Wanganella Swamp:

Ecological Monitoring of the 2010/11 Flood Event

Prepared for

Murray Catchment Management Authority,
Yanco Creek and Tributaries Advisory Council
and
NSW Office of Environment and Heritage

by

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February 2012

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Report prepared for:	Murray Catchment Management Authority, Yanco Creek and Tributaries Advisory Council and the NSW Office of Environment and Heritage.
Front cover photo:	Brolga pair, Wanganella Swamp: Philip Maher

"This project was funded by the Murray Catchment Management Authority, the Yanco Creek and Tributaries Advisory Council and the NSW Office of Environment & Heritage."

Acknowledgements

The following people provided assistance during the monitoring of the ecological response of Wanganella Swamp to the 2010-2011 flood:

- Simon Campbell (Murray CMA) produced the flood extent map and Figures 1 and 2,
- Anthony Conallin (Murray CMA) and Terry Morphett (NSW Office of Water) supplied water depth loggers and interpreted results recorded by the depth loggers,
- Colin Hood and Adam McLean (State Water) provided flow data from the various recording stations along the Billabong/Yanco Creek system,
- Emma Wilson (NSW Office of Environment & Heritage (OEH)) provided advice and assistance in the field collecting vegetation data and assisted with water quality recordings and frog survey;
- Sascha Healy (OEH) conducted the frog survey and provided data;
- David Bishop (OEH) managed emergency on-ground works.

All of these people improved the value of the monitoring and/or flow management and ensured that a multi-agency approach was undertaken.

Wanganella Swamp's land owners/managers [Colin McCrabb (Avenel), Michael Mullins (Riverina LHPA), Bill Newton (F.S. Falkiner & Sons)], Sally Dye (Murray CMA) and Ned

Hamilton (State Water) were part of a larger steering committee which provided support and guidance to ensure that the best ecological outcome from the flood event and environmental flow was achieved.

Comments on earlier drafts of this report by Anthony Conallin and Emma Wilson, significantly improved its content.

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Summary

Wanganella Swamp is a significant natural resource asset of the Billabong Creek catchment in southern NSW. In 2010/11 flood waters from the Billabong Creek and Murrumbidgee River catchments flooded the wetland for the first time since November 2006, initiating a major bird breeding event. To ensure successful completion of the breeding event, environmental water was applied to the wetland in conjunction with flood waters to maintain minimum water levels within the wetland for the duration of the breeding cycle and to ensure the majority of young birds fledged successfully. To gauge the success of this event and to improve the management of future events, a monitoring program was conducted (from November 2010 to May 2011) to examine the relationship between creek flows, environmental water and wetland water levels, bird breeding and to compare changes in vegetation dynamics with historic surveys.

Hydrology (natural flooding and environmental allocation)

The duration of the 2010-2011 flood event spanned from September 2010 to May 2011. This event consisted of an initial natural flow event in September and was followed by four natural flood peaks (early-mid November, late December, late February, mid-late March). Flow-extent mapping indicated that approximately 539 ha of the Wanganella Swamp complex was inundated on the 20 January 2011 at a gauge height of 0.62 m at Eight Mile Creek. This area included 457 ha of Eight Mile Creek and 82 ha of Clarke's Creek. Examination of flow data from gauges within the Swamp and further upstream indicate that approximately 700-800 ML/day is required over Warriston Weir (Forest Creek) to inundate the Swamp to this extent. Water level data indicated that the flood peaked later at 0.73 m on 22 March and 8 April 2011, however, detailed bathymetry is not available to determine the maximum extent of area flooded at this level.

Water supply to Wanganella Swamp from Eight Mile Creek is dependent on discharge in the Billabong and Forest Creeks. Hartwood Weir on the Billabong Creek needs to maintain a reasonable discharge to facilitate adequate flow into the Forest Creek off-take which in turn, ensures adequate flows over Warriston Weir (Forest Creek) into Eight Mile Creek. The minimum flow over Hartwood Weir to ensure a flow down Forest Creek is 200 ML/day. The flow over Warriston Weir to ensure a flow along Eight Mile Creek is dependent on the conditions within the Forest/Eight Mile Creek system below Warriston Weir. If the Forest/Eight Mile Creek is completely full (i.e. the channel contains water and the pools behind existing structures are full) and all existing structures (Piccaninny Creek off-take, Junction Weir and Mortimer's Dam) are fully functional then a flow of 60 ML/day will ensure a flow along Eight Mile Creek. However, if the system is dry as was the case in 2010 then a much larger flow is needed. To fill the Wanganella Swamp (470ha) to a depth of 0.5m would require at least 2 350 ML. If complete inundation of the wetland complex (539ha) is required as occurred in 2010/11 then 2 695 ML is required. **(Note: These figures are the totals required to fill the wetland and do not include the volumes required to deliver the water to Wanganella Swamp.)** Additional water is then required to maintain this area of inundation and future calculations of this amount will need to take into account losses below Warriston Weir.

The Finley Escape can be used to supply environmental water to the Wanganella Swamp. However, Finley Escape discharges directly into the Billabong Creek upstream of Hartwood Weir and therefore not all of the discharge can be diverted into the Forest Creek particularly when flows over Hartwood Weir are low. For flow from the Finley Escape to enter Forest Creek, the flows over Hartwood Weir need to be at least 200 ML/day and even at this flow, ~40% of discharge from the Escape continues down the Billabong Creek. Environmental water delivery from this and other escapes is also dependant on minimum flows in the Forest Creek downstream of Warriston Weir. If the Creek system is already full, the minimum flow required to deliver environmental water to the Swamp is 80 ML/day.

During the study, discrepancies between gauged flows entering the Forest Creek and those passing through Wanganella Swamp suggested that major losses of water were occurring upstream of the Swamp, possibly through Piccaninny Creek and Forest Creek at Mortimer's Dam. This requires further investigation.

An adaptive environmental water allocation, totalling 12,766ML (plus 235.5 ML of transmission losses), was made available to Wanganella Swamp from January to May 2011 to maintain minimum water levels within the Swamp to support the large-scale bird breeding event that had been triggered by the preceding natural flow event. The delivery of environmental water was initiated due to a decrease in flow over Warriston Weir in January 2011 which threatened the bird breeding event. However, due to exceptional rainfall events in February and subsequent high flows throughout the Yanco/Billabong catchment in this period, delivery of the environmental water was suspended for approximately two months (10/02/11 to 9/04/11). In April 2011 the environmental water delivery was recommenced and continued until the 02/05/11.

It is difficult to determine what volume of the delivered 12,766 ML of environmental water actually reached Wanganella Swamp due to a number of factors including:

i) only a portion of the flows out of Finely Escape pass over Hartwood weir;
ii) break-out flows back to Billabong Creek from Eight Mile Creek occur via Piccaninny and Forest Creeks upstream of the Swamp;
iii) occurrence of exceptionally heavy rainfall events whilst environmental water was in transit to the Swamp;
iv) limited gauging points along the Forest Creek system, and
v) unknown travel times between delivery points for environmental water and the Swamp.

Overall, the delivery method for environmental water to Wanganella Swamp used in 2010/2011 is inefficient; however, it was the only option available. Consideration of alternative water supply methods to Wanganella Swamp is highly recommended for future applications of environmental water. Webster and Davidson (2010) proposed a number of ways in which water could be delivered more directly and efficiently to the Swamp. These suggestions should be reviewed and investigated further, ensuring that any relevant information gathered from this monitoring study is incorporated.

Vegetation:

Monitoring of six vegetation transects identified a total of 44 species (34 native and 10 introduced species). A comparison with a previous vegetation survey revealed

significant changes in floristics from an aquatic plant dominated flora to one that was both aquatic and terrestrial and is probably more typical of the floristic diversity that occurred prior to Wanganella Swamp being permanently inundated. This change in floristics does not appear to have been detrimental to the fauna utilising the wetland during the current flood event. However, continued monitoring will ensure that key species for bird breeding (e.g. Cumbungi *Typha* sp., Spike-rush *Eleocharis* spp., Lignum *Muehlenbeckia florulenta*, Nitre Goosefoot *Chenopodium nitrariaceum*) are maintained now the wetland has been returned to an ephemeral state. (see recommendations section)

Birds:

A total of 55 water bird species were observed between October 2010 and May 2011 utilising Wanganella Swamp during the 2010/11 flood. Twenty-six species of waterbirds were observed breeding. During the 2010/11 flood Wanganella Swamp provided habitat for five threatened species (Freckled Duck *Stictonetta naevosa*, Blue-billed Duck *Oxyura australis*, Australasian Bittern, Brolga *Grus rubicunda* and Australian Painted Snipe *Rostratula australis*) and 6 species (Eastern Great Egret *Ardea modesta*, Cattle Egret *Ardea ibis*, Glossy Ibis *Plegadis falcinellus*, White-breasted Sea-Eagle *Haliaeetus leucogaster,* Latham's Snipe *Gallinago hardwickii* and Sharp-tailed Sandpiper *Calidris acuminata*) listed on international migratory bird agreements (Japan Australia Migratory Bird Agreement [JAMBA], China Australia Migratory Bird Agreement [CAMBA] Republic of Korea Australia Migratory Bird Agreement [ROKAMBA]). Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *Threskiornis spinicollis* and Royal Spoonbills *Platalea regia* were recorded nesting twice.

The presence and breeding response of certain waterbird species can be used to indicate the health of Wanganella Swamp and determine the success of the flood event. In general, key indicator species identified from the 2010-11 flood event include: Musk Duck *Bizuura lobata*, Black Swan *Cygnus atratus*, Hardhead, *Aythya australis*, Blue-billed Duck *Oxyura australis*, Australasian Bittern *Botaurus poiciloptilus*, Brolga *Grus rubicunda* and Australian Painted Snipe *Rostratula australis*.

The significant decline in water levels during January resulted in the reed beds surrounding the main portion of the wetland drying. Prior to this drop in water level the Australasian Bitterns present in the wetland were calling strongly indicating that breeding was imminent. As a result of the water decline any breeding attempt by this species was abandoned. Also present prior to the decline in water level were large numbers of ducks including young 'flappers' (i.e. ducklings that were not yet independent). The majority of ducks left the swamp when the water level dropped and the fate of the 'flappers' is unknown. The decline in water levels did not impact on the ibis colony as the nesting platforms were located in the centre of the wetland where the deepest water levels occur.

The use of environmental water ensured that the ibis colony successfully fledged thousands of chicks; however, the flow commenced too late to ensure that many other species nesting or attempting to nest on Wanganella Swamp had a successful breeding attempt. Those species that abandoned breeding included: Musk Duck, Blue-billed Duck and Australasian Bittern. Future water management should ensure that if

environmental water is to be delivered to Wanganella Swamp to aid in waterbird breeding that it occurs before water begins to recede from the surrounding beds of spike-rush *Eleocharis* sp. as they provide important habitat (both breeding and feeding) for a wide range of species.

The timing, duration of flooding, key habitats and minimum depths required to ensure successful habitation and/or breeding of the seven key indicator species is summarised below.

Key species	Time of Year	Minimum duration (months)	Minimum Water depth (m)	Key Habitat	Flow required
Musk Duck	spring-summer	3-4	1	reed beds/open water	600 ML/day
Black Swan	late winter-summer	6-7	1	reeds/open water	600 ML/day
Hardhead	spring-summer	3-4	1	lignum/spike-rush	600 ML/day
Blue-billed Duck	spring-summer	3	1	reed beds	600 ML/day
Australasian Bittern	spring-summer	3-4	0.5-.75	spike-rush	600 ML/day
Brolga	spring-summer	5-6	1	lignum/spike-rush	600 ML/day
Australian Painted Snipe	spring-summer	2-3	0.1-0.3	spike-rush/macrophytes	600 ML/day

A minimum of 600ML/day is required over Warriston Weir for 3-4 months to ensure successful breeding of the Australasian Bitterns within Wanganella Swamp. This flow rate maintains a suitable water level, i.e. ≥30cm, within the portion of the wetland that is dominated by spike-rush beds, an important breeding habitat for bitterns.

Frogs

Five frog species (Peron's Tree Frog (*Litoria peronii*), Plains Froglet (*Crinia parinsignifera),* Spotted Marsh Frog *(Limnodynastes tasmaniensis*), Barking Marsh Frog *(Limnodynastes fletcheri)* and Bibron's Toadlet (*Pseudophryne bibronii*) were recorded at Clarkes Creek and Eight Mile Creek crossings in Wanganella Swamp during a one-off survey during February 2011.

Recommendations:

Based on the flood event, use of environmental water, vegetation and waterbird response at Wanganella Swamp the following recommendations are made:

Hydrology and Structures

1. Review the apparent discrepancy between flows over Warriston Weir into Forest Creek and flows reaching Wanganella Swamp (Eight Mile Creek). It is suspected that a large amount of water returned to the Billabong Creek via Forest and Piccaninny Creeks. In particular, the area around Junction Weir, Mortimer's Dam and Warriston Weir needs to be investigated.

2. Undertake an inspection of all water control structures downstream of Warriston Weir to determine which ones may have been damaged during the 2010/2011 flood event allowing water to return to Billabong Creek rather than proceeding down Eight Mile Creek. (e.g. along Piccaninny Creek and Forest Creek).

3. Water managers (including environmental water managers) should use the Cocketgedong gauge or use a reduction factor if the Walbundrie gauge measurements are used when making their estimates of water flow further down the Billabong Creek system. The Cocketgedong gauge should also be used as a critical trigger for planning future Wanganella flood events.

4. Investigate options in Forest Creek upstream of Warriston Weir to control Cumbungi (*Typha spp*) thus improving water delivery to Warriston Weir and ultimately Wanganella Swamp.

5. Investigate whether it is feasible to construct a water control structure on the western end of Clarke's Creek (i.e. Wanganella Station/travelling stock route boundary). The structure would increase our ability to better manage natural and environmental flooding. We could do more with less water by increasing the duration, extent and depth of future flood events.

6. Investigate removing existing old water control structure from the head of Clarke's Creek to improve water entry into the creek downstream of the Cobb Highway but upstream of Wanganella Station.

7. Investigate future management options for McCrabb's regulator. This should include whether the structure should be replaced or upgraded to allow for better management of future environmental flows and flood events. Any changes to McCrabb's regulator should ensure that water levels within Wanganella Swamp are not increased to a level that causes water to escape back to the Billabong Creek north-east of McCrabb's regulator.

8. Determine the travel times and incurred losses for water to be delivered to Wanganella Swamp via the Billabong Creek verses the Forest/Eight Mile Creek system.

9. Further investigate the feasibility and practicality of constructing channels as described in Webster and Davidson (2010) to deliver environmental water more efficiently to Wanganella Swamp.

10. Investigate the most efficient options for delivering environmental water to Wanganella Swamp (e.g. via Woolami and/or Blight drains) when Forest Creek/Eight Mile Creek is wet/full or via pumps if Forest Creek/Eight Mile Creek is dry.

Vegetation:

11. Control terrestrial weeds.

12. Ensure the wetland receives an appropriate hydrological regime to ensure the vegetation communities (reedbeds [eg Cumbungi], spike-rush sedgeland, Lignum and Nitre Goosefoot) that support bird breeding are maintained in a healthy condition.

Birds:

13. The delay in acquiring environmental water threatened the success of the 2010/11 bird breeding event. Fortunately, when the water level dropped dramatically, heavy rains increased and then maintained adequate water levels ensuring the ibis did not abandon their nests. However, if and when a bird breeding event occurs in the future, it is recommended that all the necessary planning is undertaken as early as possible to ensure water can be delivered when needed to ensure a successful breeding event. The aim of using environmental water during a bird breeding event should be to ensure as many birds and species successfully fledge young, this may require filling in gaps in the hydrograph when the natural flows recede.

14. To achieve successful breeding of the Australasian Bitterns *Botaurus poiciloptilus* within Wanganella Swamp maintaining a suitable water level (≥30cm within the spike-rush *Eleocharis* sp. portion of the wetland) for at least 3-4 months is required.

15. Determine what the minimum flows required to sustain a bird breeding event are.

16. Put in place appropriate monitoring for the next flow event to help determine the minimum flows required to sustain a bird breeding event.

17. Undertake aerial surveys of large (>10 000 pairs) bird nesting events.

Frogs:

18. Surveys with multiple sampling events should be incorporated into future monitoring considerations to better understand the present frog community at Wanganella Swamp;

Land Management Issues:

19. Investigate options for removing/replacing the boundary fence of Wanganella Station that traverses the western portion of Wanganella Swamp (i.e. west of

the Cobb Highway) or replacing the barbed wire with a plain wire through this portion of the wetland. This investigation should include assessing the impacts the fence has on nesting Brolgas, birds traversing the swamp (entanglement in barbed wire) and disturbance of the wetland floor as a result of fence construction (existing fence is below ground level creating a channel through the floor of the wetland).

1.0 Background

Wanganella Swamp is a 470 ha wetland complex located on Eight Mile Creek (part of the Forest Creek anabranch system) approximately 3 km south of the hamlet of Wanganella. The complex consists of the Swamp itself and parts of Eight Mile Creek and Clarke's Creek (Figure 1). The Swamp is a significant natural resource of the Billabong Creek catchment with a number of important ecological, cultural and social values (see Hobbs (1956), Roberts and Pasma (1990), Glazebrook (2000), Webster and Davidson (2010)).

Wanganella Swamp receives water from the Billabong Creek and Murrumbidgee River catchments. Water from the Murrumbidgee River enters the Billabong Creek via the Yanco Creek (Figure 1). The Forest Creek anabranch originates from the Billabong Creek upstream of the Yanco-Billabong Creek junction and is the primary water source for Eight Mile Creek which flows through Wanganella Swamp. Historically water would have only entered Wanganella Swamp during flood flows originating from the Yanco/Billabong Creek system as the bed of Forest Creek is approximately 2m above the bed of the Billabong Creek (White *et al.* 1985). Following European settlement flows into the Forest Creek system would have increased as a result of works carried out at the Yanco Creek off-take from the Murrumbidgee River. These flows were further enhanced in 1930 with the construction of the Forest Creek cutting just downstream of the natural Forest Creek off-take (Glazebrook 2000). This allowed an almost continuous supply of stock and domestic water along the Forest Creek system (including Wanganella Swamp). From 1994 until 2000 approximately 100ML/day was delivered over Warriston Weir for stock and domestic use. This was reduced to 80ML/day in summer (Nov.-Mar.) and 60 ML/day in winter (Apr.-Oct.) from 2000 until November 2006. Consequently, between the 1930's and November 2006 Wanganella Swamp was largely, continuously wet, changing it from a naturally ephemeral wetland to a permanent wetland. The recent changes in flow management (1994-2006) has allowed Cumbungi (*Typha* spp.) to invade and choke both the Eight Mile Creek delivery channel and the main distributary channels within the wetland complex (P. Maher pers. obs.) reducing the amount of flow reaching Wanganella Swamp. In November 2006, all flows over Warriston Weir were suspended due to critical water shortages in the Murray-Darling Basin caused by severe drought (Webster and Davidson 2010). This continued until the 2010/11 flood effectively drying out the Forest Creek system completely. It is important to note that Wanganella Swamp is not a 'terminal' wetland and like Barmah-Millewa Forest, the extent of inundation is dependent on river/creek discharge.

As part of the Review of Environmental Factors for the Forest Creek system (Davidson & Webster 2007) the Department of Natural Resources (DNR) developed a model which reviewed the historic flow data at Hartwood Weir (113 years from 1892-2005). The model shows that large flows (> 10,000ML/year) occurred approximately 3 years in 10 (n = 32/113), medium flows (> 5,000ML/year) occurred approximately 4 years in 10 (n = 46/113) and small flows (> 1,000ML/year) occurred approximately 6 years in 10 (n = 64/113) – (see Figure 2 and Appendix 1 in Davidson & Webster 2007). The variation between years is marked with two dry episodes where water would not have entered the Forest Creek system for 4+ years in a row (e.g. 1910-1914) and wet periods (7) where water may enter the system up to 11 years in a row (e.g. 1986-96).

