Appendix 3

Pambalong Nature Reserve Annual Monitoring Report: 2013*

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

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WB13R_101-1151

Pambalong Nature Reserve Annual Monitoring Report 2013

Abel Underground Coal Mine, Beresfield NSW

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Bright People. Right Solutions.

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Pambalong Nature Reserve Annual Monitoring Report 2013

Abel Underground Coal Mine, Beresfield NSW

Kleinfelder Job No. 101 - 1151

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EXECUTIVE SUMMARY

Donaldson Coal Pty Ltd commenced operations at 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 in late 2007 by ecobiological.

This plan identified the need to establish a monitoring plan for Pambalong Nature Reserve (a 34 ha freshwater wetland located between the eastern extent of the Abel coal mine lease and the F3 freeway). The reserve provides critical habitat for wader and water bird species and is part of a chain of protected wetlands including those within Hunter Wetlands National Park. This national park includes the previous Kooragang and Hexham Swamp Nature Reserves, and incorporates Stockton Sandspit and part of Ash Island. The wetland depends on freshwater from Blue Gum Creek to maintain and replenish aquatic and terrestrial habitats in the reserve. Consequently any changes to the quantity and quality of water delivered from the Blue Gum Creek catchment arising from mining activities or subsidence could compromise the ecological integrity of the wetland (ecobiological 2007).

It is estimated that it will be approximately 11 years before there could be any potential for subsidence impacts on Pambalong Nature Reserve. Specific potential detrimental impacts on the wetland could be brought about by increased rates of sedimentation and a decline in the quantity and quality of water, producing a decline in wetland area and an overall loss of aquatic and terrestrial floral and faunal biodiversity. Negative impacts could also result from weeds and/or feral animals, and population increases of exotic species could occur as a result of the reserve ecosystem being weakened by external factors (ecobiological 2007).

This is the fifth annual report to establish baseline conditions at Pambalong Nature Reserve against which any changes over time can be measured and evaluated. It is important that data is collected over approximately the next 11 years to determine what constitutes normal variation so that any impacts resulting from subsidence can be properly identified and addressed with suitable management actions.

The 2012 assessment is similar to previous years in that a similar diversity and abundance of flora and fauna species were encountered. Although issues relating to the management of the reserve still exist (i.e. weed control), overall the reserve appears to be in relatively good ecological condition.

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1. INTRODUCTION

Donaldson Coal Ltd commenced mining during 2008 at a new mine (known as Abel Underground Coal Mine), located approximately 23 km north-west 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 coal mine 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 in 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:

1) farm dams that form a belt across the mine site;
2) subtropical rainforest areas of Long Gully Creek; and,
3) Pambalong Nature Reserve.

The SEMP outlines a monitoring plan for each of these areas by which baseline and subsequent monitoring data are to be gathered to inform future management. This report

forms the baseline report for Pambalong Nature Reserve which forms part of the overall SEMP.

1.1 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 seams to be mined are located under the Black Hill rural residential and adjoining forested areas. Mine access and associated surface infrastructure is located within the existing Donaldson Coal mine open cut void at Blackhill, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) immediately to the north for coal washing and rail transport to the Port of Newcastle (**Figure 1**).

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. A ridgeline associated with Black Hill runs east-west through the proposed underground mine area. Tributaries of Buttai Creek, Viney Creek, Weakley's Flat Creek and Four Mile Creek drain northwards from this ridgeline. A wide catchment containing Long Gully and Blue Gum Creek drains from the ridgeline providing water to the wet swamp at Pambalong Nature Reserve. Some cliff-lines and steeper gullies are located along sections of the Black Hill ridge.

The underground mine area is bounded on the eastern side by Pambalong Nature Reserve and 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 the northern side by existing open cut coal mining activities within the Donaldson and Bloomfield mine leases (**Figure 2**).

Pambalong Nature Reserve consists of 34 ha of predominantly freshwater wetland on the western side of the F3 Freeway, approximately 20 km north-west of Newcastle (**Figure 2**). The reserve was gazetted in December 2000 over former farmland acquired by the Roads and Traffic Authority during construction of the Freeway (DEC 2006).


Bloomfield Open Cut
Abel Pit Head
Donaldson Open Cut
WEAKLEYS DR
JOHN RENSHAW DR
Abel Underground Coal Mine Area
Pambalong Nature Reserve
SYDNEY-NEWCASTLE FWY
GEORGE BOOTH DR
0 0.25 0.5 1 1.5 2 km
Figure 1 - Locality Map
Legend
Abel Underground Coalmine Boundary
Pambalong Nature Reserve
Waterways
NSW
Regional Location
KLEINFELDER
ecobiological
Project Ref: 101-1151
Plot Date: 22/10/2012 16:44
Revision: 001 (gjoyce)
Map Projection:
GDA 1994 MGA Zone 56
Data Sources:
LPI - 2011
OEH - 2012
Kleinfelder Ecobiological - 2012
Disclaimer: This is not an official or a legal map, but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.
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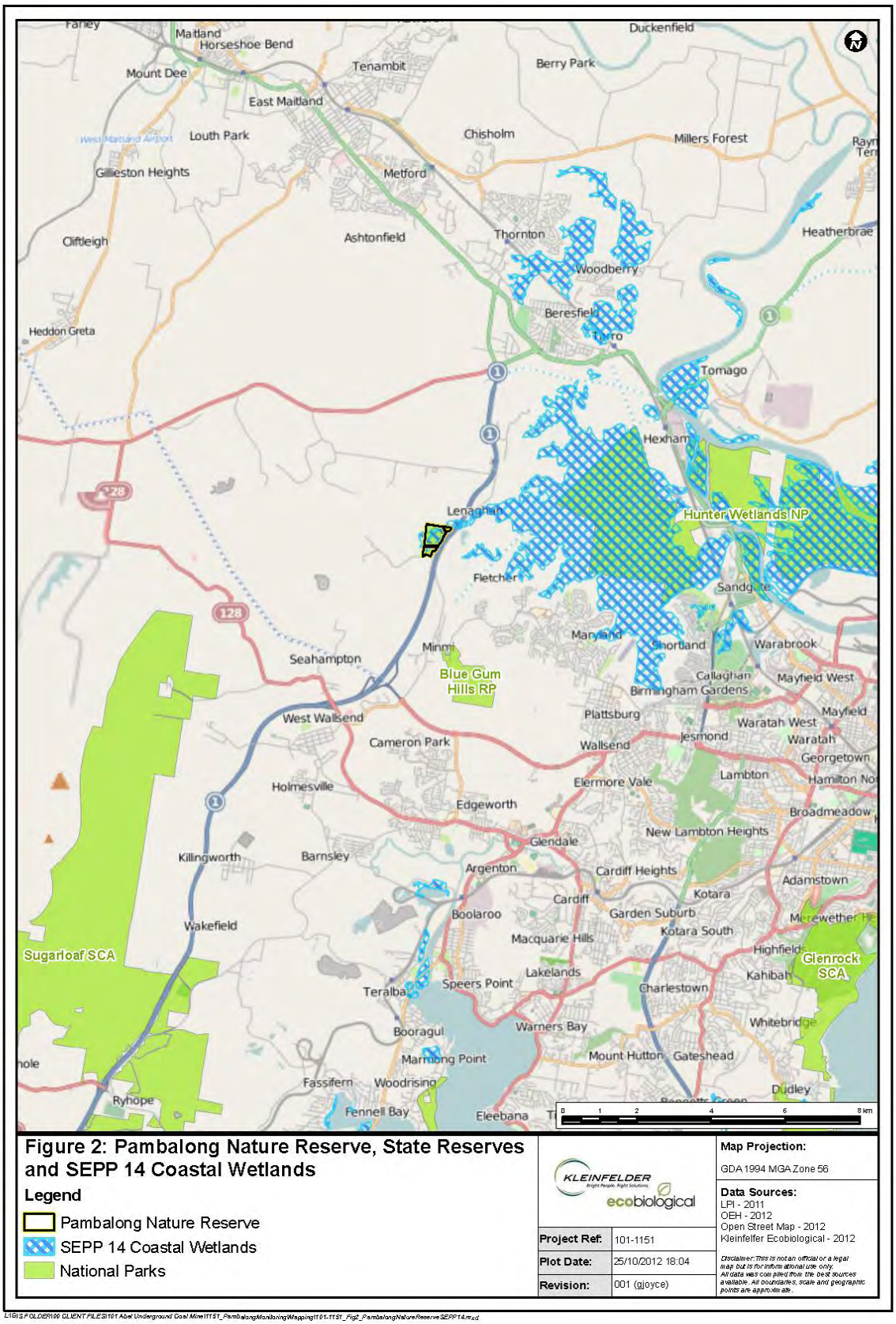

