were released into the M8 Marsh Street habitat area. In December 2020 approximately 500 captive-bred tadpoles were released into the Western RTA Pond. No GGBF tadpoles were detected in either area prior to the release of captive-bred tadpoles and no GGBF tadpoles were detected in any of the other sites during the season.

At the end of the season a population estimate for the M8 Marsh Street habitat area, obtained from mark-recapture data indicated approximately 470 adult GGBFs (with a 95% confidence interval of 412-527).

GGBFs were also recorded (but in much lower numbers) in many locations outside of the M8 Marsh Street habitat area. These included several locations south of the M5, the RTA Ponds, the Enhancement Area and three of the water features on Kogarah Golf Course.

1.6 Weather Conditions in 2021 - 2022

Rainfall between September 2021 and January 2022 was generally close to monthly averages, with the exception of November. From February onwards the season was extremely wet, with very high rainfall recorded in all months between February and May 2022 (Figure 1.2). This was driven in part by flooding events, one in February/March 2022, when approximately 604 mm of rain fell in a 15-day period from 23 February to 9 March; and one in April 2022, when 128.4 mm of rain was recorded on 7 and 8 April (Sydney Airport weather station by the Bureau of Meteorology).

Mean monthly minimum and maximum temperatures were close to average for the entire season. The number of extreme heat days over 35˚C throughout the entire season numbered two, compared with five and nine for the 2020-2021 and 2019-2020 seasons respectively.

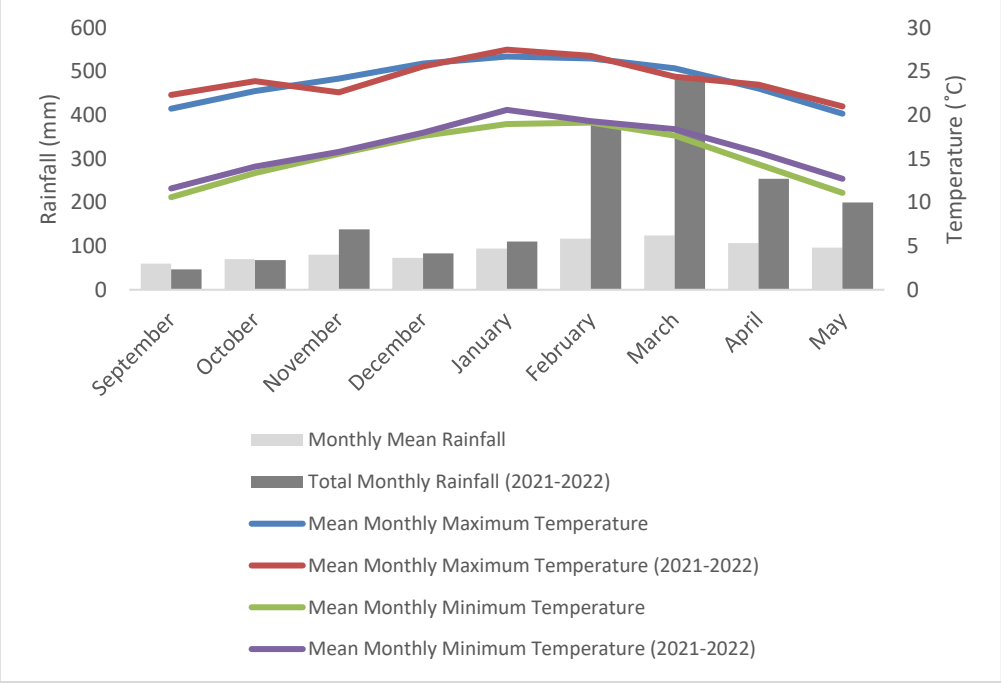

Figure 1.2: Weather data September 2021 to May 2022 (Sydney Airport 66037).

2 Methods

2.1 Captive Breeding and Tadpole Transfer

Inspections of the recipient sites, including tadpole surveys and sampling of water quality and temperature were undertaken prior to any tadpole releases. Searches for Striped Marsh Frogs and their foam egg nests were also undertaken, with any captured Striped Marsh Frogs or collected egg masses removed from the recipient sites.

Husbandry and breeding of the captive GGBFs was undertaken by Symbio Wildlife Park in Helensburgh. Tadpoles resulting from fertilised spawnings were raised until ready for transfer to Arncliffe. Tadpoles were then placed in plastic bags containing water from the rearing tank and air. The bags were sealed at the top to minimise water movement during transportation, placed in styrofoam eskies and transported immediately to the release site in an air-conditioned vehicle.

At the release site, the bags were opened and placed in the target release pond to enable temperature equilibration before release. Water from the release pond was then gradually introduced to the bags. If no negative responses were apparent, the tadpoles were released into the pond. A sample of the tadpoles were released into enclosures placed in each pond, to assist with monitoring post-release development.

After release, tadpoles in the enclosures were checked every 30 minutes for a period of at least 2 hours, then checked again after 24 hours, 72 hours, and then every 2-3 days until released. Each check involved an examination and count of the tadpoles in each of the enclosures, releasing any that were close to metamorphosis, and feeding. A check on water levels and observations of tadpoles in the ponds were made and water was added to the ponds if necessary. Net sweeps were avoided in order to minimise disturbance. Supplementary food was provided to the ponds every few days in the first 2 weeks post-release.

In late April and May 2022, a number of GGBFs were collected at Arncliffe and transported to Symbio Wildlife Park in order to supplement the ageing captive breeding stock.

2.2 Water Quality Monitoring and Maintenance Checks

Water quality and temperature surveys were undertaken approximately once per month between September 2021 and May 2022 (with the exception of any ponds or waterbodies that were dry, or too overgrown with vegetation). Water was not present in all ponds in all months and some sites in the Riverine Park surrounds and Barton Park were inaccessible. When water was present, sample sites included the M8 Marsh Street habitat area, the RTA Ponds, the Enhancement Area, and a selection of sites in Kogarah Golf Course, the Riverine Park surrounds and the northern end of Barton Park (consistent with monitoring from previous seasons and monitoring previously undertaken by Dr Arthur White).

The water quality surveys were undertaken using a Hanna IC-HI98194 hand-held probe. The key parameters that were measured were:

- temperature (°C);
- salt concentration in either Practical Salinity Units (PSU) or parts per thousand (ppt);
- pH;
- dissolved oxygen (% saturation and milligrams per litre [mg/L]);
- conductivity and resistivity (uS/cm and ms/cm);
- turbidity (NTU or FNU);
- oxidation reduction potential (mV).

Results of the temperature, salinity, pH and dissolved oxygen were compared with thresholds for GGBF and GGBF tadpole survival identified by Mahony and Beranak (undated), who provided ranges within which frogs and tadpoles survive, as well as a "higher survival range" in which the highest number of tadpoles survive (Table 2.1).

Table 2.1: Survival Threshold Range and Higher Survival Range for GGBFs and GGBF tadpoles identified by Mahoney and Beranak.

Parameter	Higher Survival Range	Survival Threshold Range		
	Tadpoles	Tadpoles	Frogs	Calling Males
Water Temperature (°C)	20 - 37	10.8 - 40.7	3.6 - 40.7	14.1 - 33
Salinity (ppt)	< 4	< 8	< 26.2	< 8
pH	7.0 - 11.8	3.5 - 12.4	2.8 - 13.5	5.0 - 10.4
Dissolved Oxygen (mg/L)	0.14 - 16	0.13 - 17.6	0.13 - 18.2	0.15 - 18.2

Maintenance checks were generally undertaken at the same time as the water quality monitoring and included assessments of:

- water level;
- presence of the introduced fish *Gambusia holbrooki*;
- density of macrophytes (in the constructed ponds);
- weeds (in the constructed pond areas);
- the frog exclusion fence surrounding the M8 Marsh Street habitat area;
- evidence of feral predators;
- any other notes of relevance.

2.3 Tadpole Monitoring

Tadpole surveys were undertaken approximately once per month between September 2021 and May 2022 (N.B. the September 2021 survey was undertaken in early October, to allow time for tadpoles to develop after a rain event in mid-September). Sample sites included the M8 Marsh Street habitat area, the RTA Ponds, the Enhancement Area and a selection of sites in Kogarah Golf Course, Riverine Park surrounds and the northern end of Barton Park. Water was not present in all ponds in all months and some sites in the Riverine Park surrounds were inaccessible, including the Northern Phragmites area and Number 9 Pond (entire season) and the Eastern Channel (parts of the season).

Survey techniques followed those previously undertaken on previous seasons and those of Dr White. Upon reaching each survey site, two ecologists observed the water surface to investigate whether there was tadpole activity. Sweeps of the waterbody were then made with a long-handled net (ten sweeps in most ponds and three sweeps in each of the small ponds in the Enhancement Area). Tadpoles captured in the net sweeps were identified to species when possible and life history stage recorded.