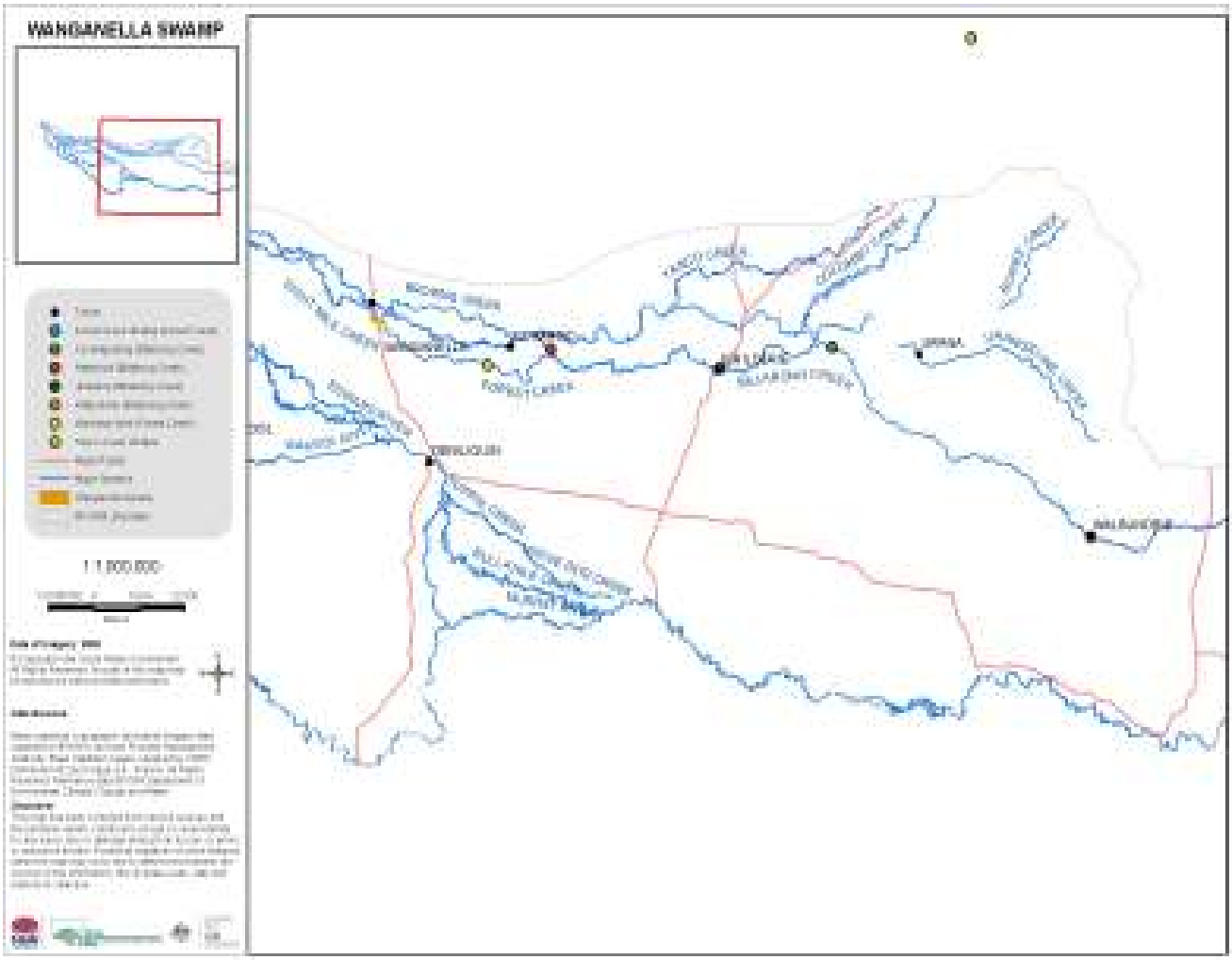

Figure 1: **Location of Wanganella Swamp and the Forest Creek system within southern NSW and location of gauging stations referred to in the text**

The vegetation of Wanganella Swamp was described by Roberts and Pasma (1993) as '*fairly rich*', consisting of 45 species of mainly wetland flora. Only two introduced species were recorded, weeping willow (*Salix babylonica*) and curled dock (*Rumex crispus*).

They identified seven vegetation types within the swamp:

1. Open water – patches of submerged herbs and localised stands of free-floating species;
2. Tall grassland – dense, tall stands of cumbungi (*Typha orientalis*) with small patches of reed (*Phragmites australis*) and giant rush (*Juncus ingens*);
3. Herbland – dense stands of milfoil, (*Myriophyllum papillosum*);
4. Sedge-herbland – mixed community of milfoils and sedges;
5. Sedgeland – dominated by sedges but with patches of mixed aquatic herbs e.g. buttercups (*Ranunculus* spp.) and nardoo (*Marsilea drummondii*);
6. Grassland – dominated by dense grasses; and
7. Shrub-sedgeland – scattered shrubs of nitre goosefoot (*Chenopodium nitrariaceum)* and lignum with understorey of sedges and rushes (*Juncus* spp).

Due to the intermittent nature of flooding prior to European settlement Roberts and Pasma (1993) predicted that the original vegetation community within Wanganella Swamp consisted of:

> '*The main channel would have a fringe of black box* Eucalyptus largiflorens *trees with the occasional river coobah* Acacia stenophylla *and perhaps a lignum* Muehlenbeckia florulenta *understorey; the flood-out areas could have been lignum with nitrebush* Chenopodium nitrariaceum *and would have sprouted dense sedge* Eleocharis sp. *growth after flooding.*'[1]

The Wanganella Swamp is recognised as a significant waterbird breeding habitat within the Billabong Creek catchment. The first published observation of waterbirds using the Swamp was made by Hobbs (1956) when he described an ibis rookery containing an estimated 30, 000 breeding pairs occurring around the central area of open water within the Swamp. Maher (1988) provides a description of the use of Wanganella Swamp by birds for the period 1978-1988. Since then there has been no formal monitoring of waterbird use of Wanganella Swamp except for opportunistic observations by P. Maher whenever the Swamp has contained water.

Project Rationale/Purpose

This report presents the results of an ecological monitoring study (hydrology, vegetation, frogs and waterbirds) of the 2010/11 flood event within Wanganella Swamp. This was the first flood to fill the Swamp since regulated flows over Warriston Weir were terminated in November 2006. The termination of flows over Warriston Weir dried the Swamp completely, possibly, for the first time in 70 years. The monitoring study was initiated to allow observations to be made as to what impact changing the wetland back to a more natural ephemeral state may have had on the vegetation of the Swamp and the bird species that use the Swamp when it floods. The report also contains recommendations for the future management of environmental water delivery to the wetland and some more general management recommendations for the wetland.

The main aims of the monitoring program were:

1. Develop an understanding of the relationship between flows in the Billabong Creek, Forest Creek, Eight Mile Creek and water depths in the Swamp.
2. Determine the effectiveness of adding environmental water.
3. Compare the current vegetation within the Swamp to historic surveys to see if it has changed (i.e. aquatic to terrestrial).
4. Identify what bird species utilised the wetland during the flood.
5. Describe and monitor the bird breeding event, particularly for Ibis *Threskiornis* spp. and Brolga *Grus rubicunda*.
6. List the frog species recorded on the Swamp during the flood.

[1] Scientific names have been added by the authors.

2.0 Methods

Monitoring of the ecological response (hydrology, vegetation, waterbirds and frogs) within Wanganella Swamp during the 2010/11 flood event took place from 25 November 2010 until 30 May 2011. Some earlier observations of waterbird response to the initial stages of flooding within the wetland are also included within this report. The methods employed to monitor vegetation, waterbirds and frogs are detailed below.

2.1 Water

2.1.1 Flow Rates

Flows within the Billabong/Yanco Creek system are monitored from a number of flow recording stations. Recordings from the following sites were used to examine the behaviour of the 2010/11 flow event along the Billabong/Forest Creek system (Figure 1):

- Yanco Creek off-take;
- Walbundrie (Billabong Creek);
- Cocketgedong (Billabong Creek);
- Jerilderie (Billabong Creek);
- Finley irrigation escape;
- Forest Creek off-take (Forest Creek);
- Hartwood (Billabong Creek); and
- Warriston Weir (Forest Creek).

Table 1: Location of water depth loggers deployed in/around Wanganella Swamp during the 2010/1011 flood event.

Logger	Location description	Coordinates	Duration Deployed	Organisation who deployed logger
1	North of the Wanganella West vegetation transect	301784E/6097206N	26/11/10–03/05/11	Murray CMA
2	Within Eight Mile Creek, west of Cobb Highway	301853E/6097842N	26/11/10–03/05/11	
3	Within Eight Mile Creek, near junction with Clarke's Creek, east of Cobb Highway	302918E/6097524N	26/11/10–03/05/11	
4	Attached to pier on downstream side of Eight Mile Creek bridge	302334E/6097323N	22/11/10–06/06/11	NSW Office of Water/OEH

2.1.2 Water Depths

Depth loggers (3 Odyssey-Water Capacitance Probes and 1 STS DLN unit) were placed at various locations across Wanganella Swamp to monitor changes in wetland water depth during the study (Table 1). Data from the water depth loggers was used to determine travel

times for water to reach the Swamp from Warriston Weir and the relationship between wetland depth and Forest Creek flow rates.

2.1.3 Environmental Water Allocation

An environmental water allocation was made available to Wanganella Swamp from January to May 2011 to support the large-scale bird breeding event that had been triggered by high natural flows. The provision of environmental water was to supplement natural flooding to maintain minimum water levels within the Swamp; prevent adult birds from abandoning nests and/or young and ensure that the majority of young birds fledged successfully.

The NSW Office of Environment and Heritage (OEH) provided the water from its Adaptive Environmental Water (AEW) Regulated River Conveyance licence held within the NSW Murray Valley. State Water Corporation (SWC) managed the physical delivery of water in close consultation with OEH. Final delivery volumes and transmission losses were calculated by SWC and debited off the OEH AEW license.

The environmental water was delivered to Wanganella Swamp via four Murray Irrigation Limited (MIL) irrigation escapes (Table 2). The majority of water was delivered via Finley Escape which is an accredited escape located upstream of the Hartwood Weir, with a maximum capacity of approximately 250ML/day. Three smaller (non-accredited) escapes: - Coree 11 extension, Coree 11B and Blighty 3D were also used. These escapes output directly into Forest Creek and have a maximum capacity of approximately 20 ML/day each. Flow rates from all escapes were recorded by MIL and the data provided to SWC.

Table 2: Coordinates for the outfalls of the four MIL irrigation escapes used to deliver environmental water to Wanganella Swamp during 2010-2011.

Irrigation Escape	Coordinates
Finley	365292E/6086925N
Coree 11 extension	343618E/6088654N
Coree 11B	345475E/6077177N
Blighty 3D	348734E/6076707N

2.1.4 Flood Inundation Mapping

A flood inundation extent map was produced by the Murray Catchment Management Authority (Murray CMA) based on survey data collected by Michael McBurnie on the 20 January 2011. The mapping was conducted by riding around the perimeter of the wetland (edge of water) on a four wheeled motorbike using a roaming Global Positioning System that recorded a point every five metres. These points where down loaded into a computer and linked to produce the area of inundation.

2.1.5 Water Quality

Water quality (i.e. dissolved oxygen, electrical conductivity, pH, temperature) was monitored at Eight Mile Creek bridge and McCrabb's bridge from the 23/03/11 to 30/05/11 using a Hydrolab Quanta unit. The dissolved oxygen parameter was of most interest due to the occurrence of a blackwater event throughout the Billabong Creek system during this period.

2.2 Vegetation

Six 50m vegetation transects were established within the Wanganella Swamp to monitor changes in vegetation structure and species composition during the flood event and to compare with historic surveys. Each transect was visited twice, once at the start of the monitoring project (December 2010) and then a second time approximately six weeks later. On each visit all species and the area covered by each species within a $1m^2$ quadrat at 5m intervals was recorded. The start of each transect was permanently marked with a steel star post and a photo point established. The photo was taken from the start peg on the same bearing as the vegetation transect. The location of each transect was recorded using Magellan Meridan Gold GPS (Magellan California) receiver (Table 3). Plants recorded were identified to species level using Flora of NSW (Harden 1990-1993).

Table 3 Location of vegetation monitoring transects within Wanganella Swamp.

Transect Name	Bearing	Datum	AMG		Date	
			Start		1st Survey	2nd Survey
			Easting	Northing		
Clarke's Ck 1	80°	WGS84	302425	6095471	25/11/2010	28/1/2011
Clarke's Ck 2	294°	WGS84	302887	6096268	25/11/2010	28/1/2011
Wang. West	300°	WGS84	301896	6097065	2/12/2010	20/1/2011
Wang. North	250°	WGS84	301472	6098600	2/12/2010	20/1/2011
Wang. East	300°	WGS84	303679	6096856	3/12/2010	28/1/2011
Wang. South	25°	WGS84	304877	6095219	29/12/2010	16/2/2011

2.3 Waterbirds

2.3.1 On-Ground Surveys

Waterbird monitoring (i.e. presence of species, estimation of numbers, use and breeding status) was conducted on average at one week intervals. Opportunistic monitoring began at the end of October (30th) 2010 with official weekly (and later fortnightly) monitoring beginning at the end of November (25th) through to the end of May 2011 (30th)

Opportunistic monitoring mainly occurred from the bridges on the Cobb Highway within Wanganella Swamp. Opportunistic monitoring was undertaken for 30-60 minute intervals and all waterbirds observed including breeding observations were recorded. The weekly/fortnightly monitoring involved walking a transect through the western portion of the wetland. This transect took approximately five hours to complete. After the water level dropped in January a shorter transect was traversed as a large portion of the wetland was no longer flooded. This shorter transect took three-four hours to complete.

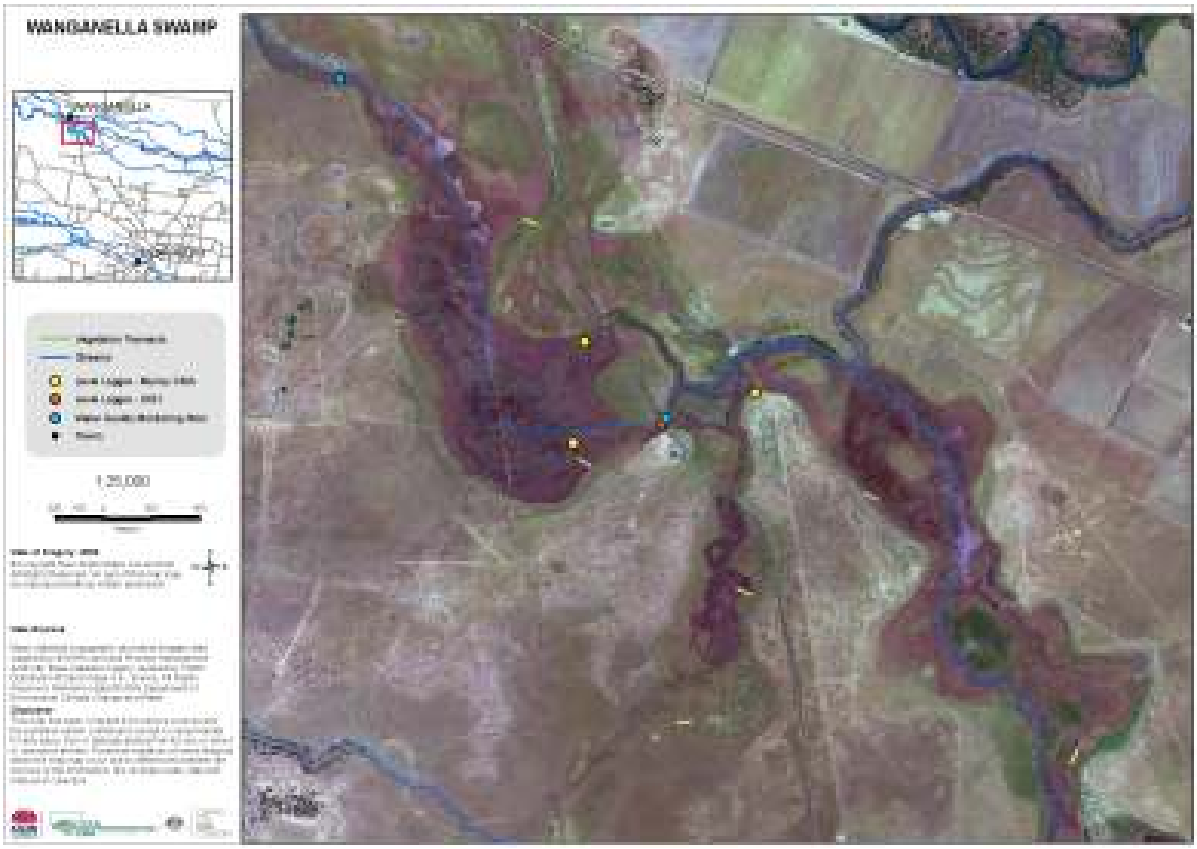

Figure 2: Location of vegetation transects , water quality monitoring sites and depth loggers within Wanganella Swamp during the 2010/11 flood event

2.3.2 Aerial Photography Survey

High resolution vertical photography, with a ground sample distance of 3 cm (i.e. each pixel covers approx. 3 cm of ground), was commissioned by OEH. This technique enables digitising of individual birds and/or nests in large waterbird colonies.

Photography of the two ibis colonies located at Wanganella Swamp, to the west and east of the Cobb Highway, was captured on the 10 December 2010. Images were mosaiced, digitised and then analysed into nine different categories (Figure 3, Table 4).

Table 4: Categories of information analysed from high resolution vertical photography.

Analysis Categories
Ibis (not on nest or trampling)
Ibis nest (not occupied)
Ibis nest (occupied)
Ibis flying
Ibis trampling lignum (no eggs)
White bird (Royal spoonbill, white ibis or egret)
White bird nesting
White bird nesting?
White bird flying
White bird roosting
White bird?
Bird nesting
Nest

Figure 3: Wanganella Swamp western and eastern waterbird colonies captured on the 10/12/10 and analysed by high resolution vertical photography

2.4 Frogs

Four opportunistic aural and visual frog surveys were conducted during a single visit in February 2011 at Clarke's Creek and Eight Mile Creek crossings on Wanganella Swamp. Using a 30 watt back pack spotlight, two people walked slowly along the floodplain bank for

20 minutes to visually identify individuals. Frog calls were identified concurrently during the survey to detect any frog species that were not visually observed.

3.0 Results & Discussion

3.1 Water

3.1.1 Natural Flows and Water Levels

To fill the Wanganella Swamp (470ha) to a depth of 0.5m from dry would require at least 2 350 Ml. If complete inundation of the wetland complex (539ha) is required as occurred in 2010/11 then 2 695 Ml is required. Additional water is then required to maintain this area of inundation and future calculations of this amount will need to take into account losses below Warriston Weir and evaporation from the wetland.

The following series of hydrographs (Figures 4-7) shows the 2010/11 flood event from various recording stations along the Billabong/Yanco Creek system. Flows over Warriston Weir began on the 18 September (Figure 7). The exact date water reached Wanganella Swamp is unknown as recording of water heights at Wanganella did not begin until approximately 20 October at the 8 Mile Creek bridge gauge and from the 22-26 November at the other sites within the wetland. The 2010/11 flood event consisted of a number of flood peaks originating from both the Murrumbidgee River and the Billabong Creek. Peaks in flow (i.e. above 4000 ML/day at Yanco Creek off-take) were recorded from the Yanco Weir during early-mid September, mid-late October and early-late December, while in the Billabong Creek peak flows (i.e. >1000 ML/day at Cocketgedong gauge) occurred from mid-October to late January and from mid-February to late-March.

Figure 4 shows that in terms of the flow past the Walbundrie and Cocketgedong gauging stations there is very little similarity in terms of event magnitude. Table 5 below presents a summary of peak flows, the dates they were recorded and difference in flow at these two flow gauges.