Figure 2: Pambalong Nature Reserve, State Reserves and SEPP 14 Coastal Wetlands

Legend

- Pambalong Nature Reserve
- SEPP 14 Coastal Wetlands
- National Parks

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Project Ref:	101-1151
Plot Date:	25/10/2012 18:04
Revision:	001 (gjoyce)

Map Projection:
GDA 1994 MGA Zone 56

Data Sources:
LPI - 2011
OEH - 2012
Open Street Map - 2012
Kleinfelder Ecobiological - 2012

Disclaimer: This is not an official or a legal map but is for information use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

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2. METHODODOLOGY

2.1 FLORAL DIVERSITY AND VEGETATION MAPPING

Flora and vegetation mapping has been undertaken in accordance with the requirements of the F&FMP. The location of flora survey activities is shown in **Figure 3**.

A base vegetation map of the wetland was prepared in the 2008 monitoring report using a combination of aerial photograph interpretation and ground-truthing to delineate community boundaries. Communities were classified based on the type of habitat provided as well as floristic content and structure. Vegetation community boundaries will be mapped and monitored yearly to identify any variations from year to year.

Two standard 0.04 ha (20 m x 20 m) floristic quadrats (Q1 & Q3), two 0.1024 ha (32 m x 32 m) floristic quadrats (Q2 & Q4) and a 50 m transect were established in representative areas of identifiable vegetation structure. Data collected in these quadrats included total floristic content and the cover abundance score for each species in the plots using the Braun-Blanquet scale which will be applied consistently over time.

Targeted searches for threatened flora species (*Tetratheca juncea*, *Maundia triglochinoides*, *Persicaria elatior* and *Zannichellia palustris*) were also conducted in appropriate communities through random meandering. The location of any threatened flora species were recorded using a GPS.

The surveys also recorded the presence and distribution of weed species across the subject site. The dominant weed species, outbreak areas and recently treated areas were mapped.

Floristic identification and nomenclature was based on Harden (1992, 1993, 2000 and 2002) with subsequent revisions as published on PlantNet (http://plantnet.rbgsyd.nsw.gov.au). Plants listed under the ROTAP scheme (Briggs and Leigh 1995) were also considered in this assessment along with species and vegetation deemed to be of local conservation significance.

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2.2 FAUNAL DIVERSITY

All observation points and transects were established and documented in such a way as to ensure that data collected for each year is from the same location. Faunal diversity monitoring was centred on two transects, one situated in the Spotted Gum – Ironbark open forest fringing the South Swamp and the other situated in the Melaleuca Swamp Forest fringing the Main Swamp.

Table 1 depicts the total trap night count. **Table 2** provides details of survey effort undertaken to record faunal diversity across the subject site. The location of fauna survey activities is shown in **Figure 3**.

Table 1: Trapping statistics for the subject site.

Trap type	Traps	Nights	Trap nights
Elliott A	40	4	160
Elliott B Tree	3	4	12
Elliott B Ground	6	4	24
Cage Trap	4	4	16
Harp Trap	2	4	8
Hair Tubes	8	4	32

Table 2: Fauna survey effort for the subject site.

Survey method	Days/nights	Locations
Anabat recording	2	4
Spotlighting	2	2
Owl call playback	2	3
Frog transect survey	2	3
Bird transect survey	2	2
Bird water body survey	8	3
Roosting bird abundance estimate	2	1
Opportunistic fauna observations	15	Across entire site


Q3
Q4
Q4
T1
Q2
Q1
Q2
0 25 50 100 150 200 Metres
Figure 3: Flora & Fauna Survey Effort
Legend
Pambalong Nature Reserve
Water Bird Survey Locations
Flora Quadrats
Flora Quadrats 2008
Owl Call Playback
HarpTrap
Anabat
Flora Meander 2012
AmphibianTransect
Flora Transect 50m
Bird Survey Transect
TrappingTransect
Frog Call Playback
KLEINFELDER
ecabiological
Project Ref: 101-1151
Plot Date: 22/10/2012 16:27
Revision: 001 (gjoyce)
Map Projection:
GDA 1994 MGA Zone 56
Data Sources:
LPI - 2011
OEH - 2012
Kleinfelfer Ecobiological - 2012
Disclaimer: This is not an official or a legal map, but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.
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2.2.1 Arboreal Mammals

Three Elliott B traps and eight hair tubes were placed in trees at heights of 3 m or above, along two transects and baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps were sprayed with a mixture of honey and water. These traps were checked daily for arboreal species and wafers from the hair tubes were collected after a 4-night period and checked for the presence of hair samples. Hair identification methods followed those of Brunner et al. (2002). If any hair sample was from a vulnerable or endangered species, the sample was sent to Barbara Triggs, an expert in hair identification.