2.4 Frog Monitoring

2.4.1 M8 Marsh Street habitat area

Eight nocturnal frog surveys were undertaken in the M8 Marsh Street habitat area between October 2021 and April 2022. Survey techniques involved a combination of call detection, call playback, spotlighting, and mark-recapture. The majority of these surveys were undertaken between January and April 2022 and focussed on mark-recapture to obtain a population estimate.

Call playback was undertaken at each pond prior to undertaking spotlighting as follows: listening for calling frogs – 3 minutes; GGBF call playback – 30 seconds; listening – 30 seconds; GGBF call playback – 30 seconds; listening – 30 seconds. All frogs heard calling were identified and an estimate of the number of calling frogs of each species was made.

Spotlighting involved timed searches of each pond, with duration varying according to the size of the pond. All frogs observed were counted and as many GGBFs as possible were captured. All captured GGBFs large enough to have a tag were scanned and, if previously tagged, the tag number was recorded. All captured GGBFs were weighed, snout-urostyle length (SUL) was measured, any untagged animals over 40 mm SUL were tagged and then the frogs were released at the site of capture. The tags used were Trovan ID100 FXD-A Midichip Passive Integrated Transponders (PIT tags, also referred to as "microchips"), which were implanted subcutaneously. A Cyanoacrylate compound (Vetbond®) was applied to seal the insertion site, as per Murray *et al.* (2011).

Timed spotlight surveys were also undertaken around the inside of the perimeter fence and along a drainage swale located inside the habitat area downslope of the ponds. All the GGBFs encountered were counted, captured where possible, weighed, measured, and tagged.

2.4.2 RTA Ponds, Enhancement Area, Kogarah Golf Course, Underpass, Riverine Park surrounds and Barton Park

Six frog surveys outside of the M8 Marsh Street habitat were undertaken between October 2021 and May 2022, including repeat surveys of the RTA Ponds, Enhancement Area, Underpass, and a selection of sites in Kogarah Golf Course, Riverine Park surrounds and the northern end of Barton Park Frog Corridor and Barton Park. The creek area east of the M8 Marsh Street habitat was also surveyed. Water was not present in all ponds in all months and some sites in the Riverine Park surrounds were inaccessible, including the Northern Phragmites area and Number 9 Pond (entire season) and the Eastern Channel (parts of the season).

Survey techniques were the same as described for the M8 Marsh Street habitat area; i.e., call detection, call playback, a timed spotlight survey, with duration of the spotlight survey depending on the size of the pond, and measurement, tagging and release of any GGBFs able to be captured.

2.4.3 Population Estimate

GGBF population estimates were undertaken by The Analytical Edge using mark-recapture data collected from the M8 Marsh Street habitat area. Closed population capture-recapture models were fitted using the R library RMark, which is an interface with the software package MARK.

3 Results

3.1 Captive Breeding and Tadpole Transfer

Inspections of the captive breeding facility by AMBS found the facility to be well-kept, with hygiene procedures and controls in place. Animals were paired following the recommendations of the Australian Museum (2018) and several spawnings occurred. However, in contrast to previous years, very few of the resulting tadpoles were able to be raised to maturity, and most of those that were, were deformed. As a result, very few tadpoles were raised by the captive breeding program 2020 – 2021.

Approximately 230 captive-bred GGBF tadpoles were collected from the captive breeding facility at Symbio Wildlife Park, transported to the M8 Marsh Street habitat area (Table 3.1). Releases took place on three occasions between the November 2021 and January 2022 (Table 3.1).

Table 3.1: Summary of GGBF tadpole releases in 2021-2022.

Date	Number of Tadpoles	Comments
19 Nov 2021	30	Released into Pond A
9 Dec 2021	100	Released into Pond A
11 Jan 2022	100	Released into Pond A

3.2 Water Quality Monitoring

Water quality results were relatively stable throughout the monitoring period. Water quality data are provided in Appendix A.

In the M8 Marsh Street habitat area, water levels were topped up prior to the release of tadpoles and maintained in all ponds throughout the monitoring period. Water was present in all ponds at all times, although water levels in Pond A (the most ephemeral pond) were allowed to drop in September and October, prior to topping up. Water temperature fluctuated in response to the prevailing climatic conditions, but was within the general survival threshold for tadpoles throughout the entire monitoring period. Water temperature in all of the ponds reached the higher survival threshold in December 2021 and returned to the general survival threshold range in April 2022. Results of salinity, dissolved oxygen and pH measurements at the M8 Marsh Street habitat area were all within the general survival threshold for the entire monitoring period; they were also all within the higher survival threshold for the entire monitoring period except for pH in February in pond A, and in January in all ponds.

Water levels in the RTA Ponds varied throughout the monitoring period, but always remained at least three-quarters-full. Water quality was within the tadpole survival thresholds. Water levels in the Enhancement Area ponds varied throughout the monitoring period, with most ponds being dry at least once. Water quality measurements in the Enhancement Area were generally within target thresholds.

Water levels and water quality in sites outside of the M8 Marsh Street habitat area, RTA Ponds and Enhancement Area varied. Most sites in the Riverine Park surrounds and Barton Park areas were dry until heavy rains fell in February and March; the main exception being the Landing Lights East site, which held water in a deep hole over the season. Conversely, most of the ponds sampled on Kogarah Golf Course had water throughout the season, with the exception of the Northern Pond and Skinny Pond, which were dry throughout. Salinity, dissolved oxygen and pH were generally within the survivorship thresholds outlined in Mahoney and Beranak at all sites, with the exception of the Mangrove Pond in Kogarah Golf Course, which had very high salinity for much of the monitoring period.

3.3 Tadpole Monitoring

Tadpole monitoring data are presented in Appendix B.

No GGBF tadpoles were detected in the M8 Marsh Street habitat area prior to the release of the captive-bred tadpoles. One GGBF tadpole was recorded in December 2021 and two in January 2022 in Pond A, corresponding with the released captive-bred individuals. Striped Marsh Frog and Peron's Tree Frog tadpoles were also detected in the ponds at different points during the monitoring period.

GGBF tadpoles were not detected in the RTA Ponds. Striped Marsh Frog tadpoles were frequently detected during the monitoring and recorded in a number of sites including the RTA Ponds, the Enhancement Area Ponds and many of the Riverine Park surrounds and Barton Park sites. Peron's Tree Frog tadpoles were detected at some ponds in the Riverine Park surrounds and Barton Park.

No tadpoles of any species were detected in the Kogarah Golf Course ponds. The introduced fish species *Gambusia holbrooki* was regularly detected in the Kogarah Golf Course ponds, often in high numbers. The fish was also detected in the Landing Lights East pond in Barton Park, where it has not previously been recorded.

3.4 Frog Monitoring

3.4.1 M8 Marsh Street habitat area

Eighty-one (81) captures of GGBFs were made over eight survey events at the M8 Marsh Street habitat area between October 2021 and April 2022 (Table 3.2). Eighty (80) GGBFs were captured around the ponds and four (4) were captured along the internal perimeter and in the swale over the eight surveys. One captured frog recorded in October 2021 was a juvenile (< 40 mm in length). The remaining 80 were > 40 mm in length and were implanted with PIT tags (microchips), if not already tagged. Fifty-seven (57) of the captures were recaptured GGBFs, including some individuals recaptured more than once.

GGBFs that were observed, but not able to be captured, included one "metamorph" in Pond B. This GGBF was in the final stages of metamorphosis and had four legs and a tail.

Five (5) of the recaptured GGBFs were originally caught and microchipped during the previous (2019-2020) season. These included one animal that was originally captured on Kogarah Golf Course (Long Pond) in February 2021 and recaptured in the M8 Marsh Street habitat area (Pond C) in March 2022.

Sex ratios this season were male-biased representing 62.9% of captures, which is similar to the 66% (2020-2021) and 61% (2019-2020) male bias recorded the previous seasons.

Analysis of the mark-recapture data indicated the best fitting model was the "constant model" (62% model support, QAICc weight = 0.615), followed by the behavioural model (QAICc weight = 0.368). The constant model suggests that capture and recapture rates are constant over time. The daily probability of capture was estimated (p = 0.22, 95% Confidence interval = 0.17 - 0.27). The resulting adult frog population estimate was 46.1 (with a 95% confidence interval of 27.7 - 64.5) individual adult GGBF across the M8 Marsh Street habitat area in 2022.

When the full data set was analysed (including GGBFs captured both within and outside of the M8 Marsh Street habitat area), the resulting population estimate was 58.4 (95% confidence interval 32.4 - 85.3) adult GGBFs.

Other frog species detected within the compound were the Striped Marsh Frog and Peron's Tree Frog. Seventy-eight (78) Striped Marsh Frog egg masses and eighteen (18) individuals were relocated from the M8 Marsh Street Habitat to surrounding habitats outside of the compound.