For the 2010/11 season there were 19 flow events that peaked in the Upper Billabong Creek (creek upstream of Colombo Creek confluence). Averaging of the peak flows at the Walbundrie and Cocketgedong gauges showed that there was a 70% decline in the water flow past the Cocketgedong gauge compared to the Walbundrie gauge. The substantial reduction in flow is a result of losses to the broadening floodplain downstream of Rand. Based on the 2010/11 flow events it would appear that for future flow events the flow at Walbundrie cannot give a true indication of the water expected in the rest of the Billabong Creek system. It is advised that water managers, including environmental water managers, should either use the Cocketgedong gauge or use a reduction factor if the Walbundrie gauge measurements are used when making their estimates of water flow further down the Billabong Creek system. The Cocketgedong gauge should also be used as a critical trigger for planning future Wanganella events.

Figure 5 shows that both input peaks from the Murrumbidgee River (Yanco Creek off-take) flatten out substantially by the time they get to Hartwood Weir on the Billabong Creek. Hartwood Weir needs to maintain a reasonable discharge to facilitate adequate flow through the Forest Creek off-take which in turn, ensures adequate flows over Warriston Weir into the

Swamp (Figure 6). Flows from Finley Escape, which outputs upstream of Hartwood Weir, are not totally diverted into Forest Creek. When Hartwood Weir flows are low the majority of Finley escape flow passes over the weir and travels down Billabong Creek. Therefore there is a need to find a more efficient conduit to reduce environmental water losses if the water is to be delivered to the Forest Creek under low flow scenarios. To push more water down Forest Creek Hartwood weir pool levels need to be raised by approximately 0.3 m, this makes it a highly inefficient way of delivering environmental water to the Forest Creek and ultimately Wanganella Swamp.

Table 5: Peak flows recorded for Walbundrie and Cocketgedong gauges for the same high flow event from 15/08/10 to 22/04/11.

Walbundrie Flow		Cocketgedong Flow		Differential	
ML	Date	ML	Date	ML	%
1817	15.08.10	0	0	1817	100
1636	22.08.10	54	28.08.10	1582	97
1830	30.08.10	691	05.09.10	1139	63
5862	08.0910	777	15.09.10	5085	87
3662	13.09.10	642	19.09.10	3020	82
37326	18.10.10	1497	27.10.10	35829	96
3613	03.11.10	1196	11.11.10	2417	67
1765	17.11.10	1075	23.11.10	690	39
2666	05.12.10	1307	11.12.10	1359	51
13469	11.12.10	1273	16.12.10	12196	91
2350	12.01.11	1155	18.01.11	1195	51
1167	17.01.11	1145	22.01.11	22	2
12002	08.02.11	1447	12.02.11	10555	88
13787	14.02.11	1406	20.02.11	12381	90
11883	20.02.11	1350	27.02.11	10533	89
12108	22.02.11	1333	01.0311	10775	89
7827	16.03.11	1575	19.03.11	6252	80
968	28.03.11	589	02.04.11	379	39
509	17.04.11	339	22.4.11	170	34

Figure 6 shows that the travel time for water along the Forest/Eight Mile Creek system is approximately 20 days. Additionally, the planning process to secure temporary environmental water takes a minimum of six weeks. This is critical information particularly if environmental water is required to maintain the water level within Wanganella Swamp. Maintenance of the water level within the swamp may be important if during a particular flow event certain ecological outcomes (e.g. a colonial waterbird breeding event) are to reach a successful conclusion. This may require filling in gaps in the hydrograph so that water levels do not drop below critical levels which may result in the failure of the ecological goals (e.g. successful waterbird breeding). Therefore if the Forest/Eight Mile Creek is to be used as a delivery route for environmental water then early planning needs to be instigated. In fact it probably should be assumed that in most years once a bird breeding event commences at Wanganella Swamp that environmental water will be required to ensure a successful conclusion to the breeding event. Therefore it is suggested that once a breeding event commences that all necessary planning to deliver environmental water is undertaken as early as possible and considers the long delivery time, so that the environmental water can be delivered as required and is not delayed.

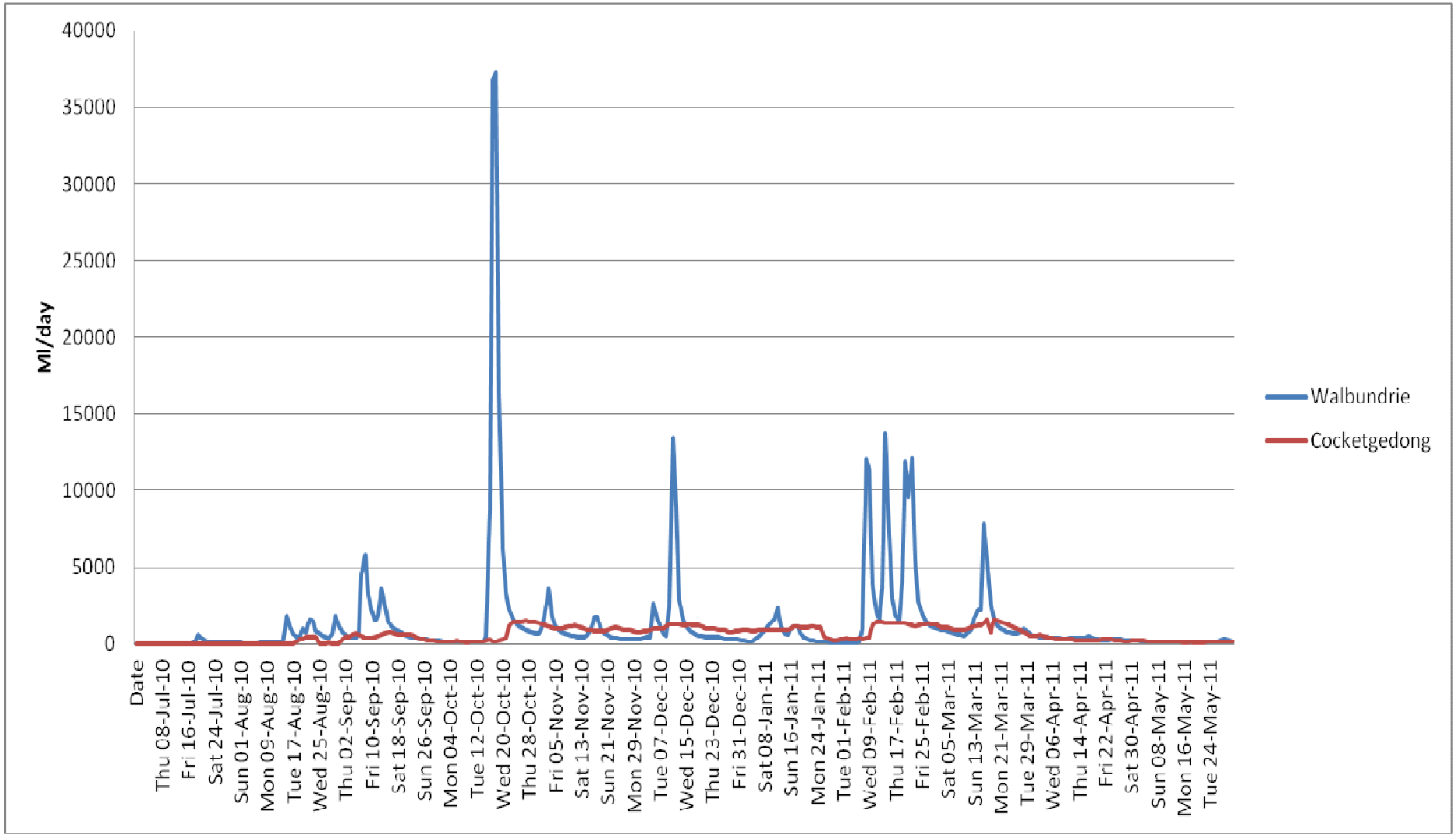

Figure 4: 2010/11 flood event - Walbundrie flow gauge compared to Cocketgegong flow gauge

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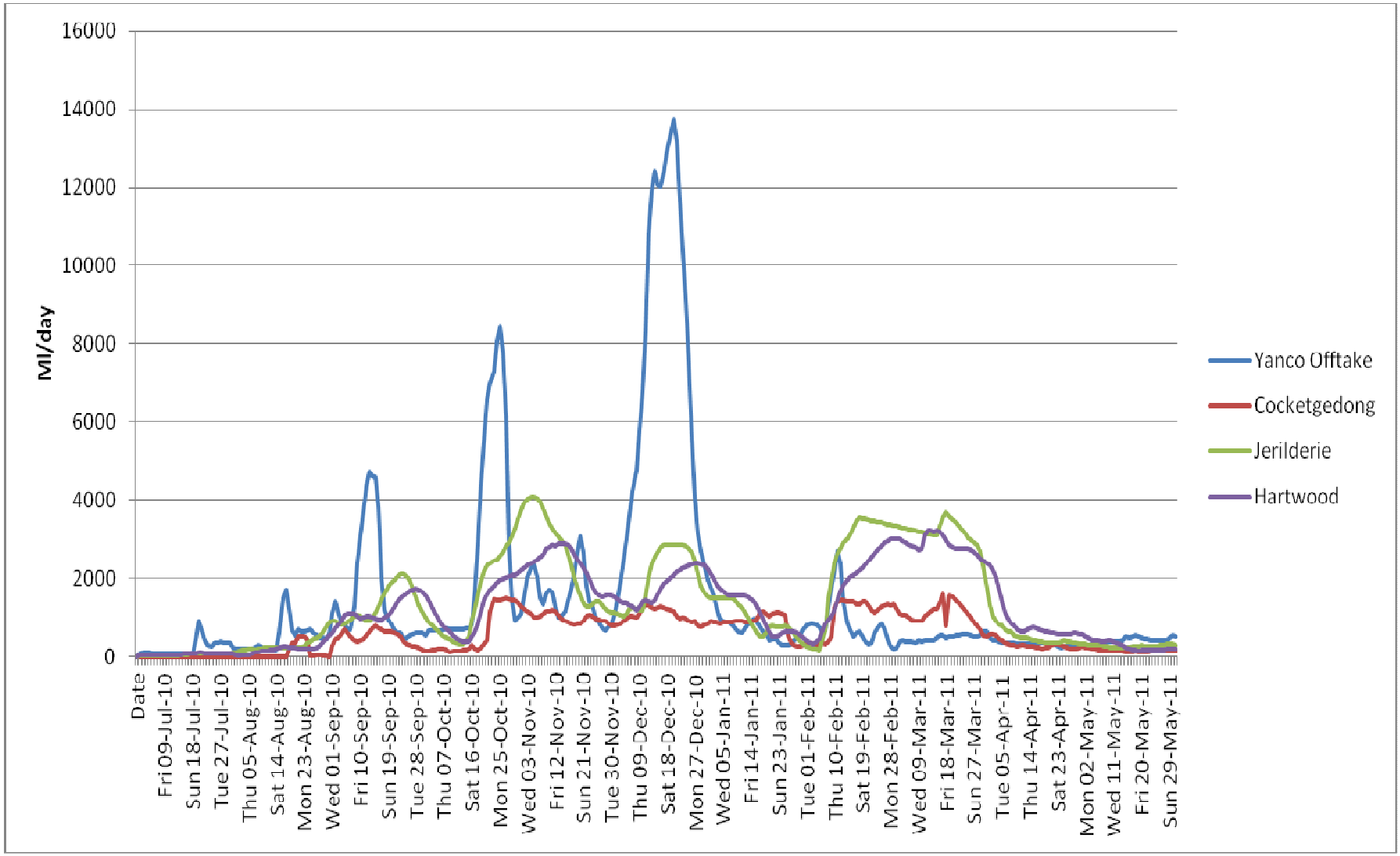


Figure 5: 2010/11 flood event showing the input from the Murrumbidgee River and upper Billabong Creek events and their relationship to Hartwood Weir

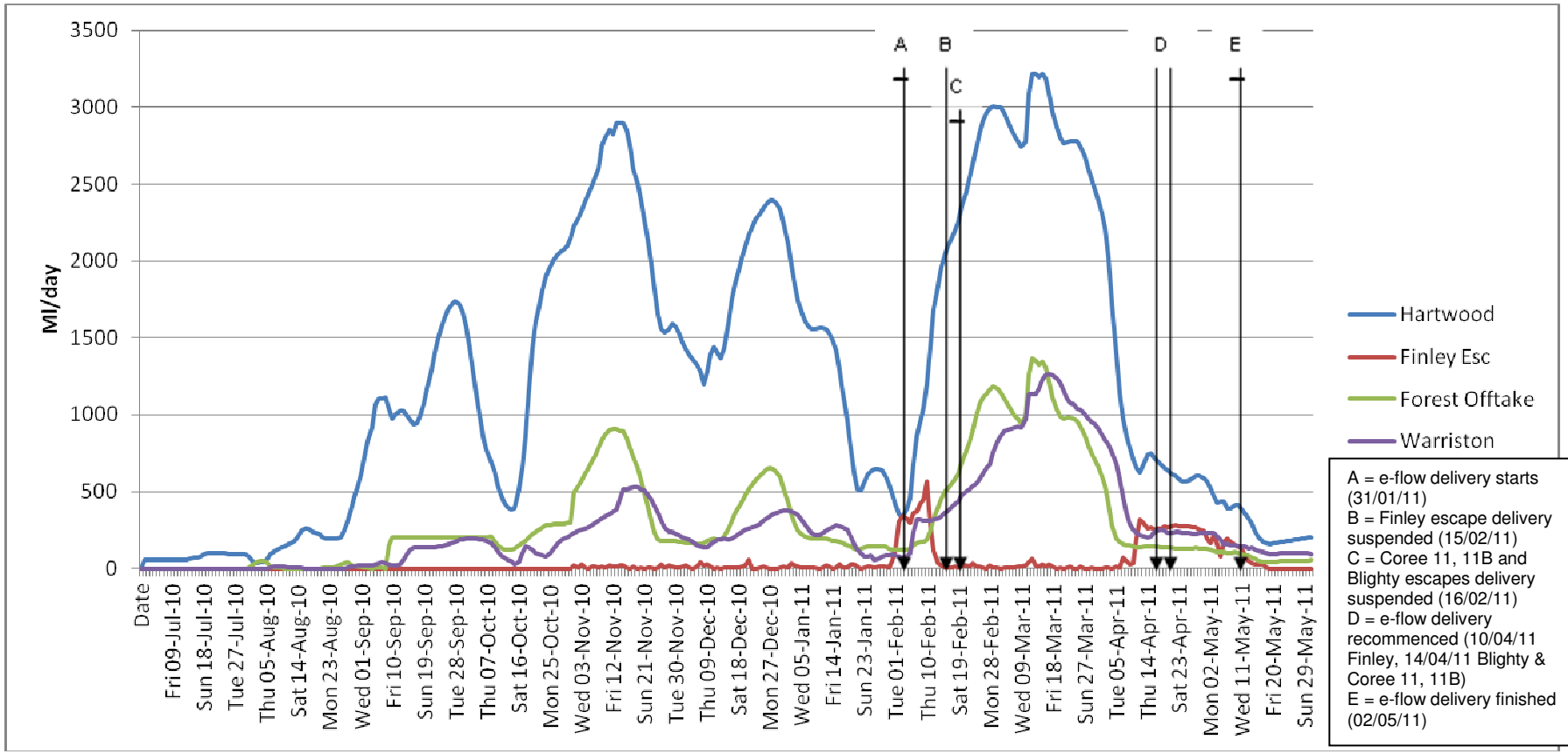


Figure 6: **2010/11 flood event showing the flow relationship between Hartwood Weir and Forest Creek off-take and the time periods when environmental water was delivered into the system**

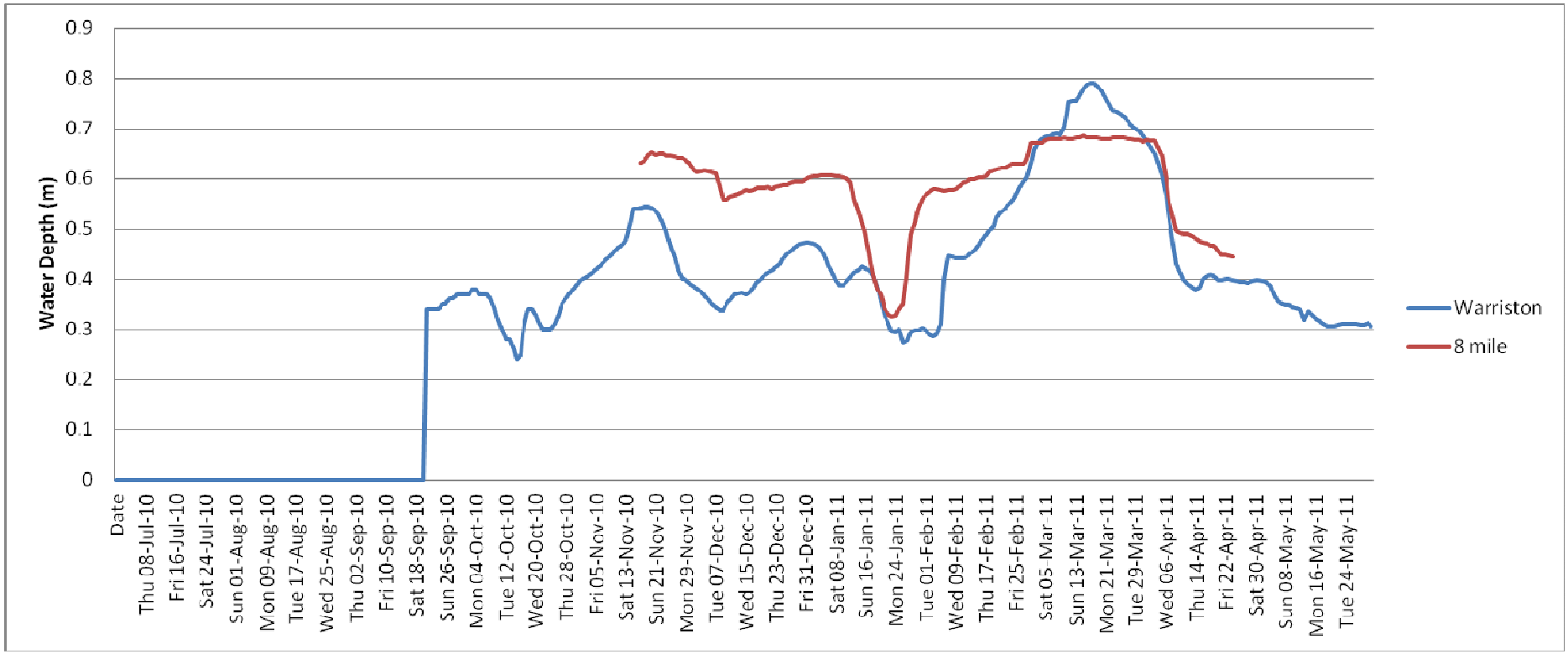


Figure 7: 2010/11 flood event showing the relationship between flows over Warriston Weir and water depths on the Eight Mile Creek road bridge (Cobb Highway) with a 20 day lag

Notes:

- Travel time in this section Forest Creek system under normal flow conditions would generally be in the region of 8 to 10 days.
- In flood situations once the system is full, the flow tends to slow and it can be clearly seen that in this graph the travel time went out to approximately 20 days.

Flow from the natural flood began to increase over Warriston Weir on the 18 September (Figure 7) but the exact date water reached Wanganella Swamp is unknown as recording of water heights within the Swamp (Eight Mile Creek) did not begin until 20 October.

Based on flows over Warriston Weir during the recent flood event the following observations have been made:

- 700-800 ML/day appears to be necessary to maintain inundation of the surrounding reed bed (i.e. a total area of approximately 539ha); and
- 600 ML/day (for 3-4 months) is required to maintain a suitable water level within the wetland complex to allow Australasian Bitterns (*Botaurus poiciloptilus)* to nest successfully. **(It should be noted that the above figures need to be assessed when system is not losing water down Piccaninny and Forest Ck through Mortimer's Dam.)**

3.1.2 Environmental Water Delivery

A total of 11,718ML (not including transmission losses) of water was delivered via four MIL irrigation escapes - Finley, Coree 11 extension, Coree 11B and Blighty 3D. The vast majority of water was delivered via the Finley Escape with flow rates ranging from 7 to 250ML/day, whilst a total of 1,957ML was delivered out of the three smaller escapes (refer to Appendix 2 for raw data). The rationale for utilising the smaller escapes was to hasten delivery times of environmental water to the swamp.