Spotlighting was undertaken along each transect from dusk over two nights to identify the presence of any arboreal mammals. Trees were inspected during daylight hours for the presence of habitat hollows and if present these were watched at dusk to see if any nocturnal birds or mammals emerged.

2.2.2 Terrestrial Mammals

Forty Elliott A, six Elliott B and four cage traps were placed along two transects at regular intervals to target terrestrial mammal species. The traps were baited with a mix of rolled oats, honey, peanut butter and treacle and set in position for four consecutive nights and checked each morning.

Spotlighting was undertaken along each transect from dusk over two nights to identify the presence of any terrestrial mammals. Careful daytime searches were conducted to detect the presence of fauna activity such as diggings, droppings or scratch marks.

2.2.3 Bats

A harp trap was erected along each transect in bat 'flyways' such as across a track at the South Swamp and in a natural forest opening in the Main Swamp to maximise the likelihood of captures. The harp traps were set in position for four consecutive nights and checked each morning. Bats captured were identified in the field and placed in specially designed 'soft release' boxes which were tethered to nearby trees to enable the bats to shelter during the day and exit at nightfall.

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Anabat II bat-call recorders (Titley Electronics, Ballina) were used to record the calls of any Microchiropteran bats feeding in the area. The units were set up at dusk and recording occurred for a total of four hours at four locations over two nights. Spotlighting searches of blossoming trees were also undertaken to identify any Megachiropteran bat species.

2.2.4 Birds

A bird survey of vegetation fringing the Main Swamp and South Swamp was undertaken by walking the lengths of each trapping transect for 20 minutes on 7 October 2012 and 13 October 2012 (**Figure 3**).

Four surveys (two dusk and two dawn) of each water body (North, Main and South) were undertaken approximately 1-week apart in Spring (October 2012) and replicated in Autumn (March 2013). A permanent monitoring location was established during the baseline survey at each site and marked with a star picket to allow replication in future years. One observer undertook all surveys which involved a 20-minute survey of all birds seen and heard within the radius of each monitoring location (focusing on open water bodies). Birds were identified by sight, with the aid of binoculars or a spotting scope, or by their calls.

Bird surveys were conducted in the morning or late afternoon when bird activity is maximised (Bibby et al. 2000). Opportunistic sightings were also recorded and listed separately to actual survey results. Transect surveys were intended to record species diversity, not density whereas water body surveys were designed to assess water bird density, therefore counts, wherever possible, or density estimates were made to facilitate statistical comparison in future years.

At the completion of one of the dusk surveys in October 2012 and one of the dusk surveys in March 2013, an abundance estimate of birds roosting in the Melaleuca Swamp Forest within the Main Swamp was undertaken. This method is replicated at approximately the same time (on nightfall) each year to facilitate statistical comparison of changes in roosting bird density and/or diversity.

After dark the calls of threatened owl species (Powerful Owl, Masked Owl, Sooty Owl, Barking Owl and Grass Owl) were broadcast over a megaphone in an attempt to encourage a call back response. The subject site was also searched to locate any regurgitated owl pellets. The size, shape and content of any pellets found were analysed to determine the

species of owl from which the pellet originated as well as the prey species the owl had been feeding on. Analysis methods followed those of Brunner et al. (2002) and Triggs (1996).

2.2.5 Amphibians

Standardised survey techniques for amphibians were carried out at each of the three main water bodies in the reserve across four days and nights. Survey techniques included diurnal habitat searches, nocturnal spotlight surveys, call playback and dip netting for tadpoles. During diurnal surveys, dip netting and visual searches were carried out to locate any tadpoles present in any water bodies. During nocturnal surveys, spotlight searches were carried out by walking lengths of suitable habitat and using head torches to search for frogs by eye shine or by physical sightings. Call playback for the endangered Green and Golden Bell Frog was carried out due to the species' historical occurrence at the site and suitable habitat being present.

Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Tadpoles were keyed out using diagnostic features including mouthparts (tooth rows, jaw sheaths and papillae), pigmentation, body size, tail structure (musculature, fin depth, fin shape, tip shape), eye direction and spacing, pupil pigmentation, nare shape and spacing, spiracle height and direction, vent length and direction, and tadpole behaviour according to Anstis (2002).

2.2.6 Feral Fauna

Several species of feral fauna such as Black Rats, rabbits, foxes, Common Myna, Spotted Dove, House Sparrow, Red-whiskered Bulbul and Common Starling have previously been recorded within the reserve (HBOC 1990 – 2008; Straw 2000; White 2000). The biodiversity of the reserve can be negatively impacted by these species. Observations of any introduced species were recorded during field surveys of the subject site. Liaison with the NSW Office of the Environment & Heritage (OEH) staff throughout the monitoring process is undertaken to address any evidence of increasing numbers of feral fauna within the Reserve.

3. RESULTS AND DISCUSSION

3.1 WEATHER CONDITIONS AND SURVEY ACTIVITIES

The prevailing weather conditions throughout the trapping survey period (15 – 24 October 2012) at the subject site were warm to hot days and mild nights with partly cloudy skies and light winds. A full list of survey activities and weather conditions during the survey period are provided in **Table 3**.

Table 3: Weather conditions throughout the survey period

Activity	Day	Date	Weather Conditions
Flora			
Transect and plot surveys and vegetation community mapping	Mon	22/10/2012	Cool, partly cloudy, no rain, moderate breeze
Threatened species search and weed surveys	Mon	22/10/2012	Cool, partly cloudy, no rain, moderate breeze
Fauna			
Trapping	Mon-Fri	15-19/10/12	Warm to hot days, cool nights, no rain, cloudy at times and light to moderate winds.
Amphibian survey	Wed	12/12/12	Mild, partly cloudy, no rain, calm
Amphibian survey	Tues	23/10/12	Cool, partly cloudy, no rain, moderate breeze
Reptile survey	Tues	23/10/12	Warm, partly cloudy, no rain, slight breeze
Reptile survey	Wed	24/10/12	Warm, clear skies, no rain, calm
Nocturnal field work (Spotlighting, owl call playback, Anabat recording	Mon	16/10/12	Cool, partly cloudy, no rain, slight breeze
	Tues	17/10/12	Cool, partly cloudy, no rain, calm
Bird survey – Dusk water body surveys	Wed	7/11/12	Warm, overcast, no rain, slight breeze
	Tues	13/11/12	Warm, overcast, no rain, slight breeze
Bird survey – Dawn water body surveys, transects	Thurs	18/10/12	Mild, humid, overcast, no rain, calm
	Wed	24/10/12	Warm, clear skies, no rain, calm

3.2 GENERAL ENVIRONMENTAL MONITORING

Changes in the wetland and surrounds could be caused by a variety of events not associated with mining such as rainfall levels, bushfire events and large-scale farming activities (ecobiological 2007). No significant bushfire events occurred within the proximity of Pambalong Nature Reserve during 2012 and Kleinfelder is not aware of any large-scale

farming activities such as clearing, road construction or dam building in the surrounding area that is likely to impact water flow or quality.