Table 3.2: M8 Marsh Street habitat area GGBF survey results.

Date	Pond	Juvenile / Subadult	Recap	Number microchipped	Total
20-Oct-21	Pond A	0	1	0	**1**
	Pond B	0	2	0	**2**
	Pond C	1	6	3	**10**
	Swale	0	0	0	**0**
	Perimeter	0	0	0	**0**
1-Feb-22	Pond A	0	1	0	**1**
	Pond B	0	0	2	**2**
	Pond C	0	3	2	**5**
	Swale	0	0	0	**0**
	Perimeter	0	1	0	**1**
16-Feb-22	Pond A	0	1	2	**3**
	Pond B	0	1	2	**3**
	Pond C	0	7	5	**12**
	Swale	0	0	0	**0**
	Perimeter	0	1	0	**1**
3-Mar-22	Pond A	0	1	0	**1**
	Pond B	0	1	0	**1**
	Pond C	0	3	0	**3**
	Swale	0	0	0	**0**
	Perimeter	0	1	0	**1**
12-Mar-22	Pond A	0	1	0	**1**
	Pond B	0	2	0	**2**
	Pond C	0	4	1	**5**
	Swale	0	0	0	**0**
	Perimeter	0	0	0	**0**
29-Mar-22	Pond A	0	2	0	**2**
	Pond B	0	1	0	**1**
	Pond C	0	2	0	**2**
	Swale	0	0	0	**0**
	Perimeter	0	0	0	**0**
14-Apr-22	Pond A	0	0	0	**0**
	Pond B	0	1	1	**2**
	Pond C	0	1	1	**2**
	Swale	0	0	0	**0**
	Perimeter	0	0	0	**0**
26-Apr-22	Pond A	0	1	0	**1***
	Pond B	0	5	4	**9***
	Pond C	0	6	0	**6***
	Swale	0	0	0	**0**
	Perimeter	0	1	0	**1***
Total		**1**	**57**	**23**	**81**

*Frogs were collected and taken to Symbio Wildlife Park for captive breeding program.

3.4.2 Underpass, RTA Ponds, Enhancement Area, Kogarah Golf Course, Riverine Park surrounds and Barton Park, Creek and Perimeter

GGBFs were located at a number of sites from November 2021 onwards. Frog monitoring data from outside the M8 Marsh Street habitat area are described below and are summarised in Appendix C.

Nineteen (19) observations of GGBFs were made from six survey sites (Table 3.3, Figure 3.1); with several of these being observations of the same frog at the same site. One of the frogs found in the Creek area was a recapture that had originally been tagged in the M8 Marsh Street habitat area.

In general detections of GGBFs outside of the M8 Marsh Street habitat were low compared to the previous season. Records for November were only across a few ponds on Kogarah Golf Course and one sighting near Landing Lights West in Barton Park. In subsequent surveys, GGBFs were detected in the Creek area, the Enhancement Area, the Circle Pond, Long Pond, and Skinny Pond on Kogarah Golf Course. No GGBFs were observed at the Underpass, the RTA Ponds, or any of the Riverine Park / Barton Park sites.

Table 3.3: Observations of GGBFs outside of the M8 Marsh Street habitat area during the 2021-2022 monitoring season (numbers in parenthesis indicate frogs observed but not caught).

Site	Nov 21	Jan 22	Mar 22	Apr 22	May 22	Total
Creek	-	(1)	-	1	-	**2**
Underpass	-	-	-	-	-	**-**
RTA Pond West	-	-	-	-	-	**-**
RTA Pond East	-	-	-	-	-	**-**
Enhancement Area	-	(2)	-	1	-	**3**
Circle Pond	1	-	3	-	-	**4**
Long Pond	(1)	-	-	2	2*	**5**
Eastern Pond	-	-	-	-	-	**-**
Skinny Pond	(1)	-	-	1	2*	**4**
Northern Pond	-	-	-	-	-	**-**
Mangrove Pond	-	-	-	-	-	**-**
Eastern Channel	-	-	-	-	-	**-**
Southern Phragmites	-	-	-	-	-	**-**
Bend Swamp	-	-	-	-	-	**-**
Southern Jungle	-	-	-	-	-	**-**
Driving Range Wetland	-	-	-	-	-	**-**
Landing Lights East	-	-	-	-	-	**-**
Landing Lights West	1	-	-	-	-	**1**
Total Observations	**4**	**3**	**3**	**4**	**4**	**19**

*Frogs were collected and taken to Symbio Wildlife Park for captive breeding program.

Figure 3.1: GGBF observations outside of the M8 Marsh Street habitat area during the 2021-2022 monitoring season.

Other frog species detected during surveys are summarised in Appendix C and described below. Striped Marsh Frogs were frequently detected in all the extended search area except in the Skinny Pond in Kogarah Golf Course, and both RTA Ponds. More ponds were occupied by this species compared to last season. After the flooding events from February and March thousands of tadpoles were observed in ephemeral ponds on the Kogarah Golf course and the Riverine Park and Surrounds and Barton Park. Peron's Tree Frogs were detected in the Underpass, RTA West, and Enhancement Area. Eastern Dwarf Tree Frogs (*Litoria fallax*) were observed and heard calling only from RTA West. Common Eastern Froglets (*Crinia signifera*) were detected at RTA West, RTA East, and the Enhancement Area Ponds which is similar to last season. Additionally, some individuals of the Eastern Banjo Frog (*Limnodynastes dumerilii*) were heard in November at the RTA East Pond. This species had historically been recorded in the area but not while AMBS has been monitoring it (Arthur White personal communication).

3.5 Maintenance

3.5.1 The M8 Marsh Street habitat area

Water levels at all ponds were supplemented when required with water from the storage tank located on site. No ponds were drained. Salt was added to Pond B during the winter, prior to the commencement of the monitoring period, with salt levels slightly raised in accordance with published literature regarding chytrid inhibition (Clulow et al. 2017). The introduced fish *Gambusia holbrooki* was not recorded in any of the ponds. Evidence of cats was sometimes recorded, including evidence of cat predation on Black Rats. Foxes were not observed.

Total Earth Care (TEC) were engaged to undertake targeted weed control in the M8 Marsh Street habitat area and the RTA Ponds. TEC continued their monthly control program designed to progressively remove (or at least limit the spread of) herbaceous and woody weeds that could influence the quality of habitats. However, the increase in annual rainfall following a period of drought resulted high weed abundance and diversity. Morning Glory (*Ipomoea indica*) that established within the site by January 2019 continues to pose challenges despite constant targeted control efforts.

3.5.2 RTA Ponds

Weed control efforts undertaken by TEC at the site again focused on woody weeds located between and fringing the two ponds, including reducing the density of shading mid story native and invasive species. Smaller infestations of weeds (e.g., *Lonicera japonica*) were targeted to prevent encroachment into key frog habitat. Some herbaceous weed (e.g., *Anredera cordifolia*) control was also undertaken along the southern perimeter following weed ingress from outside of the fence.

The introduced fish species *Gambusia holbrooki* was not observed. Feral Cats or Fox were not observed.

3.5.3 Enhancement Area

The introduced fish species *Gambusia holbrooki* was not recorded. Feral or domestic cats and foxes were observed during the monitoring period.

Terrestrial weed abundance and diversity were low in the Enhancement Area due to the majority of the site being maintained by the Golf Club as part of the golf course. Weeds have established in some of the ponds including Kikuyu (*Pennisetum clandestinum*) in several ponds and Crofton Weed (*Ageratina adenophora*) at Ponds 1 and 2.

4 Discussion

The current season was substantially different to that of recent previous seasons due to the failure of the captive breeding program to provide sufficient tadpoles for translocation in 2021-2022. Symbio Wildlife Park have made considerable efforts to investigate the reasons why and appear to have isolated the problem. (N.B. at the time of preparing this report, Symbio have successfully bred from a number of spawnings subsequent to the 2021-2022 season).

This situation provided an opportunity to see how the GGBF population responded to the absence of an influx of tadpoles from an external source. The population estimate of 58.4 adult GGBFs is similar to (but slightly less than) the population estimates obtained after the construction of the RTA Ponds up until 2012-2013, and higher than the population estimates obtained subsequent to that but prior to the implementation of the captive breeding program. The majority of the population in 2021-2022 occurred within the M8 Marsh Street habitat area and was likely to be mainly comprised of animals from previous seasons, with only limited recruitment observed in 2021-2022.