The need for an environmental flow allocation was initiated by a decrease in flow rates over Warriston Weir from 239ML/day (07/01/11) to 85.4ML/d (24/01/11) (Appendix 1). The reduction in flow rates also triggered on-ground actions that were aimed at maximising flows into the Swamp these included:

i) SWC taking out the gates at the Forest Creek off-take to maximise flows into Forest and Eight Mile Creeks;
ii) SWC putting the final two boards in at Hartwood Weir to try and reduce flows going over the weir and maximise flow diversions into Forest Creek, and
iii) OEH conducting emergency works to reduce flows over McCrabb's regulator spillway and reduce/stop breakout flows from Eight Mile Creek back to the Billabong Creek via Piccaninny and Estuary Creeks.

Delivery of the environmental allocation commenced on the 31/01/2011 (Figure 6, Appendix 1 and 2). Due to the distance between the escapes and the Swamp the water was not expected to reach the Swamp for at least 5-6 days. Depth gauge readings taken at Eight Mile Creek bridge recorded water levels at 0.275m (01/02/11) and flow rates over Warriston Weir had reduced to 65ML/day (03/02/11, Figure 7). By this stage there were grave concerns that adult birds would abandon their nests and hundreds of young birds (at varying stages of development). During 03-05/02/11 an exceptional rain event (influence from cyclones Anthony and Yasi in Queensland), resulted in approximately 100 mm falling over the Wanganella region and as a consequence water levels in the system rose rapidly (0.56m at Eight Mile Creek bridge, 08/02/11) and increased flow rates over Warriston and Hartwood Weirs (314ML/day and 1,500+ML/day (respectively), 09/02/11; Figure 6). The sudden increase in flow rate meant that environmental water delivery needed to be temporarily suspended due to water backing up the escapes and causing issues to pumps etc.; therefore flows from Finley Escape were suspended on the 15/02/11 and remained suspended whilst

flow rates over Hartwood exceeded 1,500ML/day. Suspension of delivery from the smaller escapes commenced on the 16/02/11 whilst flows over Warriston Weir exceeded 300ML/day, peaking at 1,274ML/day (16/03/11) (Figure 6, Appendix 1). Delivery of environmental water from Finley escape recommenced on the 10/04/11 and from Coree 11 extension, 11B and Blighty escapes on the 14/04/11 and continued until the 02/05/11, when MIL closed its supply channel network for end-of-season maintenance works and by this stage the majority of young birds had fledged (Figure 6, Appendix 1).

It is unknown as to what volume of the delivered 11,718ML actually reached Wanganella Swamp due to a number of factors including:

i) a portion of the flows out of Finely Escape passing over Hartwood weir,
ii) break-out flows back to Billabong Creek via Estuary and Piccaninny Creeks from Eight Mile Creek etc.;
iii) occurrence of exceptionally heavy rainfall events whilst environmental water was in transit to the Swamp;
iv) limited gauging points along the Forest Creek system, and
v) unknown travel times between delivery points for environmental water and the Swamp.

Overall, the delivery method of environmental water to Wanganella Swamp used during the 2010/2011 event is considered to be inefficient, however it was the only option available at the time. MIL operators have advised that Blighty escape is not worth considering for future watering events due to its small delivery capacity (i.e. 5 – 14ML/day, Appendix 2).

In addition to the inefficiency and uncertainty of delivered volumes reaching Wanganella Swamp, there are also accounting issues associated with this method that are problematic and need to be resolved prior to further delivery of environmental water. The NSW Office of Water (NOW) has advised OEH as of August 2011 that due to the reactivation of Water Sharing Plans in the Murray and Murrumbidgee valleys, non-accredited escapes (i.e. Coree 11 extension, Coree 11B and Blighty 3D) cannot be used to deliver environmental flows without appropriate metering in place. For water accounting purposes within NSW all watering events need to be linked to an appropriate licensed work, NOW has advised that future delivery of environmental water through non-accredited escapes for Wanganella Swamp will not be possible (P. D'Santos pers comms.).

Consideration of alternative water supply methods to Wanganella Swamp is highly recommended for future applications of environmental water. Webster and Davidson (2010) proposed a number of ways in which water could be delivered more directly and efficiently to the Swamp. These suggestions should be reviewed and investigated further, ensuring that any relevant information gathered from this monitoring study is incorporated.

3.1.3 Flood Inundation Mapping

Flow-extent mapping indicated that approximately 539ha of the Wanganella Swamp complex was inundated on the 20 January 2011 at a gauge height of 0.62 m at Eight Mile Creek (Figure 8). This area included 457ha of Eight Mile Creek and 82ha of Clarke's Creek. Examination of flow data from gauges within the Swamp and further upstream indicate that approximately 700-800 ML/day is required over Warriston Weir into the Forest Creek to inundate the Swamp to this extent.

Figure 8: **Flood extent at Wanganella Swamp on the 20/01/2011 when the Eight Mile Creek gauge board read 0.62m. Note that the maximum flood peaks of 0.73m occurred on the 22/03/2011 and 8/04/2011.**

Water level data indicates that the flood peaked later at 0.73m on 22 March and 8 April 2011, however, detailed bathymetry is not available to determine the maximum extent of area flooded at this time. This latter peak resulted in additional inundation around the entire wetland including a depression located within a fenced enclosure on the sandhill situated on the north-eastern side of Wanganella Swamp. Although this late flood peak resulted in additional land being inundated, compared to the flood extent on 20/1/2011, it did not result in the inundation of any Ibis nests (P. Maher pers. obs.).

3.1.3 Water Quality

Monitoring of water quality was conducted from the 22/03/11 to the 30/05/11. Parameters monitored included temperature, electrical conductivity, dissolved oxygen and pH.

Currently there are no formal water quality guidelines for wetlands like Wanganella Swamp (ANZECC & ARMCANZ 2000). Some guidance can be taken from trigger levels set for slightly disturbed lowland rivers of south-east Australia.

Water quality results show that hypoxic conditions were present in March 2011, with low dissolved oxygen levels remaining under 5mg/L through to May 2011 (Table 6). These low dissolved oxygen levels were widespread throughout the Billabong Creek catchment from mid-November 2010 to mid-February 2011 (based on readings from gauge 410134 west of Wanganella township). During field visits in March the occurrence of localised fish kills, comprising mainly of European Carp *Cyprinus carpio* were observed near the Eight Mile Creek bridge. Observations in Estuary Creek included small bodied fish displaying signs of surface breathing and yabbies crawling out of the water.

Other parameters – electrical conductivity (salinity), and pH were found to be within acceptable ranges for slightly disturbed lowland rivers in SE Australia (ANZECC & ARMCANZ 2000) (Table 6).

Table 6: Water quality readings taken from Eight Mile Creek Bridge and McCrabb's Bridge from the 22/03/11 to 30/5/11.

Date	Eight Mile Creek Bridge				McCrabb's Bridge			
	Temperature (^{0}C)	EC	DO (mg/L)	pH	Temperature (^{0}C)	EC	DO (mg/L)	pH
22/03/2011	22.58	234	0.7	7.12	21.79	234	0.56	7.09
29/03/2011	20.35	242	1.34	7.14	18.08	240	0.95	7.16
13/04/2011	15.14	235	3.31	7.29	13.92	227	1.61	7.17
19/04/2011	17.39	321	2.61	7.32	16.36	274	1.72	7.26
29/04/2011	15.74	244	4.81	7.48	14.72	256	3.21	7.33
9/05/2011	12.68	282	5.95	7.67	11.06	266	6.6	7.56
30/05/2011	10.11	364	10.62	7.95	9.32	344	8.58	7.33

The poor water quality recorded from March onwards did not have a major impact on waterbirds within Wanganella Swamp. The majority of waterbirds had finished breeding or had left the wetland when the water level dropped during January and were therefore not

influenced by the poor water quality between March and May. The poor water quality did not appear to influence the nesting success of the ibis.

3.2 Vegetation

The results of the vegetation monitoring are presented in Appendix 3. The monitoring of the six vegetation transects identified a total of 44 species (34 native and 10 introduced species). This is a similar diversity to that recorded by Roberts and Pasma (1993) – 45 species (43 native and 2 introduced). Although the number of species recorded by both studies is similar only 11 species were recorded in both studies. Roberts and Pasma's (1993) flora list was dominated by wetland flora, where as only 50% of the plants recorded during the current study could be considered wetland flora. The remaining 50% were terrestrial species. The increase in terrestrial and non-native species within the current study compared to Roberts and Pasma's (1993) study is due to the hydrological change in management of the wetland. That is, prior to Roberts and Pasma's study the wetland had been permanently wet for possibly over 60 years, while prior to the current study the wetland had been dry for 4-5 years. The drying of the system would have allowed terrestrial plant species to establish both around the margins of Wanganella Swamp and on the exposed areas of the wetland bed. The extended drying of the wetland may also have resulted in the decline in wetland flora diversity between the 1993 study and the current study. Another reason for the difference in the species lists could be due to the survey effort; Roberts and Pasma's list was compiled over three visits in three different seasons while the current list was compiled from two visits in a single season. The invasion of terrestrial plants is probably typical of more natural conditions (that is prior to the permanent inundation of the wetland) when dry phases would have encouraged terrestrial species. These terrestrial species would be replaced with aquatic species following inundation of the wetland. This pattern of plant diversity change occurred during this flood event as evidenced by the photos in Appendix 4. Based on the fauna response this change in plant diversity from permanent inundation to a drying and wetting phase does not appear to have been detrimental.

3.3 Waterbirds

3.3.1 On-Ground Surveys

A total of 55 water bird species were observed between 30 October 2010 and May 2011 utilising Wanganella Swamp during the 2010/11 flood. Twenty six species of waterbirds were observed breeding (Table 7, Figure 9), five threatened species (Freckled Duck *Stictonetta naevosa*, Blue-billed Duck *Oxyura australis*, Australasian Bittern, Brolga *Grus rubicunda* and Australian Painted Snipe *Rostratula australis*) and six species (Eastern Great Egret *Ardea modesta*, Cattle Egret *Ardea ibis*, Glossy Ibis *Plegadis falcinellus*, White-breasted Sea-Eagle *Haliaeetus leucogaster*, Latham's Snipe *Gallinago hardwickii* and Sharp-tailed Sandpiper *Calidris acuminata*) (Appendix 5) listed on international migratory bird agreements (Japan Australia Migratory Bird Agreement [JAMBA], China Australia Migratory Bird Agreement [CAMBA] Republic of Korea Australia Migratory Bird Agreement [ROKAMBA]) were recorded. Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *Threskiornis spinicollis* and Royal Spoonbills *Platalea regia* were recorded nesting twice during the flood event (Table 7, Appendix 5). The Brolga bred successfully.

Table 7: Breeding record of waterbirds within Wanganella Swamp, 2010/11 flood and environmental flow.

Common Name	Scientific Name	No. of Breeding Pairs	Success/Failure	Habitat	Notes
Plumed Whistling Duck	*Dendrocygna eytoni*	1	S	grassy edges	
Musk Duck	*Biziura lobata*	1	S	reed beds/deep water	
Black Swan	*Cygnus atratus*	~5	S	reed beds/deep water	
Pink-eared Duck	*Malacorhynchus membranaceus*	~10	S	tree hollows/deep water	
Grey Teal	*Anas gracilis*	~13	S	tree hollows/deep water	
Chestnut Teal	*Anas castanea*	1	S	tree hollows/deep water	
Pacific Black Duck	*Anas superciliosa*	~7	S	spike-rush/shallow water	
Hardhead	*Aythya australis*	~12	S	lignum/nitre goosefoot	Rarely observed breeding in district over last 30yrs
Australasian Grebe	*Tachybaptus novaehollandiae*	2	S	deep water/macrophytes	
Hoary-headed Grebe	*Poliocephalus poliocephalus*	~50	S/F	medium water with vegetation	Nesting in a colony with Whiskered Terns
Australian White Ibis	*Threskiornis molucca*	Event 1: ~250 Event 2: ~250	S	deep water/cumbungi	Two nesting events both consisting of ~250prs.
Straw-necked Ibis	*Threskiornis spinicollis*	Event 1: ~4000 Event 2: ~1500	S	deep water/cumbungi	Estimate from aerial photography (10/12/10, OEH) 9461 nesting, 3152 trampling reeds.
Royal Spoonbill	*Platalea regia*	Event 1: 28 Event 2: 10	S	deep water/willows/cumbungi	Nesting in Willows, Cumbungi & Lignum
Brolga	*Grus rubicunda*	1	S	deep-shallow water/lignum	2 eggs hatched & chicks were ¾ grown when last seen (22/12/10)
Purple Swamphen	*Porphyrio porphyrio*	20+	S	deep-shallow water/cumbungi	Mass breeding
Ballion's Crake	*Porzana pusilla*	1	S	shallow water/spike-rush	

Common Name	Scientific Name	No. of Breeding Pairs	Success/Failure	Habitat	Notes
Australian Spotted Crake	*Porzana fluminea*	1	S	shallow water/lignum/nitre goosefoot	
Black-tailed Native-hen	*Tribonyx ventralis*	2	S	shallow water/lignum/nitre goosefoot	
Dusky Moorhen	*Gallinula tenebrosa*	1	S	deep-shallow water/cumbungi	
Eurasian Coot	*Fulica atra*	30+	S	deep water/cumbungi	Mass breeding
Black-winged Stilt	*Himantopus himantopus*	10+	S	shallow water/spike-rush/islands	
Red-kneed Dotteral	*Erythrogonys cinctus*	6+	S	shallow water/spike-rush/islands	
Australian Painted Snipe	*Rostratula australis*	1*	S	shallow water/spike-rush/islands	At least 3 eggs hatched
Whiskered Tern	*Chlidonias hybrida*	3+	S	shallow water/spike-rush	Possibly 50 nests, nesting in mixed colony with Hoary-headed Grebes
Golden-headed Cisticola	*Cisticola exilis*	1+	S	rushy edges	
Australian Reed–Warbler	*Acrocephalus australis*	2+	S	cumbungi	
Little Grassbird	*Megalurus gramineus*	2+	S	cumbungi/lignum/nitre goosefoot/spike-rush	

Notes:

* Breeding unit consisted of 1 female and 2 males.

The presence/breeding response of certain waterbird species can be used to indicate the health of Wanganella Swamp or the success of a flood/environmental water event. Not all flood events will be of a duration similar to that of 2010/11. Therefore the species present during any flood/environmental water event will vary from event to event. However if one or more of the following species successfully breeds during a flood/environmental flow event this is a good indicator that water reached an appropriate depth within Wanganella Swamp and was of appropriate duration: Musk Duck *Bizuura lobata*, Black Swan *Cygnus atratus*, Hardhead, *Aythya australis*, Blue-billed Duck *Oxyura australis*, Australasian Bittern *Botaurus poiciloptilus*, Brolga *Grus rubicunda* or Australian Painted Snipe *Rostratula australis*.

The significant decline in water levels during January resulted in the reed beds surrounding the main portion of the wetland drying. Prior to this drop in water level the Australasian Bitterns present in the wetland were calling strongly indicating that breeding was imminent. As a result of the water decline any breeding attempt by this species was abandoned. Also present prior to the decline in water level where large numbers of ducks including young 'flappers' (i.e. ducklings that where not yet independent). The majority of ducks left the swamp when the water level dropped and the fate of the 'flappers' is unknown. The decline in water levels did not impact on the ibis colony as the nesting platforms were located in the centre of the wetland where water level was the deepest.

Unfortunately the 2010/2011 flood and environmental water use has not provided detailed information on flow rates to maintain minimum water levels for successful bird breeding within Wanganella Swamp. These flow rates will also be determined by what species future management may aim to breed. For instance the flow rate required for successful Ibis nesting is lower than for successful Australasian Bittern nesting as these two species utilise different parts of the wetland, the Ibis the central and deepest portion of the wetland and the Australasian Bittern the outer reed beds and therefore a shallower portion of the wetland. If Australasian Bitterns are to successfully nest within Wanganella Swamp then based on the 2010/11 flood event then it is possible that 600 Ml/day for 3-4 months may be required.

A wide variety of waterbird species utilised Wanganella Swamp at different times during the flood/environmental watering of this wetland. A complete list of species is included in Appendix 5. Some of the more interesting species included:

- Magpie Goose *Anseranas semipalmata* – this threatened species utilised the wetland as foraging habitat late in the flow event; it was not present during the peak of the flood.
- Wandering Whistling Duck *Dendrocygna arcuata* – a rare visitor to the Riverina that utilised the wetland from October – February. Behaviour in mid-January indicated the species may have been getting ready to breed, but declining water levels may have resulted in this species leaving the wetland as there were no records of adult or young after early February.
- Hardhead – bred successfully during the event however the decline in water levels during January resulted in a decline in clutches of young birds present on the wetland. However this breeding event is considered to be largest in the district (including Wanganella Swamp) for at least 30 years.
- Blue-billed Duck – the filling of Wanganella Swamp provided habitat for this threatened species. Although this species did not breed due to unstable water

levels it was the first record of the species on the Forest Creek system since the 1980's (P. Maher pers. obs.).

- Australasian Bittern – the unstable water levels are suspected as the cause for this threatened species not breeding, as suitable habitat was present and the species was heard calling (a sign of breeding) from November – February.
- Brolga – the flooding of the margins of Wanganella Swamp provided this species with suitable nesting and foraging habitat. When last sighted (late December) the young were three-quarters grown.
- Australian Painted Snipe – this threatened species is considered Australia's rarest wader, it was recorded nesting on Wanganella between November-December 2010. The drop in water levels is the likely explanation for this species not being observed after January 2011 (Figure 10).
- Sharp-tailed Sandpiper *Calidris acuminata* – is an international wader that was observed utilising the foraging habitat provided by Wanganella Swamp between November-February. After this, the decline in water levels reduced the area of suitable habitat.

Overall the waterbird breeding event was considered successful, although no actual figures exist to provide an estimate of the percentage of birds fledged it is suspected that prior to the drop in water levels that 80-90% of all birds nesting fledged young. The estimate for ducks is unknown as there was a large number of young ducks at the 'flapper' stage at the time the water dropped and they were not sighted afterwards. The nesting of Hardheads, Purple Swamphens *Porphyrio porphyrio* and Eurasian Coots *Fulica atra* within Wanganella Swamp contributed to what was considered to be the biggest nesting of these species in the southern Riverina since possibly the 1970's.

The successful breeding of the Brolga and Australian Painted Snipe is of regional significance and potentially of state significance . The success of the current nesting event was improved by the drying phase the wetland experienced prior to the flood. This is supported by the diversity of species and number of individuals that breed during the 2010/11 flood event.

The boundary fence of Wanganella Station passes through the western portion of the Wanganella Swamp complex. The top wire in this fence is barbed and resulted in numerous waterbirds becoming entangled. It also makes portions of the wetland unavailable to the Brolga chicks prior to them being able to fly. This can be critical particularly if the water level drops and the outer reed beds dry as these shallow water areas provide both foraging habitat for the species and protection from foxes. Entanglement in wire fences and Fox *Vulpes vulpes* predation are both known threats to the Brolga (Arnol *et al.* 1984).

Black-winged Stilt nest/eggs

Red-kneed Dotteral nest/eggs

Straw-necked Ibis nesting platform

Australian Painted Snipe nest/eggs

Figure 9: Nests and eggs of some of the waterbird species recorded breeding at Wanganella Swamp during the 2010/11 flood event

3.3.2 Aerial Photography Survey

Results from the high resolution vertical photography (captured on 10/12/10) indicate that at least 13 932 waterbirds (ibis, spoonbills and egrets) were present in the western and eastern colonies of Wanganella Swamp (Table 8). The majority of waterbirds were found in the western colony (approximately 13 223), with the eastern colony supporting 709 waterbirds.

Table 8: Analysis of vertical photography of western and eastern waterbird colonies at Wanganella Swamp captured on the 10/12/10.