Presently, there is no rainfall monitoring station at Pambalong Nature Reserve or within immediate proximity that can provide reliable long-term rainfall data. Instead, historical rainfall data has been sourced from the East Maitland Bowling Club weather station (Source: Rainman Streamflow v4) as it is relatively close by (~10 km to the north of Pambalong and a similar distance inland) and provides rainfall data over a 110-year period (1903 – 2013). Historical mean monthly rainfall (mm) from 1903 – 2013 and monthly rainfall (mm) from 2008, 2009, 2010, 2011, 2012 and 2013 is presented for comparison in (**Table 4**).

Table 4: East Maitland Bowling Club weather station Data

Yearly actuals and the historical mean	J	F	M	A	M	J	J	A	S	O	N	D	Total
2008	182	174	45	224	7	123	42	22	183	76	89	74	1241
2009	12	267	53	125	73	75	24	2	24	67	44	58	824
2010	65	53	86	22	73	111	62	32	20	60	192	63	839
2011	36	37	47	140	91	162	86	56.5	75	104	141	67	1042.5
2012	84	174	102	79	12	125	45	14	22	7	46	45	753
2013	140	134	-	-	-	-	-	-	-	-	-	-	-
Mean 1903-2012	84	98	96	83	69	84	55	49	55	61	65	82	880

Below average rainfall was recorded throughout most of 2012 compared with the historical average (1903-2012), with the exception of March and June. In 2013, there has been a significant amount of rainfall to date exceeding the monthly average by 36-56mm. Rainfall fluctuated greatly throughout the past 12 months with some months being significantly more or less than the historical average. Due to the lack of rainfall up until January 2013 the water level within each of the waterbodies had dropped exposing areas that would otherwise be inundated. **Figure 4** illustrates differences in average rainfall between each season's actual rainfall (mm) and the average seasonal rainfall recorded between 1903 – 2012. Bars that drop below zero indicate that the season has experienced below average rainfall whilst bars that rise above zero indicate hat the season has experienced above average rainfall. Is it evident that Autumn and Spring of 2012 are well below the seasonal average.

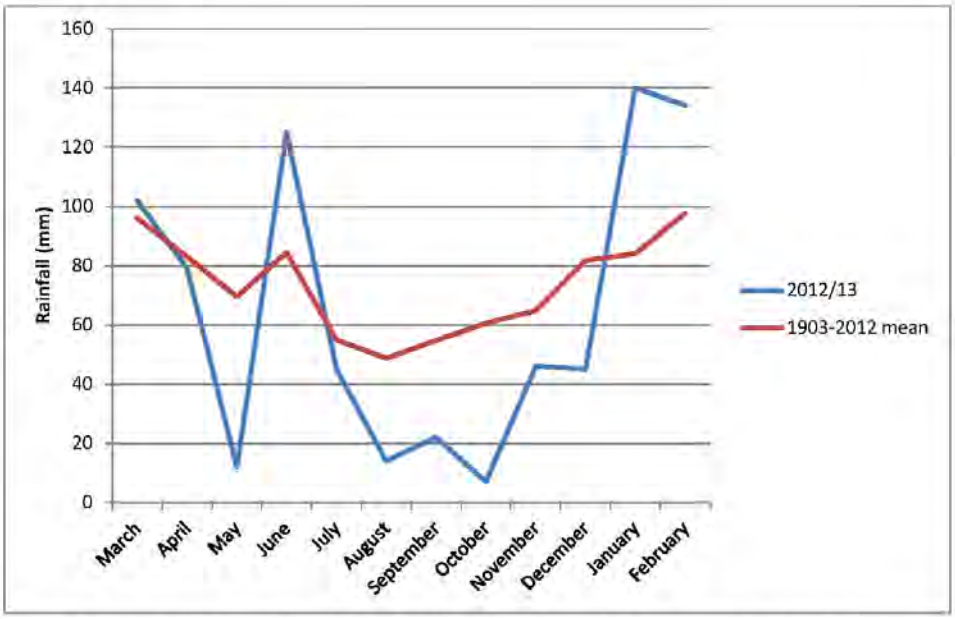

Figure 4: **Actual monthly rainfall for 2012/13 survey period compared to historical monthly average (1903-2012)**

The F&FMP (ecobiological 2007) recommends that sufficient weather stations be established in order to record rainfall in the catchment. This would assist in the collection of more accurate rainfall data over the next 10 – 15 years of pre-mining monitoring.

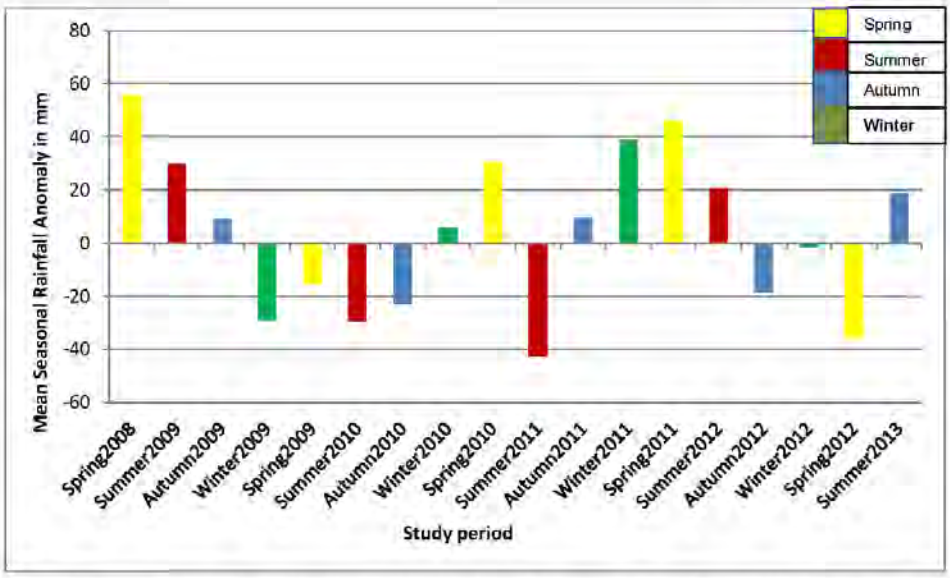

Figure 5: **Seasonal rainfall (mm) anomaly during the study period compared with mean monthly rainfall (mm) from 1900 – 2011**

The installation of permanent water depth indicators in the Main and South Swamps would also be useful to provide a quantitative level during each survey event. Permission for installation should be sought from OEH.

