1.	**Title of measure**	**TLM Koondrook Perricoota**
2.	**Proponent undertaking the measure**	**New South Wales, Victoria and South Australia**
3.	**Type of measure**	**Supply**
4.	**Requirements for notification**	
a)	Date by which the measure entered into or will enter into operation *Must be before 30 June 2024*	The measure will be operational by 30 June 2024.
b)	Confirmation that the measure is not an 'anticipated measure' *'Anticipated measure' is defined in section 7.02 of the Basin Plan to mean 'a measure that is part of the benchmark conditions of development'.*	Yes It is a new measure (not already included in the benchmark conditions).
c)	NSW agrees with the notification	Yes
d)	VIC agrees with the notification	Yes
e)	SA agrees with the notification	Yes
5.	**Surface water SDL resource units affected by the measure**	
	This measure identifies all surface water resource units in the Southern Basin region as affected units for the purposes of notifying supply measures. The identification of affected units does not constitute an agreement between jurisdictions on apportioning the supply contribution, which will be required in coming months.	
6.	**Details of relevant constraint measures**	
	The Yarrawonga to Wakool Reach constraints management strategy, one of three integrated constraints measures for the Murray River (see separate supply measure notifications for the Hume to Yarrawonga and River Murray in South Australia Constraints measure business cases), which aims to relax flow constraints in the Thule and Barbers Creeks systems to provide better outcomes for the Koondrook-Perricoota icon site beyond those outlined in this supply measure.	
7.	**Date on which the measure will enter into operation**	
	The works outlined in this measure have been built and partially commissioned by NSW Water and MDBA River Murray Operation. They will be fully operational by 30 June 2024.	
8.	**Representation of the project in the MDBA Assessment Framework**	
	This site has been represented in MSM-Bigmod. **Attachment A** shows a schematic of the Koondrook-Perricoota Forest model representation. The level-volume-area and flow-travel time-area relationships used in the model are provided below in the Koondrook-Perricoota Forest (KPF) Leveed area table. In addition to the Level-Volume –Area relationship for the Koondrook-Perricoota Forest (KPF) Leveed area provided above, the storage and area in the KPF inundation area is affected by flow routing and travel time, based on the Flow-Travel Time-Area tables below. An explanation of the calculation of combined reach and weir storage and area is provided in MDBA Technical Report 2015/15.	

Koondrook-Perricoota Forest leveed area		
Level (mADH)	**Storage (ML)**	**Area (ha)**
72.00	0	0
73.35	3000	891
73.61	3921	1160
73.82	4640	1364
74.08	5394	1557
74.34	6309	1788
74.46	6807	1914
74.73	8030	2236
74.89	9075	2523
75.05	10170	2820
75.41	13199	3653
75.67	16352	4461
75.96	20347	5362
76.14	24364	5500
77.12	49005	5600
77.94	61544	6497
78.05	69014	6838
78.16	76071	7115
78.26	83853	7371
78.37	91975	7627
78.46	98711	7841
78.54	105384	8092
78.60	110336	8164
78.70	118606	8373
78.80	127077	8564
78.90	135727	8730
79.00	144532	8878

Torrumbarry cutting to Burrumburry Creek		
Inflow (ML/d)	**Travel time (day)**	**Area (ha)**
0	4.39	0
500	4.39	525.1
1000	1.55	911.3
2000	1.55	1505.5
4000	1.25	2402.2
6000	1.1	2899.7
12000	0.85	3713.4
20000	0.6	4289
40000	0.47	5152.8
75000	0.44	6195.6

Swan Lagoon to Burrumbury Creek		
Inflow (ML/d)	**Travel time (day)**	**Area (ha)**
0	2.36	0
1000	1.46	441.1
2000	1.51	900.6
3000	1.5	1419
4000	0.89	1816.4
5000	1.15	2122.3
6000	0.63	2372.6
9000	0.99	2935.7
12000	0.4	3303.2
20000	0.46	3889.3

Burrumbury Creek to KPF Leveed area		
Inflow (ML/d)	**Travel time (day)**	**Area (ha)**
0	7.83	0
475.7	7.83	1063
957.9	3.45	1767.5
3893.6	2.1	4231.3
4882.2	3.62	4940.2
8867.5	2.47	7383.6
11831.6	1.68	8721.8
19799.9	1.26	10931.6
39774.7	1.15	13455.6
75000	0.76	14899.9

KPF lEVEED inundation area		
Inflow (ML/d)	**Travel time (day)**	**Area (ha)**
0	0.1	0
400	0.1	0
600	0.1	0
800	0.1	0
1000	0.1	0
1200	0.1	0
1400	0.1	0
1600	0.1	0
1800	0.1	0
2000	0.1	0

Interaction between river flows and site inflow

Flow to the Levee Inundation Area is calculated by three branch flows. Flow in Branches 39 and 17 are a function of the flow upstream and downstream of Torrumbarry weir respectively, using the relationships in the tables below. Flow in Branch 104 represents the environmental diversion during operation. The flow is calculated with special code (No 138).

Inflow into Torrumbarry Weir	Flow into Branch 39
0	0
49000	0
55000	2800
60000	5100
80000	22900
100000	42600
160000	101200
300000	240000

Flow DS Torrumbarry Weir	Flow into Branch 17
0	0
10000	0
15000	145
20000	440
22000	1000
24000	1600
30000	4800
35000	7700
40000	11200
45000	15000
48510	17700
53510	21000
60000	25600

Return flow from the site to the river

There are three outflows through Thule Creek, Barbers Creek and Murray Return Channel (MRC) modelled from the KPF site. The relationships of outflow are described in **Attachment B**.

Surface water loss relationships

Evaporation and rainfall are calculated using monthly data from climate stations. Rainfall data is based on the Kerang rainfall station and evaporation data is from Swan Hill and Deniliquin.

Seepage loss in Koondrook-Perricoota Forest is modelled by the inclusion of groundwater models. The Forest is represented with two main reaches – an upper channel reach and a storage reach for the lower forest. There are two branches (No 39 and 17) simulating natural overbank flows to the upper channel and one branch (No 104) from the Torrumbarry weir pool for TLM managed watering events.