Analysis Categories	Western colony	Eastern colony	Total
Ibis (not on nest or trampling)	65	-	65
Ibis nest (not occupied)	293	-	293
Ibis nest (occupied)	9168	-	9168
Ibis flying	137	-	137
Ibis trampling lignum (no eggs)	3152	-	3152
White bird (Royal spoonbill, white ibis or egret)	155	129	284
White bird nesting	221	204	425
White bird nesting?	-	324	324
White bird flying	19	6	25
White bird roosting	13	-	13
White bird?	-	16	16
Bird nesting		1	1
Nest		29	29
TOTAL	**13,223**	**709**	**13,932**

The on-ground surveys conducted during the first two weeks of December 2010 identified the following numbers of birds breeding:

- Australian White Ibis – western colony ~250 individuals, eastern colony ~100 individuals;
- Straw-necked Ibis – western colony ~4 550 individuals, eastern colony ~80 individuals; and
- Royal Spoonbill – western colony ~13 individuals, eastern colony ~15 individuals.

Figure 10: Australian Painted Snipe (male), considered Australia's rarest wader. It was recorded nesting at Wanganella Swamp during the 2010/11 flood event

No Egret species were confirmed nesting during the 2010/11 flood event. Therefore the total nesting colonial waterbirds based on ground surveys during December was ~5008 individuals. This is substantially less than was estimated from the analysis of the vertical photography. Although the vertical photography included ibis not on nests, unoccupied nests, ibis flying above the colony and white birds flying or roosting this only accounts for a small number of birds (717) and does not explain the large difference between the aerial and on ground surveys. The difference between the two survey methods could be due to a number of reasons but the most likely is that the aerial survey was able to survey a much larger area of the wetland than was possible during on ground surveys.

3.3 Frogs

Five frog species were identified at Clarkes Creek and Eight Mile Creek crossings, Wanganella Swamp during February 2011. Species included Peron's Tree Frog (*Litoria peronii*), Plains Froglet (*Crinia parinsignifera),* Spotted Marsh Frog *(Limnodynastes tasmaniensis*), Barking Marsh Frog *(Limnodynastes fletcheri)* and the Bibron's Toadlet (*Pseudophryne bibronii*). There were numerous individuals seen (hundreds) and heard (estimated in the 1000's).

Although widely distributed, *P. bibronii* was detected only on a few occasions during other Mid Murray surveys. Timing of the Wanganella Swamp survey was conducted a couple of days after local heavy rain falls which may explain the presence of this "near threatened" (as listed by the International Union for Conservation of Nature) and somewhat cryptic species, which is known to respond to such rain events.

Egg masses of *L. tasmaniensis* and *L. fletcheri* were observed amongst inundated vegetation at all surveyed sites and *L. tasmaniensis* and *C. parinsignifera* were also present on all surveyed sites which is expected as these species are all common and widely distributed in the Murray-Darling Basin.

Wetlands like Wanganella Swamp which have longer inundation rates and a higher diversity of aquatic vegetation, typically support high densities of frogs. Higher diversity of frogs typically occurs in wetlands that have longer inundation periods ~9 months (not permanent) and have complex vegetation (fringing and aquatic). This is likely because there is more time to develop from egg to adult and more aquatic plant development due to longer water regime, thus more habitats to feed, breed and shelter (Wassens *et al.*, 2011). The low diversity of frogs in this survey was most likely affected by the duration of the recent drying event.

Due to the one-off nature of the survey it is difficult to draw conclusions and develop meaningful recommendations for species observed. It is however recommended that future surveys incorporating multiple sampling events be undertaken to develop a more comprehensive understanding of the frog community present within Wanganella Swamp.

4.0 Recommendations

Based on the flood event, use of environmental water and the vegetation and waterbird response at Wanganella Swamp the following recommendations are made:

Hydrology and Structures

1. Review the apparent discrepancy between flows over Warriston Weir into Forest Creek and with the flow and water levels reaching Wanganella Swamp (Eight Mile Creek). It is suspected that a large amount of water returned to the Billabong Creek via Forest and Piccaninny Creeks. In particular, need to investigate the area around Junction Weir, Mortimer's Dam and Warriston Weir.

2. Undertake an inspection of all water control structures downstream of Warriston Weir to determine which ones may have been damaged during the 2010/2011 flood event allowing water to return to Billabong Creek (e.g. along Piccaninny Creek and Forest Creek) rather than proceeding down Eight Mile Creek.

3. Water managers (including environmental water managers) will now have to either use the Cocketgedong gauge or use a reduction factor if the Walbundrie gauge measurements are used when making their estimates of water flow further down the Billabong Creek system. The Cocketgedong gauge should also be used as a critical trigger for planning future Wanganella events.

4. Investigate options in Forest Creek upstream of Warriston Weir to control Cumbungi thus improving water delivery to Warriston Weir and ultimately Wanganella Swamp.

5. Investigate whether it is feasible to construct a water control structure on the western end of Clarke's Creek (i.e. Wanganella Station/travelling stock route boundary) to maintain a deeper water level within Clarke's Creek upstream of Wanganella Station. The main purpose of this structure would be to keep environmental flows on the TSR but allow natural flood events to pass further down the creek.

6. Investigate removing existing old water control structure from the head of Clarke's Creek to improve water entry into Clarke's Creek downstream of the Cobb Highway but upstream of Wanganella Station.

7. Investigate future management options for McCrabb's regulator. This should include whether the structure should be replaced or upgraded to allow for better management of future environmental flows and flood events. Any changes to McCrabb's regulator should ensure that water levels within Wanganella Swamp are not increased to a level that environmental water is not lost back to the Billabong Creek north-east of McCrabb's regulator.

8. Determine the travel times and incurred losses for water to be delivered to Wanganella Swamp via the Billabong Creek verses the Forest/Eight Mile Creek system.

9. Further investigate the feasibility and practicality of constructing channels (as described in Webster and Davidson (2010) to deliver environmental water more efficiently to Wanganella Swamp.

10. Investigate the most efficient options for delivering environmental water to Wanganella Swamp (e.g. via Coree escapes) when Forest Creek/Eight Mile Creek is wet/full or via pumps if Forest Creek/Eight Mile Creek is dry.

Vegetation

11. Control terrestrial weeds.

12. Ensure the wetland receives an appropriate hydrological regime to ensure the vegetation communities (reedbeds [eg Cumbungi], spike-rush sedgeland, Lignum and Nitre Goosefootthat support bird breeding are maintained in a healthy condition.

Birds

13. The delay in acquiring environmental water threatened the success of the bird breeding event. Fortunately, when the water level dropped dramatically, heavy rains maintained/increased water levels and the ibis did not abandon their nests. However, if and when a bird breeding event occurs in the future, it is recommended that all the necessary planning is undertaken as early as possible to ensure water can be delivered when needed to ensure a successful waterbird breeding event. The aim of using environmental water during a bird breeding event should be to ensure as many birds and species successfully fledge young, this may require filling in gaps in the hydrograph when the natural flows recede.

14. To achieve successful breeding of the Australasian Bitterns *Botaurus poiciloptilus* within Wanganella Swamp maintaining a suitable water level (≥30cm within the spikerush *Eleocharis* sp. portion of the wetland) for at least 3-4 months is required.

15. Determine what the minimum flows required to sustain a bird breeding event are.

16. Put in place appropriate monitoring for the next flow event to help determine the minimum flows required to sustain a bird breeding event.

17. Undertake aerial surveys of large (>10 000 pairs) bird nesting events.

Frogs:

18. Surveys with multiple sampling events should be incorporated into future monitoring considerations to better understand the present frog community at Wanganella Swamp.

Land Management Issues

19. Investigate options for removing/replacing the portion of boundary fence of Wanganella Station that traverses the western portion of Wanganella Swamp (i.e. west of the Cobb Highway) or replacing the barbed wire with a plain wire through this portion of the wetland. This investigation should include assessing the impacts

the fence has on nesting Brolgas, birds traversing the swamp (entanglement in barbed wire) and disturbance of the wetland floor as a result of fence construction (existing fence is below ground level creating a channel through the floor of the wetland).

5.0 References

ANZECC and ARMCANZ. 2000. Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Environmental Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Canberra, Australia.

Arnol, J.D., White, D.M. and Hastings, I. 1984. Management of the Brolga (*Grus rubicundus*) in Victoria. Resources and Planning Branch. Fisheries and Wildlife Service. Technical Report Series No. 5.

Davidson, I. and Webster, R. 2007. Forest Creek Review of Environmental Factors. Unpublished report for Department of Natural Resource. Regeneration Solutions, Glenrowan.

Glazebrook, H. 2000. Draft Management Plan for the Forest Creek System including Forest Creek ,Eight Mile Creek and the Forest Anabranch. Department of Land and Water Conservation, Deniliquin.

Harden, G.J. (Ed.) 1990. *Flora of New South Wales. Volume 1.* New South Wales University Press, Kensington.

Harden, G.J. (Ed.) 1991. *Flora of New South Wales. Volume 2.* New South Wales University Press, Kensington.

Harden, G.J. (Ed.) 1992. *Flora of New South Wales. Volume 3.* New South Wales University Press, Kensington.

Harden, G.J. (Ed.) 1993. *Flora of New South Wales. Volume 4.* New South Wales University Press, Kensington.

Hobbs, J.N. 1956. A Flood Year in the Riverina. *Emu 56:* 349-352.

Maher, P. 1988. Historical records on bird species utilising Wanganella Swamps 1978-1988, Forest and Clarke's Creek Areas. Unpubl. report to NSW Department of Water Resources.

Roberts, J. and Pasma, S. 1993. Wanganella Swamps. *In River, Plain and Sandhill.* Vol. 1 pg 59-74. Ed. A. Wilson. Proceedings Southern Riverina Field Naturalists Club, Deniliquin.

Wassens, S., Healy, S. & Watts, R. (2011). Optimising frog breeding responses to flooding in managed wetlands *(ii) Frog distributions through the Murray Floodplain report to Murray Wetlands Working Group, Albury.*

Webster, R. and Davidson, I. 2010. Management Plan for Wanganella Swamp. Unpubl. report to Water for Rivers. Ecosurveys Pty Ltd, Deniliquin.

White, G., Andrews, S. and McAllister, R. 1985. Environmental Assessment of Works to Augment Regulated Flows within the Yanco, Colombo and Billabong Creeks System. Water Resources Commission, Environmental Studies Group.

6.0 Appendices

Appendix 1

Chronological record of events, flow rates, water depths and management decisions made in relation to the management of flows (natural and environmental) into Wanganella Swamp from the 15/11/10 to 30/05/11.

Date	Comments/Meetings/Actions
15/11/10	First steering committee teleconference held. Steering committee consisted of: Ned Hamilton (SWC), Adam McLean (SWC), Justen Simpson (OEH), Emma Wilson (OEH), David Bishop (OEH), Paula D'Santos (OEH, steering committee coordinator), Richard Sleigh (YACTAC), Jim Parett (YACTAC), Colin McCrabb (landholder, Avenel), Micheal Mullins (LHPA), Sally Dye (Murray CMA), Rick Webster (Ecosurveys). Observers: David Leslie (Murray CMA), Digby Jacobs (NOW), Philip Maher (Australian Ornithological Services), Bill Newton (FS Falkiner), Kaye Dalton (Water for Rivers). Purpose of steering committee was to keep an eye on bird breeding event and flow rates. If/when required OEH would consider making available an environmental allocation to ensure a successful bird breeding event. Steering committee to provide advice on how best to manage e-flow allocation, if/when required. Approx. 1,000 straw-necked ibis (SNI) pushing down reeds following high system flows, with more birds being attracted to the swamp. Discussions on how McCrabb's regulator could be managed to retain stable water levels within the swamp. Suggested fox baiting be conducted to protect birds, especially young brolga chicks. Depth loggers identified as being required to help with understanding of flows through system during the event.
23/11/10	~ 5,000 prs of ibis building nests. First hearing of Australasian bittern call. Painted Snipe sighted (23/11/10), 2 brolga chicks hatched (~2 weeks old).
26/11/10	OEH deploys a STS DLN depth logger d/s of Eight Mile Ck.
28/11/10	OEH receives letter from Rick Webster and Phil Maher raising concerns with bird breeding event and suggestions on appropriate water regimes.
29/11/10	Second steering committee teleconference held. Renewed high flow down Yanco Ck due to rainfall and Murrumbidgee EWA (50GL) release. Considered to be no risk of low water levels in Wanganella until after Christmas/New Year. Water running back to Billabong Ck from Forest Ck at two locations: - ~25-35 ML/d through 600mm pipe east of Estuary Ck; - Estuary Ck flowing ~5-6 ML/d; - Piccaninny Ck also flowing well. Two depth loggers deployed by Murray CMA. Salinity recorded: 0.27 mg/L within Eight Mile Creek. Uncertainty on flow travel times between Warriston Weir and Wanganella Swamp,

	estimated to be 5-6 days, Finley Escape to Warriston Weir estimated 5-6 days. Decided that fox baiting would not be conducted due to poor uptake of bait earlier in season. NOW advised that until flows change from supplementary to regulated (i.e. environmental flow) that water within the swamp cannot be held up by shutting off McCrabb's regulator, which is State Water structure. Due to paucity of information difficult to establish 'trigger levels' within the swamp to alert need for environmental flows. Therefore best approach to keep watch on flow rates over Warriston Weir and levels within the swamp. Where possible use data from 2005/06 event.
1/12/10	Water levels = 0.66m (Eight Mile Ck bridge)
3/12/10	Third depth logger deployed by Murray CMA.
5/12/10	Water levels = 0.62m (Eight Mile Ck bridge)
6/12/10	Initial concerns on falling flow rates. Flood flow coming down the system predicted to hit Warriston Weir around Christmas Day – so approx. 15 days lag till increase in flows reach the swamp. A request put to SWC to put boards in at Hartwood Weir to push more water down Forest Ck and maintain at least 150ML/d flow through to Warriston/swamp. Eastern side of swamp – 100s of Aust. White ibis, ~50 prs Whiskered Terns and Grebes.
7/12/10	Flows from Jerilderie to Hartwood Weir approx. 4-7 days travel time, Hartwood to Warriston approx. 4 days. Flow rate of 200ML/d into swamp estimated to be required to maintain adequate levels for nesting birds.
9/12/10	Brolga chicks sighted ~ ½ - 1/3 grown. Road between Conargo and Wanganella was still closed due to high flows.
10/12/10	OEH commissions high resolution vertical photography of Wanganella Swamp ibis colony. Western colony - a total of 13,223 birds detected, includes 9,461 straw-necked ibis on nests, 3,152 trampling nests.
11/12/10	Water level = 0.5m (Estuary Ck gauge) Pair of blue-billed ducks sighted. Most ibis nests in 0.3m depth of water, with some in 0.15 – 0.23m depths, so very vulnerable to abandoning nests.
13/12/10	Third Steering committee teleconference held. Agreed that boards are to be kept in at Hartwood Weir until such time higher flow have reached the weir and/or flows over Warriston exceed 200ML/d. Knowledge gap: flow rate d/s of McCrabb's regulator. Review of effectiveness of McCrabb regulator and spillway required to improve future water management through system. To be included in monitoring report. Breeding event considered to be 1 in 30 year event.
14/12/10	Water levels = 0.6m (Estuary Ck gauge)

19/12/10	Levels within the swamp had fallen to 0.55m (Estuary Ck gauge), preferred height 0.6m. 0.55m (Eight Mile Ck)
20/12/10	OEH and SWC fly-over over Wanganella Swamp.
21/12/10	Fourth Steering committee teleconference held. Drop in water levels within swamp reported to have drained margins of the swamp putting pressure on a suite of nesting bird sp. including Australian Painted Snipe. 3-4 Australian Painted Snipe eggs hatched. Malfunction noticed in one of the CMA data loggers. Boards still in at Hartwood and to remain until levels within the swamp are on the increase again. Preferable to remove 2 rows prior to peak of flow reaching weir to minimise OHS risk. Uncertain if last 2 boards were in.
22/12/10	Water levels = 0.57m (Eight Mile Ck bridge)
23/12/10	Water levels = 0.58m (Eight Mile Ck bridge)
24/12/10	Flow peak reached Hartwood Weir. Warriston Weir flows = 300 ML/d. SWC will try to maintain this rate over Warriston.
05/01/11	First mention of need to order environmental water for the Swamp. Ideal to maintain flows of 300ML/d until end of January – this rate inundates the shallower margins of the swamp which is supporting a diversity of bird species.
6/01/11	Warriston Weir flows = 264.05 ML/d Water levels = 0.61m (Eight Mile Ck bridge)
7/01/11	Warriston Weir flows = 239 ML/d
10/01/11	Gates fully out at Forest Ck off-take.
11/01/11	Final 2 boards put in at Hartwood Weir. Water level = 0.61m (Eight Mile Ck bridge)
12/01/11	9 – 12/01/11 – Avenel station recorded 30mm rain.
18/01/11	Water level = 0.6m (Eight Mile Ck bridge)
19/01/11	Warriston Weir flow = 172.1 ML/d
20/01/11	Final lot of boards put in at Hartwood. Water levels = 0.59m (Eight Mile Ck bridge) Enquiry to MIL to look at alternative escapes that could be used to deliver water to swamp, in addition to Finely Escape.
22/01/11	Water levels = 0.55m (Eight Mile Ck bridge)
24/01/11	Fifth Steering committee teleconference held.

	Forecast for no substantial flows coming down the system. Warriston Weir flow = 85.4 ML/d Water levels = 0.48m With falling water levels and thousands of young birds ½-3/4 grown there is an urgent need to keep water levels up until February to prevent abandonment by adults. Discussion on environmental water management options: Scenario 1: Do nothing Scenario 2: Use of Finley Escape Scenario 3: Use of non-accredited escapes exiting directly into Forest Ck only. Scenario 4: Use of Finley Escape and non-accredited Forest Ck escapes. Scenario 4 supported.
27/01/11	OEH conduct emergency works on McCrabb's regulator to reduce water flow over spillway.
28/01/11	Approval from NOW received to transfer e-water via MIL infrastructure to Swamp. Environmental water order for 6,000ML placed with State Water. MIL's Finley, Corree 11 extension, Corree 11B and Blighty 3D escapes to be used. Water level = 0.34m (Eight Mile Ck bridge) Highest numbers (~40) of Latham's Snipe recorded in 20 years.
29/01/11	Water level = 0.3m (Eight Mile Ck bridge)
31/01/11	E-water delivery via MIL escapes commenced.
1/02/11	Water level = 0.275m (Eight Mile Ck bridge)
3 – 5/02/11	Rainfall = 100mm over Wanganella region (influence from cyclones Anthony and Yasi). Warriston Weir flow = 65 ML/d (03/02/11) Minor works conducted to prevent flows down Piccaninny Ck and increase flows down Eight Mile Ck to swamp.
8/02/11	Water level = 0.54m (am), 0.56m (pm) (Eight Mile Ck bridge)
9/02/11	Warriston Weir flow = 314 ML/d
10/02/11	Warriston Weir flow = 312 ML/d Environmental flows out of Finley Escape suspended due to high flows within Billabong Creek. Flows from smaller escapes to continue.
15/02/11	Environmental flows out of Corree 11 extension, 11B and Blighty 3D escapes suspended due to >300ML/d flow achieved over Warriston Weir.
16/02/11	Dissolved oxygen levels = <2 mg/L in swamp. Small numbers of carp observed.
1/03/11	Warriston Weir flow = 765.2 ML/d
8/03/11	Warriston Weir flow = 923.5 ML/d
16/3/11	Warriston Weir flow = 1,274 ML/d (peak)
17/03/11	Warriston Weir flow = 1,267 ML/d Ibis observed to be still building nests and laying eggs.

