Appendix 2

2015 Abel Underground Coal Mine Dam Monitoring and Management Survey*

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*Note: A copy of this Appendix is available on the Project CD

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2015 Abel Underground Coal Mine Dam Monitoring and Management Survey

Yancoal Australia Pty Ltd

Abel Underground Coal Mine, Beresfield, NSW

January 2016

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2015 Abel Underground Coal Mine Dam Monitoring and Management Survey

Abel Underground Coal Mine, Beresfield, NSW

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EXECUTIVE SUMMARY

Donaldson Coal Pty Ltd commenced operating Abel Underground Coalmine at Beresfield in the lower Hunter Valley, New South Wales, during 2008. To comply with part of the conditions of consent a Flora and Fauna Management Plan was prepared (Ecobiological 2007). This identified the need to establish a Surface Ecological Monitoring Plan (SEMP), comprised of several different monitoring programs. This Dam Monitoring and Management Plan (DMMP) is one of the monitoring programs.

In 2008, baseline ecological data was recorded at 156 dams in the Abel underground mine area (Ecobiological 2008). As well, assessment of the habitat value of dam sites for threatened fauna and flora was undertaken so that future monitoring could target dams which exhibited habitat that may potentially support target threatened species. This report builds on the baseline information collected in previous surveys regarding the occurrence of threatened and non-threatened species at the targeted dams.

Over time, the number of participants (land holders) with surveyed dams has declined due to a range of factors including lack of interest and changing ownership. In 2015, only 49 dams were surveyed for amphibians out of a possible 66 dams surveyed in 2008, only two out of the four dams were surveyed for Blue-billed Duck, and only 57 dams out of the original 87 were surveyed for Maundia triglochinoides*.*

Species diversity and composition data for frogs, in addition to abundance for water-dependent bird species, were recorded at each of the targeted dams for the 2015 survey. These data provide a means of measurement and evaluation of potential subsidence impacts at each of the dams over time. The data collected over the last eight years will enable evaluation of potential subsidence impacts in the future.

At the time of the 2015 surveys, mining is taking place below several of the dams. Subsidence has been detected at least two of the surveyed dams. As such, the data compiled in previous reports are considered to be a continuation of sampling under baseline conditions. Depending on the extent of mine development, future surveys will need to examine data for changes in baseline ecological conditions that could be attributed mine impacts.

No frog species listed as threatened under State or Commonwealth legislation were recorded during field surveys. A total of eight species of frog were detected across all dams during 2015 surveys. There has still been a general pattern of decline in total species recorded since 2011.

There is a negative correlation between the mean number of frog species per dam and average temperature in the three months preceding the survey, there is, however, no correlation between total rainfall during these months and number of frog species recorded. Temperature, or some other factor, and not rainfall, is possibly the limiting factor for frog diversity in the area.

The Blue-billed Duck was not detected during 2015 surveys. A total of 61 bird species, including 23 waterbirds and 38 woodland/forest birds have been recorded between 2008 and 2015 across all of the dams surveyed. The 2015 surveys detected 37 species (9 waterbirds and 28 woodland/forest birds) across the two dams. Waterbird diversity and abundance at both dams has been relatively constant over the survey years. The number of woodland/forest bird species was the highest recorded in 2015. These results suggest that activity at the Abel underground mine has not had a negative impact on bird diversity at either of these dams.

The Grey-crowned Babbler, listed as Vulnerable under the TSC Act. A group of 6 individuals were observed foraging and tending to a nest in a Paperbark (Melaleuca spp.) overhanging Dam 7 at the SW end.

No individuals of the threatened plant, Maundia triglochinoides *were identified. However* Eichhornia crassipes, *(water hyacinth) a Class 3 listed noxious aquatic weed was idenitified in 10 dams. Additionally,* Lycium ferocissium *(African Boxthorn) and* Cortadeia sellaona *(Pampas Grass) – also Class 3 listed weeds - were observed at one dam each.*

Monitoring will continue until one year after mining has passed the Long Gully and Blue Gum Creek catchments. The information and management recommendations from these and other surface monitoring studies will then be available to inform best practice measures to be incorporated into the Subsidence Management Plan (SMP).

Surveys of water quality, water level, conditions and habitat suitability assessment at each dam, particularly those which have not yet been undermined are strongly recommended. These data will be important for differentiating mining impacts from other factors that effect the composition and abundance of frog and water bird species at the target dams.

Contents

EXECUTIVE SUMMARY II

1. INTRODUCTION 1

2. LOCATION 3

3. OBJECTIVES 5

4. METHODS 8

4.1 AMPHIBIANS 8

4.1.1 Green and Golden Bell Frog (*Litoria aurea*) 8

4.1.2 Green-thighed Frog (*Litoria brevipalmata*) 8

4.2 BIRDS 9

4.2.1 Blue-billed Duck (*Oxyura australis*) 9

4.2.2 Weather Conditions during Fauna Survey Period 10

4.3 FLORA 10

4.3.1 Maundia triglochinoides 10

5. RESULTS 11

5.1 AMPHIBIANS 11

5.2 . BIRDS 14

5.3 FLORA 17

6. DISCUSSION 18

6.1 AMPHIBIANS 18

6.1.1 Green and Golden Bell Frog 18

6.1.2 Green-thighed Frog 19

6.1.3 Non-threatened Frogs 19

6.2 BIRDS 21

6.3 FLORA 22

7. CONCLUSION 23

8. RECOMMENDATIONS 25

9. REFERENCES 26

Tables

Table 1: Species targeted by the Dam Monitoring and Management Plan..... 5
Table 2: Species targeted by the Dam Monitoring and Management Plan in 2015 5
Table 3: Weather during the fauna survey period (Maitland Visitors Centre) 10

Figures

Figure 1: The location of the Abel Underground mine area and surface facilities..... 4
Figure 2: The Abel Mine area showing the layout of dams surveyed in 2015 with corresponding habitat classes. 6
Figure 3: The Abel Mine area showing the layout of dams excluded from surveys in 2015 with corresponding habitat classes. 7
Figure 4: Total number of species detected across all ponds each year. 11
Figure 5: Frequency distributions of the numbers of frog species recorded across all dams for each of the survey years 2008 – 2015. 12
Figure 6: Relationship between mean temperature (Oct-Dec; °C) and the mean number of frog species per dam (source: Maitland Visitors Centre). 14
Figure 7: Relationship between total rainfall (Oct-Dec; mm) and the mean number of frog species per dam (source: Maitland Visitors Centre). 14
Figure 8: Number of bird waterbird and woodland bird species recorded at each dam 2008-2015. 16
Figure 9: Total number of individual water and woodland birds recorded at each dam 2008-2015. 16

Appendices

Appendix 1. Target species profiles
Appendix 2. Suitability of habitat at target dams
Appendix 3. Amphibian species recorded in each dam surveyed
Appendix 4. Bird species abundance at target dams 2015
Appendix 5. Contributions and qualifications of Kleinfelder staff
Appendix 6. Licensing
Appendix 7. Photos

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1. INTRODUCTION

Donaldson Coal Pty Ltd (Donaldson) commenced operations at Abel Underground Mine in 2008. The seams to be mined are located under the Black Hill rural and adjoining forested areas. Mine access and associated surface infrastructure are located within the existing Donaldson Coal mine open cut void at Beresfield, approximately 23 kilometres north-west of Newcastle, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) to the north for coal washing and rail transport to the Port of Newcastle. The mine will extract up to 4.5 million tonnes per year over 21 years using high productivity continuous miner based bord and pillar systems, and pillar extraction techniques.

Underground coal mining is often associated with adverse environmental impacts because of subsidence (Bell *et al*. 2000, Sidle *et al*. 2000). Subsidence can cause loss of productive land, damage to underground pipelines and above-ground structures, decreased stability of slopes and escarpments, contamination of groundwater by acid drainage and dewatering of streams and groundwater supplies (Sidle *et al*. 2000). Of these, one of the major environmental concerns arising from the Abel mine is the effect of subsidence on local and regional hydrology. Surface and sub-surface cracking associated with mining subsidence can alter and create preferential flow paths, thus causing dewatering and rerouting of surface water and groundwater (Sidle *et al*. 2000). Alterations in channel and drainage morphology may also affect channel erosion, sediment delivery, and routing in streams and riparian habitat.

Associated with development approval for the Abel coalmine were a number of conditions of consent. These conditions included a requirement for the preparation of a Flora and Fauna Management Plan (F & FMP) which was prepared by Ecobiological (2007). The F & FMP, which forms part of a comprehensive Environmental Management System for the Abel mine, sets out a strategy to monitor the effectiveness of the conservation measures proposed in the Environmental Assessment (EA) Statement of Commitments for the overall operation of the mine.

Part of this strategy was to establish a Surface Ecological Monitoring Plan (SEMP) to monitor the effectiveness of the conservation measures proposed in the EA to mitigate against subsidence impacts on three distinct habitat areas; farm dams that form a belt across the mine site; subtropical rainforest areas of Long Gully Creek; and Pambalong Nature Reserve. The SEMP outlines a monitoring program for each of these areas by which baseline and

subsequent monitoring data are to be gathered to inform future management. This report builds upon the baseline report for the Dam Monitoring and Management Program (DMMP) which forms part of the overall SEMP.

The Dam Monitoring and Management Plan (DMMP) gathered data for 156 dams in 2008, all of which are located above the Abel underground mining area. In 2009, the number of dams identified for longer-term monitoring was reduced to 84, following assessment of their habitat suitability for the threatened Green and Golden Bell Frog (*Litoria aurea*), Green-thighed Frog (*Litoria brevipalmata*), Blue-billed Duck (*Oxyura australis*) and the aquatic plant *Maundia triglochinoides*. Preferred habitat of each is detailed in **Appendix 1**.

Over time, the number of participants (land holders) with surveyed dams has declined due to a range of factors including lack of interest and changing ownership. Sixty-four (64) dams with suitable Green and Golden Bell Frog habitat were surveyed for this species in 2008 and 2009, 61 dams in 2010 and 2011, 65 in 2012 and 2013, and 49 in 2014. Thus fluctuations of surveyed dams are largely a result of private landholders preventing access to their land.

Eighty-seven (87) dams were originally assessed as containing suitable habitat for the aquatic plant *M. triglochinoides*, but with knowledge gained from past surveys this number has been reduced; only 57 dams were surveyed in 2015.

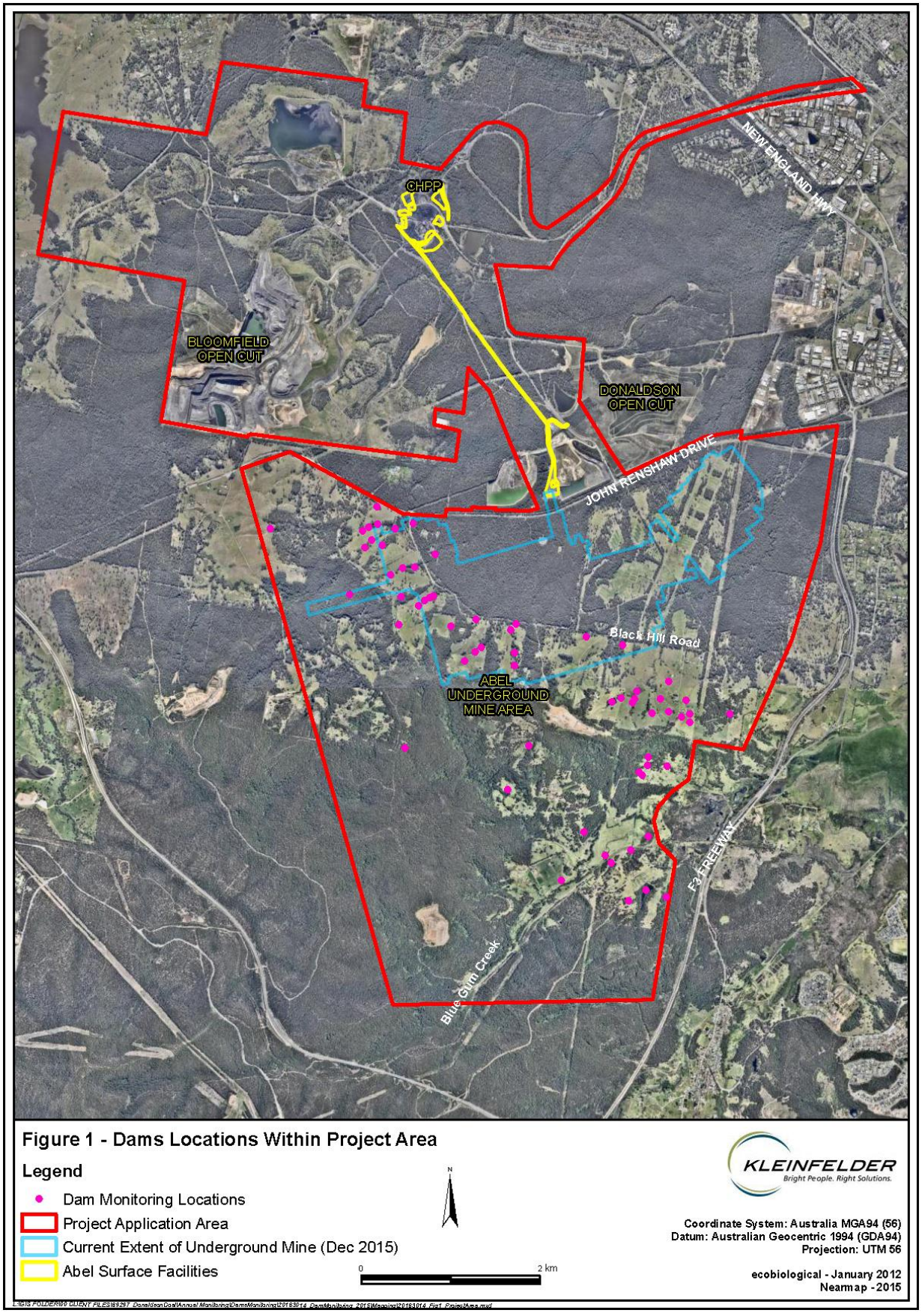
Species diversity, abundance and composition data for water-dependent bird species at four of the dams containing preferred habitat have historically been recorded since 2008, however only two dams were surveyed in 2015 due to lack of access. These data provide a means of measurement and evaluation of potential subsidence impacts at each of the dams over time to later be incorporated into the SMP.