The seepage loss in each reach is modelled as antecedent dependent and continuing losses. The antecedent dependent loss is conceptualised with storage in groundwater which can be charged to a maximum level and depleted gradually between watering events. The groundwater charge (GW_h) is modelled as:

$$GW_h = P_2\left(1 - \frac{Max(P_1 \sum GW_T}{P_1}\right)$$

where, GW_T is the total storage in groundwater, P_1 is the water depth in groundwater store and P_2 is the seepage rate from surface water to ground water. The storage in groundwater can also be reduced by:

$$GW_d = P_4(GW_t - evaporation\ loss)$$

where , GW_d is groundwater depletion and P_4 is the percolation rate.

In addition, the continuous loss (GW_c) is modelled as a function of inundation depth in the forest:

$$GW_c = P_3 \frac{Inundated\ volume}{Inundated\ Area}$$

Total storage in groundwater reads:

$$GW_T = GW_h - GW_d + GW_c$$

	Upper Forest	Lower Forest
$P1$, Groundwater depth (m)	0.6	0.02
P_2, Seepage rate (mm/d)	20	10
$P3$, Continuing loss coefficient (day-1)	0.01	0.5
$P4$, Percolation rate	0.004	0.004

Control variables and special code numbers:

Groundwater (GW) models have been include in the special code, for upper, middle and lower Koondrook-Perricoota Forest.

Reach	Variable	Control variable	Special code
KFP upper forest (R285)	GW Loss	1175	278
	GW Store	1176	279
KFP upper forest dummy (R385)	GW Loss	634	123
	GW Store	635	124
KFP middle Forest (R258)	GW Loss	919	163
	GW Store	910	165
KFP middle Forest dummy (R358)	GW Loss	927	167
	GW Store	929	169
KFP lower Forest (R259)	GW Loss	920	162
	GW Store	911	164
KFP lower Forest dummy (R359)	GW Loss	928	166
	GW Store	930	168

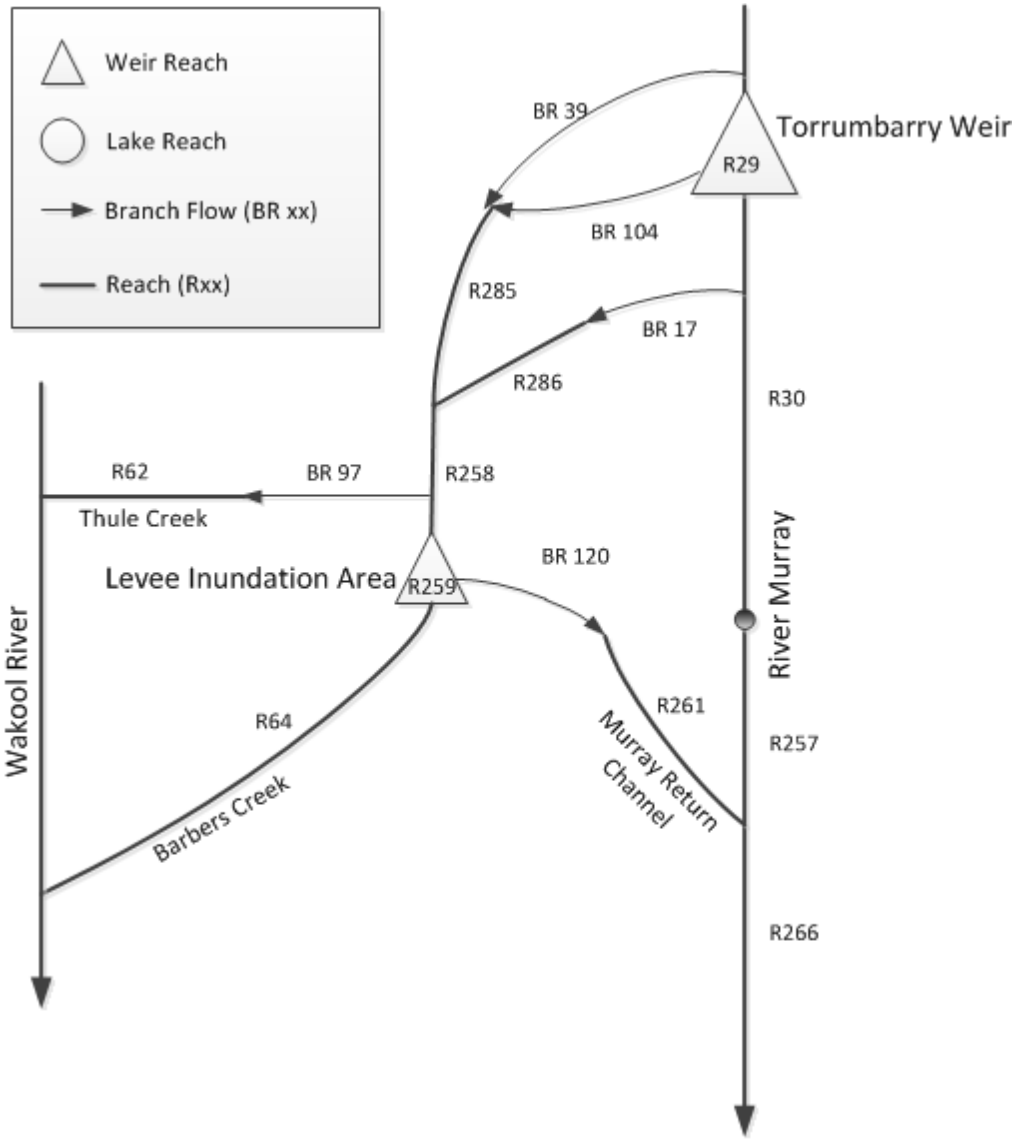
9.	**Details for the representation of each operating strategy, policy or rule change proposed.**	
a)	Description of the works or measures that constitute the measure	Works include: a) Upstream structures to divert water into the forest from Torrumbarry Weir including an inlet channel, inlet regulator and associated fishway and turtle ramp, as well as regulators at Swan Lagoon to control flows re-entering the Murray; and b) Downstream structures to control release of water from the forest and to maximise return flows back to the Murray, including a levee to retain water in the forest, floodway within the forest, as well as the Return regulator and associated channels, Thule Creek regulator, Calf, Cow, Barber Creek and Runner A outlet regulators and a return channel to discharge water to the downstream waterways. c) The location of these works is shown in Figures 1 and 2 of **Attachment F**
b)	Capacity of the measure to operate as a supply measure *'Supply measure' is defined in section 7.03 of the Basin Plan to mean 'a measure that operates to increase the quantity of water available to be taken in a set of surface water SDL resource units compared with the quantity available under the benchmark conditions of development'.*	Yes