The key results from 2021-2022 were:

1. A population of GGBFs continued to be present in the M8 Marsh Street habitat area, despite a lack of recruitment from the captive breeding program, although the population size was considerably reduced;
2. GGBFs were generally absent from many of the other areas outside of the M8 Marsh Street habitat area, including the RTA Ponds;
3. A small number of GGBFs persisted in some of the ponds on Kogarah Golf Course;
4. Observations of juvenile frogs on the Golf Course and in the M8 Marsh Street habitat area towards the latter half of the season (including a metamorphling with four legs and a tail in Pond B of the M8 Marsh Street habitat area) indicates that some recruitment occurred during the season;
5. The animal captured on the Golf Course and recaptured in the M8 Marsh Street habitat area indicates that movement from north-south across the M5 is possible.

Weed establishment and spread is currently a maintenance challenge in both the M8 Marsh Street habitat area and the RTA Ponds. Key maintenance recommendations are:

1. Resolve the water supply issue to the RTA Ponds. It is recommended that a suitable, long-term alternative to the current arrangement be found.
2. Continue with weed reduction in the M8 Marsh Street habitat area and the RTA Ponds.

5 Conclusion

As stated in Section 1.4, the objectives of the monitoring program are stated in the PoM as "to assess the ongoing survival of the Arncliffe population at the Kogarah Golf Course and within the RTA Ponds" and in the HCCBP as "to provide information for adaptive management on the effectiveness of the habitat created as part of the project" (i.e., the M8 Marsh Street habitat area).

One of the key results from 2021-2022 was the detection of GGBF movement between the north and south of the M5. Although only a single individual has been recorded, it demonstrates that movement between these areas is possible.

Monitoring in 2021-2022 detected only a small number of GGBFs on Kogarah Golf Course. The lack of GGBFs in the RTA Ponds indicates that the survival of this population is currently heavily dependent on the M8 Marsh Street habitat area.

The population size estimate for the M8 Marsh Street habitat area was considerably less than in previous seasons when there was recruitment from the captive breeding program. However, some natural recruitment was observed, with a small number of juveniles or small adults being observed towards the latter half of the season.

The results indicate that the M8 Marsh Street habitat area has so far been effective in creating an environment suitable for the growth of captive-bred tadpoles, their metamorphosis into frogs, and the continued growth of the metamorphosed animals into adult frogs. Further, the results from 2021-2022 indicate that breeding has occurred in least one of the ponds. However, both the adult population size and the number of juvenile frogs observed was considerably less than in previous seasons. We conclude that, at this stage of the program, the ongoing survival of the GGBF population at Arncliffe remains dependent on the continuation of the captive breeding program.

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Appendix A: Water quality data

October 2021

Location	Date	Pond	General Condition	mVpH	pH	ORP [mV]	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	5/10/2021	A	100%	-10.1	7.4	8.7	0.2	19.3	18.9	No
	5/10/2021	B	100%	-20.9	7.3	8.9	0.36	13.4	20.1	No
	5/10/2021	C	100%	-18.3	7.4	-4.9	0.2	6.3	17.3	No
RTA	5/10/2021	Western	100%	-10.2	7.2	11.9	0.08	21.3	18.5	No
	5/10/2021	Eastern	100%	-14.7	7.1	-32.7	0.1	11.2	17.6	No
Enhancement Area	5/10/2021	1	Dry	-	-	-	-	-	-	No
	5/10/2021	2	Dry	-	-	-	-	-	-	No
	5/10/2021	3	Dry	-	-	-	-	-	-	No
	5/10/2021	4	Dry	-	-	-	-	-	-	No
	5/10/2021	5	Dry	-	-	-	-	-	-	No
	5/10/2021	6	Dry	-	-	-	-	-	-	No
Kogarah Golf Course	5/10/2021	Circular	100%	2.1	7.6	21.3	2.8	39.1	20.1	Yes
	5/10/2021	Long	100%	-33	7.8	24.1	2.1	14.9	19.9	Yes
	5/10/2021	Mangrove Pond	100%	-26.9	6.9	89.7	18.4	11.3	18.4	Yes
Riverine & Barton Park	5/10/2021	Eastern Channel	5%	-	-	-	-	-	-	-
	5/10/2021	Southern Phragmites	5%	-	-	-	-	-	-	-
	5/10/2021	Bend Swamp	Dry	-	-	-	-	-	-	-
	5/10/2021	Southern Jungle	Dry	-	-	-	-	-	-	-
	5/10/2021	Landing Lights East	25%	-47.1	7.2	68.4	3.8	24.5	17.8	No
	5/10/2021	Landing Lights West	Dry	-	-	-	-	-	-	-
	5/10/2021	Driving Range Wetland	Dry	-	-	-	-	-	-	-

November 2021

Location	Date	Pond	General Condition	mVpH	pH	ORP [mV]	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	3/11/2021	A	10%	-22.4	7.6	14.4	572	527	286	0.28	15.1	20.9	No
	3/11/2021	B	25%	-24.7	7.5	52.2	1408	1281	704	0.71	12	20.2	No
	3/11/2021	C	100%	-18.6	7.3	-29.1	496	446	248	0.24	6.6	19.1	No
Enhancement Area	3/11/2021	1	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	2	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	3	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	4	100%	1.9	6.9	-66	253	225	127	0.12	12.6	19.1	No

	3/11/2021	5	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	6	Dry	-	-	-	-	-	-	-	-	-	-
Kogarah Golf Course	3/11/2021	Circular	10%	-49	7.8	-69.4	113.8	102	5101	6.53	20.5	19.5	Yes
	3/11/2021	Long	50%	-77.8	8.3	-56.1	415.2	385.6	2013	2.21	17.1	21.3	Yes
	3/11/2021	Mangrove Pond	100%	-42.6	7.7	-73.2	514.3	458.2	2532	33.89	21.1	19.3	Yes
Riverine & Barton Park	3/11/2021	Eastern Channel	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	Southern Phragmites	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	Bend Swamp	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	Southern Jungle	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	Landing Lights East	25%	-51.6	7.9	-54.1	418.3	399.6	2093	2.23	18.7	22.6	No
	3/11/2021	Landing Lights West	Dry	-	-	-	-	-	-	-	-	-	-
	3/11/2021	Driving Range Wetland	Dry	-	-	-	-	-	-	-	-	-	-

December 2021

Location	Date	Pond	General Condition	mVpH	pH	ORP [mV]	% Sat (DO%)	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	10/12/2021	A	Full	-17	7.2	35.5	0	312	292	156	0.15	12.1	21.7	No
	10/12/2021	B	Full	-18.3	7.3	43.7	0	344	316	172	0.16	17	20.7	No
	10/12/2021	C	Full	-37.7	7.6	33.5	0	411	387	206	0.2	2	21.9	No
RTA	10/12/2021	Western	Full	-17.4	7.8	-60.8	0	240	225	120	0.11	14.9	21.8	No
	10/12/2021	Eastern	Full	-26.6	7.6	-6.6	0	144	131	72	0.07	9.6	20.8	No
Enhancement Area	10/12/2021	1	Shallow	16.8	6.6	114.8	0	131	113	67	0.06	7.9	17.6	No
	10/12/2021	2	1/2 Full	5.5	6.8	88.6	0	120	107	62	0.06	7.9	17	No
	10/12/2021	3	Full	15.2	6.7	65.3	0	120	107	62	0.06	12.5	18.8	No
	10/12/2021	4	Shallow	24.1	6.5	67.3	0	82	76	43	0.04	35.2	20	No
	10/12/2021	5	Shallow	26.8	6.5	189.5	0	200	175	101	0.09	6.2	18.5	No
	10/12/2021	6	Shallow	23.3	6.5	234.3	0	423	359	212	0.2	28.1	16.9	No
Kogarah Golf Course	10/12/2021	Circular	Full	-12.6	7.1	50.2	0	5770	5271	2954	3.37	13.9	21.5	Yes
	10/12/2021	Long	Full	-52.4	7.9	26.3	0	2951	2713	1475	1.54	27.8	20.8	Yes
	10/12/2021	Mangrove Pond	Full	-7.5	7.1	251.5	0	335500	314500	16600	20.71	53.8	21.7	Yes
	10/12/2021	Eastern	Full	-50.7	7.8	5.3	0	5050	4737	2522	2.72	30.6	21.8	Yes
	10/12/2021	Skinny	Not sampled											
	10/12/2021	Northern	Not sampled											
Barton Park	10/12/2021	No.9 Pond	Not sampled											

	10/12/2021	Eastern Channel	Dry											
	10/12/2021	Southern Phragmites	1/2 full	-36	7.6	33.5	0	132	117	66	0.07	6.3	17.7	No
	10/12/2021	Northern Phragmites	Not sampled											
	10/12/2021	Bend Swamp	Shallow	-22.2	6.9	76.6	0	508	438	254	0.16	16.1	17.7	No
	10/12/2021	Southern Jungle	Shallow	-20.9	7.3	60	0	1110	1054	558	0.55	7.1	22.3	No
	10/12/2021	Landing Lights East	Full	-25.4	7.4	50.7	0	3507	3312	1761	1.86	30.2	22	Yes
	10/12/2021	Landing Lights West	Dry											
	10/12/2021	Driving Range Wetland	Dry											