2. LOCATION

The Abel Underground Mine is located within Newcastle, Cessnock and Maitland local government areas (LGAs). The majority of the underground mine and surface infrastructure area is within the Cessnock LGA.

The location of the underground mine area, surface facilities and the current extent of the underground mine are shown in **Figure 1**. The underground mine area is bounded on the eastern side by the F3 Freeway; the western and southern sides by a tract of forest that extends south to the Central Coast and beyond to Hornsby and to the northern side by existing open cut coal mining activities within the Donaldson and Bloomfield mine leases.

The Abel underground mine area is approximately 2750 ha and consists of low undulating forested hills with patches of cleared land for 110 rural/residential properties. Approximately 175 farm dams are located above the underground mining area, scattered across these various properties. Large areas of land are owned by Donaldson Coal, Coal and Allied (Rio Tinto) and the Catholic Diocese of Maitland and Newcastle. Black Hill Public School, various local roads and other infrastructure are located in the area.


CHPP
NEW ENGLAND HWY
BLOOMFIELD OPEN CUT
DONALDSON OPEN CUT
JOHN RENSHAW DRIVE
Black Hill Road
ABEL UNDERGROUND MINE AREA
F3 FREEWAY
Blue Grim Creek
Figure 1 - Dams Locations Within Project Area
Legend
Dam Monitoring Locations
Project Application Area
Current Extent of Underground Mine (Dec 2015)
Abel Surface Facilities
N
0
2 km
KLEINFELDER
Bright People. Right Solutions.
Coordinate System: Australia MGA94 (56)
Datum: Australian Geocentric 1994 (GDA94)
Projection: UTM 56
ecobiological - January 2012
Nearmap - 2015

3. OBJECTIVES

The Abel EA submission notes that the 175 dams located above the underground mining area are vulnerable to subsidence impacts such as cracking or tilting with significant water loss as a result. The DMMP aims to develop a set of data for 87 of these dams (**Appendix 2**) focusing on sensitive flora and fauna (targeting threatened species), species diversity, composition and abundance to inform the SMP. **Figure 2** shows the location of the accessible dams across the mine area in 2014 as well as other significant surface features. **Figure 3** shows the dams not accessible in 2014 due to landowner disinterest.

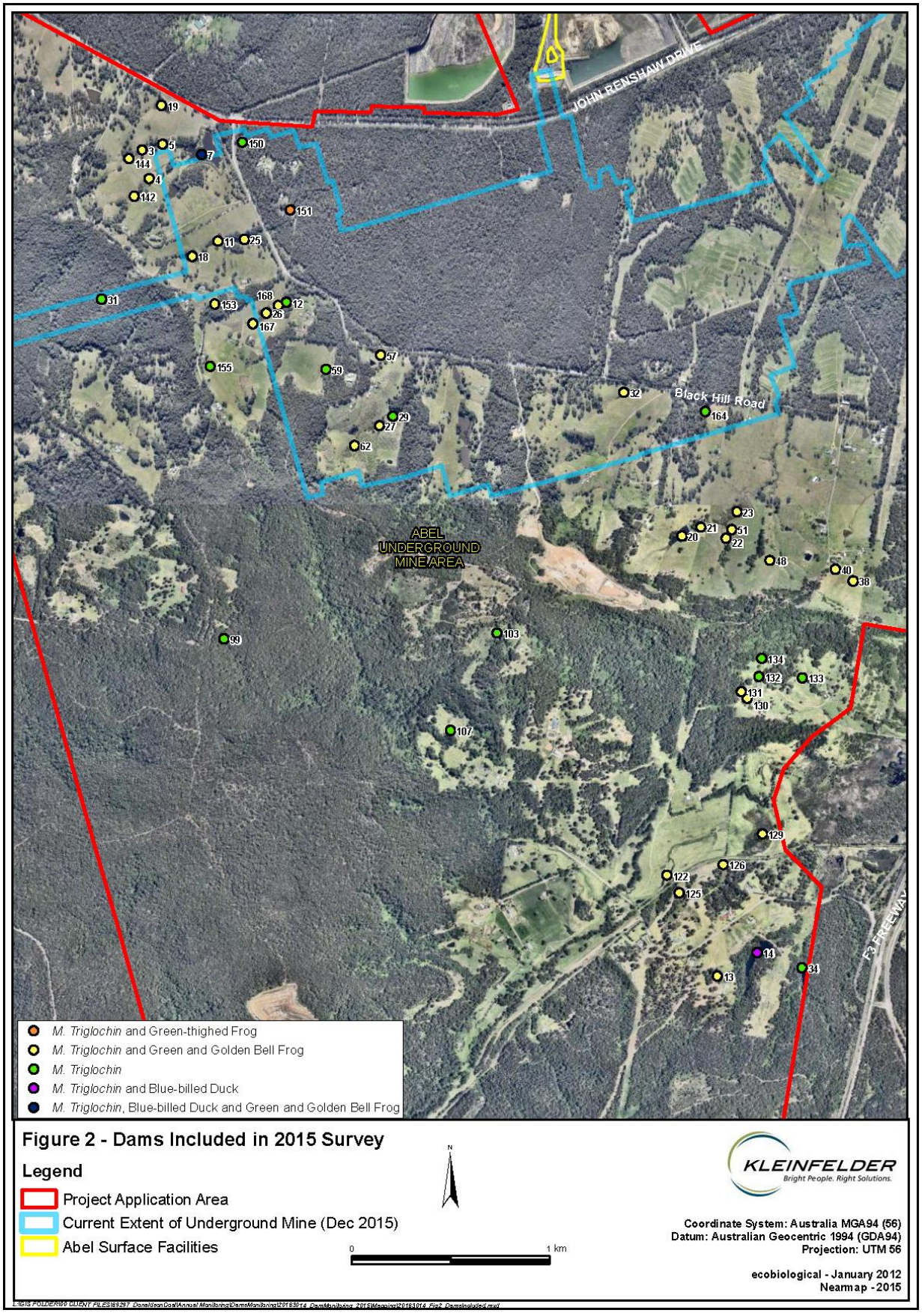
Table 1 sets out the target threatened species, appropriate methods and monitoring times as outlined in the F & FMP.

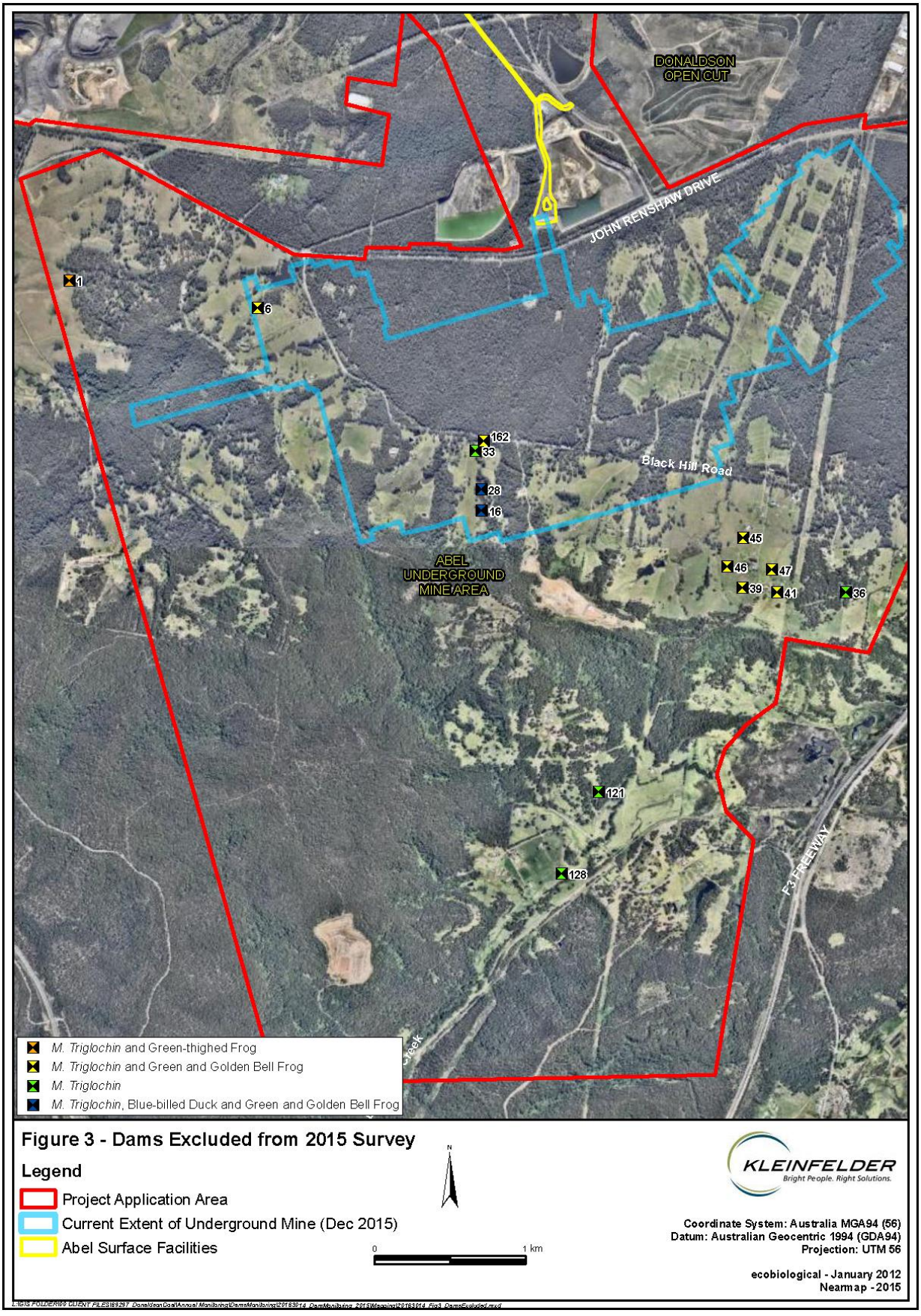
Table 1: Species targeted by the Dam Monitoring and Management Plan.