c)	Geographical location of the measure	Koondrook–Perricoota Forest is located in the Riverina region of New South Wales, downstream of Torrumbarry Weir on the NSW side of the River Murray. It extends from the area opposite the Victorian township of Torrumbarry in the south to a few kilometres from Barham in the north. The location of the measure is shown in Figure 2.1 in **Attachment E** and in Figure 3 of **Attachment F.**
d)	Spatial data describing the inundation extent associated with the operation of the measure	*The inundation extent associated with the operating strategies for this measure are set out in Appendix D Hydraulic model – key outputs of* ***Attachment C and F.***
e)	Representation of the measure in the MDBA modelling framework	Details of works and their physical capabilities included in this measure are outlined in Section 5 of **Attachment F.** This information will form the basis of MDBA's modelling of this measure
f)	Representation of each operating strategy in the MDBA modelling framework.	This measure sets out the operating strategy for managed events and overbank events, with a number of scenarios for each. This strategy is described in Section 6 of **Attachments D and F.** MDBA modelling of this measure will reflect these parameters.

Attachments:

A	MDBA	Koondrook-Perricoota Forest representation in the Murray model
B	MDBA	Return flow from the site to the river
C	MDBA	Spatial data describing the inundation extent associated with the operation of
D	MDBA	Operating strategy used for KFP in MSM-Bigmod
E	MDBA, February 2012	Koondrook–Perricoota Environmental Water Management Plan
F	MDBA, The Living Murray Program, August 2012	Koondrook- Perricoota Forest Flood Enhancement Works Operating Plan Version 3.3.

Attachment A Koondrook-Perricoota Forest representation in the Murray model (based on Bigmod Rev. 254)



Attachment B - Return flow from the site to the river

Thule Creek

The outflow to Thule Creek (Br 97) is calculated as a function of natural overbank flows (ie without TLM intervention) to the site using the table below.

Natural overbank flow into the site (ML/d)	**Flow to Thule Creek (ML/d)**
449	0.0
907	0.0
1388	139.2
1857	231.2
2423	320.0
2806	441.6
3760	629.6
4721	960.0
5677	1248.0
8585	2125.6
11509	2679.2
15437	3360.8
19379	4360.0
39241	10368.0
74130	16865.0

Barbers Creek (Special Code 141)

In the model, Barbers Creek represents a number of small creek systems including Calf Creek, Cow Creek and flood runners (Runner A).

For overbank flows, Barbers Creek outflow will be determined depending on the site level (Table below).
If TLM water is delivered under fully regulated condition, it is determined as a minimum of 2,000 ML/d and flows based on site level (Table below). The release rate of 2,000 ML/d is based on the Yarrawonga to Wakool CMS measure relaxing constraints up to 50,000 ML/d at Yarrawonga DS. During a hybrid intervention (ie piggybacking on unregulated overbank flows), outflows are increased to at least bypass the unregulated overbank flows).
For calculating outflows through the other creeks, regulated water delivered by TLM is not released to these creeks. However, for an unregulated or hybrid event, outflows are calculated to bypass the unregulated flow component.

Level	Outflow	Level	Outflow	Level	Outflow	Level	Outflow	Level	Outflow
72.000	0	73.590	0	72.000	0	76.781	12750	75.136	0
73.158	250	74.429	250	72.202	250	76.796	13000	75.705	250
73.669	500	74.659	500	72.670	500	76.810	13250	75.837	500
74.017	750	74.836	750	73.019	750	76.822	13500	75.933	750
74.311	1000	74.993	1000	73.306	1000	76.835	13750	76.013	1000
74.561	1250	75.184	1250	73.553	1250	76.848	14000	76.081	1250
74.780	1500	75.388	1500	73.772	1500	76.860	14250	76.145	1500
74.965	1750	75.485	1750	73.970	1750	76.872	14500	76.206	1750
75.140	2000	75.602	2000	74.152	2000	76.884	14750	76.263	2000
75.277	2250	75.710	2250	74.321	2250	76.895	15000	76.310	2250
75.380	2500	75.806	2500	74.479	2500	76.906	15250	76.354	2500
75.607	2750	75.913	2750	74.623	2750	76.917	15500	76.399	2750
75.719	3000	75.986	3000	74.756	3000	76.928	15750	76.443	3000
75.834	3250	76.073	3250	74.887	3250	76.939	16000	76.484	3250
75.932	3500	76.228	3500	75.017	3500	76.949	16250	76.522	3500
76.045	3750	76.251	3750	75.140	3750	76.960	16500	76.558	3750

76.126	4000	76.306	4000	75.247	4000	76.970	16750	76.594	4000
76.183	4250	76.352	4250	75.338	4250	76.980	17000	76.629	4250
76.251	4500	76.399	4500	75.443	4500	76.990	17250	76.664	4500
76.310	4750	76.445	4750	75.564	4750	77.000	17500	76.697	4750
76.356	5000	76.486	5000	75.661	5000	77.010	17750	76.730	5000
76.406	5250	76.529	5250	75.729	5250	77.020	18000	76.761	5250
76.452	5500	76.570	5500	75.798	5500	77.030	18250	76.791	5500
76.495	5750	76.609	5750	75.869	5750	77.040	18500	76.820	5750
76.529	6000	76.641	6000	75.941	6000	77.050	18750	76.849	6000
76.562	6250	76.673	6250	76.013	6250	77.060	19000	76.877	6250
76.596	6500	76.705	6500	76.070	6500	77.070	19250	76.901	6500
76.632	6750	76.739	6750	76.129	6750	77.079	19500	76.925	6750
76.672	7000	76.773	7000	76.192	7000	77.089	19750	76.949	7000
76.707	7250	76.802	7250	76.248	7250	77.098	20000	76.972	7250
76.739	7500	76.830	7500	76.285	7500	77.107	20250	76.995	7500
76.772	7750	76.857	7750	76.323	7750	77.116	20500	77.017	7750
76.804	8000	76.883	8000	76.363	8000	77.125	20750	77.039	8000
76.835	8250	76.909	8250	76.395	8250	77.134	21000	77.060	8250
76.861	8500	76.932	8500	76.421	8500	77.143	21250	77.080	8500
76.883	8750	76.952	8750	76.447	8750	77.152	21500	77.101	8750
76.903	9000	76.972	9000	76.476	9000	77.161	21750	77.121	9000
76.923	9250	76.989	9250	76.506	9250	77.169	22000	77.141	9250
76.941	9500	77.006	9500	76.539	9500	77.178	22250	77.160	9500
76.958	9750	77.019	9750	76.574	9750	77.186	22500	77.180	9750
76.976	10000	77.040	10000	76.608	10000	77.195	22750	77.199	10000
				76.623	10250	77.204	23000		
				76.639	10500	77.212	23250		
				76.655	10750	77.220	23500		
				76.672	11000	77.229	23750		
				76.687	11250	77.237	24000		
				76.703	11500	77.246	24250		
				76.719	11750	77.254	24500		
				76.735	12000	77.262	24750		
				76.752	12250	77.270	25000		
				76.767	12500				

Murray Return Channel is activated for releasing pooled water to Murray only when a TLM (fully managed or hybrid) intervention occurs. When it is operated, outflows are based on water levels at River and the site using a bi-linear interpolation as shown at the Table below.