January 2022

Location	Date	Pond	General Condition	mVpH	pH	ORP [mV]	% Sat (DO%)	Diss. O2 [mg/l]	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	17/01/2022	A	Full	8.4	6.8	127.9	11.5	0.96	409	299	204	0.15	1.6	24.3	No
	17/01/2022	B	Full	26.7	6.5	120.7	10.4	0.86	511	534	264	0.24	1.1	25.4	No
	17/01/2022	C	Full	1.6	6.9	82	102.1	8.16	596	504	248	0.24	20.7	25.8	No
RTA	17/01/2022	Western	Full	-44.4	7.7	31.3	49.2	4.01	187	192	95	0.09	2.2	26.2	No
	17/01/2022	Eastern	Full	-37.7	7.2	89.2	43.2	3.59	160	158	81	0.08	1.7	24.2	No
Enhancement Area	17/01/2022	1	Dry												
	17/01/2022	2	Dry												
	17/01/2022	3		+	6.7	-24.5	23.3	1.88	1361	1307	676	0.67	45.5	23.1	No
	17/01/2022	4	Full	72.2	5.7	61.3	17.7	1.43	253	254	128	0.12	30.5	24.9	No
	17/01/2022	5		41.4	6.4	3.4	17.5	1.49	195	189	99	0.09	21.2	23.2	No
	17/01/2022	6	1/4 Full	-30.6	7.4	-88.7	57.5	4.91	263	250	133	0.13	27.2	22.3	No
Kogarah Golf Course	17/01/2022	Circular	Full	-19.8	7.3	-140.6	76.5	5.87	8922	9195	4461	4.97	0.09	26.5	Yes
	17/01/2022	Long	Full	-68.9	8.1	51.5	50.6	3.88	3844	4052	1927	2.02	16.3	27.7	Yes
	17/01/2022	Mangrove Pond	Full	-32.4	7.5	217.7	25.5	1.15	357860	385840	181100	22.45	114	28.5	Yes
	17/01/2022	Eastern	Full	-75	8.2	31.8	49.3	3.66	4929	5133	2461	2.63	0.7	27.4	Yes
	17/01/2022	Skinny	Not sampled												

	17/01/2022	Northern	Not sampled											
Barton Park	17/01/2022	No.9 Pond	Not sampled											
	17/01/2022	Eastern Channel	Dry											
	17/01/2022	Southern Phragmites	1/4 Full	-7.2	7.05	-65.2	27.3	2.37	356	320	174	0.17	10.2	21.3	No
	17/01/2022	Northern Phragmites	Not sampled											
	17/01/2022	Bend Swamp	Dry											
	17/01/2022	Southern Jungle	Almost Dry	-9.5	7.1	-59.4	11.4	0.94	303	185	72	0.8	7.6	26.7	No
	17/01/2022	Landing Lights East	3/4 Full	-56.4	7.9	60	35.3	2.71	5152	5314	2573	2.76	13.6	26.6	No
	17/01/2022	Landing Lights West	Dry											
	17/01/2022	Driving Range Wetland	Dry											

February 2022

Location	Date	Pond	General Condition	mVpH	pH	ORP	DO %	Diss. O2 [mg/l]	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	15/02/2022	A		10.8	6.8	64.3	9.7	0.83	320	299	159	0.15	10.1	21.9	No
	15/02/2022	B		-15.5	7.2	60.3	29.5	2.45	469	441	235	0.23	8.8	21.9	No
	15/02/2022	C		-27.4	7.4	69.7	20.6	1.64	460	443	230	0.22	1.2	23.1	No
RTA	15/02/2022	Western	3/4 Full	-50.1	7	-12.8	62	5.36	0.22	0.14	0	0.01	11.9	23.2	No
	15/02/2022	Eastern	Full	-20.4	7.3	89	22.7	1.97	0.96	0.89	49	0.05	8.3	21.2	No
Enhancement Area	15/02/2022	1	Dry												
	15/02/2022	2	Dry												
	15/02/2022	3	Dry												
	15/02/2022	4		22.8	6.5	-102.6	20.2	1.71	0.14	0.003	0	0	33.6	21.7	No
	15/02/2022	5	Dry												
	15/02/2022	6	Dry												
Kogarah Golf Course	15/02/2022	Circular		-46.6	7.8	-113.4	24.2	1.9	139.3	135.9	2004	8.1	25.1	23.6	Yes
	15/02/2022	Long		-57.2	7.8	-36.7	19.3	1.52	394.2	402.2	1984	2.09	5.9	25.7	Yes
	15/02/2022	Mangrove Pond	Full	-59.6	7.9	-28.8	46.1	2.52	599.5	592.7	3016	26.6	16.8	23.4	Yes
	15/02/2022	Eastern		-116.6	9	-21.1	36.5	3.77	413.5	401.2	0	3.3	18.3	24.3	Yes

	15/02/2022	Skinny	Not sampled												
	15/02/2022	Northern	Not sampled												
Barton Park	15/02/2022	No.9 Pond	Not sampled												
	15/02/2022	Eastern Channel	Dry												
	15/02/2022	Southern Phragmites	Dry												
	15/02/2022	Northern Phragmites	Not sampled												
	15/02/2022	Bend Swamp	Dry												
	15/02/2022	Southern Jungle	Dry												
	15/02/2022	Landing Lights East		43.6	7.7	-95.3	27.1	2.26	521.6	503.5	2621	2.82	16.8	23.1	Yes
	15/02/2022	Landing Lights West	Dry												
	15/02/2022	Driving Range Wetland	Dry												

March 2022

Location	Date	Pond	General Condition	mVpH	pH	ORP [mV]	% Sat (DO%)	Diss. O2 [mg/l]	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	23/03/2022	A	Full	-12.6	7.2	-79.4	22.6	1.91	142	134	86	0.06	0.8	21.9	No
	23/03/2022	B	Full	-15.2	7.2	-97.2	23.2	1.97	120	113	60	0.01	0.9	21.7	No
	23/03/2022	C	Overfull	-13.3	7.2	-88.50	21	1.84	315	303	157	0.15	0.6	23	No
RTA	23/03/2022	Western	Full	-57.7	7.5	-24	31	2.66	82	73	4	0.01	14.1	21.7	No
	23/03/2022	Eastern	Full	11.6	6.9	32.4	8.5	0.69	115	126	33	0.03	15.3	20.2	No
Enhancement Area	23/03/2022	1	Dry												
	23/03/2022	2	Dry												
	23/03/2022	3	Dry												
	23/03/2022	4	Full	-17.2	7.2	6.9	18.4	1.56	104	102	31	0.01	6.7	20.7	No
	23/03/2022	5	Very low	-34.3	7.5	-87.3	13	1.04	167	165	41	0.04	8.8	19.8	No
	23/03/2022	6	Half full	-17.5	7.3	-139.3	9	0.78	116.1	104.9	579	0.56	15.4	17.6	No
Kogarah Golf Course	23/03/2022	Circular	Full	-23.2	7.4	55.2	68.4	5.61	500.2	477.3	2496	2.68	17.1	22.7	Yes
	23/03/2022	Long	Overflowing - Very full	-57.7	7.9	17.4	36.5	3.07	244.8	235.3	1225	1.26	3.8	22.9	Yes

	23/03/2022	Mangrove Pond	Full	-60.6	7.9	-141.7	10.9	0.88	183.4	169.7	919	0.93	24.3	21.1	Yes
	23/03/2022	Eastern	Full	-55.5	7.9	28.8	30.5	2.56	259.2	249	1296	1.34	11.6	22.9	Yes
	23/03/2022	Skinny	Not sampled												Yes
	23/03/2022	Northern	Not sampled												
Riverine Park and surrounds and Barton Park	23/03/2022	No.9 Pond	Not sampled												
	23/03/2022	Eastern Channel	Flooded	-17.3	7.2	-210.6	5	0.43	733	628	371	0.36	7.7	20.2	No
	23/03/2022	Southern Phragmites	Flooded	-20.4	7.3	-189.6	8	0.7	104.2	934	521	0.52	7.1	19.5	No
	23/03/2022	Northern Phragmites	Not sampled												
	23/03/2022	Bend Swamp	Flooded	-15.5	7.2	-197.4	4.4	0.37	610	573	395	0.37	5.6	20.1	No
	23/03/2022	Southern Jungle	Flooded	-18.2	7.3	-111.1	15.8	1.32	161.8	155.2	810	0.82	11.7	22.7	No
	23/03/2022	Landing Lights East	Flooded	-61.3	8	-74.4	19.6	1.61	188.5	177	941	0.95	10.6	21.7	Yes
	23/03/2022	Landing Lights West	Dry												
	23/03/2022	Driving Range Wetland	1/2 full	-42.4	7.2	127.1	11.8	0.97	246.9	230.3	1235	1.28	11.9	21.5	No