Scientific name	Common Name	Method	No. of Dams	Monitoring Period
Litoria aurea	Green and Golden Bell Frog	Call playback and targeted search	64	Warm nights during or after rain (October – February)
Litoria brevipalmata	Green-thighed Frog	Targeted search	3	Warm nights after heavy rain (October – February)
Oxyura australis	Blue-billed Duck	Targeted search	4	Summer
Maundia triglochinoides	-	Targeted search	87	Late spring to early autumn

Table 2: Species targeted by the Dam Monitoring and Management Plan in 2015

Scientific name	Common Name	Method	No. of Dams	Monitoring Period
Litoria aurea	Green and Golden Bell Frog	Call playback and targeted search	49	Warm nights during or after rain (October – February)
Litoria brevipalmata	Green-thighed Frog	Targeted search	2	Warm nights after heavy rain (October – February)
Oxyura australis	Blue-billed Duck	Targeted search	2	Summer
Maundia triglochinoides	-	Targeted search	57	Late spring to early autumn


JOHN RENSHAW DRIVE
Black Hill Road
ABEL UNDERGROUND MINE AREA
M. Triglochin and Green-thighed Frog
M. Triglochin and Green and Golden Bell Frog
M. Triglochin
M. Triglochin and Blue-billed Duck
M. Triglochin, Blue-billed Duck and Green and Golden Bell Frog
Figure 2 - Dams Included in 2015 Survey
Legend
Project Application Area
Current Extent of Underground Mine (Dec 2015)
Abel Surface Facilities
0
1 km
KLEINFELDER
Bright People. Right Solutions.
Coordinate System: Australia MGA94 (56)
Datum: Australian Geocentric 1994 (GDA94)
Projection: UTM 56
ecobiological - January 2012
Nearmap - 2015


DONALDSON OPEN CUT
JOHN RENSHAW DRIVE
Black Hill Road
ABEL UNDERGROUND MINE AREA
F3 FREEWAY
1
6
162
33
28
16
45
46
47
39
41
36
121
128
M. Triglochin and Green-thighed Frog
M. Triglochin and Green and Golden Bell Frog
M. Triglochin
M. Triglochin, Blue-billed Duck and Green and Golden Bell Frog
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Project Application Area
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Datum: Australian Geocentric 1994 (GDA94)
Projection: UTM 56
ecobiological - January 2012
Nearmap - 2015

4. METHODS

4.1 AMPHIBIANS

4.1.1 Green and Golden Bell Frog (*Litoria aurea*)

Sixty-four (64) dams with suitable Green and Golden Bell Frog habitat were surveyed for this species in 2008 and 2009, 61 dams in 2010 and 2011, 65 in 2012 and 2013, 50 in 2014, and 49 in 2015. Fluctuations of surveyed dams are a result of private landholders preventing access to their land.

Surveys were conducted on the 14 – 17 December 2015. Although numbers of available dams had dropped since 2013, the 49 dams surveyed in 2015 were located where underground mining is currently occurring and areas where mining will occur in the future. As such, the dams surveyed were considered to be suitably representative of the total dams present and provided the best practicable opportunity of detecting the Green and Golden Bell Frog.

Both targeted habitat surveys and call playback surveys were conducted throughout the survey period. At each dam an initial two minute quiet listening period was carried out to see if any Green and Golden Bell Frogs were calling and to record any other common species heard. This was followed by 10 minutes of call playback and 10 minutes of habitat searching. During call playback, pre-recorded calls of the Green and Golden Bell Frog were broadcast over a megaphone to attempt to illicit a response from any males that may have been present.

The call playback period consisted of 1 minute of playing the calls followed by 20 seconds of quiet listening, repeated until the 10 minute period was complete. The habitat searches consisted of searching suitable habitat with the aid of a head-torch to locate any adults or juveniles. All other frog species observed were also recorded.

Weather conditions during the survey period are described below in **Table 3**.

4.1.2 Green-thighed Frog (*Litoria brevipalmata*)

Three (3) dams were deemed potentially suitable for the Green-thighed Frog, however only two dams were available in 2015. Dam 87 and Dam 151 were surveyed for this species on 14 January and 15 January, respectively. Access could not be gained for Dam 1.

Surveys are required to be completed after heavy rainfall during the breeding season (November -February) (DECC 2009). A rainfall event occurred on the 10 January of 9.2 mm followed by 30.4 mm on the 11 January (Maitland weather station; Bureau of Meteorology, 2015). Weather conditions during the survey period area described below in **Table 3**.

Quiet listening and a habitat search were carried out for the Green-thighed Frog at each dam. The species only calls on a small number of nights (usually <5) in any given season and only after significant rainfall (usually 70mm). It does not readily respond to call playback. The habitat search consisted of searching suitable habitat with the aid of a head-torch to locate any adults or juveniles.

4.2 BIRDS

4.2.1 Blue-billed Duck (*Oxyura australis*)

Two dams (Dams 7 and 14) were surveyed for the Blue-billed Duck on the 8 January 2015. Dams 16 and 28 could not be surveyed due to private landholders withholding access. Originally only four dams were considered to have suitable habitat for the Blue-billed Duck. The surveyed dams were chosen based on their size (with only large dams usually being inhabited by the species), the amount of deep, open water and the amount of fringing aquatic vegetation present.

Targeted surveys for the Blue-billed Duck involved a 20-minute walking transect along the edge of each of the selected dams. This time period enabled the inspection of the entire surface area of each dam for the target species. The surveys were carried out during clear and warm conditions. Individual counts of all other waterbird and woodland/forest species observed utilising the surface of the water body or foraging either within the vegetated margins or aerially foraging over each dam was also recorded.

4.2.2 Weather Conditions during Fauna Survey Period

Table 3: Weather during the fauna survey period (Maitland Visitors Centre)

Weather	Date				
	14/12/15	15/12/15	16/12/15	17/12/15	8/1/16
Temp. Min. (°C)	14.3	15.3	20	16.2	14.5
Temp Max. (°C)	35	34.8	24	29.5	26.9
Relative Humidity (%) 9am	71	83	79	70	70
Relative Humidity (%) 3pm	19	48	91	43	44
Rain	0	0	0.8	9.2	0
Max wind gust (km/hr)	15	5	4	2	4
Wind direction	NNW	SE	S	SE	W

4.3 FLORA

4.3.1 Maundia triglochinoides

Eighty-seven (87) dams were originally assessed as containing suitable habitat for the aquatic plant *M. triglochinoides*, but with knowledge gained from past surveys this number has been reduced to 57 dams. Searches were conducted on the 9 and 10 of December 2015. Surveys were conducted by completely circumnavigating the edges of the dams on foot (where physically possible) ensuring that all water edge environments were searched. The surveys were conducted in December to coincide with the flowering time of *M. triglochinoides* as it is difficult to detect and distinguish from closely related species during the non-flowering period.

5. RESULTS

5.1 AMPHIBIANS

No Green and Golden Bell Frogs were detected at any of the 49 dams surveyed. No Green-thighed Frogs were detected at the two dams containing suitable habitat for this species. No frog species listed as threatened under State or Commonwealth legislation were recorded during field surveys.

A total of eight species of frog were detected across all dams during 2015 surveys (**Figure 4**). All eight species are considered common in the region and are known to breed in dams and ponds. This is an increase from the six species recorded in 2014, but there has still been a general pattern of decline in total species recorded since 2011.

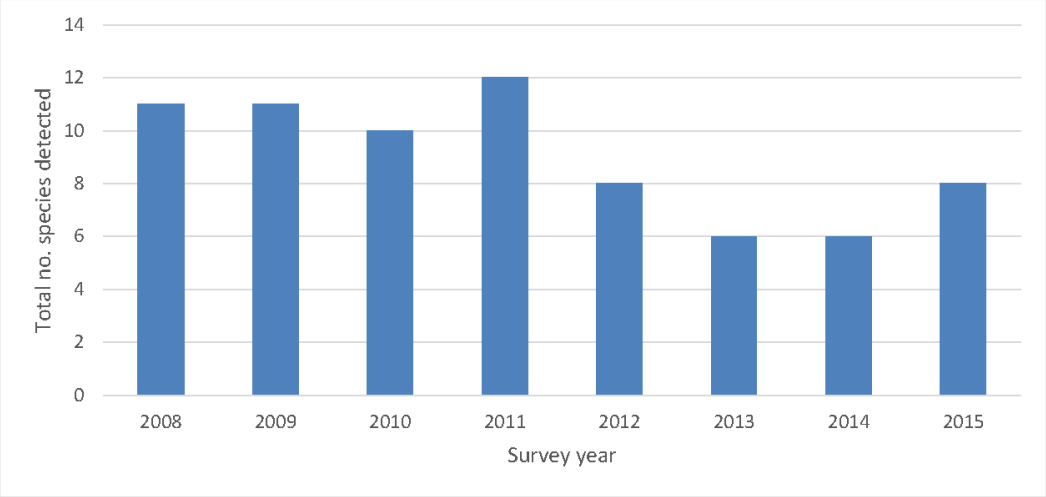

Figure 4: Total number of species detected across all ponds each year.

Species richness was used to estimate frog diversity at each of the dams. **Figure 5** shows the frequency distribution of numbers of frog species found at each dam. The distribution of frog diversity is seen to fluctuate throughout the years with the years 2008 – 2012 showing the widest distributions. The distributions of frog diversity in 2014 and 2015 are negatively skewed, with most dams containing 1 – 3 species. Despite this pattern, the 2015 monitoring recorded an increase in frog species number from 2014 levels at 24 of the dams. There was a decrease in frog species number at only 10 dams, and 15 dams had no change in species number.

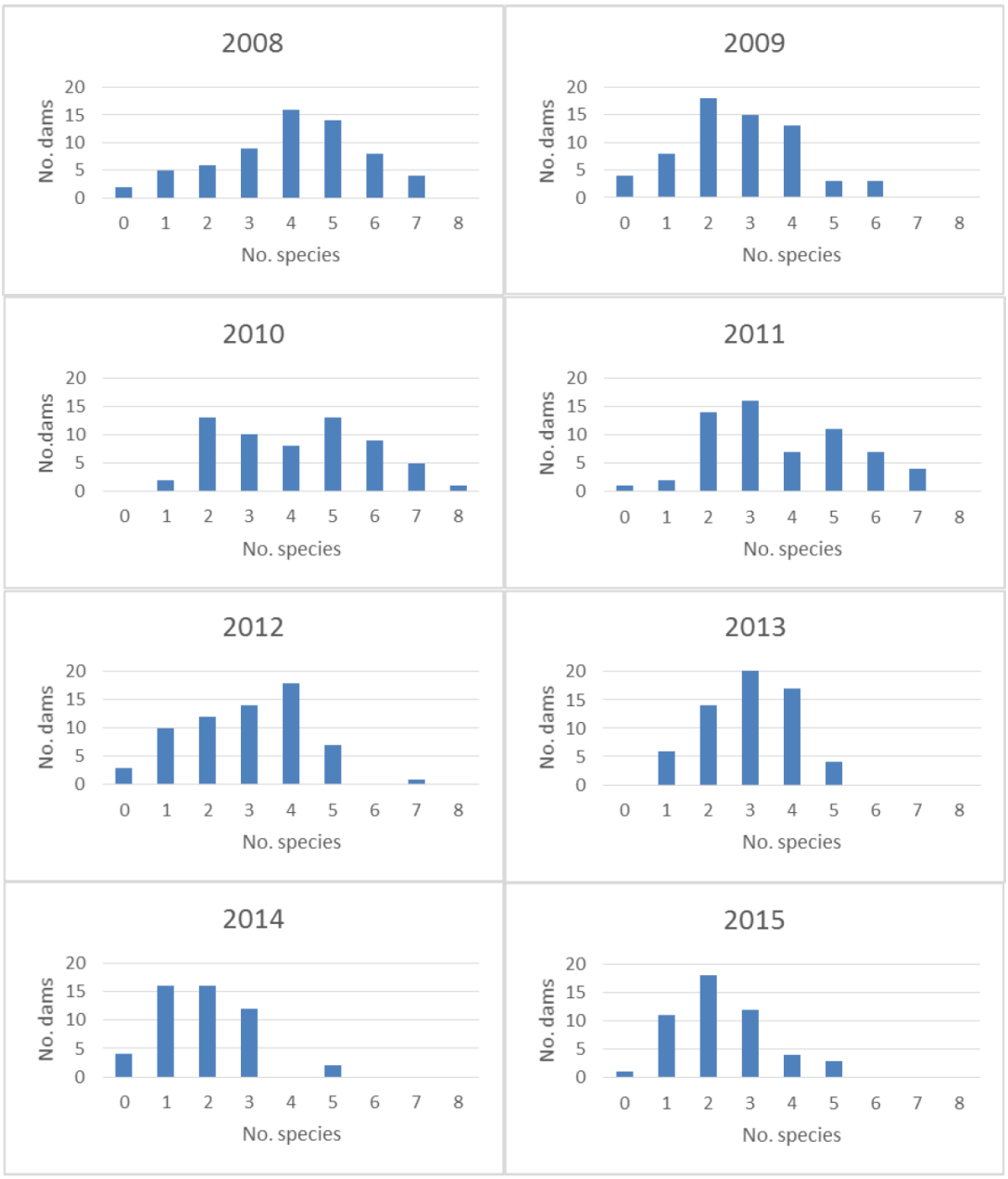

Figure 5: **Frequency distributions of the numbers of frog species recorded across all dams for each of the survey years 2008 – 2015.**

When observed over all survey years, there is a negative correlation between the mean number of frog species per dam and average temperature in the three months preceding the survey (**Figure 6)**. The highest number of frog species was observed in 2011, when the average temperature from October to December was 25.3°C; conversely, the lowest number of frog species detected was in 2013 and 2014 when average temperatures for October and December were 28°C and 29°C, respectively.