KPF level at Murray Return Channel (mAHD)																				
Murray river level at Murray Return Channel (mAHD)	-	77.32	77.4	77.5	77.6	77.7	77.8	77.9	78	78.1	78.2	78.3	78.4	78.5	78.6	78.7	78.8	78.9	79	79.1
	76	0	47	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.1	0	47	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.2	0	47	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.3	0	47	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.4	0	46	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.5	0	46	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.6	0	46	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.7	0	45	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.8	0	44	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	76.9	0	43	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	77	0	42	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	77.1	0	40	66	151	273	432	628	866	1144	1460	1814	2213	2664	3118	3573	4027	4482	4936	5391
	77.2	0	36	66	150	273	432	628	866	1141	1457	1812	2213	2629	3046	3462	3879	4296	4712	5129
	77.3	0	28	66	150	272	430	628	865	1141	1457	1812	2208	2659	3114	3568	4023	4477	4932	5386
	77.4	0	0	61	146	267	429	626	862	1138	1453	1808	2205	2625	3042	3458	3875	4292	4708	5125
	77.5	0	0	0	129	254	414	616	855	1132	1447	1804	2200	2650	3105	3559	4014	4468	4923	5377
	77.6	0	0	0	0	213	384	587	833	1121	1437	1793	2192	2641	3095	3550	4005	4459	4914	5368
	77.7	0	0	0	0	0	311	533	783	1078	1418	1777	2177	2627	3082	3536	3991	4445	4900	5355
	77.8	0	0	0	0	0	0	422	700	1000	1346	1746	2150	2600	3055	3509	3964	4418	4873	5327
	77.9	0	0	0	0	0	0	0	543	880	1235	1633	2105	2585	3085	3585	4085	4585	5085	5585
	78	0	0	0	0	0	0	0	0	675	1073	1483	1945	2489	3044	3600	4156	4711	5267	5822
	78.1	0	0	0	0	0	0	0	0	0	814	1277	1750	2288	2913	3538	4163	4788	5413	6038
	78.2	0	0	0	0	0	0	0	0	0	0	956	1494	2039	2650	3275	3900	4525	5150	5775
	78.3	0	0	0	0	0	0	0	0	0	0	0	1107	1722	2357	3071	3786	4500	5214	5929
	78.4	0	0	0	0	0	0	0	0	0	0	0	0	1267	1971	2679	3393	4107	4821	5536
	78.5	0	0	0	0	0	0	0	0	0	0	0	0	0	1442	2242	2957	3671	4386	5100
	78.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1625	2508	3342	4175	5008
	78.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1810	2810	3810	4810
	78.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	3030	4030
	78.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2187	3437
	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2375
	79.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment C - Spatial data describing the inundation extent associated with the operation of the measure

The area of inundation associated with the operation of the works has been modelled with the hydrodynamic model. The total area of inundation for each of the operating strategies is given in the table below.

Operation strategy	**Inundation area (ha)**
Koondrook Wetland (KPW)	610
Koondrook Forest (KPF)	16872
Koondrook Bird Breeding (KPB)	8191

For the purpose of calculating scaling factors for the Ecological Outcomes scoring method, the maps of the inundation areas associated with the works were combined with maps of SFI flow bands and maps representing the ecological elements used in the scoring method. The areas for the resulting hydrological assessment units (HAU) are provided in tables below. In this case the areas for the works represent the inundation area that is *additional* to the area already inundated by a nested work. For example, if KPF is operated, the inundation areas associated with the operation of KPW and KPB are also inundated, but figures in the table below refer to the additional area the KPW operation would inundate.

Inundation area (ha) for KPW	**SFI Flow Bands**				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	329.0	62.0	1184.0	693.0	263.0
Bitterns, crakes and rails	326.1	58.0	939.7	257.9	80.0
Breeding – Colonial-nesting waterbirds	329.0	62.0	1184.0	693.0	263.0
Breeding – other waterbirds	326.1	58.0	939.7	257.9	80.0
Redgum Forest	32.2	14.1	91.4	8.4	1.7
Redgum Woodlands	4.9	4.9	58.6	31.1	17.1
Forests and Woodlands: Black Box	46.5	29.9	623.7	459.5	178.5
Lignum (Shrublands)	0.0	0.0	7.8	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	12.3	11.6	272.6	151.8	71.8
Benthic Herblands	313.8	46.5	667.1	106.2	8.2
Short lived fish	326.1	58.0	939.7	257.9	80.0
Long lived fish	329.0	62.0	1184.0	693.0	263.0

Inundation area (ha) for KPF	**SFI Flow Bands**				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance - all Waterbirds	2.0	494.0	1355.0	2145.0	4075
Bitterns, crakes and rails	1.4	91.1	84.3	72.6	106.655
Breeding - Colonial-nesting waterbirds	2.0	494.0	1355.0	2145.0	4075
Breeding - other waterbirds	1.4	91.1	84.3	72.6	106.655
Redgum Forest	0.3	0.7	0.2	0.2	6.585
Redgum Woodlands	1.4	449.8	1173.3	1662.1	3100.323
Forests and Woodlands: Black Box	0.2	40.3	174.9	473.6	910.71
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0
Tall Grasslands, Sedgelands and Rushlands	1.4	91.1	84.3	72.6	106.655
Benthic Herblands	0.0	0.0	0.0	0.0	0
Short lived fish	1.4	91.1	84.3	72.6	106.655
Long lived fish	2.0	494.0	1355.0	2145.0	4075