3.3 FLORA RESULTS

Flora surveys for this report were conducted during October 2012. A total of 188 flora species have been identified on the site since surveying commenced in 2008 within four survey quadrats, a 50 m transect and a meandering survey (**Appendix 1**).

The Coastal Foothills Spotted Gum - Ironbark Forest (Q1) has previously been found to contain the highest species diversity of the flora plots surveyed in the Reserve (**Plate 1**). Floral diversity has increased each year since 2008 (**Figure 6**). Although flora diversity was similar in 2012 to previous years, three flora species were recorded for the first time. These included *Lomandra glauca*, *Digitaria parviflora* (Small-flowered Finger Grass) and *Paspalidium distans*. The most significant weed recorded in this plot is Lantana (*Lantana camara*).

Overall, the vegetation community appears to be in a relatively good state of health with no obvious signs of decline.

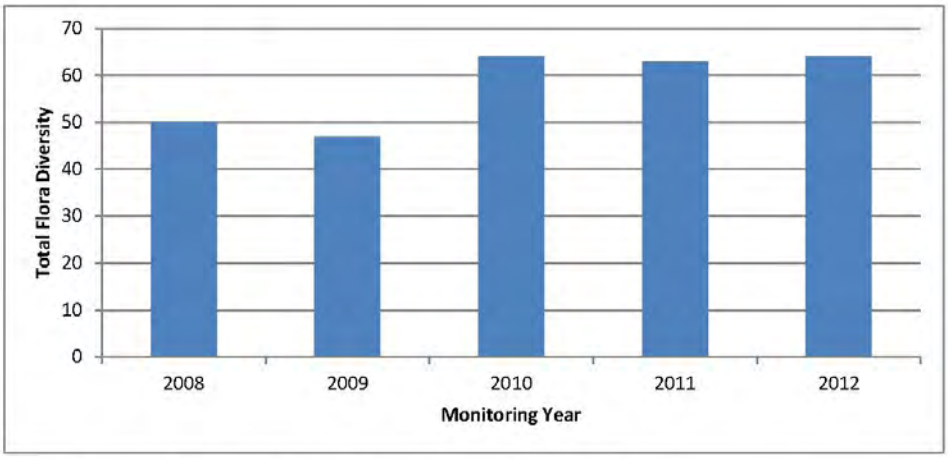

Figure 6: **Total Flora diversity within Q1 from 2008 to 2012**

Plate 1: **Flora quadrat 1 located in Coastal Foothills Spotted Gum - Ironbark Forest. Photograph taken in 2012.**

Ten flora species were recorded in the Freshwater Wetland Complex (Q2) in 2008 (**Plate 2**). This quadrat was relocated in 2009 following an OEH recommendation. It was thought that the new placement of the quadrat would provide data more relevant to the scope of the survey.

Floral diversity has decreased slightly within the quadrat over the past few years (**Figure 7**). This variation is likely to be due to natural seasonal variation. Two new flora species were identified in 2012. These included the exotic species, *Vicia sativa* subsp *sativa* (Common Vetch) and the native species *Ranunculus inundatus* (River Buttercup).

Overall the wetland appears to be in good health in that the dominant species are native (i.e. *Typha orientalis*, *Bolboschoenus caldwellii* and *Eleocharis equisetina*). The majority of exotic species occur in low abundance.

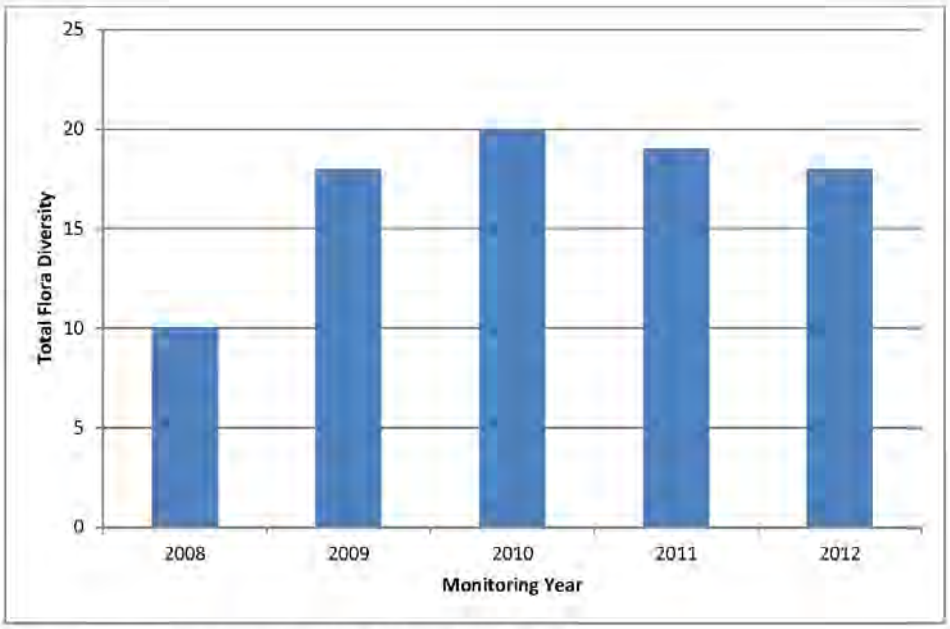

Figure 7: **Flora diversity within Q1 from 2008 to 2012**

Plate 2: **Flora quadrat 2 located in Freshwater Wetland Complex dominated by Typha. Photograph taken in 2012.**

Floral diversity in the Paperbark Swamp Forest (Q3) has varied over the survey period (**Figure 9, Plate 3**). The number of species recorded in 2012 was slightly less than the past three years of monitoring. This is likely to be due to natural seasonal variation and also due to changes in the amount of standing water within the swamp during the sampling period. The swamp was much drier in 2012 compared to 2011. The 2012 conditions have allowed the proliferation of *Sigesbeckia orientalis* subsp *orientalis*. There is some debate as to whether this species is native or exotic (Bean 2007). It is likely that as the swamp returns to a wetter state, the abundance of this species will decrease.