There was, however, no correlation between mean number frog species per dam and the total rainfall for during the three months preceding the surveys (**Figure 7**). The three years that recorded the highest number of frog species per dam, 2008, 2010 and 2011, all received over 250 mm of rain in the three months preceding the surveys. During these months in 2015, 280 mm of rain was recorded, however, the number of species per dam was the second lowest since monitoring began at just above 2 species.

The three months preceding the surveys in 2015 had the second highest average temperature of the eight survey years at 28.7. Rainfall in this period was slightly above average at 281 mm with one significant rainfall event of 34 mm in the few days before the survey.

The list and number of frog species identified from each dam are shown in **Appendix 3.**

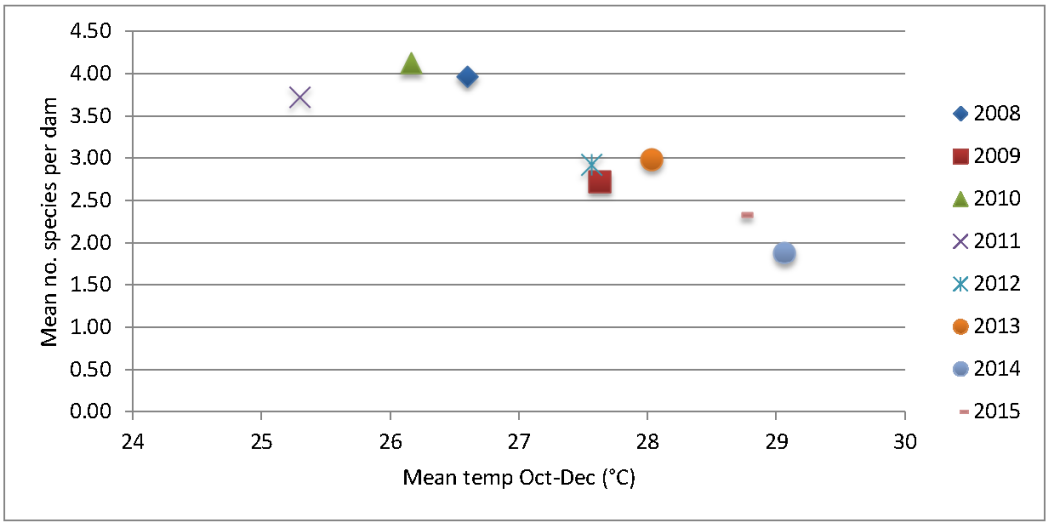

Figure 6: **Relationship between mean temperature (Oct-Dec; °C) and the mean number of frog species per dam (source: Maitland Visitors Centre).**

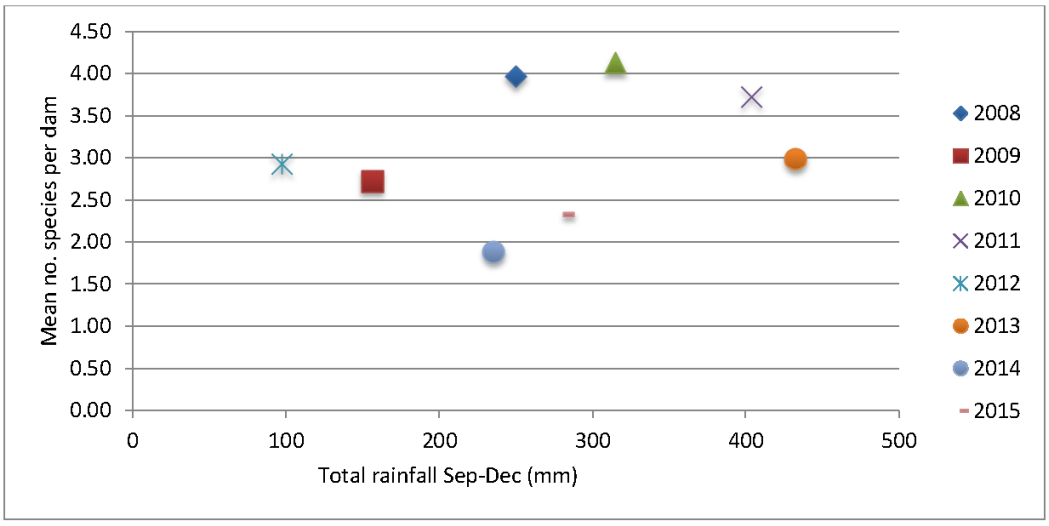

Figure 7: **Relationship between total rainfall (Oct-Dec; mm) and the mean number of frog species per dam (source: Maitland Visitors Centre).**

5.2 . BIRDS

The Blue-billed Duck was not detected during 2015 surveys. As discussed in the methodology, only two of the four dams were surveyed due to access issues.

A total of 61 bird species, including 23 waterbirds and 38 woodland/forest birds have been recorded between 2008 and 2015 across all of the dams surveyed (**Appendix 4**). The 2015 surveys detected 37 species (9 waterbirds and 28 woodland/forest birds) across the two dams. Eight waterbird and 16 woodland forest species were recorded at Dam 7, while five waterbird and 20 woodland/forest species were recorded at Dam 14 (**Figure 8**). No new waterbird species were recorded at either dam in 2015, however, eight previously undetected woodland/forest species were recorded. These were: Grey-crowned Babbler (*Pomatostomus temporalis*), White-winged Chough (*Corcorax melanorhamphos*), Noisy Miner (*Manorina melanocephala*), Rufous Whistler (*Pachycephala rufiventris*), Rainbow Lorikeet (*Trichoglossus moluccanus)*, Red-rumped Parrot (*Psephotus haematonotus*), Channel-billed Cuckoo (*Scythrops novaehollandiae*), and Red-browed Finch (*Neochmia temporalis*).

Of note was the recording of the Grey-crowned Babbler, listed as Vulnerable under the TSC Act. A group of 6 individuals were observed foraging and tending to a nest in a Paperbark (*Melaleuca* spp.) overhanging Dam 7 at the SW end.

The 2015 survey recorded the highest number of both water bird and woodland/forest species at Dam 7 since monitoring began in 2008 (**Figure 8**). At Dam 14, the second highest number of waterbird and the highest number of woodland/forest bird species since 2008. Waterbird diversity at Dam 7 has been relatively constant over the monitoring years, despite a small drop in 2010 and 2011. The diversity at Dam 14 in 2015 was equal to that of 2014. Overall, waterbird diversity has remained relatively constant at this Dam, although, 2013 recorded approximately twice the number of species as in other years.

The diversity of woodland/forest birds at both dams shows an increasing trend across the survey years with approximately a two-fold increase in 2015 from 2014 at both dams.

The number of individual waterbirds at Dam 7 was similar to that of previous years, and has been consistent across the all survey years (**Figure 9**). Abundance of water birds at Dam 14 in 2015 was also similar to other years, except 2009, which recorded an abundance of waterbirds approximately eight times greater than in any other survey year. Woodland bird abundance at both dams in 2015 was higher than in any other survey year.

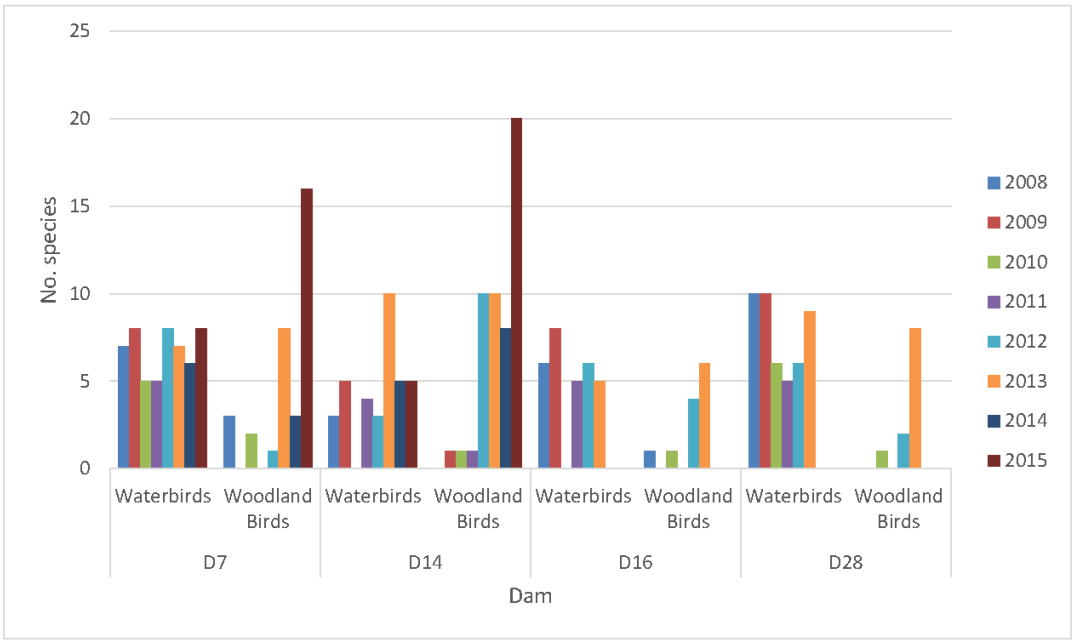

Figure 8: Number of bird waterbird and woodland bird species recorded at each dam 2008-2015.

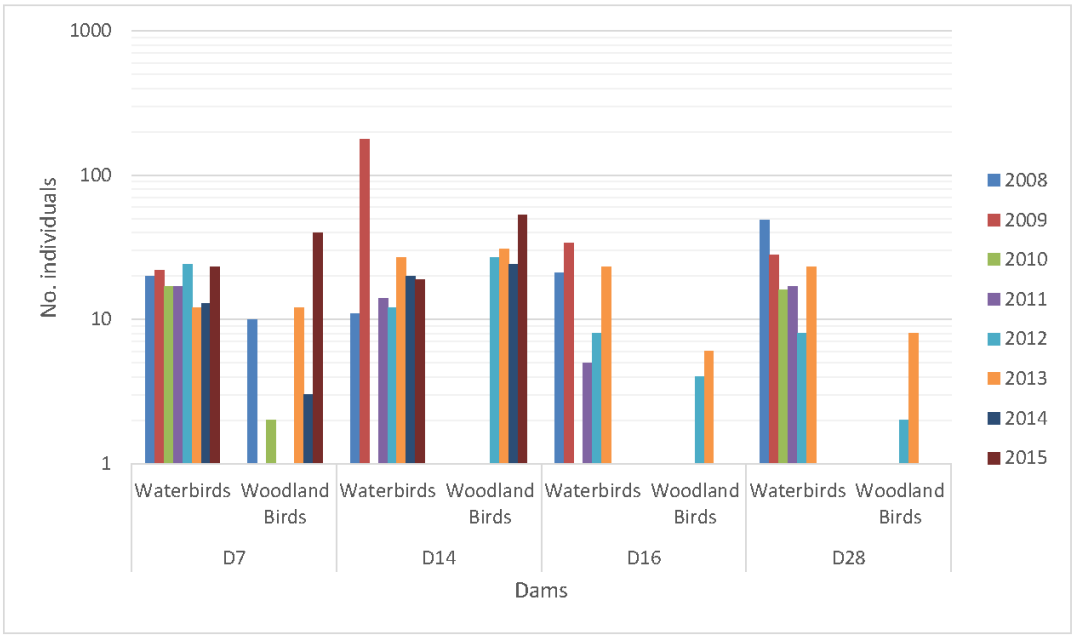

Figure 9: Total number of individual water and woodland birds recorded at each dam 2008-2015.

5.3 FLORA

Maundia triglochinoides was not detected at any of the 57 dams surveyed. Permission to survey four dams was declined by the current owners (dams no. 93, 120, 121 and 128), while two owners did not respond to requests for permission to enter (Dam 6 and 36). No other flora species listed as threatened under State or Commonwealth legislation or under the ROTAP (Rare or Threatened Australian Plant) scheme were recorded during field surveys.

While *M. triglochinoides* was the main focus of the survey, the opportunity was also used to also assess the flora within the dams; one noxious water borne weed species - *Eichhornia crassipes* (Water Hyacinth) was identified in 14 of the dams during surveys.