Inundation area (ha) for KPB	**SFI Flow Bands**				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance - all Waterbirds	13.0	1271.0	2113.0	1570.0	3224.0
Bitterns, crakes and rails	10.6	246.1	198.0	69.5	152.1
Breeding - Colonial-nesting waterbirds	13.0	1271.0	2113.0	1570.0	3224.0
Breeding - other waterbirds	10.6	246.1	198.0	69.5	152.1
Redgum Forest	3.3	4.6	1.7	1.3	6.4
Redgum Woodlands	6.9	1134.7	1796.5	1238.4	2500.1
Forests and Woodlands: Black Box	1.2	121.9	293.7	318.6	687.3
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	10.6	246.1	198.0	69.5	152.1
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	10.6	246.1	198.0	69.5	152.1
Long lived fish	13.0	1271.0	2113.0	1570.0	3224.0

Attachment D - Operating strategy used for KPF in MSM-Bigmod

Operating strategy	Optimal frequency	Resilience period	Min river flow to operate	Equivalent natural flow	Comment
Wetland watering	6 in 10 yrs	2 yrs	N/A	35,000 ML/d for 2 months at Torrumbarry D/S	
Red Gum watering	3 in 10 yrs	4 yrs	N/A	35,000 ML/d for 3 months at Torrumbarry D/S	
Bird breeding	4 in 10 yrs	3 yrs	N/A	25,000 ML/d for 3 months at Torrumbarry D/S	2,000 ML/d for 30 days, ramping down to 500 ML/d over 10 days and maintaining 500 ML/d for 60 days

Australian Government

MURRAY–DARLING BASIN AUTHORITY

MURRAY-DARLING BASIN AUTHORITY

Koondrook–Perricoota

Environmental Water Management Plan

February 2012

Koondrook–Perricoota

Environmental Water Management Plan

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Murray–Darling Basin Authority

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Cover image: Koondrook–Perricoota Forest.

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Contents

About this plan

This environmental water management plan consists of:

i. A long-term strategic plan, (per Clause 117 of The Living Murray Business Plan), which outlines the icon site's environmental water requirements and how to broadly achieve them with a combination of environmental water and works and measures.

ii. Schedules detailing operational information about the icon site such as Operating, Condition Monitoring, Risk Management and Communication Plans. These Schedules will be added to the environmental water management plan as they become available and updated to reflect learnings from the operation of works, the results of environmental waterings and the latest science.

The environmental water management plans provide context for an icon site's water planning, delivery, monitoring and consultation processes. While the environmental water management plans include proposed operating strategies, annual water planning and implementation will be responsive to changing water resource conditions, opportunities and environmental priorities throughout the season and from year to year.

This environmental water management plan and associated schedules have been prepared by TLM partner governments in consultation with the relevant stakeholders. The MDBA would like to acknowledge the significant contribution of all those involved in the development of the environmental water management plans.

Summary

The Living Murray (TLM) Initiative is one of Australia's most significant river restoration programs. The program is delivered by six partner governments as outlined in the Murray–Darling Basin Intergovernmental Agreement (2004), which is facilitated through a formal governance framework coordinated by the Murray–Darling Basin Authority (MDBA) and ultimately overseen by the Murray–Darling Basin Ministerial Council. This overarching framework is underpinned by state-based governance arrangements.

Almost 500 GL (long-term Cap equivalent) has now been recovered through TLM. This water will be used at six icon sites to improve environmental outcomes: Barmah–Millewa Forest; Gunbower–Koondrook–Perricoota Forest; Hattah Lakes; Chowilla Floodplain and Lindsay–Wallpolla Islands; Lower Lakes, Coorong and Murray Mouth; and the River Murray Channel.

Environmental water management plan

This environmental water management plan establishes priorities for the use of TLM water within the Koondrook–Perricoota component of the Gunbower–Koondrook–Perricoota icon site, and identifies environmental objectives and targets (where appropriate), water delivery options and regimes that can utilise TLM water portfolio.

This revision builds on previous iterations of the Koondrook–Perricoota Environmental Management Plan (previously known as environmental management plans) and reflects the larger volume now held in The Living Murray water portfolio, uses The Living Murray works and measures (as construction is completed) and the monitoring information gathered at the icon site.

Koondrook–Perricoota Forest

The Koondrook–Perricoota Forest is a large mosaic of river red gum (*Eucalyptus camaldulensis*), black box (*E. largiflorens*) and grey box (*E. microcarpa*) communities, interspersed by wetland ecosystems in southern New South Wales. The forest has a number of environmental, social, cultural and economic values. Its current condition reflects the long-term inadequacy of the primary driver of floodplain forest health—the flood regime.

Management interventions

Ecological objectives have been defined for the site to focus management efforts. The First Step Decision ecological objectives, approved by Ministerial Council are to:

Maintain and restore a mosaic of healthy floodplain communities as indicated by;

- 80% of permanent and semipermanent wetlands in healthy condition
- 30% of river red gum forest in healthy condition
- successful breeding of thousands of colonial waterbirds in at least three years in 10
- healthy populations of resident native fish in wetlands.

The Flood Enhancement Works project under construction is designed to help achieve these ecological objectives. The works will enable a range of natural flood events to be mimicked achieving broadscale inundation of up to 50% of the forest, including watering river red gum communities and wetlands and promoting colonial waterbird breeding events.

The Flood Enhancement Works project will provide significant additional opportunities to achieve the ecological objectives for the Koondrook–Perricoota site over and above the pumping options. The delivery of larger watering events will lead to additional cultural, social and economic benefits.

Environmental water delivery

Water will be delivered to the Koondrook–Perricoota icon site via a number of mechanisms. The primary method will be using the Flood Enhancement Works project to deliver a range of flows at varying frequencies to meet the First Step Decision and refined objectives. In addition, water will continue to be delivered to Pollack Swamp through the private irrigation infrastructure, or by pumping outflows from the Barber Creek works. Approvals have also been secured to allow pumping from the River Murray directly into lagoons alongside the river that will not benefit from the works.

Consultation and engagement

Several committees have been established as part of the icon site governance arrangements for Koondrook–Perricoota. Together with the Joint Indigenous Group and working groups comprising project partners, these committees undertake community engagement activities and provide a mechanism to consult with stakeholder representatives from community and Indigenous groups, organisations and agencies. This consultation will continue as the site progresses to operating the works.