April 2022

Location	Date	Pond	General Condition	mVpH	pH	ORP [mV]	% Sat (DO%)	Diss. O2 [mg/l]	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	29/04/2022	A	Pond full	-31	7.5	47.3	23.3	2.16	135	119	67	0.06	4.1	18.8	No
	29/04/2022	B	Pond full	-25.2	7.4	61.6	34.5	3.15	120	105	60	0.06	11.3	18.7	No
	29/04/2022	C	Pond full	-19.6	7.3	20.4	16.7	1.54	286	254	143	0.14	1.4	19.1	No
RTA	29/04/2022	Western	Pond full	-75.4	8.3	-48.1	30.5	2.84	47	41	0	0	2.4	18.5	No
	29/04/2022	Eastern	Pond full	-36	7.6	4.7	9.2	0.8	95	82	48	0.04	3.6	17.5	No
Enhancement Area	29/04/2022	1	Dry												
	29/04/2022	2	Dry												
	29/04/2022	3	Dry												
	29/04/2022	4	Pond full	-11.5	7.1	35.8	16.1	1.53	185	168	98	0.09	14.7	17	No
	29/04/2022	5	Overgrown with grass	-53	7.8	-44.4	6	0.56	150	129	75	0.07	5.3	17.5	No
	29/04/2022	6	Pond full	-28.4	7.5	-26.9	3.4	0.31	916	79.5	461	0.46	20.8	17.8	No
Kogarah Golf Course	29/04/2022	Circular	Pond full	-18.4	7.3	-14.4	24.1	2.14	3795	3441	1907	2.03	118	19.9	Yes
	29/04/2022	Long	Pond full	-65.5	8.1	4.8	30.4	2.74	2884	2587	1428	1.51	5.8	19.6	Yes

	29/04/2022	Mangrove Pond	Pond full	-35.9	7.6	-248.9	3.2	0.29	2603	2310	1290	1.33	25.4	19.3	Yes
	29/04/2022	Eastern	Pond full	-66	8.1	11.3	23.5	2.14	2907	2594	1453	1.52	6.5	19.4	Yes
	29/04/2022	Skinny	Not sampled												
	29/04/2022	Northern	Not sampled												
Riverine Park and surrounds and Barton Park	29/04/2022	No.9 Pond	Not sampled												
	29/04/2022	Eastern Channel	Not sampled												
	29/04/2022	Southern Phragmites	Pond full	-28.4	7.5	-166.8	5.2	0.58	1207	1052	612	0.62	8.3	17.9	No
	29/04/2022	Northern Phragmites	Not sampled												
	29/04/2022	Bend Swamp	Pond full	-33	7.5	-196.1	4	0.35	858	744	430	0.42	5.7	18	No
	29/04/2022	Southern Jungle	Pond full	-25.2	7.4	-100.2	17.6	1.58	2055	1857	1051	1.06	21.5	18.7	No
	29/04/2022	Landing Lights East	Pond full	-65.3	8.1	-182.4	7.8	0.68	1988	1729	998	1.03	18.5	18	Yes
	29/04/2022	Landing Lights West	Dry												
	29/04/2022	Driving Range Wetland	Pond full	-36	7.5	-137.3	8.8	0.79	2113	1852	1036	1.09	19.3	19.2	No

May 2022

Location	Date	Pond	General Condition	mVpH	pH	ORP	DO %	Diss. O2 [mg/l]	Conduct [uS/cm]	Resist [ms/cm]	TDS ppm	Salinity (PSU)	Turbidity [FNU]	Temp [C°]	Gambusia
M8 Marsh Street habitat area	31/05/2022	A	Pond full	-18	7.26	176.6	28	2.95	119	88	59	0.06	1.9	11.32	No
	31/05/2022	B	1/2 full	-14.1	7.18	183	25.2	2.65	130	97	65	0.06	3.5	11.5	No
	31/05/2022	C	Pond full	-12.3	7.17	141.1	15	1.49	276	214	138	0.13	1.1	13.4	No
RTA	31/05/2022	Western	Pond full	-15.5	7.18	38.7	-15.1	2.11	111	89	381	0.21	8.5	11.7	No
	31/05/2022	Eastern	Pond full	-17.8	7.01	-16.2	11.2	1.58	186	152	410	0.08	4.3	11.5	No
Enhancement Area	31/05/2022	1	Dry												
	31/05/2022	2	Dry												
	31/05/2022	3	Dry												
	31/05/2022	4	Pond full	-15.7	7.22	33.1	37	4.11	150	111	79	0.07	667	9.4	No
	31/05/2022	5	Overgrown with grass	-34.1	7.56	-4.6	8.1	0.86	99	71	49	0.5	6	10.1	No
	31/05/2022	6	Pond full	-27.4	7.45	-72.9	9.2	0.95	1370	1022	688	0.7	15.3	11.71	No
Kogarah Golf Course	31/05/2022	Circular	Pond full	24.4	7.37	-118.1	15.2	1.33	5483	4517	2762	3.01	278	15.57	Yes
	31/05/2022	Long	Pond full	-51.8	7.87	-42.1	5.2	0.52	2779	2132	1391	1.45	2.5	12.71	Yes
	31/05/2022	Mangrove Pond	Pond full	-31	7.5	-156.1	7.6	0.6	41.57	35.11	20.71	26.63	19.1	17.02	No
	31/05/2022	Eastern	Pond full	-58.5	8.02	-28.4	50.3	5.18	2678	2024	1345	1.4	25.1	12.1	Yes
	31/05/2022	Skinny	Pond full	-39.2	7.63	-168.1	6.8	0.58	12.27	10.03	6150	7.1	15.6	15.3	No
	31/05/2022	Northern	Dry												

Riverine Park and surrounds and Barton Park	31/05/2022	No.9 Pond	Not sampled												
	31/05/2022	Eastern Channel	Pond full	537	7.94	-29.8	15.8	1.72	905	645	452	0.45	791	9.94	No
	31/05/2022	Southern Phragmites	Pond full	-72.1	8.25	5.4	66.4	6.81	728	562	365	0.36	13.7	12.97	No
	31/05/2022	Northern Phragmites	Not sampled												
	31/05/2022	Bend Swamp	Pond full	-72.1	8.25	5.4	66.4	6.81	728	562	365	0.36	13.7	12.97	No
	31/05/2022	Southern Jungle	Pond full	-50.1	7.84	-119.1	7.5	0.7	778	598	390	0.38	78.3	12.77	No
	31/05/2022	Landing Lights East	Pond full	-73.7	8.27	-274	15.1	1.56	14.39	1054	719	0.73	66.4	10.94	No
	31/05/2022	Landing Lights West	Dry												
	31/05/2022	Driving Range Wetland	Pond full	-29.3	7.47	-112.9	9.6	0.84	2292	1850	1147	1.19	165	14.77	No

Appendix B: Tadpole net sweep results

October 2021

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A			-	-	-	-
	B			-	-	-	-
	C			-	-	-	-
RTA Ponds	Western		*Limnodynastes peronii*	-	5	1	-
	Eastern			-	-	-	-
Enhancement Area	1	Dry		-	-	-	-
	2	Dry		-	-	-	-
	3	Dry		-	-	-	-
	4	Dry		-	-	-	-
	5	Dry		-	-	-	-
	6	Dry		-	-	-	-
Kogarah Golf Course	Circular			-	-	-	-
	Long			-	-	-	-
	Eastern			-	-	-	-
	Skinny	Not surveyed		-	-	-	-
	Northern	Dry		-	-	-	-
	Mangrove	Not surveyed		-	-	-	-
Riverine & Barton Park	No.9 Pond	Dry		-	-	-	-
	Eastern Channel	Dry		-	-	-	-
	Southern Phragmites	Dry		-	-	-	-
	Northern Phragmites	Dry		-	-	-	-
	Bend Swamp	Dry		-	-	-	-
	Southern Jungle	Dry		-	-	-	-
	Landing Lights East		*Limnodynastes peronii*	-	3	-	-
	Landing Lights West	Dry		-	-	-	-
	Driving Range Wetland	Dry		-	-	-	-

November 2021

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A			-	-	-	-
	B			-	-	-	-
	C	Not surveyed		-	-	-	-
RTA Ponds	Western	Not surveyed		-	-	-	-
	Eastern	Not surveyed		-	-	-	-
Enhancement Area	1	Dry		-	-	-	-
	2	Dry		-	-	-	-
	3	Dry		-	-	-	-
	4		*Limnodynastes peronii*	-	-	1	-
	5	Dry		-	-	-	-
	6	Dry		-	-	-	-
Kogarah Golf Course	Circular			-	-	-	-