	Temporary block in Piccaninny Ck blown out due to higher flows.
18/03/11	Dissolved oxygen levels = 0.5 mg/L (Eight Mile Ck bridge) Observation of dead carp (varying in size) in Eight Mile Ck.
22/03/11	Water level = 0.73m (Eight Mile Ck bridge) Warriston Weir flow = 1099.9 ML/d Dissolved oxygen levels = 0.7 mg/L(Eight Mile Ck), = 0.56 mg/L (McCrabb's bridge)
27/03/11	Water level = 0.72m (Eight Mile Ck bridge)
28/03/11	Dissolved oxygen = <1 mg/L (Estuary Ck) Small bodied fish observed surface-breathing and yabbies crawling out of Estuary Creek. Piccaninny Ck flows broken through to Billabong Ck. Estuary ck flows to Billabong Ck ~ 80-100ML/d. Estuary Creek regulator was closed by SWC.
29/03/11	Water level = 0.72m (Eight Mile Ck bridge) Warriston Weir flow = 950.4 ML/d Dissolved oxygen levels = 1.34 mg/L(Eight Mile Ck), = 0.95 mg/L (McCrabb's bridge) Approx. 700 prs of SNI and 100 prs of Aust. White ibis recently hatched. Approx 300 prs of SNI and 100 prs of Aust. White ibis chicks half grown.
9/04/11	Environmental flows recommenced through Finley, Coree 11 extension, Corree 11B and Blighty 3D escapes.
13/04/11	Water level = 0.71m (Eight Mile Ck bridge) Warriston Weir flow = 207.04 ML/d Dissolved oxygen levels = 3.31 mg/L(Eight Mile Ck), = 1.61 mg/L (McCrabb's bridge)
19/04/11	Water level = 0.48m (Eight Mile Ck bridge). Water probably escaping back to Billabong Ck before it is reaching the swamp. Warriston Weir flow = 245.06 ML/d Dissolved oxygen levels = 2.61 mg/L(Eight Mile Ck), = 1.72 mg/L (McCrabb's bridge)
29/04/11	Water level = 0.465m (Eight Mile Ck bridge) Warriston Weir flow = 228.75 ML/d Dissolved oxygen levels = 4.81 mg/L(Eight Mile Ck), = 3.21 mg/L (McCrabb's bridge) 800 clutches of SNI are on the wing or close to. 800 prs of ibis 1-2 weeks from flying off. 1 juvenile Baillon's Crake observed.
2/05/11	Delivery of environmental flows ceased due to closure of MIL channels for the 2010-2011. Gradual recession in flow rates through Finley escape will continue for next couple of weeks.
9/05/11	Water level = 0.42m (Eight Mile Ck bridge) Warriston Weir flow = 150.9 ML/d

	Dissolved oxygen levels = 5.95 mg/L(Eight Mile Ck), = 6.6 mg/L (McCrabb's bridge) Seven Magpie Geese sighted (first seen on 05/05/11) behind sandhill along Eight Mile Ck. Clarke's Creek swamp almost drained. This is the most botanically diverse of TSR wetlands. Normally this wetland does not fill unless high flows in system for prolong duration, but with minor works this could be changed to benefit waterbird species. Further investigation required.
30/05/11	Water level = 0.365m (Eight Mile Ck bridge) Warriston Weir flow = 98.09 ML/d Dissolved oxygen levels = 10.62 mg/L (Eight Mile Ck), = 8.58 mg/L (McCrabb's bridge) All young ibis and spoonbills can now fly, but many young still hanging around colony. Probably still being fed by adults. Estimate another 1-2 weeks before fully independent. Second nesting for season considered to be highly successful, although smaller clutch sizes.

Appendix 2

Actual volumes of environmental water released from the MIL escapes – Blighty, Coree 11, Coree 11B and Finley for the Wanganella Swamp event 2010-2011. NB: The numbers in the table below do not account for transmission losses.

Date	Blighty	Coree 11 extension	Coree 11B	Finley
31/01/2011	-	-	-	128
1/02/2011	22	20	22	307
2/02/2011	13	21	20	337
3/02/2011	12	21	20	325
4/02/2011	10	26	33	299
5/02/2011	15	22	32	362
6/02/2011	10	32	24	371
7/02/2011	12	22	16	420
8/02/2011	12	20	20	448
9/02/2011	9	20	24	567
10/02/2011	9	21	20	280
11/02/2011	10	21	18	113
12/02/2011	9	16	19	37
13/02/2011	10	18	18	18
14/02/2011	10	23	15	8
15/02/2011	10	18	21	7
16/02 – 09/04/11	Water delivery suspended			
10/04/2011	-	-	-	204
11/04/2011	-	-	-	316
12/04/2011	-	-	-	288
13/04/2011	-	-	-	259
14/04/2011	5	23	29	269
15/04/2011	11	22	37	251
16/04/2011	11	22	35	262
17/04/2011	10	29	29	261
18/04/2011	10	22	29	272
19/04/2011	10	24	29	270
20/04/2011	10	22	27	274
21/04/2011	10	20	30	279
22/04/2011	10	20	28	277
23/04/2011	10	20	28	272
24/04/2011	10	20	27	272
25/04/2011	10	20	27	274
26/04/2011	10	20	27	269
27/04/2011	11	20	25	266
28/04/2011	11	20	26	256
29/04/2011	10	20	26	247
30/04/2011	14	20	27	196
1/05/2011	14	20	30	100
2/05/2011	11	20	23	100
TOTAL	**371**	**725**	**861**	**9761**

Appendix 3

Results of vegetation monitoring at Wanganella Swamp during the 2010/2011 flood event.

VEGETATION MONITORING DATA SHEET										
Date: 25/11/2010			Site No:		Transect No: CCk 1		Wetland Name: Clarke's Creek			
Collector: Philip Maher			Bearing: 80°		GPS: 302425E/6095475N			Photo No: 1424 17/12/10		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lactuca serriola								<1	<1	
Avena sp.	<1	<1	<1							
Panicum sp.	1			<1	4	<1				
Convolvulus erubescens					5					
Gnaphalium sphaericum					<1					
Phalaris sp.		<1								
Chenopodiumn nitariaceum	<1									
Muehlenbeckia florulenta										20
Echium plantagineum				<1				1	<1	1
Oxalis perennans										<1
Sonchus oleraceus										<1
Senecio quadridentatus										5
Lepidium africanum	1	<1	<1	<1					<1	
Open Water	50	40	20	10	11	20	20	40	20	24
Leaf Litter	50	60	80	90	80	80	80	60	80	50
Bare Ground										
Other Comments/Observations										

VEGETATION MONITORING DATA SHEET										
Date: 28/1/2011			Site No:		Transect No: CCk 1		Wetland Name: Clarke's Creek			
Collector: Philip Maher			Bearing: 80°		GPS: 302425E/6095475N			Photo No: 2024 28/1/2011		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Marsilea drummondii									1	2
Damasonium minus				<1	<1		<1			
Panicum decompositum					<1	<1				
Chenopodiumn nitariaceum	30									
Muehlenbeckia florulenta										30
Open Water	40	30								
Leaf Litter	30	70	100	100	100	100	100	100	99	68
Bare Ground										
Other Comments/Observations	Shallow water covered in dead grass.									

VEGETATION MONITORING DATA SHEET										
Date: 25/11/2010			Site No:		Transect No: CCk 2		Wetland Name: Clarke's Creek			
Collector: Philip Maher			Bearing: 294°		GPS: 302887E/6096268N			Photo No: 1422 17/12/10		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lemna minor					<1					
Ranunculus undosus		1	1	30						
Eleocharis acuta	<1	5	2							
Agrostis avenacea			2							
Muehlenbeckia florulenta	5									
Typha sp.				4	<1		5	4	2	
Lactuca serriola	2	1	1		10				1	
Cirsium vulgare					<1					
Lythrum hyssopifolium	1	1								
Polypogon monspeliensis		<1								
Open Water	12	42	44	16	25	<1	<1	<1	<1	<1
Leaf Litter	80	50	50	50	65	100	95	96	98	99
Bare Ground										
Other Comments/Observations	Q10 consists of dead cumbungi & water									
	Q4 *Rumex crispus*									
	Q2 *Eleocharis acuta* flowering									
	Q1 *Muehlenbeckia florulenta* flowering									

VEGETATION MONITORING DATA SHEET										
Date: 25/11/2010			Site No:		Transect No: CCk 2		Wetland Name: Clarkes Creek			
Collector: Philip Maher			Bearing: 294°		GPS: 302887E/6096268N			Photo No: Clarke's Ck 2 25/11/10		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lemna minor					<1					
Ranunculus undosus		1	1	30						
Eleocharis acuta	<1	5	2							
Agrostis avenacea			2							
Muehlenbeckia florulenta	5									
Typha sp.				4	<1		5	4	2	
Lactuca serriola	2	1	1		10				1	
Cirsium vulgare					<1					
Lythrum hyssopifolium	1	1								
Polypogon monspeliensis		<1								
Open Water	12	42	44	16	25	<1	<1	<1	<1	<1
Leaf Litter	80	50	50	50	65	100	95	96	98	99
Bare Ground										
Other Comments/Observations	Q10 consists of dead cumbungi & water									
	Q4 *Rumex crispus*									
	Q2 *Eleocharis acuta* flowering									
	Q1 *Muehlenbeckia florulenta* flowering									

VEGETATION MONITORING DATA SHEET										
Date: 2/12/2010			Site No:		Transect No: WW		Wetland Name: Wang West			
Collector: Philip Maher			Bearing: 300^{o}		GPS: 301896E/6097065N			Photo No: 1127 2/12/10		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lythrum hyssopifolium	2									
Medicago sp.	<1									
Juncus sp.	<1									
Agrostis avenacea	5	1	5	1	<1	<1				
Stellaria angustifolia	<1									
Polygonum lapathifolium	<1		<1	<1						
Myriophyllum propinquim					<1					<1
Cynodon dactylon	5	1	<1	<1	<1	<1				<1
Ranunculus undosus										
Eleocharis acuta	5		30	90	90	2	<1			60
Polygonum aviculare				1						<1
Polypogon monspeliensis	10		1							<1
Algae	10	5	3							10
Damasonium minus			1			<1	<1	<1	1	
Open Water	63	93	60	8	10	98	99	99	99	30
Leaf Litter							1	1		
Bare Ground										
Other Comments/Observations										

VEGETATION MONITORING DATA SHEET										
Date: 20/1/2011			Site No:		Transect No: WW		Wetland Name: Wang West			
Collector: Philip Maher			Bearing: 300^{o}		GPS: 301896E/6097065N			Photo No: 1843 20/1/2011		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lythrum hyssopifolium	1						1	2	5	4
Medicago sp.							5			5
Rumex sp.										<1
Agrostis avenacea	1	40	1	1		1				<1
Stellaria angustifolia	1							1	<1	
Polygonum lapathifolium								2		
Myriophyllum propinquim			<1				1			1
Cynodon dactylon	90	30	10	10	5				15	
Ludwigia peploides				1						
Eleocharis acuta	2	20	20	80	95	90	90	90	80	90
Damasonium minus			40	5		1				
Polypogon monspeliensis			1							
Open Water	5	10	28	3		8	3	5		
Leaf Litter										
Bare Ground										
Other Comments/Observations										

VEGETATION MONITORING DATA SHEET										
Date: 2/12/2010			Site No:		Transect No: WN		Wetland Name: Wang North			
Collector: Philip Maher			Bearing: 250^{o}		GPS: 301472E/6098600N			Photo No: 1126 2/12/10		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lythrum hyssopifolium	1	10	5	1	<1	<1	<1		<1	
Pratia sp.							<1			
Lemna minor		<1				<1				
Agrostis avenacea	1	<1			5	5	10	5	5	<1
Stellaria angustifolia		<1								
Polygonum lapathifolium						<1		<1		
Myriophyllum propinquim				<1			<1		<1	<1
Cynodon dactylon								<1		
Muehlenbeckia florulenta		10	10							
Eleocharis acuta	20	10			<1	<1	10	70	70	90
Chenopodiumn nitariaceum									<1	
Polypogon monspeliensis	5	10	5	<1	<1	<1	20	<1	<1	
Ranunculus undosus	<1	<1		<1	<1	<1		<1	<1	
Marsilea drummondii			<1							
Open Water	10	20	20	20	15	20	10	25	25	10
Leaf Litter	64	40	60	80	75	50				
Bare Ground										
Other Comments/Observations	Leaf litter is mainly dying *Agrostis avenacea* (from inundation)									

VEGETATION MONITORING DATA SHEET										
Date: 20/1/2011			Site No:		Transect No: WN		Wetland Name: Wang North			
Collector: Philip Maher			Bearing: 250^{o}		GPS: 301472E/6098600N			Photo No: 1839		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lythrum hyssopifolium	18	10			1					
Azolla sp.									5	<1
Ludwigia peploides									1	
Agrostis avenacea	1				<1		<1	<1	1	
Algae*		60	34	18		20				
Polygonum lapathifolium	1					1	<1			
Ranunculus undosus			1		2					
Cynodon dactylon				30		30	20	20	5	
Marsilea drummondii			5	<1						
Eleocharis acuta	80	20	60	50	70	20	80	80	10	90
Open Water		10			27	29			68	10
Leaf Litter									10	
Bare Ground										
Other Comments/Observations	Water level varies from 0-150mm in depth									
	* Algae floating on open water									

VEGETATION MONITORING DATA SHEET										
Date: 3/12/2010			Site No:		Transect No: WE		Wetland Name: Wang East			
Collector: Philip Maher			Bearing: 300^{o}		GPS: 303679E/6096856N			Photo No: 1132 3/12/2010		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Lemna minor	<1			<1		1			<1	<1
Ranunculus undosus	1			10	10	10	10	5	9	50
Eleocharis acuta	20	10	40	60	90	60	80	95	90	40
Agrostis avenacea									<1	<1
Marsilea drummondii		1	1	2	<1	<1			<1	
Stellaria angustifolia	10				<1	<1			<1	
Damasonium minus		1	1	<1			<1			
Rumex sp.									<1	
Lythrum hyssopifolium						<1	<1			<1
Juncus sp.						1				
Cynodon dactylon	<1									
Algae		5								
Open Water	68	83	58	28		27	10		1	10
Leaf Litter	1					1				
Bare Ground										
Other Comments/Observations	Water 30-40cm deep, *Eleocharis acuta* flowering									

VEGETATION MONITORING DATA SHEET										
Date: 28/1/2011			Site No:		Transect No: WE		Wetland Name: Wang East			
Collector: Philip Maher			Bearing: 300°		GPS: 303679E/6096856N			Photo No: 2008		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Myriophyllum propinquim								<1	<1	<1
Ranunculus undosus	1	<1	2	<1	20	2	<1	1	<1	<1
Eleocharis acuta	50	10	80	95	50	95	95	95	90	95
Agrostis avenacea			<1						2	
Marsilea drummondii	1	1	2		<1		<1		<1	<1
Stellaria angustifolia	20			1	30			<1		
Damasonium minus		20	<1	<1						
Epilobium hirtigerum					<1					<1
Lythrum hyssopifolium									<1	
Amphibromus neesii										<1
Cynodon dactylon	20				<1		<1			
Muehlenbeckia florulenta	1									
Open Water										
Leaf Litter										
Bare Ground	7	69	16	4		3	5	4	8	5
Other Comments/Observations	Q1 *Muehlenbeckia florulenta* reshooting									
	Q2 Mud covered in algae									
	Swamp largely dry									

VEGETATION MONITORING DATA SHEET										
Date: 29/12/10			Site No:		Transect No: WS		Wetland Name: Wang South			
Collector: Philip Maher			Bearing: 25°		GPS: 304877E/6095210N			Photo No: 1536 29/12/2010		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Senecio cunninghamii		5		5	5	10	20	10	50	50
Lemna minor	<1	10	5	15	90	90	90	90	90	90
Azolla sp.	40	20			<1	<1	1	<1	<1	<1
Agrostis avenacea	5	1				<1	<1	<1	<1	
Typha sp.	<1	1	<1			1	1			1
Polygonum lapathifolium	1				<1	<1		<1	<1	1
Ranunculus scleratus						<1				
Polygon monspeliensis		<1								
Ranunculus undosus	<1									
Open Water	50	20	94	80						
Leaf Litter										
Bare Ground										
Other Comments/Observations	Senicio is dying from inundation									

VEGETATION MONITORING DATA SHEET										
Date: 16/2/2011			Site No:		Transect No: WS		Wetland Name: Wang South			
Collector: Philip Maher			Bearing: 25°		GPS: 304877E/6095210N			Photo No: 2207		
Species	Qudrat 1 (0m)	Qudrat 2 (5m)	Qudrat 3 (10m)	Qudrat 4 (15m)	Qudrat 5 (20m)	Qudrat 6 (25m)	Qudrat 7 (30m)	Qudrat 8 (35m)	Qudrat 9 (40m)	Qudrat 10 (45m)
Senecio cunninghamii					20		10	10	30	5
Lemna minor		<1			<1		<1			<1
Azolla sp.		<1	<1	<1	<1		1			<1
Agrostis avenacea	10	10			1	<1		<1	<1	<1
Typha sp.	5	10	20	2	10		10		10	5
Polygonum lapathifolium	5	1		1	2			2	<1	5
Myriophyllum propinquim	1									
Cynodon dactylon	10									
Ranunculus undosus	5									
Eleocharis acuta	<1									
Open Water	62	74	80	77	67		80	88	60	80
Leaf Litter	2	5		20						
Bare Ground										
Other Comments/Observations	Water levels have recently dropped and re-flooded. Senecio largely dead.									

Appendix 4

Photos of the vegetation transects within Wanganella Swamp complex showing changes over time as the 2010/2011 flood event progressed.

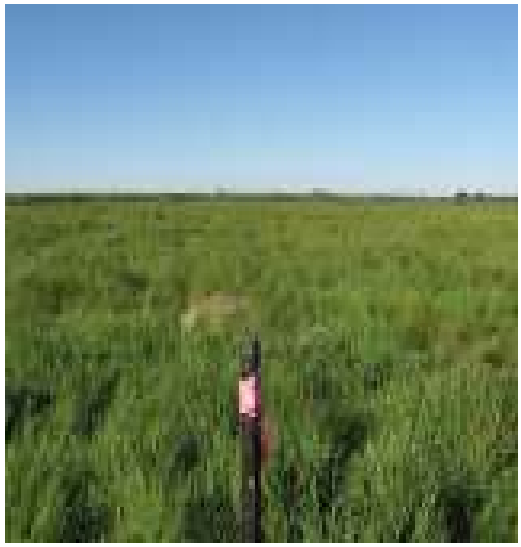
Clarke's Ck1 (17/12/20110)

Clarke's Ck 1 (28/1/2011)

Clarke's Creek 2 (17/12/2010)

Clarke's Creek 2 (28/1/2011)

Wanganella West (2/12/2010)



Wanganella West (16/2/2011)

Wanganella North (2/12/2010)

Wanganella North (20/1/2011)

Wanganella East (3/12/2010)

Wanganella East (28/1/2011)

Wanganella South (29/12/2010)

Wanganella South (20/1/2011)

Appendix 5

Waterbirds and wetland-related species recorded at Wanganella swamps (Forest & Eight Mile Creeks) from 30 October 2010 to 30 May 2011 with particular reference to breeding records.

🗐 denotes breeding.
* denotes listed as a threatened species under the TSC Act 1995
# denotes listed as threatened or migratory species under the EPBC Act 2000.
+ denotes listed on CAMBA
++ denotes listed on JAMBA
+++ denotes listed on ROKAMBA

Magpie Goose *Anseranas semipalmata**
4 May 2011: Seven birds (two adults and five immatures) on the TSR at 8 Mile Creek. Possible first record for Wanganella wetlands.
9 May 2011: Seven birds still present.

🗐**Plumed Whistling-Duck** *Dendrocygna eytoni*
November & December 2010: Flocks of up to 15 birds seen in November 2010 and pairs recorded in December 2010: all on the TSR.
29 December 2010: Pair with about eight three-quarter grown young seen at the 8 Mile Creek bridge.
28 January 2011: 20 — 30 birds seen at Clarke's Creek swamp on the TSR.
22 March 2011: Flock of approximately 20 flying about the ibis rookery.
8 April 2011: Small number of about 20 birds seen at the west end of the ibis rookery.
19 April 2011: A flock of around 60 birds flying around the west end of the ibis colonies.