Monitoring

Monitoring is being undertaken, primarily through the icon site condition monitoring program, to determine progress towards achieving ecological objectives for the Koondrook–Perricoota icon site. Event-based monitoring comprising ecological response, risk and operations monitoring will also be undertaken to inform operation of the works.

Monitoring outcomes are reported to key stakeholders and will be used as part of the adaptive management process for the site. The Koondrook–Perricoota Forest Environmental Water Management Plan will be reviewed periodically to capture the key lessons and changes in icon site management practices.

1. The Living Murray

The Living Murray TLM) Initiative is one of Australia's most significant river restoration programs. Established in 2002, TLM is a partnership of the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory; it is coordinated by the Murray–Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

The Living Murray aims to improve the environmental health of six icon sites chosen for their significant ecological, cultural, recreational, heritage and economic values:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands (including Mulcra Island)
- River Murray Channel
- Lower Lakes, Coorong and Murray Mouth.

Through its First Step water recovery initiative, TLM has acquired a water portfolio consisting of environmental water entitlements. As of May 2011, there was 478.97 gigalitres long-term Cap equivalent (LTCE), with another 7.1 GL to be recovered in 2011–2012. The actual volume of water available against these entitlements depends on the allocations. This portfolio will be used to achieve environmental objectives at the icon sites. Regulating structures, water delivery channels and fishways, known as works and measures, will deliver and manage the environmental water at the icon sites. On-ground works for each icon site will be progressively constructed from 2010 to 2012. The success of the environmental watering against the objectives will be monitored using fish, birds and vegetation as an overall indicator of the icon site's health.

The Living Murray will seek to align itself to the requirements of the Basin Plan Environmental Watering Plan, once finalised.

Further information on TLM is available on the MDBA website at **←www.mdba.gov.au/programs/tlm→**.

Figure 1.1: Location of The Living Murray icon sites

The Living Murray icon site environmental water management plans

The Koondrook–Perricoota Environmental Water Management Plan establishes priorities for the use of TLM water within the icon site, and identifies environmental objectives and targets (where appropriate), and water delivery options and regimes for this site that can use TLM water portfolio.

Development of the environmental management plans has been coordinated by the MDBA in consultation with the Environmental Watering Group to ensure a consistent approach to planning and management across the icon sites.

This revision builds on previous iterations of the Koondrook–Perricoota Environmental Management Plan (previously known as environmental management plans) and incorporates consultation, research into icon site key species, learning from water behaviour modelling and outcomes from previous environmental watering. The Koondrook–Perricoota Environmental Water Management Plan reflects the larger volume now held in The Living Murray water portfolio, and uses TLM works and measures (as construction is completed) and monitoring information gathered at the icon site.

Planning context and legislation framework agreements

Ramsar Convention on Wetlands of International Importance

The Ramsar Convention on Wetlands of International Importance (the Ramsar Convention) is an international treaty with the broad aim of halting the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. For wetlands to be listed as Ramsar wetlands, they need to be representative, rare or unique in terms of their ecological, botanical, zoological, limnological or hydrological importance. Ramsar-listed wetlands can be natural, artificial, permanent or temporary swamps, marshes, billabongs, lakes, salt marshes or mudflats classified as wetlands.

Signatories to the Ramsar Convention, including Australia, are required to formulate and implement their planning so as to promote the conservation of wetlands included in the Ramsar list, and as far as possible the wise use of all wetlands in their territory. Ramsar wetlands in Australia are protected under the *Environment Protection and Biodiversity Conservation Act 1999* as a matter of national environmental significance. (Department of Sustainability, Environment, Water, Population and Communities 2011b).

Bilateral migratory bird agreements

Over the past 30 years Australia has signed three bilateral migratory bird agreements in an effort to conserve migratory birds in the east Asian and Australian region: China–Australia Migratory Bird Agreement (signed in 1986); Japan–Australia Migratory Bird Agreement (signed in 1974); and the Republic of Korea–Australia Migratory Bird Agreement (came into effect in 2007).

These agreements protect terrestrial, water and shorebird species that migrate from Australia to Japan or China. The Japan–Australia Migratory Bird Agreement also provides for cooperation on the conservation of threatened birds, while the Republic of Korea–Australia Migratory Bird Agreement ensures conservation of migratory birds and collaboration on the protection of migratory shorebirds and their habitat (Department of Sustainability, Environment, Water, Population and Communities 2011a).

Murray–Darling Basin agreements

The Murray–Darling Basin Ministerial Council established TLM in 2002. In 2004, the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory signed the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin, which gave effect to a funding commitment (made in 2003) of $500 million over five years for TLM. The Living Murray program's First Step aimed to recover 500 GL of water for the River Murray and focused on improving the environment at the six icon sites. A supplementary Intergovernmental Agreement was signed in 2006 which provided increased funding of $200 million to The Living Murray.

The role of the Intergovernmental Agreement on Murray–Darling Basin Reform, signed by the Council of Australian Governments, is to:

- promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water and other natural resources of the Murray–Darling Basin (Council of Australian Governments 2008b).

This Agreement was the foundation for the *Water Act 2007*, which established the MDBA whose role is to manage the Basin's water resources through the development of a Basin plan.

Commonwealth legislation

Water Act 2007

The Intergovernmental Agreement on Murray–Darling Basin Reform was the foundation for the federal *Water Act 2007*, which established the MDBA, whose role is to manage the water resources of the Murray–Darling Basin in an integrated, consistent and sustainable manner. The Water Act requires the MDBA to prepare and oversee a Basin Plan, which will be a legally enforceable document that provides for the integrated and sustainable management of water resources in the Basin.

The Basin Plan's Environmental Watering Plan will provide a strategic framework for coordinated environmental water planning and environmental watering throughout the Murray–Darling Basin. In the future, TLM will align with the Environmental Watering Plan in the development of Basin states' long-term and annual environmental watering plans and through the annual environmental water prioritisation processes.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (including natural, historic or Indigenous Australian places) —defined in the EPBC Act as matters of national environmental significance. There are eight matters of national environmental significance to which the EPBC Act applies.

The EPBC Act aims to balance the protection of these crucial environmental and cultural values with our society's economic and social needs by creating a legal framework and decision-making process based on the guiding principles of ecologically sustainable development (Department of Sustainability, Environment, Water, Population and Communities 2011a).

New South Wales legislation

Operation of the Flood Enhancement Works project has been approved under Part 3 of the *Environmental Planning and Assessment Act 1979*, which effectively overrides or fulfils the conditions of other state planning legislation.