6. DISCUSSION

6.1 AMPHIBIANS

6.1.1 Green and Golden Bell Frog

While a third of all the dams identified and surveyed in 2008 were considered to contain suitable Green and Golden Bell Frog habitat, the species has not been detected in any of the seven surveys. However, habitat characteristics (increased turbidity, change in water depth and dam profile, changes in vegetation types and densities) of target dams have changed, or have been modified by landholders; altering the suitability of the habitat for the Green and Golden Bell Frog

The Green and Golden Bell Frog prefers large, permanent water bodies containing high levels of emergent vegetation such as Typha, Baumea and the introduced *Juncus acutus*. Some of the target dams surveyed did not contain any or some of the features required by the Green and Golden Bell Frog. Issues at some of the target dams included Water Hyacinth covering entire surfaces, no bank vegetation due to cattle grazing, or no open water.

Regardless of the current status of occupancy of dams by the targeted species, the presence of a large number of dams with habitat suitable for these species (particularly those that interconnect and form habitat complexes) is an important factor for their future recovery. This is particularly true for the Green and Golden Bell Frog, a relatively mobile species that is known to be able to travel considerable distances and traverse hostile habitats to reach suitable ones (Daly 1995).

Currently there are two recognised key populations of Green and Golden Bell Frog at opposite ends of Hexham Swamp (known as the Sandgate and Kooragang Island populations). The species was also once known to be widespread right through the Hexham Swamp and adjoining areas. Old records of this species are known from within a 10 kilometre radius of the Black Hill area; however these populations are now thought to be extinct (M. Mahoney pers. comm.). Nevertheless, should this species recover in the near future it is highly conceivable that it may migrate back through this area towards Pambalong Nature Reserve and onto the adjoining belt of farm dams.

6.1.2 Green-thighed Frog

Ephemeral pools, partly or wholly within rainforest or wet sclerophyll forest are ideal habitat for the Green-thighed Frog. They also forage in and amongst fallen leaf litter and logs. Locally, the Green-thighed Frog is only known from two records approximately 13 km from the Black Hill area and is not known for its high mobility.

In 2008, only three dams were considered to contain suitable Green-thighed Frog habitat (Dams 1, 87 and 151). While the surveys carried out were scientifically robust, Green-thighed frogs are cryptic in nature: they may only call on one or two nights of the year (Lemckert *et al.* 2006) and are very difficult to detect on other nights.

Only two dams were available for survey in 2015: Dam 87 and Dam 151. Access was not granted for Dam 1. Additionally, impacts from cattle grazing in and around the two dams have also degraded the habitat and water quality. The two ponds which once contained suitable habitat for the Green-thighed Frog now represent habitat of little value for this species and, without habitat restoration, their presence in future surveys is not expected.

6.1.3 Non-threatened Frogs

The detection of numerous species of non-threatened frogs is a positive sign of ecosystem health. Amphibian calling activity recorded throughout the survey period was high, resulting in a high level of confidence that the majority of species present were likely to be detected.

Data from the 2015 survey indicate that species diversity has decreased from that observed in the first few years of monitoring. The start of the decline was first observed in 2012, when the total number of species detected across all dams decreased from 12 in 2011 to 8. There was a further drop in 2013 to 6 species and 2015 has seen a slight increase to 8 species.

The fluctuating numbers in frog species diversity over the last seven years could reflect fluctuating weather patterns across the region. Abnormally warm conditions prevailed through much of November 2009 with above average temperatures (National Climate Centre 2009), which may explain the drop in species diversity per dam in this year (**Figure 6**). Frog diversity across all ponds, however, was not lower in this year (**Figure 4**). The higher temperatures and lower rainfall in this year, therefore, may have reduced dispersal of frogs across the landscape; leading to lower numbers of species at each dam but not lower numbers overall.

Figure 6 shows a strong negative correlation between frog species diversity at each dam and the average temperature in late spring and early summer months; with higher temperatures in 2014 and 2015 associated with lower frog diversity per dam than other years. The current survey in 2015 recorded the second lowest number of frog species per dam since monitoring began in 2008. Rainfall, however, was slightly above average in 2015. These results suggest that average temperature, and not total rainfall, is contributing the greatest to frog diversity per dam in the area. When conditions are poor, frogs conserve energy by going into torpor and foregoing breeding. When conditions improve; i.e. when it rains, and the probability of reproductive success improves, the number of frogs observed will increase due to heightened activity and calling. Frog abundance has often been observed to correlate with rainfall so it is surprising that these data do not support a trend of higher rainfall and higher frog diversity. It may be that rainfall was not the limiting factor in frog diversity across the Abel Dams. Other factors that may be limiting frog diversity are survey bias or the impact of predators or pathogens

The number of frogs detected may not always reflect the total species present due to a sampling bias. Survey methods for amphibians are largely focused on detecting males as they vocalise to attract a mate. When conditions to breed are not appropriate males will refrain from calling, therefore reducing their detectability. However, they may still be present in the environment but not be as obvious compared to other years. The loss of 15 dams from the study sample in 2014 may also have had an impact on the total number of species recorded in 2015.

Some species of frog potentially occurring in the study area have not been detected in the seven years of surveys, particularly the Green Tree Frog (*Litoria caerulea*), Bleating Tree Frog (*Litoria dentata*), Ornate Burrowing Frog (*Platyplectrum ornatum*), Pobblebonk (*Limnodynastes dumerilii*), Haswell's Frog (*Paracrinia haswelli*), Bibron's Toadlet (*Pseudophryne bibronii*) and Tyler's Toadlet (*Uperoleia tyleri*). One species, the Red-backed Toadlet, (*Pseudophryne coriacea*), was detected in 2008 at one dam site that was not selected for further monitoring. The absence of these species, and the varying diversity and species composition at the dams over seven years, may be due to a variety of factors such as the health of the dam ecosystems (cattle disturbance is widespread), or the Chytrid fungus (a pathogenic fungus that is considered largely responsible for the recent global amphibian decline) (Berger *et al.*, 1998), unsuitability of local habitat, changing weather conditions, weed infested dams with little open water or just chance. Mosquito fish (*Gambusia holbrooki*) may also pose a great threat to frog eggs and tadpoles. Mosquito fish are known to breed quickly

and adversely impact or even wipe out native tadpole populations (Anstis 2002). Mosquito Fish were detected in the majority of dams surveyed in 2014.

6.2 BIRDS

During the 2008 baseline surveys, four dams were considered to contain potential Blue-billed Duck habitat. This species is considered to be an uncommon visitor to the Hunter region, and has been irregularly recorded from key sites including Walka Water Works, Oakhampton Heights (approximately 8 km north of the study area) and Deep Pond, Kooragang Island (approximately 13 km east of the study area). The Blue-billed Duck is a mobile species that may re-appear at suitable deep dams at any time given suitable conditions. This species is also known from the Bloomfield Dam (NSW Wildlife Atlas 2010) to the north of the Abel mine area. Only two dams were available for surveys in 2015 due to landholder restrictions. The Blue-billed Duck was not recorded during the 2015 surveys and has not been recorded during any survey event since monitoring began in 2008.

One threatened species, Grey-crowned Babbler, was recorded in 2015 at Dam 7 for the first time since monitoring began in 2008. A group of six individuals were observed foraging and tending a nest in a Paperbark (*Melaleuca* spp.) overhanging the dam at the SW end. This species is listed as Vulnerable under the TSC Act.

In 2015, waterbird diversity was equal to the highest recorded at Dam 7 and equal to the second highest recorded at Dam 14. At both dams the number of water bird species has been relatively constant over the survey years, despite a slight drop in 2010 and 2011 at Dam 7 and a peak of ten species at Dam 14 in 2013. The total number of individual waterbirds at each dam has also shown little variation over the monitoring years at both dams, except for an unusually high number at Dam 14 in 2009. These results suggest there has been no negative impact on waterbird diversity or abundance at either Dam.

The high number of woodland/forest bird species recorded may be due to increased bird activity following the cessation of a major rain event, or may be due to other factors such as surveyor bias, detectability or the species ecological tenancies. It has been highlighted in past reports (ecobiological 2008, 2009, 2010, 2011 and Kleinfelder 2012, 2013) that bird diversity varies with rainfall in the area prior to surveys. The Hunter Region experienced a major rainfall event in the few days leading up to the survey, receiving 236 mm over three days.

Many of the bird species that have been recorded to date are also nomadic/itinerant in that they often travel large distances and sporadically occupy multiple areas as they move. Birds of this nature are largely unpredictable in determining their specific movements and thus appear irregularly. Collection of data on non-threatened bird species observed during the standardised surveys will be used to make comment on the ongoing health of the dam ecosystems into the future.

6.3 FLORA

While a third of all the dams identified and surveyed in 2008 were considered to contain habitat suitable for *Maundia triglochinoides*, this species was not detected in any of the previous surveys or in the present survey period.

Only three records of *Maundia triglochinoides* in close proximity to the study area exist, one from Kooragang Wetlands (pers. obs., D. Pedersen), Irrawang Wetlands (pers. obs., Dan Pedersen) and the Medowie area, some 25 km from the Abel Mine site (NSW Wildlife Atlas, 2010). However, a close inspection of suitable dams over the six year period has not recorded this species. As this species mainly disperses via stream flow, it is unlikely that it will appear at any of the dam sites which are not generally connected to natural streams. It may also be dispersed by duck faeces; this however is an unlikely occurrence.

The presence of *E. crassipes* (Water Hyacinth) in several (10) dams is of concern as they have the potential to spread to water ways downstream of the dams during times of high rainfall. This is a listed noxious weed (Class 3 in Maitland, Lake Macquarie and Newcastle Council areas) which states that the plant must be fully and continuously suppressed and destroyed.

Other observed weed species listed as Class 3 in the Maitland, Lake Macquarie and Newcastle Council areas included;

- *Cortaderia selloana* (Pampas Grass) on single dam; and,
- *Lycium ferocissimum* (African Boxthorn) on a single dam.

7. CONCLUSION

Frogs

Frog species diversity in 2015 was the second lowest since surveys began in 2008. There has been an overall decline in frog species recorded since 2011. Total rainfall and average temperature for the three months preceding the surveys was slightly above average for this period. There is a strong negative correlation between frog diversity per dam and average temperature. There was no correlation between total rainfall and frog diversity per dam, suggesting that rainfall has not been the limiting factor affecting frog diversity in the area over the years of monitoring. There was, however, a negative relationship between average temperature in the three months preceding the surveys and the average number of frog species per dam. Temperature, or some other factor, could, therefore, be limiting factor for frog diversity across the Abel Dams. No targeted threatened frog species were recorded.

Birds

No Blue-billed Ducks, the targeted threatened species, were recorded in 2015.

Total bird diversity over the survey period increased in 2015 compared to previous years, mainly due to a higher number of woodland/forest species, including eight previously undetected species being recorded. Sixty-one species have now been recorded from the four dams.

Due to access restrictions, only two dams (Dam 7 and Dam 14) were surveyed in 2015. The number of waterbird species and individuals recorded at each dam have been relatively constant over the monitoring years. The highest number of woodland/forest birds since monitoring began in 2008 was recorded 2015. This may be due to increased activity at the sites following a major rainfall event or may be due to survey bias. These results indicate that activity at the Abel underground mine has not has a negative impact on bird diversity at Dam 7 and 14.

Maundia triglochinoides

The data collected over the last eight years will enable evaluation of potential subsidence impacts in the future. At the time of the 2015 surveys, mining had causede subsidence at two dams – dams 27 and 29 owned by Mrs Osbourne. Water levels in these dams were greatly reduced as a result and has the potential to affect the habitat value of these dams. It should be stated here that both the oweners and Donaldson Coal were aware of this subsidence and remediation efforts were being undertaken.

No individuals of the threatened plant, *Maundia triglochinoides*, were identified.

Where noxious listed weeds were observed, land owners should be made aware their presence.

More detailed statistical analyses will be appropriate following the 2015 annual monitoring event to evaluate impacts arising from the mine expansion currently occurring in the study area. An accompanying water quality and condition assessment of the target dams is recommended to identify factors, such as eutrophication, recent fertiliser applications or nutrient runoff and local surface runoff. Any of these factors may impact species abundance and diversity.

8. RECOMMENDATIONS

It is recommended that during future amphibian surveys, water quality and aquatic habitat assessments of the relevant dams be made to determine if any future changes in frog diversity or species composition at the dams may be explained by local environmental factors. Indices of water quality that can be collected with minimal cost and effort include temperature, pH and salinity (EC) as well as visual observations of water and aquatic vegetation health.

It is also recommended that the habitat suitability for Green and Golden Bell Frogs and Green-thighed frogs at each dam be reassessed as habitat characteristics have changed over time. This will assist in the future to identify factors, such as eutrophication of dams from stock, recent fertiliser applications, or nutrient runoff from farming practices and local surface runoff which may contribute to local frog and bird decline rather than effects from mining.