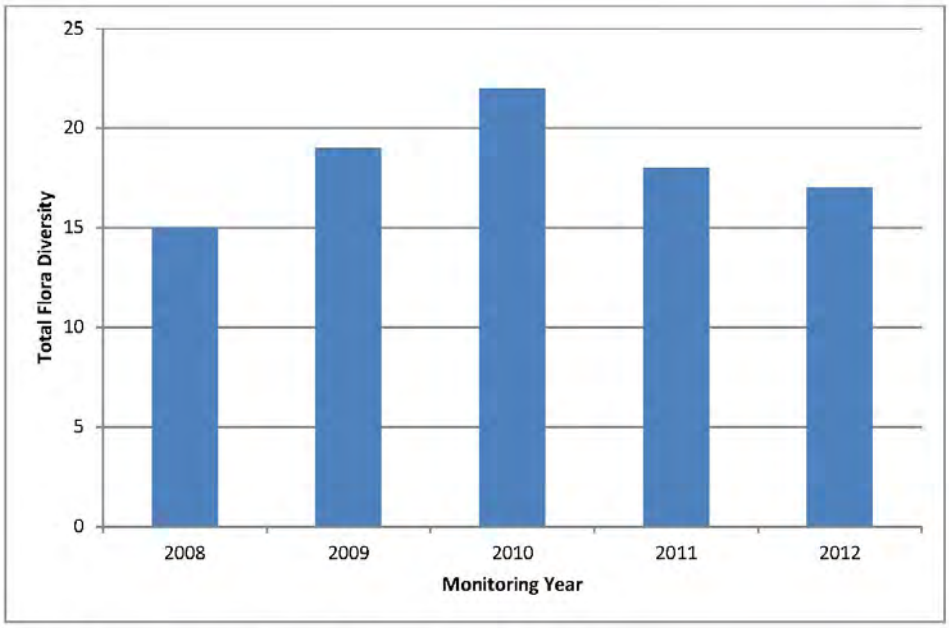

Figure 8: Flora diversity within Q3 from 2008 to 2012

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Plate 3: Flora quadrat 3 located in Paperbark Swamp Forest. Photograph taken in 2012.

A total of 12 species were recorded in the Paperbark Swamp Forest (Q4) in 2008 (**Plate 4**). This quadrat was relocated as per a request from the OEH (I.e. the new location was considered to be likely to produce more informative seasonal data). There has been a gradual decrease in the number of flora species recorded during the past four years (**Figure 9**). This is likely to be due to natural seasonal variation.

Alternanthera philoxeroides (Alligator Weed) has been recorded in both 2011 and 2012. The abundance of this noxious weed has increased slightly since it was first detected; however, at this stage it is causing only minor impacts (i.e. does not appear to be out-competing native vegetation).

Water Hyacinth (*Eichhornia crassipes*) continues to persist at the location in moderate densities.

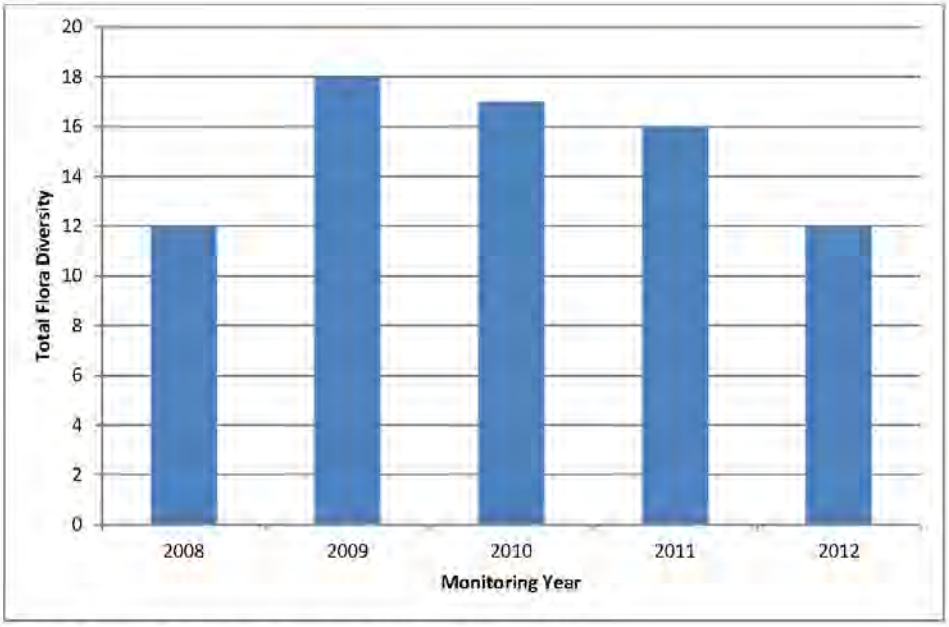

Figure 9: Flora diversity within Q4 from 2008 to 2012

Plate 4: **Flora quadrat 4 located in Paperbark Swamp Forest. Photograph taken in 2012.**

The species richness of the flora transects has remained relatively static over the monitoring period (**Figure 10**). A total of 13 species have been detected during each survey event with the exception of 2011 when *Cynodon dactylon* (Couch) was not detected.

Water Hyacinth (*Eichhornia crassipes*) continues to persist at the location at high densities, although there has been some reduction in surface area due to herbicidal treatment as part of the Pambalong nature reserve enhancement project.