This means that operation of the works must be carried out in accordance with the environmental assessment, preferred project report, response to submissions and statement of commitments prepared by the proponent and conditions of consent issued as part of the approval. These documents regulate the operating regime, operation during unregulated events, and monitoring and consultation.

The conditions of consent also require development of an operational environmental management plan, including a number of sub-plans, and a biodiversity operational plan, fish management plan, dual fishway and turtle ramp operational plan, and an emergency plan. A compliance tracking program must also be developed. These documents are currently in preparation; they will replace the Preliminary Operating Plan for the works and be appended to the Koondrook–Perricoota Environmental Water Management Plan as a schedule.

Water management not connected with the scheme of works (e.g. pumping into lagoons and diversions into Pollack Swamp) remains subject to legislation listed below.

The following New South Wales legislation is relevant to water management at the Koondrook–Perricoota icon site:

- *Environmental Planning and Assessment Act 1979* (including state, regional and local environmental planning instruments)
- *Fisheries Management Act 1994*
- *Protection of the Environment Operations Act 1997*
- *Threatened Species Conservation Act 1995*
- *National Parks and Wildlife Act 1974*
- *Water Management Act 2000*
- *Heritage Act 1977*
- *Forestry Act 1916*
- *Crown Land Act 1989*
- *Native Vegetation Act 2003*
- *Noxious Weeds Act 1993*

These Acts are described in Appendix A of this report.

Governance and planning arrangements

The Living Murray is a joint initiative and is managed collaboratively by partner governments. The Murray–Darling Basin Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin (Council of Australian Governments 2004) outlines governance arrangements for implementing TLM. The 2004 intergovernmental agreement is complemented by The Living Murray Business Plan, which provides operational policies to guide TLM implementation.

The groups with a direct role in TLM governance are the Murray–Darling Basin Ministerial Council, MDBA, Basin Officials Committee, TLM Committee and the Environmental Watering Group (see **Figure 1.2** for TLM governance structure)

While MDBA plays a key coordination role at a TLM-wide level, management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located. The ultimate responsibility to ensure the icon sites at Koondrook–Perricoota Forest are successfully governed lies with Forests NSW, as the manager of these icon sites.

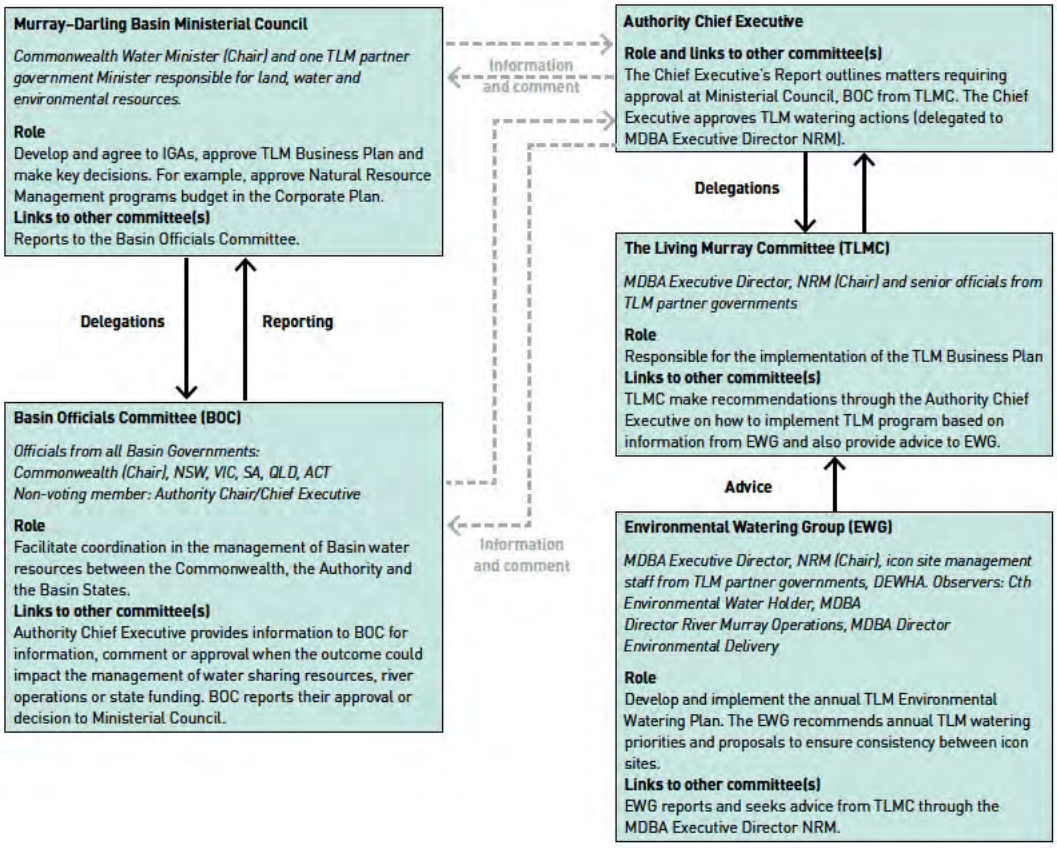

Figure 1.2 The Living Murray governance structure (MDBA)

The governance arrangements for the Koondrook–Perricoota Forest icon site are responsive to the construction and operational planning phase of the works project; they are summarised in **Figure 1.3** (below). The roles and responsibilities of the various groups and organisations specific to the Koondrook–Perricoota Forest are discussed in this section.

Icon site management arrangements following construction of the works will continue to occur in a collaborative manner, with a number of key organisations and groups. It is intended that governance arrangements will be established for the ongoing management phase of the program enabling communication between relevant organisations already involved during the planning and construction phase, and others where appropriate.