Frog and bird monitoring should continue to detect any impacts of the Abel underground mine should they arise in the future.

Owners of properties where Class 3 noxious weeds were observed should be made aware of their presence to facilitate early control and/or access any grant funding that may be available.

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APPENDIX 1. TARGET SPECIES PROFILES

Green and Golden Bell Frog (*Litoria aurea*)

The Green and Golden Bell Frog is a large frog with a robust body form ranging from 45mm to 110mm in size. Diagnostic features include a gold or cream-white stripe running along the side, extending from the upper eyelids to groin, with a narrow dark stripe beneath which runs from the nostril to the eye (DEC 2005). The body colour varies; it is usually a vivid pea green with splotches of metallic brown or green and a bluish green colour on the inside of the thighs. Some individuals may have an entirely green back, but this is variable and others may be primarily covered in the metallic markings.

This species was once one of the most common frog species on the east coast of Australia. It inhabited many lentic freshwater habitats throughout its distribution which occurred predominately along the coast but also extending as far inland as Bathurst and along the highlands in the north and south of the state (White and Pyke 1996). The Green and Golden Bell Frog has undergone a widespread and unexplained range contraction since the mid 1970's and the species is now listed as endangered under the *Threatened Species Conservation Act 1995*, NSW (TSC Act) and as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* Cth, (EPBC Act). It is currently restricted to isolated pockets along the coast throughout its former range with only one known remaining highland population at Queanbeyan.

The habitat preference and requirements of the Green and Golden Bell Frog are not well understood and difficult to define (Mahony 1999) resulting in some disagreement and confusion. Some of the differing views on its ecology may be due to a failure to take into account the role of the pathogenic Chytrid fungus that is thought to be primarily responsible for changes in the frog's distribution and abundance in the last two decades (Berger *et al.* 1998).

The species uses different habitat components throughout the various stages of its life cycle including different breeding, foraging and refuge habitats and has been known to disperse several kilometres between these various habitats. Generally large, permanent water bodies containing high levels of emergent vegetation such as Typha, Baumea and the introduced *Juncus acutus* are favourable habitat for the Green and Golden Bell Frog, however it has been observed using a wide range of natural and man-made water bodies including; coastal swamps, marshes, dune swales, lagoons, lakes, estuary wetlands, riverine floodplain wetlands, billabongs, storm water retention basins, farm dams, bounded areas, storage tanks, water troughs, drains, ditches and other excavation areas capable of capturing water such as quarries and brick pits (DEC 2005).

Terrestrial habitat attributes that appear to favour the species include large grassy areas associated with adjacent cover from logs, rocks or tussock forming vegetation that provide shelter. There also appears to be a preference shown to habitat containing a complexity of terrestrial and aquatic vegetation structure (Hamer *et al.* 2002). The introduced mosquito fish,

Gambusia holbrooki, is believed to feed on small tadpoles; habitat which is free of these fish is preferred (White & Pike 1996)

The Green and Golden Bell Frog is frequently active during the day and night during warmer months and can often be observed sitting in emergent vegetation well above the water level (0.5-1m). It has also been observed well away from water altogether. The breeding period generally occurs between September and March although reproductive behaviour has been noted to occur between late winter and early autumn (DEC 2005a). Breeding events occur most often during, and just after, heavy rain events with a peak around January/February when summer storms are common. Males call while floating in the water or from pond-side vegetation mostly at night but will occasionally call during the day. Individuals or small groups of males often respond to call play back or call imitation.

Green-thighed Frog (*Litoria brevipalmata*)

The Green-thighed Frog was only discovered in 1970, originally at Wauchope, NSW and later in the Gosford area (Barker & Grigg 1977). It reaches around 40mm in length and is chocolate brown on the dorsum with yellowish lower flanks. A dark stripe runs from the snout, through the eye and tympanum and ends in the flank. The groin and backs of thighs are a distinct bright blue-green with black flecks throughout and the belly is pale cream (Robinson 1998). The Green-thighed Frog is listed as vulnerable under the TSC Act.

It is found in forests and swamps of the coast and adjacent ranges from central New South Wales to south east Queensland (Cogger, 2000; Hines *et al*. 1999). Its habitat requirements have remained highly cryptic for a long time with breeding noted to take place after heavy summer rains in rainforest and wet sclerophyll forest but also around temporary and semi-permanent ponds, flooded ditches and swamps including areas such as roadsides and power easements.

More recent research however has shed some light on the biology of this highly cryptic species, particularly in relation to its breeding habitat requirements and calling behaviour. In a study by Lemckert *et al*. (2006) it was found that over 90% of breeding sites consisted of ephemeral pools, partly or wholly within rainforest or wet sclerophyll forest (84% of the time). There are however some records from around permanent, artificial ponds within dry sclerophyll forest, and a small number from coastal forests and swamps. Natural depressions adjacent to streams (e.g. old billabongs) are the most commonly used calling sites, although breeding also occurs in artificial water bodies such as human excavated hollows and flooded road verges (around half of sites recorded). These pools are usually either leaf or shrub filled depressions, or have significant amounts of grass in and around them (Lemckert *et al*. 2006).

The duration of calling events for the species is brief, lasting for a median of only one night and a mean of 1.4 nights (Lemckert *et al*. 2006). Calling occurs between September and May, although greater than 90% of all calling activity occurs between November and February, with between 1 and >100 males calling (most commonly 2-10 individuals) (Lemckert *et al*. 2006). The species in the southern part of its range often displays only one calling event in a season, with two calling events observed on only four occasions in a study by Lemckert *et al*. (2006), and three calling events in a season observed only once. The maximum total recorded number of nights of calling activity at any site in a season in the 2006 study was five, with only one day

or less per season recorded 80% of the time, indicating that the Green-thighed Frog has the lowest number of calling days of any temperate Australian anuran species (Lemckert *et al.* 2006). Calling is likely to occur only after rainfall events that are significantly above the mean daily or three daily levels for the given time of year (when it is more likely that flooding will occur in breeding ponds), and it is believed that the flooding of the breeding pools is the significant factor in calling behaviour, rather than the intensity of the rain itself.

The majority of Green-thighed Frogs are found within 100m of a tract of natural vegetation >20ha in size and none were found in the 2006 study (Lemckert *et al*. 2006) to occur in largely cleared (>50%) grazing lands or within entirely urban areas. While broad scale habitat clearing is a clear threat for this frog, it appears that partial clearing of vegetation within an area does not prevent Green-thighed Frogs from calling at a site and that they may have some tolerance for disturbance (Lemckert *et al.* 2006). Fire, particularly high-intensity fire, is also listed as a potential threat to the Green-thighed Frog, especially when associated with multiple disturbance events in rapid succession (Lemckert *et al.* 2006).

Blue-billed Duck (*Oxyura australis*)

The adult male Blue-billed Duck has a slate blue bill with a glossy black head and neck. The back and wings are a rich chestnut and the tail coverts are a black-brown. During the summer breeding season the bill of the male turns bright blue (DEC 2005b). The adult female has a grey-brown bill with plumage darker than the male with each feather barred with narrow bands of light brown. Juveniles are similar to the adult female but paler with a grey-green bill (Marchant & Higgins 1990).

Preferred habitat is large, deep, well-vegetated swamps where they spend almost all of their time in the water, often in large flocks. Occasionally the species can be found using creeks, rivers and farm dams for foraging and breeding (Frith 1982). The Blue-billed Duck feeds on the surface of the water or by diving for aquatic insects such as chironomid larvae, caddis flies, dragonflies, damselflies, flies and water beetle larvae (Schodde & Tidemann 1986).

The Blue-billed Duck is endemic to Australia occurring mainly within temperate wetlands of the south-eastern and south-western parts of the continent (Marchant & Higgins 1990). The Blue-billed Duck has also been reported from central Australia and Tasmania with little change in reporting rate over the last 20 years (Barrett *et al.* 2003). The Blue-billed Duck is listed as vulnerable under the TSC Act. Nationally the Blue-billed Duck is classed as of 'least concern' because of the very large flocks that inhabit large artificial wetlands (Garnett & Crowley 2000) although threats such as the destruction or modification of habitat, particularly by drainage works, clearing, cropping or burning are noted (Marchant & Higgins 1990).

Maundia triglochinoides

Maundia triglochinoides is a perennial plant with rhizomes about 5mm thick and emergent tufts of leaves arising along their length. Leaves are triangular in cross section, to 80 cm long, 5 - 10mm wide. Inflorescence is up to 10cm long and 2.5 cm wide. Carpels (female parts of flower) are 6 - 8mm long, sessile, each with a spreading beak (Harden, 1993). This species is found along the NSW coast and southern Queensland. There are historic records of this species occurring as far south as Sydney, however it is presumed extinct south of Wyong (DECC 2005). *M. triglochinoides* is listed as vulnerable under the TSC Act.

M. triglochinoides grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay and low nutrients and it is often associated with wetland species e.g. *Triglochin procera*. Flowering occurs during warmer months (November to January). The plant is likely to be wind pollinated. Long distance dispersal is through seed and root tubers, which are probably dispersed by water. The plant spreads vegetatively, with tufts of leaves arising along the rhizomes (DECC, 2005b). The main threats to this species are loss and fragmentation of habitat, changes in hydrology and water quality, and weed invasion (DECC 2008).

APPENDIX 2. SUITABILITY OF HABITAT AT TARGET DAMS

GGBF = Green and Golden Bell Frog (*Litoria aurea*); GTF = Green-thighed Frog (*Litoria brevipalmata*); BBD = Blue-billed Duck (*Oxyura australis*). Cells highlighted red indicate dams that were not surveyed in 2015 due to access restrictions.

Dam Number	*M. triglochinoides*	Other Listed Weeds	GGBF	GTF	BBD
1	✓		✓	✓	
3	✓		✓		
4	✓		✓		
5	✓		✓		
6	✓		✓		
7	✓		✓		✓
11	✓		✓		
12	✓				
13	✓		✓		
14	✓				✓
15	✓		✓		
16	✓		✓		✓
18	✓		✓		
19	✓		✓		
20	✓		✓		
21	✓		✓		
22	✓	Water Hyacinth	✓		
23	✓	Water Hyacinth	✓		
25	✓		✓		
26	✓		✓		
27	✓		✓		
28	✓		✓		✓
29	✓				
31	✓				
32	✓		✓		
33	✓				
34	✓	Water Hyacinth			
35	✓		✓		
36	✓				
38	✓		✓		

Dam Number	*M. triglochinoides*	Other Listed Weeds	GGBF	GTF	BBD
39	✓		✓		
40	✓		✓		
41	✓		✓		
42	✓		✓		
45	✓		✓		
46	✓		✓		
47	✓		✓		
48	✓		✓		
51	✓		✓		
53	✓		✓		
54	✓		✓		
57	✓		✓		
58	✓		✓		
59	✓				
61	✓		✓		
62	✓		✓		
85	✓		✓		
87				✓	
91	✓		✓		
92	✓		✓		
93	✓				
99	✓	Pampas Grass			
103	✓				
107	✓	Water Hyacinth			
112	✓		✓		
121	✓				
122	✓	African Boxthorn	✓		
123	✓		✓		
125	✓		✓		
126	✓	Water Hyacinth	✓		
128	✓				
129	✓		✓		
130	✓	Water Hyacinth	✓		
131	✓	Water Hyacinth			
132	✓	Water Hyacinth			
133	✓	Water Hyacinth			
134	✓	Water Hyacinth			
142	✓		✓		

Dam Number	*M. triglochinoides*	Other Listed Weeds	GGBF	GTF	BBD
144	✓		✓		
148	✓		✓		
149	✓		✓		
150	✓				
151	✓			✓	
152	✓		✓		
153	✓		✓		
154	✓		✓		
155	✓				
157	✓		✓		
160	✓		✓		
161	✓		✓		
162	✓		✓		
163	✓		✓		
164	✓				
167	✓		✓		
168	✓		✓		
169	✓		✓		
Total with Suitable Habitat	85		63	2	4
Total Surveyed	55		50	2	2

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APPENDIX 3. AMPHIBIAN SPECIES RECORDED IN EACH DAM SURVEYED

'x' – indicates presence NA – No available access Dam = Dam Number Survey Year = 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015