	Long			-	-	-	-
	Eastern			-	-	-	-
	Skinny			-	-	-	-
	Northern			-	-	-	-
	Mangrove			-	-	-	-
Riverine & Barton Park	No.9 Pond	Dry		-	-	-	-
	Eastern Channel	Dry		-	-	-	-
	Southern Phragmites	Dry		-	-	-	-
	Northern Phragmites	Dry		-	-	-	-
	Bend Swamp	Dry		-	-	-	-
	Southern Jungle	Dry		-	-	-	-
	Landing Lights East			-	-	-	-
	Landing Lights West	Dry		-	-	-	-
	Driving Range Wetland	Dry		-	-	-	-

December 2021

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A		*Litoria aurea*	-	1	-	-
			Litoria peronii	-	1	-	-
	B			-	-	-	-
	C			-	-	-	-
RTA Ponds	Western			-	-	-	-
	Eastern			-	-	-	-
Enhancement Area	1			-	-	-	-
	2			-	-	-	-
	3			-	-	-	-
	4			-	-	-	-
	5			-	-	-	-
	6			-	-	-	-
Kogarah Golf Course	Circular			-	-	-	-
	Long			-	-	-	-
	Eastern			-	-	-	-
	Skinny	Not surveyed		-	-	-	-
	Northern	Not surveyed		-	-	-	-
	Mangrove			-	-	-	-
Riverine & Barton Park	No.9 Pond	Not surveyed		-	-	-	-
	Eastern Channel	Dry		-	-	-	-
	Southern Phragmites			-	-	-	-
	Northern Phragmites	Not surveyed		-	-	-	-
	Bend Swamp			-	-	-	-
	Southern Jungle	Too shallow to net		-	-	-	-
	Landing Lights East			-	-	-	-
	Landing Lights West	Dry		-	-	-	-
	Driving Range Wetland	Dry		-	-	-	-

January 2022

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A		*Litoria aurea*	-	2	-	-
			Litoria peronii	-	6	-	-

	B		*Litoria peronii*	-	2	-	-
	C		*Litoria peronii*	-	18	-	-
RTA Ponds	Western			-	2	-	-
	Eastern			-	3	-	-
Enhancement Area	1	Dry		-	-	-	-
	2	Too shallow to net		-	-	-	-
	3	Too shallow to net		-	-	-	-
	4		*Limnodynastes peronii*	-	14	-	-
	5	Too shallow to net		-	-	-	-
	6			-	-	-	-
Kogarah Golf Course	Circular			-	-	-	-
	Long			-	-	-	-
	Eastern			-	-	-	-
	Skinny	Not surveyed		-	-	-	-
	Northern	Not surveyed		-	-	-	-
	Mangrove			-	-	-	-
Riverine & Barton Park	No.9 Pond	Not surveyed		-	-	-	-
	Eastern Channel	Dry		-	-	-	-
	Southern Phragmites			-	-	-	-
	Northern Phragmites	Not surveyed		-	-	-	-
	Bend Swamp			-	-	-	-
	Southern Jungle	Almost dry		-	-	-	-
	Landing Lights East	Dry		-	-	-	-
	Landing Lights West			-	-	-	-
	Driving Range Wetland	Dry		-	-	-	-

February 2022

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A		*Litoria peronii*	-	9	-	-
	B			-	-	-	-
	C		*Litoria peronii*	-	-	1	-
RTA Ponds	Western			-	-	-	-
	Eastern			-	-	1	-
Enhancement Area	1	Dry		-	-	-	-
	2	Dry		-	-	-	-
	3	Dry		-	-	-	-
	4	Recently filled	*Limnodynastes peronii*	-	1	1	-
	5	Dry - Overgrown		-	-	-	-
	6	Dry		-	-	-	-
Kogarah Golf Course	Circular			-	-	-	-
	Long			-	-	-	-
	Eastern			-	-	-	-
	Skinny	Not surveyed		-	-	-	-
	Northern	Not surveyed		-	-	-	-
	Mangrove			-	-	-	-
Riverine & Barton Park	No.9 Pond	Not surveyed		-	-	-	-
	Eastern Channel	Dry		-	-	-	-

	Southern Phragmites	Dry		-	-	-	-
	Northern Phragmites	Not surveyed		-	-	-	-
	Bend Swamp	Dry		-	-	-	-
	Southern Jungle	Dry		-	-	-	-
	Landing Lights East			-	-	-	-
	Landing Lights West	Dry		-	-	-	-
	Driving Range Wetland	Dry		-	-	-	-

March 2022

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A	Full		-	-	-	-
	B	Full		-	-	-	-
	C	Full		-	-	-	-
RTA Ponds	Western	Full	*Litoria peronii*	-	3	1	-
			Limnodynastes peronii		1		
	Eastern	Full		-	-	-	-
Enhancement Area	1	Dry		-	-	-	-
	2	Dry		-	-	-	-
	3	Dry		-	-	-	-
	4	Full	*Limnodynastes peronii*	-	7	1	-
	5	Too shallow to net		-	-	-	-
	6	Half full	*Limnodynastes peronii*	-	6	-	-
Kogarah Golf Course	Circular	Full		-	-	-	-
	Long	Full		-	-	-	-
	Eastern	Full		-	-	-	-
	Skinny	Not surveyed		-	-	-	-
	Northern	Not surveyed		-	-	-	-
	Mangrove	Full		-	-	-	-
Riverine & Barton Park	No.9 Pond			-	-	-	-
	Eastern Channel		*Litoria peronii*	-	2	-	-
	Southern Phragmites	Flooded, joined to Northern Phragmites	*Litoria peronii*	-	7	-	-
	Northern Phragmites	Flooded, joined to Southern Phragmites		-	-	-	-
	Bend Swamp	Full	*Limnodynastes peronii*	-	20+	-	-
	Southern Jungle	Full	*Limnodynastes peronii*	-	20+	-	-
	Landing Lights East	Flooded	*Limnodynastes peronii*	-	4	-	-
	Landing Lights West	Dry		-	-	-	-
	Driving Range Wetland	Half full	*Limnodynastes peronii*	-	20+	-	-

April 2022

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A	Full		-	-	-	-
	B	Full	*Litoria peronii*	-	1	-	-
			Limnodynastes peronii	-	2	-	-
	C	Full		-	-	-	-
RTA Ponds	Western	Full	*Litoria peronii*	-	1	-	-
			Limnodynastes peronii	-	1	-	-
	Eastern	Full		-	1	-	-
Enhancement Area	1	Dry		-	-	-	-
	2	Dry		-	-	-	-
	3	Dry		-	-	-	-
	4	Full	*Limnodynastes peronii*	-	20 +	-	-
	5	Full - overgrown		-	3	-	-
	6	Full	*Limnodynastes peronii*	-	12	-	-
Kogarah Golf Course	Circular	Full		-	-	-	-
	Long	Full		-	-	-	-
	Eastern	Full		-	-	-	-
	Skinny	Not surveyed		-	-	-	-
	Northern	Not surveyed		-	-	-	-
	Mangrove	Full		-	-	-	-
Riverine & Barton Park	No.9 Pond	Not surveyed		-	-	-	-
	Eastern Channel		*Limnodynastes peronii*	-	6	-	-
	Southern Phragmites	Full	*Limnodynastes peronii*	-	20 +	10 +	-
	Northern Phragmites	Full		-	-	-	-
	Bend Swamp	Full	*Limnodynastes peronii*	-	20 +	10 +	-
	Southern Jungle	Full	*Limnodynastes peronii*	-	12	-	-
	Landing Lights East	Full	*Limnodynastes peronii*	-	-	-	-
	Landing Lights West	Dry		-	-	-	-
	Driving Range Wetland	3/4 Full	*Limnodynastes peronii*	-	3	-	-

May 2022

Area	Pond	Pond status	Species	Number and Stage			
				A	B	C	D
M8 Marsh Street habitat area	A			-	-	-	-
	B			-	-	-	-
	C			-	-	-	-
RTA Ponds	Western			-	-	-	-
	Eastern			-	-	-	-
Enhancement Area	1			-	-	-	-
	2			-	-	-	-
	3			-	-	-	-

	4		*Limnodynastes peronii*	23 +	26 +	-	-
	5		*Limnodynastes peronii*	1	16	-	-
	6		*Limnodynastes peronii*	-	2	-	-
Kogarah Golf Course	Circular			-	-	-	-
	Long			-	-	-	-
	Eastern			-	-	-	-
	Skinny			-	-	-	-
	Northern			-	-	-	-
	Mangrove			-	-	-	-
Riverine & Barton Park	No.9 Pond			-	-	-	-
	Eastern Channel		*Limnodynastes peronii*	-	7	-	-
	Southern Phragmites			-	-	-	-
	Northern Phragmites			-	-	-	-
	Bend Swamp			-	-	-	-
	Southern Jungle			-	-	-	-
	Landing Lights East			-	-	-	-
	Landing Lights West			-	-	-	-
	Driving Range Wetland			-	-	-	-