Wandering Whistling-Duck *Dendrocygna arcuata*
30 October 2010: Three seen on TSR, thereafter one to three seen on many occasions in November and December. The last sighting was of a pair on 29 December 2010 at the 8 Mile Creek bridge.
3 December 2010: A pair seen about 2 km upstream on Wanganella Station.
18 January 2011: Pair seen south side of the TSR, 8 Mile Creek, and another single bird 300 metres downstream of the 8 Mile Creek bridge. The behaviour of this single bird (calling and agitated) would suggest there might have been young nearby. If so, this is possibly the first breeding record for this species in the Riverina.
8 February 2011: One adult downstream of 8 Mile Creek bridge.

🗐**Musk Duck** *Biziura lobata*
21 November 2010: One bird recorded on TSR.
2-3 December 2010: About three seen on TSR and another upstream on Wanganella Station; two males displaying on 3 December 2010.
16 December 2010: Three males displaying upstream of Cobb Highway on Wanganella Station.
29 December 2010: Male displaying at the 8 Mile Creek bridge.
18 January 2011: Male downstream and female upstream of 8 Mile Creek bridge. As males have been displaying for two to three weeks, breeding is probably underway.
28 January 2011: One female seen at the 8 Mile Creek bridge.

8 February 2011: Two birds seen including a juvenile bird near the 8 Mile Creek bridge - the first breeding record for this species during the current flood event at Wanganella.
15 March 2011: One adult seen at 8 Mile Creek bridge.
19 April 2011: A pair on the middle bridge on the downstream side and a displaying male at the upstream side of 8 Mile Creek, presumably a female was looking on.
7 May 2011: An immature bird at 8 Mile Creek bridge.

Freckled Duck *Stictonetta naevosa**
20 January 2011: One adult female seen on open water near McCrabb's boundary; the first Freckled Duck recorded on the Wanganella swamps for over a decade. Historically, the observer has recorded at this particular locality.
15 March 2011: One dead bird on a barb-wire fence.

Black Swan *Cygnus atratus*
3 December 2010: Three nests seen on Wanganella Station — one being constructed and two with eggs (1 x 4 eggs, 1 x 6 eggs).
5 December 2010: One clutch of cygnets seen on the TSR**.**
13 December 2010: One nest with five eggs on the TSR.
18 January 2011: About twelve birds in the vicinity of ibis rookery; some full-grown immatures seen; about six disused nests seen.
28 January 2011: Pair with five small cygnets near the middle bridge.
8 February 2011: About six adults seen.
15 March 2011: About 20 adults seen about the ibis rookery.
22 March 2011: A few around the bridges.
29 March 2011: About 20 birds around the rookery and the highway.
8 April 2011: About 20 around the ibis rookery; same birds as 29 March.
19 April 2011: Pair with two small young on the upstream side of 8 Mile Creek bridge. About 20 seen in the vicinity of the ibis colonies. One adult dead under the power lines near 8 Mile Creek bridge.
29 April 2011: Four clutches of small young seen, approximately two weeks old, near the bridges and the ibis colony. Around 20 adults around the ibis colony.
9 May 2011: About ten adults around the ibis colonies and a pair with young at middle bridge.
30 May 2011: A few adults and one immature bird that could just fly were recorded. The fate of the clutches of small young seen on 29 April is unknown; hopefully they have moved to deeper holes.

Australian Wood Duck *Chenonetta jubata*
November & December 2010: A few seen, probably some breeding.
16 December 2010: About 50 seen upstream on Wanganella Station.
29 March 2011: Approximately 50 birds about the ibis rookery.
8 April 2011: Just a few seen.
19 April 2011: A small number seen.
29 April 2011: A couple of small flocks seen.

Pink-eared Duck *Malacorhynchus membranaceus*
21 November 2010: Adult at a nest hollow on the TSR, east side Cobb Highway.
3 December 2010: One clutch of young seen; an adult sitting on a stick nest on Wanganella Station.

16 December 2010: Five clutches of eggs and five clutches of small to half-grown young on Wanganella Station, upstream of Cobb Highway.
29 December 2010: One clutch of four half-grown young seen near Cobb Highway.
28 January 2011: About three adults and six juveniles near the 8 Mile Creek bridge.
8 February 2011: One clutch of young seen at the 8 Mile Creek bridge.
29 April 2011: A few about the ibis colonies.
30 May 2011: A couple of adults seen at the middle bridge.

Australasian Shoveller *Anas rhynchotis*
November & December 2010: A few pairs or small flocks seen most visits; probably some breeding.

Grey Teal *Anas gracilis*
2 & 3 December 2010: Three clutches of young seen on the TSR, west of the Cobb Highway.
13 December 2010: Three clutches of young seen on the TSR, west of the Cobb Highway.
16 December 2010: Two clutches of eggs and about eight clutches of small to half-grown young on Wanganella Station, upstream of Cobb Highway.
18 January 2011: Four clutches of full-grown young seen.
28 January 2011: A few seen.
8 February 2011: Quite a few dead juveniles seen; mortality possibly a result of botulism brought about by low water levels and high temperatures.
15 March 2011: About 50 adults seen.
22 March 2011: A few small groups around the bridges.
29 March 2011: Approximately 80 about the ibis rookery.
8 April 2011: About 80 around the ibis rookery (as previous date).
19 April 2011: A few hundred seen about McCrabb's bridge and around the ibis colonies; numbers increasing.
29 April 2011: Large flock of about 300 birds near the ibis colonies. Few fresh dead seen, presumably dying of botulism.
9 May 2011: Around 60 about the ibis colonies and bridges.
30 May 2011: Around 30 seen about the ibis colonies and bridges; a couple of birds looking poorly.

Chestnut Teal *Anas castanea*
22 November 2010: Pair with about eight juveniles seen on TSR along Cobb Highway.

Pacific Black Duck *Anas superciliosa*
27 November 2010: Nest with 10 eggs; several clutches of juvenile young seen during November.
13 December 2010: Three clutches of young on the TSR.
16 December 2010: Four clutches of young on Wanganella Station, upstream of Cobb Highway.
18 January 2011: Three clutches of almost full-grown young seen in the vicinity of the ibis rookery.
28 January 2011: Some seen every visit.
8 February 2011: Moderate numbers of adults and immatures.
15 March 2011: About 30 adults seen.
22 March 2011: A few small groups around the bridges.
29 March 2011: Approximately 50 about the ibis rookery.

8 April 2011: A big increase in the numbers of this species; 300 - 400 birds about the ibis rookery.
19 April 2011: A couple of hundred seen with Grey Teal about McCrabb's bridge and the ibis colonies.
29 April 2011: A hundred or so with the Grey Teal, and other scattered pairs. Two clutches of well-grown young near the 8 Mile Creek bridge, the first young seen for some months.
9 May 2011: Around 50 seen about the ibis colonies including a clutch of young about one week old.
30 May 2011: Around 30 seen about the ibis colony.

Hardhead *Aythya australis*
2 December 2010: Two nests, one with six eggs, the other with nine eggs, located in lignum *Muehlenbeckia florulenta*[2] on the TSR on the west side of the Cobb Highway.
9 December 2010: Clutch of 11 well-grown young on the TSR.
13 December 2010. Two nests with eight and 10 eggs and two clutches of about 10 small young seen on the TSR, west side Cobb Highway.
17 December 2010: One nest with nine eggs on the TSR, west side Cobb Highway. One of the more numerous ducks present. Rarely seen breeding in the district over the last 30 years.
18 January 2011: About eight clutches of young seen from one week to almost full-grown. Some clutches contained up to 18 or so young, indicating that two or more clutches have joined together with the one pair of adults.
20 January 2011: Another four clutches of small young seen that had not previously been recorded.
28 January 2011: Dozens of juveniles seen around the bridges**.**
8 February 2011: A few clutches of well-grown young seen although numbers are well down on those recorded prior to the drop in water levels in late January.
15 March 2011: About 20 adults seen.
22 March 2011: A small flock along the highway.
29 March 2011: Approximately 50 about the ibis rookery and the highway.
8 April 2011: Around 50 mainly immature birds around the ibis rookery.
19 April 2011: 20 - 30 birds about the highway and ibis colonies.
29 April 2011: Small numbers about the ibis colonies and one female with two small young at 8 Mile Creek bridge; the first breeding for some months.
9 May 2011: One seen near the ibis colonies.
Comment: This is probably this species biggest breeding event for the last 30 years.

Blue-billed Duck *Oxyura australis**
11 December 2010: One pair seen.
16 December 2010: Single male bird seen.
19 December 2010: Single male bird seen.
The first sighting of this species in the Forest Creek system since the 1980s. Breeding should occur if water levels are maintained.
18 January 2011: Pair seen upstream of McCrabb's regulator. Single males seen downstream of 8 Mile Creek bridge. Behaviour of all birds suggest breeding is occurring or about to occur.
20 January 2011: Single male near McCrabb's boundary.

[2] (syn. *M. cunninghamii*)

8 February 2011: Single adult female near the ibis rookery.
15 March 2011: One female seen near ibis rookery.
Comment: Thought not to have bred successfully this season.

Australasian Grebe *Tachybaptus novaehollandiae*
November & December 2010: Few pairs seen on the TSR, some probably are nesting.
18 January 2011: Immature birds seen near the 8 Mile Creek bridge, indicating that this species has also successfully bred here.
28 January 2011: One seen near the 8 Mile Creek bridge.
8 April 2011: Three seen about the ibis rookery.
19 April 2011: About 10 seen along the highway and the ibis rookery.
29 April 2011: A few seen.
9 May 2011: One seen near the ibis colonies.
30 May 2011: Around six about the ibis colonies; the water level is almost too shallow for them.

Hoary-headed Grebe *Poliocephalus poliocephalus*
3 December 2010: Nesting colony with about 50 nests, most with two to four eggs about 2 km upstream on Wanganella Station with Whiskered Terns.
18 January 2011: Adults and immatures near 8 Mile Creek bridge. 20 January 2011: A pair with juvenile young near the McCrabb's boundary indicating more have bred in that area (they normally breed in a colony).
28 January 2011: Three seen near the 8 Mile Creek bridge. Several deserted nests seen at the breeding colony on Wanganella Station upstream of the TSR.

Great-crested Grebe *Podiceps cristatus*
3 December 2010: The first sightings of two separate birds; one on the east side of Cobb Highway on the TSR; the other on Wanganella Station, upstream of Cobb Highway.
5 December 2010: A pair recorded on the TSR at the 8 Mile Creek bridge. This species has not been seen at this locality since it nested here in early 1980s. It was hoped that they would breed here this season but they were not seen again subsequent to the drop in water levels after 5 December.
22 March 2011: Pair at 8 Mile Creek bridge upstream, not seen on 23 March.
17 April 2011: Two immature birds seen upstream of the 8 Mile Creek bridge; probably just passing through.

Darter *Anhinga novaehollandiae*
3 December 2010: One male flying over.
13 December 2010: One male flying over willows on west side of Cobb Highway; possibly nesting.
28 January 2011: One seen on the 8 Mile Creek, southeast side, TSR.
16 February 2011: Three birds, 8 Mile Creek, Wanganella Station.

Little Pied Cormorant *Microcarbo melanoleucos*
November & December 2010: Few about the swamps on the TSR and on Wanganella Station.
28 January 2011: Few seen each visit.
22 March 2011: Flock of about 20 flying over at the bridges.
19 April 2011: Around 10 birds seen about the highway.
29 April 2011: A couple about the highway.

9 May 2011: A few about the bridges.
30 May 2011: A few feeding about the ibis colonies and bridges.

Great Cormorant *Phalacrocorax carbo*
5 December 2010: One near ibis rookery on TSR.
28 January 2011: About six seen on the 8 Mile Creek, southeast side, TSR. Influx probably due to water dropping and fish becoming more concentrated.
16 February 2011: Two birds, 8 Mile Creek, Wanganella Station.

Australian Pelican *Pelecanus conspicillatus*
November 2010: Single birds flying overhead of the TSR on a couple of occasions.

Australasian Bittern *Botaurus poiciloptilus*[#]/*
November 2010: One male calling over several weeks on the east side of the Cobb Highway on Wanganella Station about 2 km upstream.
3 December 2010: Locality of call was established; should be nesting; the low rushy swamp looks suitable for breeding.
11 December 2010: A male calling north of 8 Mile Creek, probably on the TSR
16 December 2010: Searched thoroughly for this bird on Wanganella Station but it could not be located. The drop in water level on Wanganella Station would not be conducive to this species nesting.
19 December 2010: A male calling north of 8 Mile Creek, probably on the TSR.
18 January 2011: One flew across the TSR near the 8 Mile Creek bridge. Observer's first actual sighting of this species at Wanganella since the early 1990s. This species could still be breeding at Wanganella and the importance of stable water levels cannot be over-emphasized.
20 January 2011: One bird, on two occasions, flew in and landed in a bed of common spike rush. Later in the day a bird flew over at the 8 Mile Creek bridge and landed on the TSR on the east side of the Cobb Highway. There was an unsuccessful attempt to find a nest on the TSR north of the 8 Mile Creek. Some areas looked suitable for nesting but as the previous entry notes, unstable water levels will not suit them. There were no calls heard during the day.
16 February 2011: One bird calling along the Cobb Highway, south side of the creek system.
22 March 2011: One found dead in the swamp northwest of 8 Mile Creek bridge in the area where this species was recorded in January.

White-necked Heron *Ardea pacifica*
November & December 2010: Up to about 15 birds about the swamps on the TSR; present on most visits.
16 December 2010: Up to 50 birds feeding in the receding swamps near the Wanganella Station woolshed.
18 January 2011: Two feeding about the TSR.
28 January 2011: About thirty birds at the drying-out Clarke's Creek on the TSR.
19 April 2011: A few seen feeding about the highway.
29 April 2011: One feeding along the highway.

Eastern Great Egret *Ardea modesta*[#/+]
November & December 2010: Just a couple of birds seen occasionally on the TSR.
16 December 2010: About 10 birds feeding on the receding swamps on Wanganella Station.

8 February 2011: One bird feeding about the TSR.

Intermediate Egret *Ardea intermedia*
27 November 2010: Up to 20 birds present on TSR, west side of Cobb Highway.
2 December 2010: Up to 20 birds present on TSR, west side of Cobb Highway.
13 December 2010: Few seen on the TSR, west side of Cobb Highway

Cattle Egret *Ardea ibis*[+/++]
2 December 2010: About 20 birds on TSR west side of Cobb Highway; many in breeding plumage; the first recorded in the district for several years.
5 December 2010: Two birds on TSR, west side of Cobb Highway

White-faced Heron *Egretta novaehollandiae*
November & December 2010: Few about the swamps on the TSR.
18 January 2011: A few feeding about the TSR.
28 January 2011: A few seen each visit.
19 April 2011: Around six seen feeding about the highway and near the ibis rookery.
29 April 2011: A few seen.
9 May 2011: A couple along the highway.
30 May 2011: One or two feeding about the TSR.

Nankeen Night-Heron *Nycticorax caledonicus*
November & December 2010: About 20 birds seen on numerous occasions roosting out in the cumbungi *Typha* sp. on the TSR and flying about during the day.
13 December 2010: About 100 birds, mostly immatures, roosting in willows on Wanganella Station, on the west side of Cobb Highway.
16 December 2010: About 300 birds, including many immatures, roosting along the creek on Wanganella Station upstream of Cobb Highway.
20 January 2011: One bird seen in a willow tree near McCrabb's boundary.

Glossy Ibis *Plegadis falcinellus*[#/+]
Late November & December 2010: Up to 20 birds seen flying about the main ibis rookery on several occasions.
16 December 2010: Up to 100 birds feeding in receding swamps near the woolshed on Wanganella Station. No sign of breeding.
24 January 2011: About 30 birds seen feeding in the drying-out Clarke's Creek swamp on the TSR.

Australian White Ibis *Threskiornis molucca*
1 November and 25 November 2010: Several nests seen at the Straw-necked Ibis colony on the TSR/Wanganella Station, west side of Cobb Highway.
3 December 2010: Scattered colonies of up to 100 pairs nesting about 2km upstream on Wanganella Station; all with eggs.
13 December 2010: About 250 pairs comprising about 100 pairs incubating, about 100 pairs with small to half-grown young, and about 50 pairs with almost fledged young. All nesting with Straw-necked Ibis at the main colony on the TSR/Wanganella Station on the west side of the Cobb Highway.
16 December 2010: Good numbers feeding in receding swamps on Wanganella Station.

18 January 2011: Two to three hundred pairs nesting on TSR and Wanganella Station. Nests seen at all stages from eggs and recently hatched young through to flying young with the majority thought to have about half-grown young.

28 January 2011: Some seen feeding in the swamp and soaring over the rookery.

8 February 2011: The majority of eggs and small young seen on 18 January 2011 have seemingly been deserted; just a couple of nests with small young seen today. The rest of the young are well grown and will be flying within a couple of weeks.

15 March 2011: About 150 pairs nesting with Straw-necked Ibis. All stages of nesting were observed: construction of nests; incubation of eggs; and young from recently hatched to almost fledged. Some nests will be inundated in the next one to two weeks.

22 March 2011: Still numerous about the rookery

29 March 2011: Approximately 200 pairs nesting with Straw-necked Ibis and some also on their own in small colonies. Nests at all stages were seen, from incubating eggs through to recently hatched young to almost fully-fledged young. The majority of the estimated 200 pairs probably have recently hatched young. No nests have been inundated.

8 April 2011: 200 - 300 pairs nesting with Straw-necked Ibis and on their own in small colonies; most nests in Cumbungi but also in Willow trees. Nests at all stages were seen from eggs through to fully fledged young. The majority of nests probably have half-grown young. Most eggs have now hatched.

19 April 2011: 200 - 300 pairs still nesting, many at a similar stage to the Straw-necked Ibis. These young should be fledged, for the most part, in three to four weeks' time. Quite a few almost fledged young seen, as well as some clutches of small young.

29 April 2011: 200 - 300 pairs still nesting; many clutches of flying and almost flying young seen; the remainder should be, for the most part, fledged in around two weeks' time. A number of smaller young were also seen.

9 May 2011: About 200 pairs still nesting, the majority with flying or near flying young. The near-flying young should be flying in about a week and possibly still dependent for one to two weeks after that.

30 May 2011: All young now flying with possibly about 100 clutches still being fed by adults, which should be completed within two weeks.

Straw-necked Ibis *Threskiornis spinicollis*

1 November 2010: Approximately 1000 pairs starting to build nests on the TSR, west side of the Cobb Highway.

22 November 2010: Three to five thousand pairs thought to be nesting in main colony on the west side of the Cobb Highway; nests with one to five eggs, mostly one to two eggs; many still building.

25 November 2010: Approximately 2000 pairs recorded nesting; nests containing one to three eggs; some birds still pushing down cumbungi; only part of the colony was checked.

3 December 2010: Three to five thousand pairs nesting in main colony on the west side of the Cobb highway; few pairs nesting with White Ibis at upstream colony on Wanganella Station[3].

13 December 2010: At the main colony on the TSR/Wanganella Station on the west side of the Cobb Highway, the Straw-necked Ibis were at the following stages — about 1000 pairs laying eggs, about 800 pairs nest building, about 1500 pairs incubating eggs, about 200 pairs just hatching and about 50 pairs with almost fledged young. About a

[3] Numbers subsequently increased to approximately 80 pairs.

1000 pairs incubating eggs[4] were not checked as they were inspected on 25 November 2010.

16 December 2010: About 80 pairs constructing nests at the colony 2 km upstream on Wanganella Station and good numbers feeding in receding swamps further upstream.

18 January 2011: Three to five thousand pairs nesting on the TSR and Wanganella Station. Nests seen at all stages from eggs and recently hatched young through to flying young. The breakdown in numbers is roughly 1000 pairs with half-grown young (these are the birds that were laying on the observer's last visit, 13 December); 800 pairs with small young (building nests on the last visit); about 1500 pairs with half to three-quarter grown young (incubating eggs on the last visit); about 1000 pairs with three-quarter to full-grown young; about 200 pairs with eggs or recently hatched young.

28 January 2011: Hundreds soaring over the rookery

8 February 2011: Approximately a 1000 pairs with half-grown young should be flying in about three weeks; the remaining young are at various stages of from two-thirds to fully-fledged. The two hundred or so pairs with eggs and small young seen on 18 January 2011 appear to have deserted.