DAM	*Litoria fallax* (Dwarf Green Tree Frog)								*Litoria peronii* (Emerald-spotted Tree Frog)								*Litoria tyleri* (Southern Laughing Frog)								*Litoria latopalmata* (Broad-palmed Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
1	x	x	x	x	x	x	NA		x		x	x	x	x	NA		x		x	x	x	x	NA						x		NA	
3	x	x		x	x	x	x	x		x						x												x	x			x
4	x	x	x		x	x	x	x				x	x	x							x				x	x		x	x		x	x
5	x	x	x	x	x	x	x	x		x		x	x	x		x	x							x				x				
6	x	x	x	x	x	x	NA							x	NA								NA					x		x	NA	
7	x	x	x	x	x	x	x	x				x		x		x	x											x	x		x	
11	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x				x	x											x
13	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x		x			x	x	x		x	
15	x	x	x	x	x	x	x	x	x	x				x		x						x		x	x	x			x	x		
16	x		x	x	x	x	NA				x		x	NA	NA					x	x	NA	NA		x		x			NA	NA	
18	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x			x	x								x			
19	x	x	x	x	x	x	x	x																								
20	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x		x		x			x				x	x	x	x	x
21	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x			x	x	x	x	x	
22	x	x	x	x	x	x	x						x						x						x	x	x	x				
23	x	x	x	x	x	x	x	x		x									x			x			x	x	x				x	
25	x	x	x	x	x	x	x	x	x			x	x			x												x	x			
26	x		x	x	x	x	x	x	x			x	x							x												
27	x	x	x	x	x	x	x	x	x		x	x	x	x			x		x		x						x	x	x			
28	x		x	x	x	x	NA				x		x	x	NA					x	x		NA		x		x	x			NA	
32	x	x	x	x	x	x	x		x		x	x	x			x	x		x		x	x		x	x		x	x	x	x	x	x
35	x		x	x	x	x	x	x											x	x		x			x		x					
38	x	x	x	x	x	x	x	x	x		x	x	x	x											x		x	x	x	x	x	
39	x	x	NA	NA	x	x	NA		x	x	NA	NA	x	x	NA		x		NA	NA			NA		x		NA	NA	x	x	NA	
40	x	x	x	x	x	x		x	x		x	x		x		x				x		x			x	x	x	x	x			
41	x	x	x	x	x	x	NA			x	x	x	x	x	NA					x		x	NA		x	x	x			x	NA	

DAM	*Litoria fallax* (Dwarf Green Tree Frog)								*Litoria peronii* (Emerald-spotted Tree Frog)								*Litoria tyleri* (Southern Laughing Frog)								*Litoria latopalmata* (Broad-palmed Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
42	x		x	x		x	x	x	x		x	x	x	x	x	x	x					x		x	x	x	x	x		x	x	
45	x	x	NA	NA	x	x	NA		x		NA			x	NA		x	x	NA	NA	x	x	NA		x	x	NA	NA		x	NA	
46	x	x	NA	NA	x	x	NA		x		NA	NA	x		NA		x		NA	NA		x	NA		x	x	NA	NA	x		NA	
47			x	x	x	x	NA						x		NA					x	x	x	NA							x	NA	
48	x	x	x	x	x	x	x	x	x		x	x					x		x	x		x			x		x			x		
51	x	x	x	x	x	x	x	x											x						x		x		x		x	
53	x	x	x	x		x	NA								NA					x		x	NA							x	NA	
54	x			x	x		NA		x		x				NA								NA		x		x	x	x	x	NA	
57	x		x	x	x	x	x	x			x	x	x	x	x	x						x		x			x	x	x	x	x	x
58			x	x	x	x	x	x			x	x	x							x							x	x	x	x	x	
61	x	x	x	x	x	x	x				x				x		x		x	x	x	x					x	x				
62	x	x	x	x	x	x	x	x		x	x	x		x				x				x					x				x	x
85	x	x	x	x	x	x	x	x	x			x	x	x	x	x				x	x	x		x					x		x	x
87																														x	x	
91								x						x		x						x							x			x
92	x	x	x	x	x	x	NA		x	x	x		x	x	NA		x		x	x		x	NA						x	NA		
93					x	x	NA						x		NA						x	x	NA							NA		
112	x	x	x	x	NA	x	NA			x	x	x	NA	NA	NA		x	x	x	x	NA	NA	NA				x		NA	NA	NA	
122	x	x	x	x	x	x	x	x																								
123	x	x	x	x	x	x	x	x											x	x		x										
125	x		x	x	x	x	x	x			x		x						x	x		x					x			x		
126	x	x	x	x	x	x	x	x									x		x	x	x	x										
129	x	x	x	x	x	x	x	x									x		x	x		x										
130	x	x	x	x	x	x	x	x		x											x									x		
131	NA	NA	NA	NA	x	x	x	x	NA	NA	NA	NA		x			NA	NA	NA	NA	x	x		x	NA	NA	NA	NA				
142	x	x	x	x	x	x		x				x																		x		x
144	x	x		x	x	x		x		x		x	x	x				x												x		
148	x	x	x	x	x	x	NA						x		NA				x	x	x		NA		x	x			x	x	NA	
149	x	x	x	x	x	x	NA								NA							x	NA				x	x		x	NA	
151	x	x	x	x	x	x	x	x		x			x	x					x			x	x	x								
152	x	x		x	x	x	x	x	x	x	x	x	x	x			x			x	x	x		x	x			x	x		x	
153	x			x	x	x	x	x	x		x	x	x	x	x	x			x	x	x	x	x	x	x			x	x			x
154	x	x	x	x	x	x	x	x				x		x						x								x				x

DAM	*Litoria fallax* (Dwarf Green Tree Frog)								*Litoria peronii* (Emerald-spotted Tree Frog)								*Litoria tyleri* (Southern Laughing Frog)								*Litoria latopalmata* (Broad-palmed Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
157					x	x	x							x											x	x		x			x	x
160	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x			x	x				x	x	x	x	x	x	x	x	x
161	x		x	x	x	x	NA		x		x	x	x		NA		x		x	x	x	x	NA		x		x	x	x	x	NA	
162			x	x	x	x	NA				x		x		NA		x		x	x	x	x	NA				x	x			NA	
163	x		x	x		x		x		x									x									x				
167	x			x	x	x	x	x	x							x				x												
168	x		x	x	x	x		x													x								x			
169			x	x		x														x							x	x		x		x

DAM	*Litoria nasuta* (Rocket Frog)								*Litoria verreauxii* (Whistling Tree Frog)								*Limnodynastes peronii* (Striped Marsh Frog)								Limnodynastes tasmaniensis (Spotted Grass Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
1				x			NA		x	x		x	x	x			x		x				NA									
3												x		x			x					x										
4													x	x							x											
5											x	x		x									x									
6							NA		x	x		x		x				x	x	x			NA									
7									x	x			x	x			x			x		x	x									
11									x					x				x			x		x		x		x					
13																											x	x				
15																	x	x	x				x	x								
16						NA	NA			x	x			NA			x				x	NA	NA								NA	
18										x		x	x	x																		
19										x				x										x								
20														x			x		x													
21											x						x															
22											x						x	x	x	x		x	x	x								
23											x						x		x	x	x	x	x	x			x					
25									x	x	x	x		x			x	x		x							x	x				
26													x	x							x											
27									x	x	x		x	x			x	x	x	x		x	x									
28							NA				x			x	NA		x		x	x	x		NA								NA	
32											x						x	x			x											
35											x								x	x	x	x	x	x								
38																				x	x			x	x		x					
39			NA	NA			NA				NA	NA			NA				NA	NA	x		NA				NA	NA			NA	
40												x					x	x	x			x			x	x	x	x				
41							NA				x				NA			x			x		NA								NA	
42										x						x						x		x	x		x	x				
45			NA	NA			NA				NA	NA			NA		x		NA	NA	x	x	NA		x	x	NA	NA			NA	
46			NA	NA			NA				NA	NA			NA		x		NA	NA		x	NA				NA	NA			NA	
47							NA								NA					x	x	x	NA								NA	
48											x													x	x		x					
51											x									x	x			x								
53							NA							x	NA		x	x	x	x	x	x	x	x							NA	

DAM	*Litoria nasuta* (Rocket Frog)								*Litoria verreauxii* (Whistling Tree Frog)								*Limnodynastes peronii* (Striped Marsh Frog)								Limnodynastes tasmaniensis (Spotted Grass Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
54							NA				x				NA								NA		x		x				NA	
57																									x		x					
58																						x			x							
61																			x		x		x					x				
62																		x					x	x								
85																			x		x	x	x	x								
87																						x										
91														x			x		x	x		x										
92							NA			x					NA			x					NA								NA	
93							NA								NA						x		NA								NA	
112					N/A	NA	NA				x		N/A	NA	NA				x	x	N/A	NA	NA				x		N/A		NA	
122																	x		x	x					x		x	x				
123																											x					
125											x		x				x		x	x	x	x		x	x							
126																	x		x	x							x					
129																				x	x	x		x			x					
130																					x	x	x	x								
131	NA	NA	NA	NA					NA	NA	NA	NA									x											
142														x							x											
144									x	x	x																					
148							NA							x	NA		x						NA								NA	
149							NA							x	NA					x		x	NA					x			NA	
151		x							x					x			x		x	x	x	x	x								NA	
152	x													x																		
153														x					x			x	x			x						
154	x	x							x										x	x	x		x									
157														x						x							x					
160																							x		x	x	x					
161							NA				x			x	NA		x		x	x			NA								NA	
162							NA		x		x			x	NA		x			x	x	x	NA								NA	
163																							x				x					
167																		x	x	x	x	x	x	x								
168											x			x			x			x	x	x	x		x							

DAM	*Litoria nasuta* (Rocket Frog)								*Litoria verreauxii* (Whistling Tree Frog)								*Limnodynastes peronii* (Striped Marsh Frog)								Limnodynastes tasmaniensis (Spotted Grass Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
169																							x				x	x				

DAM	*Uperoleia fusca* (Dusky Toadlet)								*Uperoleia laevigata* (Smooth Toadlet)								*Crinia signifera* (Common Eastern Froglet)								*Adelotus brevis* (Tusked Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
1	x		x				NA		x		x	x			NA					x			NA								NA	NA
3			x						x	x	x		x					x	x													
4			x	x					x	x	x		x				x	x														
5				x					x								x	x	x													
6			x				NA		x						NA		x	x	x	x	x		NA								NA	NA
7				x													x	x	x													
11									x	x	x	x					x		x													
13			x	x					x								x															
15									x								x	x		x												
16							NA								NA		x	x	x				NA								NA	NA
18									x			x					x	x	x													
19																		x	x													
20									x		x						x	x														
21									x								x	x														
22									x								x															
23																	x	x	x		x											
25			x	x					x		x						x	x	x													
26									x	x							x	x	x													
27									x										x													
28							NA					x			NA		x	x					NA								NA	NA
32																																
35									x				x					x														
38									x		x						x															
39			NA	NA			NA				NA	NA			NA			x	NA	NA			NA				NA	NA			NA	NA
40									x	x	x	x				x	x	x														
41							NA		x	x		x	x		NA		x	x	x				NA								NA	NA
42																		x														
45			NA	NA			NA		x		NA	NA	x		NA				NA	NA			NA				NA	NA			NA	NA
46			NA	NA			NA				NA	NA			NA				NA	NA			NA				NA	NA			NA	NA
47							NA								NA				x				NA								NA	NA
48									x	x																						
51																	x	x														
53							NA		x						NA			x					NA								NA	NA

DAM	*Uperoleia fusca* (Dusky Toadlet)								*Uperoleia laevigata* (Smooth Toadlet)								*Crinia signifera* (Common Eastern Froglet)								*Adelotus brevis* (Tusked Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
54							NA		x	x	x	x			NA			x					NA								NA	NA
57																		x														
58												x					x	x														
61									x	x	x	x					x	x	x													
62									x								x	x														
85																																
87																																
91																																
92							NA		x			x			NA			x	x				NA								NA	NA
93							NA								NA								NA								NA	NA
112			x		N/A		NA		x	x			N/A		NA						N/A		NA						N/A		NA	NA
122									x		x							x	x	x				x								
123																																
125			x						x			x				x	x			x								x				
126			x						x		x	x						x	x													
129			x	x					x		x	x						x	x	x												
130												x				x	x	x	x													
131																																
142									x		x																					
144									x	x			x					x	x													
148							NA					x			NA			x					NA								NA	NA
149							NA					x			NA			x					NA								NA	NA
151												x	x				x		x													
152		x	x	x					x	x	x																					
153		x	x							x	x	x	x		x		x	x														
154									x	x							x	x	x	x												
157																		x														
160									x		x	x	x		x	x																
161							NA		x	x		x	x		NA			x					NA								NA	NA
162			x	x			NA		x	x		x			NA		x	x		x			NA								NA	NA
163																	x	x														
167									x	x							x	x	x													
168			x						x	x	x						x	x	x													