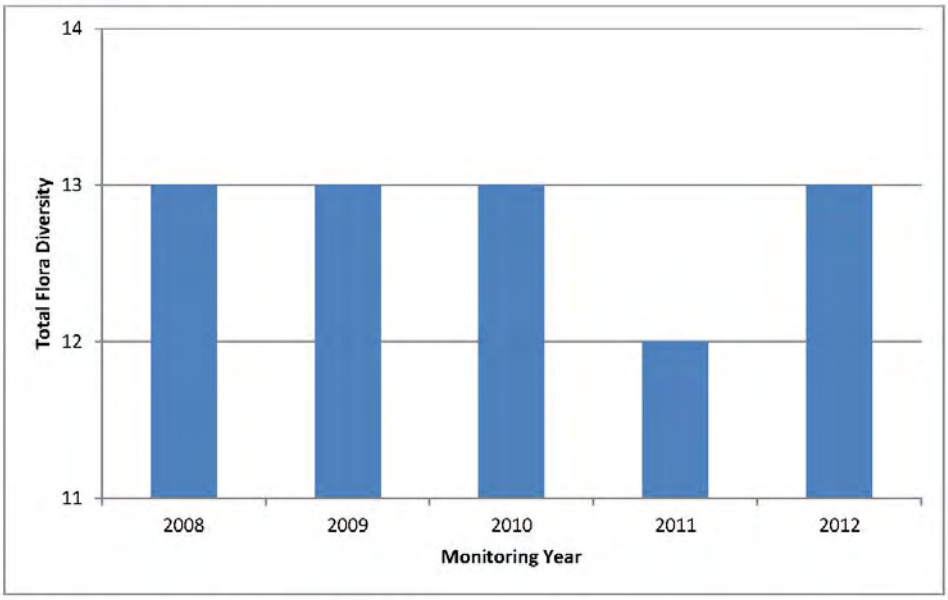

Figure 10: **Flora diversity within T1 from 2008 to 2012**

Plate 5: **Flora transect located in Freshwater Wetland Complex. Photograph taken in 2012.**

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No threatened flora species were recorded during the field surveys. Three species considered as regionally significant by Eco Logical (2003) were detected in the surveys, including *Cyperus odoratus*, *Melaleuca linariifolia* and *Enydra fluctuans*. All three species have been recorded in previous studies.

3.4 WEED SPECIES

The reserve had significant weed infestations across both disturbed areas and within the natural vegetation. The primary weeds at the time of survey were:

- **Water Hyacinth** (*Eichhornia crassipes*) – this species can survive for a long time and when conditions are favourable, can spread rapidly and cover large areas of open water. This rapid spread can choke out sunlight for natural inundated plant species and reduce open water access and usage for water birds. The life cycle of this plant means that it would continue to become established from both local and regional sources as it can float downstream and seeds can be delivered by itinerant birdlife.

  This weed species was found dominating the water outlet from the Main Swamp to the North Swamp during the first monitoring event in 2008 (**Plate 6**). Prior to the 2009 monitoring event, some Water Hyacinth has been extracted from the open water and a grate installed to prevent this weed blocking the under road culvert (**Plate 7**).

  The 2012 monitoring event found that the coverage of *Eichhornia crassipes* has decreased from the previous year due to weed spraying (Pambalong nature reserve enhancement project) (**Appendix 5**). The spraying has resulted in more open water present in the North Swamp (**Plate 10**).

  Water Hyacinth is a declared Class 4 Noxious Weed in Newcastle, Cessnock and Maitland and the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority. Ongoing management would need to be coordinated through local government and stakeholders. The NPWS Hunter Region Pest Management Strategy (2002) has identified control of Water Hyacinth at Pambalong Nature Reserve as a "high priority" and an active program has been operating in the reserve since 2002.

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Plate 6: **Water Hyacinth at the Northern Swamp inlet in 2008.**

Plate 7: **Water Hyacinth at the Northern Swamp inlet in 2009 (shows grate construction).**

Plate 8: **Water Hyacinth at the Northern Swamp inlet in 2010.**

Plate 9: **Water Hyacinth at the Northern Swamp inlet during the 2011 monitoring event.**

Plate 10: **Water Hyacinth at the Northern Swamp inlet during the 2012 monitoring event.**

- **Kikuyu (*Pennisetum clandestinum*)** is forming dense, monoculture grassy thickets within disturbed areas of the subject site (**Plate 11**). The thickets are preventing any other growth at the wetland edges which is in turn preventing natural vegetation recruitment.

  Kikuyu is a species listed under the Key Threatening Process (KTP) *'Invasion of native vegetation communities by exotic perennial grasses'*.

  The boundary of Kikuyu dominance is restricted by the hydrological regime, generally adjacent to the high water mark, and the thickets are unlikely to spread into the wetland areas.

  Large densities of Kikuyu were identified in the north-west and south-east corners of the subject site (**Figure 11**).

Plate 11: **Kikuyu in the north-west corner of the reserve.**

- **Blackberry (*Rubus fruticosus aggregate*)** is found in areas of previous disturbance within the reserve, and forms a dense thicket to 1 m high, preventing natural regeneration. Blackberry thickets can restrict fauna access to the wetland areas and provide shelter for feral animals. Blackberry is a declared Class 4 Noxious Weed in Newcastle, Cessnock and Maitland and the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority (the plant may not be sold, propagated or knowingly distributed).

  The NPWS Hunter Region Pest Management Strategy (2002) identifies Blackberry as a "high priority" weed. Outbreaks of this species were treated in 2008; however, regrowth and regeneration of this species was recorded during the 2012 monitoring event. Follow up treatment is required to eradicate/suppress re-establishment of this species.

- **Lantana (*Lantana camara*)** is a primary weed of the dry sclerophyll woodland at the southern portion of the subject site. This species is dominating the shrub and mid stratum, effectively out-competing native species. The thickets of Lantana reduce the natural plant biodiversity and also offer refuge for feral animals.

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The '*Invasion, establishment and spread of Lantana camara*' is listed as a Key Threatening Process (KTP) under the NSW TSC Act.

Lantana is a declared Class 4 Noxious Weed in Cessnock and Class 5 Noxious Weed in all of NSW. The NPWS Hunter Region Pest Management Strategy (2002) identifies Lantana as a "high priority" weed, although at this stage there is no specific control program for this species in the reserve.

- **Crofton Weed (*Ageratina adenophora*)** is tolerant of wet soils and will extend into wetlands if unmanaged. This species is a Noxious Weed and control is required where the weed is found. The NPWS Hunter Region Pest Management Strategy (2002) identifies Crofton Weed as a "high priority" weed, although at this stage there is no specific control program for this species in the reserve. There were no significant outbreaks of this species recorded in the 2012 surveys.

  Crofton Weed is a declared Class 4 Noxious Weed in Newcastle, Cessnock and Maitland and the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

- **Alligator Weed (*Alternanthera philoxeroides*)** may infest both terrestrial and aquatic environments. Although only a few small plants were identified, this species is known to have the potential to cause severe impacts and should continue to be closely monitored. Alligator Weed has the potential to infest waterways and invade adjoining land. Alligator Weed is easily spread and once established it is virtually impossible to eradicate. It is a declared noxious weed and eradication measures are required. The NPWS Hunter Region Pest Management Strategy (2002) identifies Alligator Weed as a "high priority" weed.

Other weeds found at the subject site were general weeds of disturbed areas (e.g. former rail line, roadsides etc.) and pastures. These weeds are confined to the fringes of the reserve, roadsides and the former rail line. Generally these species are located outside the natural vegetation areas.