New nesting event

15 March 2011: About 1000 pairs nesting of which about 200 pairs have well-incubated eggs or recently hatched young. Around 800 pairs are either on eggs or are constructing nests, or have just started laying eggs. Two to three hundred nests will probably be inundated in the next one to two weeks.

22 March 2011: Still good numbers about the rookery area.

29 March 2011: 1000+ pairs nesting: approximately 300 pairs with half-grown young, approximately 700+ pairs with recently hatched young or well-incubated eggs, small number still attempting to construct nests.

8 April 2011: About 1500 pairs nesting: approximately 300 pairs now have 'runners' that should be flying in about three weeks; about 700 pairs with young approximately one-third grown; around 200 pairs with eggs just hatching or have small young; and about 100 pairs bashing down cumbungi or egg laying.

19 April 2011: About 1500 pairs nesting: around 200 pairs have well-grown young, one to two weeks off flying; around 800 pairs with runners, about half-grown, that should be flying in about three weeks; around 60 pairs have young that are one-third grown, still in nests and about four weeks off flying; around 40 pairs have young one-quarter grown and about five weeks off flying.

29 April 2011: Around 1500 pairs nesting: 300 pairs with flying or near flying young; around 800 pairs with large young, about three-quarters grown, one to two weeks off flying; around 100 pairs with half-grown young, about three weeks off flying. The ibis seen building nests on 8 April 2011 probably abandoned as they could not be found.

9 May 2011: Around 1500 pairs nesting: about 200-300 pairs with flying but still dependent young; around 800 pairs with almost flying young, which should be flying in about a week and independent about two weeks after they can fly; around 100 pairs with young that should be flying in about two weeks and independent in about four weeks.

30 May 2011: All young now flying. About 800 clutches of young, standing around the nesting colony, are probably still dependent on adults for food. Many other fledged young are feeding in the drying out wetlands. There is still quite a bit of water in the section of the creek where the main colony of ibis nested.

[4] In retrospect, these birds were likely to have had small young as many were almost at the flying stage on 18 January 2011.

Yellow-billed Spoonbill *Platalea flavipes*
18 December 2010: At least two birds seen on TSR on the west side of Cobb Highway.

Royal Spoonbill *Platalea regia*
25 November 2010: At least five pairs nesting in a willow tree and on lignum on the west side of the Cobb Highway in the Straw-necked Ibis colony.
3 December 2010: About fifteen pairs nesting with White Ibis in dead trees and on cumbungi about 2 km upstream of the Cobb Highway on Wanganella Station. Two nests were checked at this location — one nest had one egg and two young and the other had two eggs and two young.
13 December 2010: Another six nests with eggs or still being built on Wanganella Station in willows and on cumbungi on the west side of the Cobb Highway; one nest checked contained three eggs. This makes a total of 11 nests on the west side of the Cobb Highway and about 15 nests on the east side on Wanganella Station.
18 January 2011: Two nests, not seen previously, were checked at the northern end of the ibis rookery. One nest contained three three-quarter grown young and the other nest four three-quarter grown young. Most nests will be at a similar stage.
28 January 2011: A few feeding around the swamps.
8 February 2011: Several fledged young and almost fledged young in nests seen.
15 March 2011: One clutch of three well-grown young seen in a Willow tree near the ibis rookery.
22 March 2011: Few adults and immatures flying about the rookery.
29 March 2011: Three nests with almost fledged young and one nest with one fresh egg were seen in Willow trees at the west end of the ibis rookery.
8 April 2011: About 10 pairs nesting in Willows and at all stages from eggs to fully fledged young but with the majority having large young.
19 April 2011: About 10 pairs nesting; a couple of clutches of almost fledged young seen, and another clutch with almost half-grown young.
29 April 2011: Around 10 pairs nesting: eight pairs with flying young; two pairs with half-grown young, about three weeks off flying.
9 May 2011: Most pairs have fledged or near fledged young. Just three pairs remaining with half to three-quarter grown young still in nests.
30 May 2011: All young now flying. Approximately 15 juvenile birds still about the nesting areas. As no adults were seen, these juveniles are probably independent. A successful outcome.

White-bellied Sea-Eagle *Haliaeetus leucogaster*[#/+]
2 November 2010: One sub-adult seen.
23 December 2010: Same bird seen.

Whistling Kite *Haliastur sphenurus*
8 February 2011: One seen over the ibis rookery, probably scavenging dead birds.

Swamp Harrier *Circus approximans*
November & December 2010: Around three pairs over the TSR along the Cobb Highway and on Wanganella Station. Should be nesting.
18 January 2011: Two birds working the swamps.
28 January 2011: Two or three birds seen every visit including juvenile plumaged birds.
8 February 2011: Few adults and immatures working the swamp.

22 March 2011: An adult and an immature bird working the swamps about the Cobb highway.
29 March 2011: One immature bird along the highway.
8 April 2011: An adult and an immature working the swamps.
19 April 2011: Four birds, both adults and immatures, actively hunting about the swamps.
29 April 2011: About four birds hunting over the swamp.
9 May 2011: Four to six adults and immatures still hunting over the wetlands.
30 May 2011: About six adults and immatures hunting over the wetlands; probably eating mice as well as waterbirds as there are a multitude of mice in the swamp.

Wedge-tailed Eagle *Aquila audax*
8 February 2011: Two seen over the ibis rookery

Peregrine Falcon *Falco peregrinus*
8 February 2011: One adult male hunting over Clarke's Creek swamp.

Brolga *Grus rubicunda**
1 November 2010: A pair with a nest with two eggs on the TSR on the west side of the Cobb Highway in the ibis colony.
21 November 2010: Two chicks, about two-week old, seen with adults on the TSR on the west side of the Cobb Highway.
5 December 2010: Both chicks were sighted with adults on the TSR on the west side of the Cobb Highway.
17 December 2010: The adult pair seen on the TSR on the west side of the Cobb Highway; young not seen in tall grass.
22 December 2010: Both young seen with the adults on the TSR on the west side of the Cobb Highway; now about three-quarters grown.
28 January 2011: Not seen by observer since 22 December 2010.

Purple Swamphen *Porphyrio porphyrio*
November and December 2010: A mass breeding of this species is occurring all along the creek system. About 20 nests with eggs were recorded east and west of the Cobb Highway; some birds still building late December.
13 &16 December 2010: A few more nests with eggs seen on the TSR and Wanganella Station.
19 December 2010: One nest with eggs on the TSR.
18 January 2011: About 20 birds were seen, comprising adults and well-grown young. No nests with eggs recorded.
28 January 2011: Many adults and juveniles seen along the Cobb Highway, many of which are being run over.
8 February 2011: Several clutches of juveniles with adults seen.
15 March 2011: About 10 seen, others heard in Cumbungi. One dying adult observed near the ibis rookery.
22 March 2011: A few seen about the highway, some are still being killed on the road.
29 March 2011: Quite a few, mainly immature birds seen.
8 April 2011: About 50 birds seen mainly immatures.
19 April 2011: About 40 birds seen including many immatures and a pair with small young along the highway.
29 April 2011: About 80 adults and immatures feeding along the highway and about the ibis colonies.

9 May 2011: About 80 adults and immatures feeding along the highway in beds of Spikerush and out in the ibis colonies where they appear to be feeding on Phragmites.
30 May 2011: Some big flocks of adults and immatures feeding about the reedbeds; over 100 birds recorded. Probably the most numerous waterbird present in the wetland now that the ducks and Eurasian Coots have, for the most part, have left.

Buff-banded Rail *Gallirallus philippensis*
November 2010: Two or three birds calling along the highway on several occasions.
27 November 2010: One adult seen on the TSR beside the Cobb Highway.
13 April 2011: One flushed from the edge of the swamp, near the sandhill.
29 April 2011: One adult seen feeding at Clarke's Creek crossing.
30 May 2011: One bird flushed from a patch of Cumbungi.

Baillon's Crake *Porzana pusilla*
12 November 2010: An adult flushed on the TSR, east side of the Cobb Highway.
3 December 2010: An adult flushed on Wanganella Station, upstream of the Cobb Highway.
17 December 2010: One bird flushed from common spike-rush *Eleocharis acuta* on the TSR, west side of the Cobb Highway.
20 January 2011: One flushed from a fairly open swamp (about 300 mm deep) that contained scattered spikerush, nitre goosefoot and dead roly-poly *Sclerolaena muricata* on the TSR, north-east side near the Wanganella—Conargo Road.
29 March 2011: One flushed from a bed of water couch behind the sandhill.
29 April 2011: One juvenile about three weeks' old seen feeding on a bed of Milfoil in the table drain alongside an extensive but drying Spikerush swamp beside the highway. Despite its young age and downy appearance, it seemed to be independent of an adult that was about 40 metres away. Breeding records for this species are rare in the Riverina and this sighting was P. Maher's third breeding record in more than 30 years of observation. It is also the latest in the season P. Maher has seen this species, which is a summer migrant to the Riverina.
9 May 2011: Three immatures feeding in a bed of milfoil in a table drain beside the highway. One of these birds is thought to be the juvenile seen on 29 April. These immatures will probably migrate north in a week or two. Adults have probably already moved north.

Australian Spotted Crake *Porzana fluminea*
25 November 2010: One or two calling on the TSR at Clarke's Creek lignum swamp as it was filling.
29 January 2011: Two juveniles spotlighted in the Clarke's Creek swamp; these birds have bred in this swamp.
7 May 2011: Two birds calling at Clarke's Creek crossing.

Spotless Crake *Porzana tabuensis*
7 May 2011: Around four birds seen and another two heard at Clarke's Creek, the first recorded at the Wanganella wetlands since the area dried out in the summer of 2006/2007.
30 May 2011: One bird calling in the reedbeds near an ibis colony; presumably more are present.

Black-tailed Native Hen *Tribonyx ventralis*

25 November 2010: Nest with seven eggs in cumbungi on TSR, west side of the Cobb Highway.

3 December 2010: Another nest with one egg on the east side of the highway in lignum on Wanganella Station.

28 January 2011: Around 10 birds, adults and juveniles, seen at the Clarke's Creek swamp; these birds have bred in this swamp.

8 February 2011: Around 25 adults and juveniles seen the Clarke's Creek swamp.

Dusky Moorhen *Gallinula tenebrosa*

November & December 2010: Few pairs sighted about the TSR.

19 December 2010: One pair building a nest at the 8 Mile Creek bridge.

18 January 2011: Two separate adults were seen, one near the 8 Mile bridge with juvenile young about half-grown, indicating that this species has successfully bred at Wanganella swamps

28 January 2011: Adult and juvenile seen at the 8 Mile Creek bridge.

8 February 2011: One seen at the 8 Mile Creek bridge.

22 March 2011: About three clutches of immatures along the highway.

29 March 2011: This appears to be the only species, apart from the colonial nesting birds, that is still breeding. Two clutches of small to half-grown young seen at 8 Mile Creek bridge. One clutch was attended by an immature bird, which may indicate that this species can breed at a young age.

8 April 2011: A few about the highway.

19 April 2011: About eight mainly immature birds feeding along the highway.

29 April 2011: A few immature and adult birds.

9 May 2011: Around 10, mainly immature birds, along the highway.

30 May 2011: About 10 adults and immatures about the bridges and ibis colonies.

Eurasian Coot *Fulica atra*

3 - 29 December 2010: A mass breeding of this species all along the creek. About thirty nests seen in total to date; some hatching recorded on 3 December and several clutches of young seen on 3 and 5 December 2010. Have lost count of the number of clutches of young now seen on the TSR and Wanganella Station. Some were still laying eggs on 16 December 2010; some young were nearly fully grown on 29 December 2010.

18 January 2011: Many clutches of well-grown young seen about the bridge and the ibis rookery. No nests with eggs recorded.

28 January 2011: Many birds seen, mainly juveniles, around the bridges.

8 February 2011: Many birds present around the bridges.

15 March 2011: About 50 seen about the bridges, mainly immatures.

22 March 2011: Numbers seem to be decreasing along the highway, immatures appear to be dispersing.

29 March 2011: About 50 immatures along the highway; few about the ibis rookery.

8 April 2011: Around 50 immatures along the highway.

19 April 2011: About 200, mainly immatures, feeding in flocks along the highway and about the rookery; numbers are increasing, most seen since summer.

29 April 2011: Numbers have decreased since the last survey (19 April); only about 80 seen, mainly feeding along the highway.

9 May 2011: Numbers decreasing, about 60 birds along the highway and the ibis colonies.

30 May 2011: Just a few birds about the bridges and ibis colonies.

Black-winged Stilt *Himantopus himantopus*

November 2010: About ten nests with eggs seen on the TSR, west side of the Cobb Highway.

3 & 4 December 2010: Most eggs had hatched; young from tiny to three-quarter grown were recorded. Also a few pairs nesting on the east side of the highway on Wanganella Station.

19 December 2010: Flying young seen on TSR, west side of the Cobb Highway.

18 January 2011: About ten birds total, adults and fully-grown young, seen on south side of 8 Mile Creek. Many have moved on due to the common rush weed becoming too thick in the shallow water.

28 January 2011: Some adults and young present in the drying-out Clarke's Creek swamp.

8 February 2011: A flock of 50 to 60 adults and immatures at Clarke's Creek swamp.

Red-kneed Dotterel *Erythrogonys cinctus*

November, **2 & 5 December 2010**: About six nests seen, still all with eggs in loose colony with Black-winged Stilts and Australian Painted Snipe on the TSR, west side of the Cobb Highway.

19 December 2010: Adults performing distraction displays on the TSR, west side of the Cobb Highway; young thought to be present.

28 January 2011: About 100 Red-kneed Dotterels, adults and immatures, in the drying-out swamps at Clarke's Creek and Wanganella Station.

Masked Lapwing *Vanellus miles*

November & December 2010: Many pairs present all along the creek; one was seen chasing a Swamp Harrier on the TSR, an indication of breeding having occurred.

18 January 2011: Adults an immature birds seen, indicating that this species has successfully bred at the Wanganella swamps.

28 January 2011: A few seen every visit.

8 February 2011: Adults and immatures at the 8 Mile and Clarke's Creek swamps.

Australian Painted Snipe *Rostratula australis**/#

22 November 2010: Two males recorded on the TSR, west side of the Cobb Highway.

27 November 2010: Three birds recorded, two males and one female and nest with four eggs on the TSR, west side of the Cobb Highway.

5 December 2010: Nest seen again, still with four eggs; male not seen; female nearby.

13 December 2010: Male near nest behaving secretively; female nearby; nest now with only one egg remaining; presumably the other three had hatched.

19 December 2010: Male doing distraction displays; young not seen but the male's behaviour indicated the young were present.

29 December 2010: None seen.

24 January 2011: A male seen at Clarke's Creek swamp.

28 January 2011: Five or six birds seen**,** possibly the two adult males and the female plus the young from the nest that was first recorded 27 November. (Three of the four eggs are thought to have hatched).

29 January 2011: Two birds spotlighted at Clarke's Creek, both thought to be males; observer unsure if either were immatures.

8 February 2011: None seen.

Latham's Snipe *Gallinago hardwickii*

1 November 2010: About 12 birds seen on TSR, west side of the Cobb Highway.

22 November 2010: Four birds seen on TSR, west side of the Cobb Highway.
27 November 2010: One bird seen on TSR, west side of the Cobb Highway.
2 December 2010: One bird seen on TSR, west side of the Cobb Highway.
3 December 2010: One bird seen on TSR, west side of the Cobb Highway.
13 December 2010: Four birds seen on TSR, west side of the Cobb Highway.
29 December 2010: Five birds seen on TSR, west side of the Cobb Highway.
24 January 2011: About 30 seen.
28 January 2011: Up to 40 seen; the most seen in over 20 years in these swamps.
29 January 2011: About six spotlighted at Clarke's Creek swamp.
8 February 2011: About six seen at Clarke's Creek swamp; numbers reduced from those recorded on 24 and 28 January 2011.

Sharp-tailed Sandpiper *Calidris acuminata*[#/+/++/+++]
1 November 2010: About 10 birds seen on the TSR, west side of Cobb Highway.
12 November 2010: About 10 birds seen on the TSR, west side of Cobb Highway.
3 December 2010: Two birds seen on Wanganella Station, upstream of Cobb Highway.
24 January 2011: Around six birds seen.
28 January 2011: Around six birds seen - a few at Wanganella Station on the east side and a few at Clarke's Creek.
8 February 2011: One with flock of Red-kneed Dotterels at Clarke's Creek swamp.

🗐 **Whiskered Tern** *Chlidonias hybrida*
3 December 2010: Nesting colony with Hoary-headed Grebes about 2 km upstream on Wanganella Station; up to 50 pairs present, probably many still building; three nests all with three eggs recorded.
16 December 2010: A few birds seen on nests at the above colony.
18 January 2011: About thirty adults and immature birds flew across, downstream of 8 Mile Creek bridge.
28 January 2011: Around 50**;** several stranded young seen in rapidly dropping swamp, Wanganella Station, upstream of TSR.
29 April 2011: A tight flock of about 80 birds flew over swiftly; likely to be on migration north.

🗐 **Golden-headed Cisticola** *Cisticola exilis*
November & December 2010: A couple of pairs recorded on the TSR, west side of the Cobb Highway.
2 December 2010: One seen building a nest on the TSR, west side of the Cobb Highway.
29 December 2010: One pair seen on Wanganella Station, upstream of the Cobb Highway.
18 January 2011: One bird calling south side of TSR at 8 Mile Creek.

🗐 **Australian Reed-Warbler** *Acrocephalus australis*
November & December 2010: A few pairs about the cumbungi on the TSR.
13 December 2010: Nest with eggs in willow tree on the west side of the TSR.
16 December 2010: Nest with eggs in common reed *Phragmites australis* along the creek on Wanganella Station, upstream of the Cobb Highway.
18 January 2011: Many calling and a few seen all through the cumbungi and Phragmites about the ibis rookery. No nests recorded.
28 January 2011: Seen every visit.
15 March 2011: Many calling in Cumbungi.
22 March 2011: Still quite a few calling in the Cumbungi along the highway.

29 March 2011: Still good numbers present, many feeding on beds of Azolla along the highway.
8 April 2011: Many immatures still feeding on beds of Azolla along the highway.
29 April 2011: Quite a few still present.
9 May 2011: A few still present in Cumbungi.

Little Grassbird *Megalurus gramineus*
November & December 2010: Moderately common about the TSR, many calling.
16 December 2010: Nest with eggs seen in lignum on Wanganella Station, upstream of Cobb Highway.
18 January 2011: Few heard and one nest recorded with about five eggs in cumbungi near the ibis rookery.
28 January 2011: Adults and juveniles were seen every visit, many at the Clarke's Creek swamp.
15 March 2011: Many calling in Cumbungi.
22 March 2011: Still quite a few calling in the Cumbungi along the highway.
29 March 2011: A few calling, numbers appear to be dropping.
8 April 2011: Just a few still calling.
19 April 2011: Several birds feeding on beds of Azolla about the 8 Mile Creek bridge.
29 April 2011: Just a few seen. The beds of Azolla, which this species had been feeding on, have disappeared.
9 May 2011: Many feeding in the drying beds of Spikerush.
30 May 2011: Many still present feeding in the dry beds of Spikerush and in the Cumbungi

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Reptiles
Tiger Snake *Notechis scutatus*
18 January 2011: One swimming in the swamp on the south side of the ibis rookery. The observer's first sighting of a live Tiger Snake since the Wanganella swamps dried out in 2006; however, one dead specimen was seen on the Cobb highway in November 2010.
22 March 2011: Becoming more common; three seen in past two weeks. Good size, well-fed specimens. Acted aggressively.
24 March 2011: Three on the edge of the sandhill beside the swamp.
13 April 2011: One seen on edge of sandhill.
19 April 2011: One seen on edge of sandhill.
29 April 2011: One juvenile seen, about 30 cm long, indicating breeding had occurred.
30 May 2011: Two pairs seen; one pair sunning on the edge of the sandhill and the other pair out on a bank in the swamp.

Mammals
Common Water-rat *Hydromys chrysogaster*
30 May 2011: One Common Water-rat swimming and diving and also some activity on a bed of water plants. First record at Wanganella for many years.