DAM	*Uperoleia fusca* (Dusky Toadlet)								*Uperoleia laevigata* (Smooth Toadlet)								*Crinia signifera* (Common Eastern Froglet)								*Adelotus brevis* (Tusked Frog)							
	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15	08	09	10	11	12	13	14	15
169											x	x			x					x												

Dam	Number of amphibian species recorded each year							
	2008	2009	2010	2011	2012	2013	2014	2015
D1	7	2	6	7	5	4	NA	NA
D3	3	4	3	3	3	3	1	3
D4	4	4	3	3	7	3	2	2
D5	4	3	3	5	2	3	2	3
D6	4	4	4	5	2	4	NA	NA
D7	5	3	2	6	3	4	3	2
D11	7	4	4	2	4	4	3	3
D13	5	3	6	6	4	3	3	2
D15	6	5	2	2	2	4	2	4
D16	4	2	5	2	4	NA	NA	NA
D18	5	4	3	5	5	2	1	2
D19	1	3	2	1	1	1	1	2
D20	6	2	5	3	3	3	3	4
D21	6	4	5	4	4	3	3	3
D22	5	3	5	3	2	2	2	1
D23	4	4	7	2	3	3	3	2
D25	6	4	6	7	3	2	1	2
D26	4	2	2	3	4	2	1	1
D27	6	3	7	4	5	4	2	1
D28	4	1	5	5	4	3	NA	NA
D32	5	2	5	3	5	3	2	3
D35	3	1	5	3	3	3	2	2
D38	6	1	5	4	4	3	2	2
D39	4	3	NA	NA	4	3	NA	NA
D40	7	6	6	7	2	4	0	3
D41	4	6	5	4	4	4	NA	NA
D42	5	3	4	4	1	5	3	5
D45	7	4	NA	NA	4	5	NA	NA
D46	5	2	NA	NA	3	3	NA	NA
D47	0	0	2	3	4	4	NA	NA
D48	6	2	6	3	1	3	1	2
D51	3	2	4	2	3	1	2	2
D53	3	3	2	3	1	5	1	1
D54	5	2	5	3	2	1	NA	NA
D57	2	1	4	3	3	4	3	4
D58	2	1	3	5	3	3	2	3
D61	4	3	7	5	3	2	3	
D62	3	5	3	2	1	3	3	3
D85	2	1	2	3	5	4	3	5

Dam	Number of amphibian species recorded each year							
	2008	2009	2010	2011	2012	2013	2014	2015
D87	NA	NA	NA	0	0	2	1	0
D91	1	0	1	1	1	3	0	2
D92	4	5	4	2	2	4	NA	NA
D112	3	4	8	5	NA	1	NA	NA
D122	4	2	5	4	1	1	1	2
D123	1	1	3	2	1	2	1	1
D125	5	0	7	6	4	4	1	3
D126	4	2	7	4	2	2	1	1
D129	3	2	6	6	2	3	1	2
D130	2	3	2	2	3	3	2	3
D131	NA	NA	NA	NA	3	3	1	2
D142	2	1	2	2	2	3	0	2
D144	3	6	2	2	3	2	0	1
D148	3	3	2	3	4	2	NA	NA
D149	1	2	2	5	1	4	NA	NA
D151	4	3	4	3	4	5	3	2
D152	5	4	3	5	4	3	2	3
D153	4	4	5	5	5	4	5	4
D154	5	4	3	6	2	2	2	2
D157	1	2	1	2	1	2	2	1
D160	5	3	6	5	4	3	5	5
D161	6	2	6	6	5	4	NA	NA
D162	5	2	6	7	4	4	NA	NA
D163	2	2	3	2	0	1	1	1
D167	4	3	2	3	2	2	2	3
D168	5	2	5	2	4	3	1	1
D169	0	0	4	6	0	2	2	1

APPENDIX 4. BIRD SPECIES ABUNDANCE AT TARGET DAMS 2015

Family	Scientific Name	Common Name	Dam No. 7								Dam No. 14								Dam No. 16								Dam No. 28							
			2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015
Waterbirds																																		
Acrocephalidae	*Acrocephalus australis*	Australian Reed Warbler				1	1	1																	NA	NA		1			1		NA	NA
Anatidae	*Anas castanea*	Chestnut Teal									4	40				2				10			1	10	NA	NA	2				1		NA	NA
Anatidae	*Anas gracilis*	Grey Teal										60					6	2		6					NA	NA	5						NA	NA
Anatidae	*Anas superciliosa*	Pacific Black Duck	1	4						2	1	72		1	6		4	2	5	5			3		NA	NA	2	10		10			NA	NA
Anatidae	*Aythya australis*	Hardhead																		1			1	4	NA	NA	3					1	NA	NA
Anatidae	*Chenonetta jubata*	Australian Wood Duck	6				4			2	6	4		10		10	8	10	10	4					NA	NA	26	3	5				NA	NA
Anatidae	*Cygnus atratus*	Black Swan	1						2	2												1			NA	NA			5	1		1	NA	NA
Anhingidae	*Anhinga novaehollandiae*	Australasian Darter					1	1	1										1						NA	NA				1	1	1	NA	NA
Ardeidae	*Ardea ibis*	Cattle Egret																				1		1	NA	NA						4	NA	NA
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	2	1												1									NA	NA			1				NA	NA
Ardeidae	*Nycticorax caledonicus*	Nankeen Night Heron						2															1		NA	NA		1			1		NA	NA
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow							2	2															NA	NA							NA	NA
Charadriidae	*Vanellus miles*	Masked Lapwing		1			1	1		5						1		3	2						NA	NA						2	NA	NA
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican																							NA	NA		1					NA	NA
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant			1											1									NA	NA							NA	NA
Phalacrocoracidae	*Phalacrocorax melanoleucos*	Little Pied Cormorant		1		2	1	1																	NA	NA		1					NA	NA

Family	Scientific Name	Common Name	Dam No. 7								Dam No. 14								Dam No. 16								Dam No. 28							
			2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	4	2	2	3	3	2								1	1							2	NA	NA	2	3	2	3			NA	NA
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant														1			1						NA	NA						1	NA	NA
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe				1		1				2		1	2					4		1	1		NA	NA	2	3			2		NA	NA
Rallidae	*Fulica atra*	Eurasian Coot	4	1	2	8	11	3	2	3						1	1			2					NA	NA	2	1			1	4	NA	NA
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen		2	2		1							2	4	1			2	2		1	1		NA	NA	3	2	1	2	1	2	NA	NA
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	2	10	10	2	1		5	5						8		2				1		6	NA	NA	2	2	2			7	NA	NA
Scolopacidae	*Gallinago hardwickii*	Latham's Snipe							1	2															NA	NA							NA	NA
Total individuals recorded on each dam			**20**	**22**	**17**	**17**	**24**	**12**	**13**	**23**	**11**	**178**	**0**	**14**	**12**	**27**	**20**	**19**	**21**	**34**	**0**	**5**	**8**	**23**	**0**	**0**	**49**	**28**	**16**	**17**	**8**	**23**	**0**	**0**
No. of species recorded on each dam			**7**	**8**	**5**	**5**	**8**	**7**	**6**	**8**	**3**	**5**	**0**	**4**	**3**	**10**	**5**	**5**	**6**	**8**	**0**	**5**	**6**	**5**	**0**	**0**	**10**	**10**	**6**	**5**	**6**	**9**	**0**	**0**
Woodland Birds																																		
Accipitridae	*Circus approximans*	Swamp Harrier	2															1	1						NA	NA							NA	NA
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle													1									3	NA	NA						3	NA	NA
Accipitridae	*Haliastur sphenurus*	Whistling Kite			1											2									NA	NA							NA	NA
Artamidae	*Cracticus tibicen*	Australian Magpie								1								5							NA	NA						1	NA	NA
Artamidae	*Strepera graculina*	Pied Currawong																1							NA	NA							NA	NA
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo																							NA	NA							NA	NA
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike							1	1						1		1							NA	NA						1	NA	NA
Cinclosomatidae	*Psophodes olivaceus*	Eastern Whipbird															1	1							NA	NA							NA	NA
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove													1			1					1		NA	NA							NA	NA
Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough																7							NA	NA							NA	NA

Family	Scientific Name	Common Name	Dam No. 7								Dam No. 14								Dam No. 16								Dam No. 28							
			2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015
Corvidae	*Corvus coronoides*	Australian Raven						3																	NA	NA						1	NA	NA
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo																2							NA	NA							NA	NA
Estrildidae	*Neochmia temporalis*	Red-browed Finch																3							NA	NA							NA	NA
Falconidae	*Falco berigora*	Brown Falcon																							NA	NA						1	NA	NA
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra							1	4						1		4						1	NA	NA						1	NA	NA
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher	1		1							1	1	1	1		1				1				NA	NA			1				NA	NA
Hirundinidae	*Hirundo neoxena*	Welcome Swallow						1		2					8		12	3					2		NA	NA							NA	NA
Maluridae	*Malurus cyaneus*	Superb Fairy-wren						1		5							2	1					2	1	NA	NA					1		NA	NA
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill						1																	NA	NA							NA	NA
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater								3					1			1							NA	NA						8	NA	NA
Meliphagidae	*Manorina melanocephala*	Noisy Miner								8								3							NA	NA							NA	NA
Meliphagidae	*Manorina melanophrys*	Bell Miner													10	20	3	10						5	NA	NA							NA	NA
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater																1					1		NA	NA							NA	NA
Monarchidae	*Grallina cyanoleuca*	Magpie-lark						1	1	1								1						1	NA	NA							NA	NA
Monarchidae	*Myiagra rubecula*	Leaden Flycatcher														1									NA	NA							NA	NA
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole						1							1			1							NA	NA							NA	NA
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler														1									NA	NA							NA	NA
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler								1															NA	NA							NA	NA
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin								1					1	1									NA	NA							NA	NA

Family	Scientific Name	Common Name	Dam No. 7								Dam No. 14								Dam No. 16								Dam No. 28							
			2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015	2008	2009	2010	2011	2012	2013	2014	2015
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler								6															NA	NA							NA	NA
Psittaculidae	*Platycercus eximius*	Eastern Rosella						2		1															NA	NA							NA	NA
Psittaculidae	*Parrot Hybrid*	Eastern Rosella/Mallee Ringneck	7													2									NA	NA							NA	NA
Psittaculidae	*Trichoglossus moluccanus*	Rainbow Lorikeet																4							NA	NA							NA	NA
Psittaculidae	*Psephotus haematonotus*	Red-rumped Parrot								1															NA	NA							NA	NA
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail						2		2						1	2							2	NA	NA						1	NA	NA
Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail								1					2		1								NA	NA							NA	NA
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail					1								1		2	3							NA	NA					1		NA	NA
Zosteropidae	*Zosterops lateralis*	Silvereye								2						1									NA	NA							NA	NA
Total individuals recorded on each dam			**10**	**0**	**2**	**0**	**1**	**12**	**3**	**40**	**0**	**1**	**1**	**1**	**27**	**31**	**24**	**53**	**0**	**0**	**1**	**0**	**6**	**13**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**17**	**0**	**0**
No. of species recorded on each dam			**3**	**0**	**2**	**0**	**1**	**8**	**3**	**16**	**0**	**1**	**1**	**1**	**10**	**10**	**8**	**20**	**1**	**0**	**1**	**0**	**4**	**6**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**8**	**0**	**0**

APPENDIX 5. CONTRIBUTIONS AND QUALIFICATIONS OF KLEINFELDER STAFF

Name	Qualification	Title	Contribution
Gayle Joyce	B. Sc (Forestry) (Hons)	GIS Officer	Map preparation
Daniel O'brien	BSc Env & Mngt (Hons)	Ecologist	Amphibian Survey
Frederick Rainsford	BEnvSc & Mgt (Hons) GradCert Ornithology	Ecologist (Ornithologist)	Bird surveys, report preparation
Nigel Fisher	BSc (Hons) PhD	Ecologist	Flora Surveys, report preparation

APPENDIX 6. LICENSING

Kleinfelder employees involved in the current study are licensed or approved under the *National Parks and Wildlife Act 1974* (License Number: SL100730, Expiry: 31st March 2016) and the *Animal Research Act 1985* to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.

APPENDIX 7. PHOTOS

Emerald Spotted Tree Frog *Litoria peronii*

Eastern Dwarf Tree Frog *Litoria fallax*

Broad Palmed Rocket Frog *Litoria latopalmata*

Smooth Toadlet *Uperoleia laevigata*

Striped Marsh Frog *Limnodynastes peronii*