Appendix C: Frog monitoring data for sites outside the M8 Marsh Street habitat area

November 2021

Area	Pond	Frogs Present	Species	Number	Comment
Underpass	Creek (west)	Yes	*Limnodynastes peronii*	9	Observed
	Creek (east)	Yes	*Limnodynastes peronii*	8	3 calling and 5 observed
	Underpass	No			
RTA Ponds	Western	Yes	*Litoria peronii*	5	Call play back
			Litoria fallax	10	Call play back
			Limnodynastes peronii	3	Call play back
	Eastern	Yes	*Limnodynastes peronii*	2	Call play back
			Limnodynastes dumerilli	3	Call play back
			Crinia signifera	10	Call play back
			Litoria aurea	4	Call play back
Enhancement Area	6	Yes	*Limnodynastes peronii*	3	Observed
	5	No			
	4	Yes	*Limnodynastes peronii*	1	Call play back
	3	No			
	2	No			
	1	No			
	Creek	Yes	*Limnodynastes peronii*	20	Observed
			Litoria peronii	3	Observed
			Crinea signifera	1	Heard
Kogarah Golf Course	Circular	Yes	*Litoria aurea*	3	2 Heard 1 captured and microchipped
			Litoria peronii	1	Observed
	Long	Yes	*Litoria aurea*	1	Observed – not caught
	Skinny	Yes	*Litoria aurea*	1	Observed – not caught
	Northern	Not surveyed			
	Mangrove Pond	No			
Riverine & Barton Park	No.9 Pond	No			
	Eastern Channel	No			
	Southern Phragmites	No			
	Northern Phragmites	No			
	Bend Swamp	Yes	*Limnodynastes peronii*	1	
	Southern Jungle	Yes	*Limnodynastes peronii*	40	Call play back
			Litoria peronii	1	
	Landing Lights East	No			
	Landing Lights West	Yes	*Litoria aurea*	1	Captured and microchipped
	Driving Range Wetland	No			

January 2022

Area	Pond	Frogs Present	Species	Number	Comment
Underpass	Creek (west)	Yes	*Litoria aurea*	1	Observed not captured
	Creek (east)	No			
	Underpass	No			
RTA Ponds	Western	Yes	*Litoria peronii*	11	7 Call Play back - 4 observed
			Litoria fallax	5	4 Call Play back - 1 observed
			Crinia signifera	2	Call play back
	Eastern	Yes	*Litoria peronii*	2	Call play back
			Litoria fallax	3	Call play back
	6	No			

Area	Pond	Frogs Present	Species	Number	Comment
Enhancement Area	5	Yes	*Litoria peronii*	2	Call play back
	4	Yes	*Limnodynastes peronii*	2	Call play back
	3	No			
	2	No			
	1	No			
	Creek	Yes	*Litoria aurea*	2	Observed not captured; 1 adjacent to pond 5; 1 between pond 2 and 3
			Limnodynastes peronii	5	Observed
Kogarah Golf Course	Circular	Yes	*Litoria fallax*	1	
	Eastern	No			
	Long	No			
	Skinny	Yes	*Limnodynastes peronii*	1	
	Northern	Not surveyed			
	Mangrove Pond	No			
Riverine & Barton Park	No.9 Pond	Not surveyed			
	Eastern Channel	No			
	Southern Phragmites	Yes	*Limnodynastes peronii*	2	1 Heard 1 observed
	Northern Phragmites	No			
	Bend Swamp	No			
	Southern Jungle	No			
	Landing Lights East	No			
	Landing Lights West	No			
	Driving Range Wetland	No			

March 2022

Area	Pond	Frogs Present	Species	Number	Comment
Underpass	Creek (west)	Yes	*Limnodynastes peronii*	3	
	Underpass	Yes	*Litoria peronii*	1	Observed
			Limnodynastes peronii	1	Observed
	Creek (east)	No			
RTA Ponds	Western	Yes	*Litoria fallax*	7	6 Call playback 1 observed
			Litoria peronii	1	Observed
			Crinia signifera	22	Call playback
	Eastern	Yes	*Crinia signifera*	4	Heard
Enhancement Area	6	Yes	*Limnodynastes peronii*	100	Tadpoles
			Litoria peronii	1	Observed
	5	No			
	4	Yes	*Limnodynastes peronii*	30	10 heard 20 tadpoles observed
	3	Yes	*Limnodynastes peronii*	1	Observed
	2	No			
	1	No			
Kogarah Golf Course	Circular	No			
	Eastern	No			
	Long	No			
	Skinny	No			
	Northern	Yes	*Limnodynastes peronii*	3	2 observed 1 heard
	Mangrove Pond	Yes	*Limnodynastes peronii*	2	Heard
Riverine & Barton Park	No.9 Pond	Not surveyed			
	Eastern Channel	Yes	*Limnodynastes peronii*	10	7 heard 3 observed; thousands of young tadpoles
	Southern Phragmites	No			
	Northern Phragmites	No			
	Bend Swamp	No			

Area	Pond	Frogs Present	Species	Number	Comment
	Southern Jungle	Yes	*Limnodynastes peronii*	30+	Heard
	Landing Lights East	Yes	*Limnodynastes peronii*	102+	2 observed, 100+ heard
	Landing Lights West	Yes	*Limnodynastes peronii*	1	Observed
	Driving Range Wetland	Yes	*Limnodynastes peronii*	4	Observed

April 2022

Area	Pond	Frogs Present	Species	Number	Comment
Underpass	Creek (west)	Yes	*Litoria aurea*	1	Captured and microchipped
	Underpass	Yes	*Litoria peronii*	1	Observed
			Limnodynastes peronii	1	Observed
	Creek (east)	Yes	*Limnodynastes peronii*	1	Observed
RTA Ponds	Western	Yes	*Crinia signifera*	10	Call playback
			Litoria peronii	2	Observed
			Litoria fallax	1	Observed
	Eastern	Yes	*Crinia signifera*	10	Call playback
Enhancement Area	6		*Litoria peronii*	1	Observed
			Limnodynastes peronii	6	4 heard 2 observed
			Crinia signifera	1	Heard
	5	No			
	4	No			
	3	Yes	*Limnodynastes peronii*	1	Observed
	2	Yes	*Crinia signifera*	1	Heard
	1	Yes	*Limnodynastes peronii*	1	Observed
	Creek	Yes	*Limnodynastes peronii*	8	Observed
			Litoria aurea	1	Captured, juvenile not microchipped
Kogarah Golf Course	Circular	Yes	*Limnodynastes peronii*	1	Observed
	Eastern	No			
	Long	Yes	*Litoria aurea*	2	Captured and microchipped
			Limnodynastes peronii	1	Heard
	Skinny	Yes	*Litoria aurea*	1	Captured and microchipped
	Northern	Not surveyed			
	Mangrove Pond	Yes	*Limnodynastes peronii*	2	Observed
Riverine & Barton Park	No.9 Pond	Not surveyed			
	Eastern Channel	Yes	*Limnodynastes peronii*	18	Heard
	Southern Phragmites	Yes	*Limnodynastes peronii*	6	1 observed 5 heard
	Northern Phragmites	Not surveyed			
	Bend Swamp	Yes	*Limnodynastes peronii*	2	1 observed 1 heard
	Southern Jungle	Yes	*Limnodynastes peronii*	3	3 adults; 2 heard 1 observed; thousands of tadpoles present
	Landing Lights East	Yes	*Limnodynastes peronii*	40+	Heard
	Landing Lights West	No			
	Driving Range Wetland	Yes	*Limnodynastes peronii*	19	4 observed 15 heard

May 2022

Area	Pond	Frogs Present	Species	Number	Comment
Underpass	Creek (west)	Not surveyed			
	Underpass	Not surveyed			

Area	Pond	Frogs Present	Species	Number	Comment
	Creek (east)	Not surveyed			
RTA Ponds	Western	No			
	Eastern	No			
Enhancement Area	6	No			
	5	No			
	4	No			
	3	No			
	2	No			
	1	No			
Kogarah Golf Course	Circular	No			
	Eastern	No			
	Long	Yes	*Litoria aurea*	2	Captured and microchipped
	Skinny	Yes	*Litoria aurea*	2	Captured and microchipped
	Northern	Not surveyed			
	Mangrove Pond	No			
Riverine & Barton Park	No.9 Pond	Not surveyed			
	Eastern Channel	Not surveyed			
	Southern Phragmites	Not surveyed			
	Northern Phragmites	Not surveyed			
	Bend Swamp	Not surveyed			
	Southern Jungle	Not surveyed			
	Landing Lights East	Not surveyed			
	Landing Lights West	Not surveyed			
	Driving Range Wetland	Not surveyed			