Other significant weeds not identified during field surveys but which have the potential to occur were:

- **Noogoora Burr (*Xanthium occidentale*) –** has been identified from previous studies. The NPWS Hunter Region Pest Management Strategy (2002) identifies Noogoora Burr

as a "high priority" weed, although at this stage there are no specific control programs for this species in the reserve.

Legislation requires that noxious weeds be controlled. Alligator Weed, Blackberry, Crofton Weed, Water Hyacinth and Lantana are considered noxious in the Newcastle, Maitland and Cessnock City Council LGA's.

Some naturally occurring species may also present a problem if they become too abundant. Typha (*Typha orientalis*) and Phragmites (*Phragmites australis*) have the potential to spread into areas of open water, restricting the habitat of species preferring or utilising open water, such as pelicans, ducks and swans. If these native plant species threaten the habitat value of the reserve, they may also require control.

3.5 VEGETATION COMMUNITIES

Three natural vegetation communities and associated variations, and two altered vegetation types were mapped on the subject site in 2008 (**Figure 12**). The community extent did not change in the 2012 surveys.


N
0 25 50 100 150 200 Metres
Figure 11: Weed Species Mapping
Legend
Pambalong Nature Reserve
Blackberry (Treated 2009)
Water Hyacinth (Treated 2009)
Water Hyacinth
Lantana
Kikuyu and Various Weeds
KLEINFELDER
ecabiological
Project Ref: 101-1151
Plot Date: 25/10/2012 18:05
Revision: 001 (gjoyce)
Map Projection:
GDA 1994 MGA Zone 56
Data Sources:
LPI - 2011
OEH - 2012
Kleinfelfer Ecobiological - 2012
Disclaimer: This is not an official or a legal map, but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.
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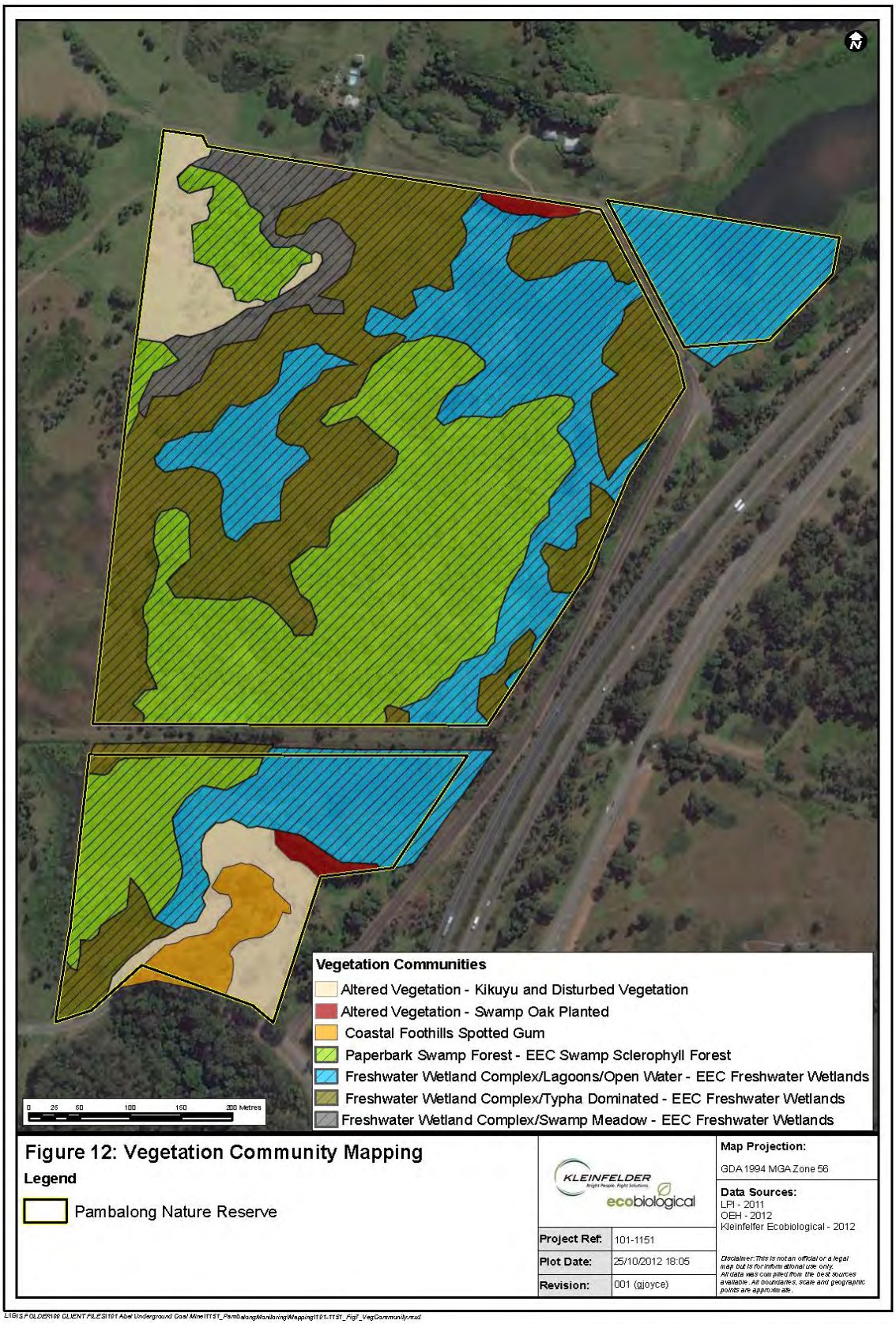
Vegetation Communities
Altered Vegetation - Kikuyu and Disturbed Vegetation
Altered Vegetation - Swamp Oak Planted
Coastal Foothills Spotted Gum
Paperbark Swamp Forest - EEC Swamp Sclerophyll Forest
Freshwater Wetland Complex/Lagoons/Open Water - EEC Freshwater Wetlands
Freshwater Wetland Complex/Typha Dominated - EEC Freshwater Wetlands
Freshwater Wetland Complex/Swamp Meadow - EEC Freshwater Wetlands
0 25 50 100 150 200 Metres
Figure 12: Vegetation Community Mapping
Legend
Pambalong Nature Reserve
KLEINFELDER
ecobiological
Project Ref: 101-1151
Plot Date: 25/10/2012 18:05
Revision: 001 (gjoyce)
Map Projection:
GDA 1994 MGA Zone 56
Data Sources:
LPI - 2011
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