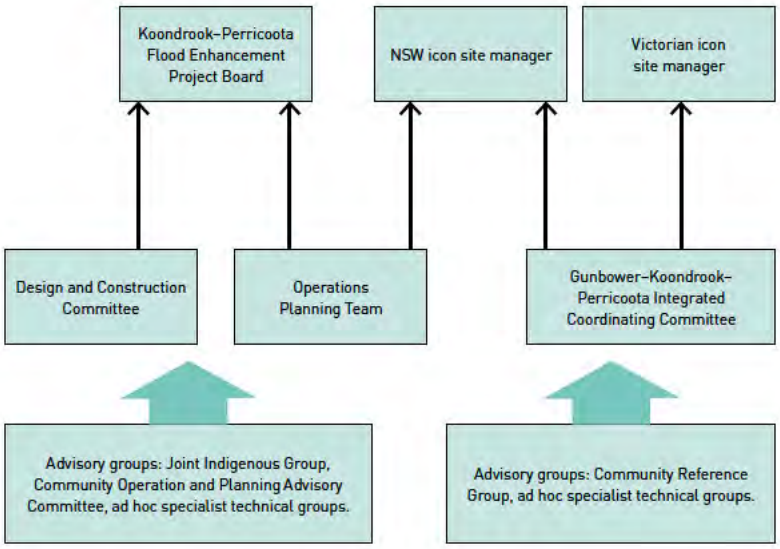

Figure 1.3: Cross-border governance arrangements: Koondrook–Perricoota Forest

Organisations

The majority of organisations involved in Koondrook–Perricoota Forest management are involved in one or more of the committees or groups described below. The broad roles and responsibilities of these organisations are detailed in chapter 6.

Project Board

The Project Board is responsible for the successful, cost-effective and timely delivery of the Koondrook–Perricoota Forest Flood Enhancement Project in accordance with the stated TLM objectives and broader water management and environmental outcomes. The board ensures that high-level communication is maintained and promoted to ensure project understanding and cooperation across member organisations. Project Board members are the Murray–Darling Basin Authority (Chair); Forests NSW; the New South Wales Office of Environment and Heritage; NSW State Water Corporation; and the NSW Office of Water.

Operations Planning Team

The Operations Planning Team provides coordinated stakeholder advice to the icon site manager regarding operation of the Koondrook–Perricoota Flood Enhancement Works project and provides a multidisciplinary technical forum for the development of the operational plan and sub-plans. The Operations Planning Team membership includes representatives from a range of Australian Government and New South Wales and Victorian agencies, as well as from the Community Operations and Planning Advisory Committee and the Joint Indigenous Group.

Community Operation and Planning Advisory Committee

The Community Operation and Planning Advisory Committee comprises 11 community members who provide local experience and advice in respect of the planning and operating of events delivered and managed by the Flood Enhancement Works. A delegate from the Community Operations and Planning Advisory Committee also sits on the Operations Planning Team to ensure that community issues are correctly conveyed to that group and to provide an avenue for direct feedback.

Design and Construction Committee

The Design and Construction Committee oversees development of detailed designs and construction of the Flood Enhancement Works project. The group shares expertise to ensure that the works are designed, constructed and commissioned efficiently and effectively to provide the agreed environmental outcomes. The committee comprises experts from State Water Corporation, the NSW Office of Water, Department of Primary Industries, Forests NSW and the MDBA.

Joint Indigenous Group

The Joint Indigenous Group ensures that the Indigenous community is given the opportunity to provide input into water management and a chance to raise and identify their cultural and spiritual links to the forest. This group is made up of representatives from the Yorta Yorta and Barapa Barapa nations (the Traditional Owners of Koondrook–Perricoota) and from the Moama and Deniliquin Local Aboriginal land councils. These representatives, mainly chief executive officers and elders, ensure cultural heritage and values are considered and incorporated by the icon site manager, and that information is provided to local Indigenous communities. Refer to chapter 7 for further details.

Operations Committee

The Operations Committee provides coordinated technical advice to the MDBA River Operations staff (River Management Division) before and during watering events. Advice includes the recommended inflow to the forest for optimum ecological response within legal and other constraints. The committee includes representatives from Goulburn–Murray Water, NSW State Water, Forests NSW and other members as required. The committee meets regularly during watering events to provide feedback on how the operation is going and to plan ahead for future environmental watering (GHD 2010).

Cross-border management arrangements

Integrated Coordinating Committee

Management of the Koondrook–Perricoota Forest is currently coordinated with the Gunbower Forest (managed by Victoria) through the Integrated Coordinating Committee. The Integrated Coordinating Committee comprises representatives from Forests NSW and Victorian North Central Catchment Management Authority (the icon site managers), New South Wales Murray Catchment Management Authority, Victorian Department of Sustainability and Environment, federal Department of Sustainability, Environment, Water, Population and Communities, and the MDBA.

The Integrated Coordinated Committee identifies areas for integration (e.g. water sharing, opening and/or shutting structures, and implementation of monitoring), and ensures that this integration occurs. The committee identifies efficiencies and ensures that cross-communication and information-sharing occur consistently; it also assists in identifying priorities across the entire forest system.

The Koondrook–Perricoota Environmental Water Management Plan, although a separate plan, has been developed to complement the Gunbower Forest Environmental Water Management Plan.

Icon Site Community Reference Group

The Gunbower–Koondrook–Perricoota Community Reference Group provides a mechanism to seek advice and a community perspective on the communication and engagement activities proposed for the icon site. The community reference group will be engaged as an advisory body for the implementation of communication tools and actions. Membership of the group includes six representatives from the local community and the chair rotates yearly between the chairs of the Victorian North Central Catchment Management Authority and New South Wales Murray Catchment Management Authority boards (MDBC 2006). Chapter 6 also contains information about community consultation and communication.

2. Icon site description

Koondrook–Perricoota Forest is located in the Riverina region of New South Wales, downstream of Torrumbarry Weir. It extends from the area opposite the Victorian township of Torrumbarry in the south to a few kilometres from Barham in the north. Koondrook Forest is located at the Barham end of the forest, while Perricoota Forest lies toward the Echuca–Moama end. The forest is located within two local government areas, Murray Shire Council and Wakool Shire Council, and is an important local feature for the Moama, Barham, Mathoura, Moulamein, Womboota, Wakool and Bunnaloo communities. The forest is within the Murray Catchment Management Authority region.

Koondrook–Perricoota Forest is a state forest (Crown land) managed by Forests NSW and is listed on the Register of the National Estate. Forests NSW is responsible for sustainably managing the forest for the benefit of present and future generations. The river red gum (*Eucalyptus camaldulensis*) forests of south-western New South Wales, which include the Koondrook–Perricoota Forest, have been managed as multiple-use forests for over 150 years.

To the north-east, the land surrounding the forest is predominantly flat, consisting of private agricultural land that supports mainly irrigated and dryland cereal-cropping and stock-grazing enterprises. Other uses of lands adjacent to the forest include horticulture, private native forestry and rural residential development. Isolated pockets of forested areas occur across the landscape (GHD 2010; MDBC 2006).

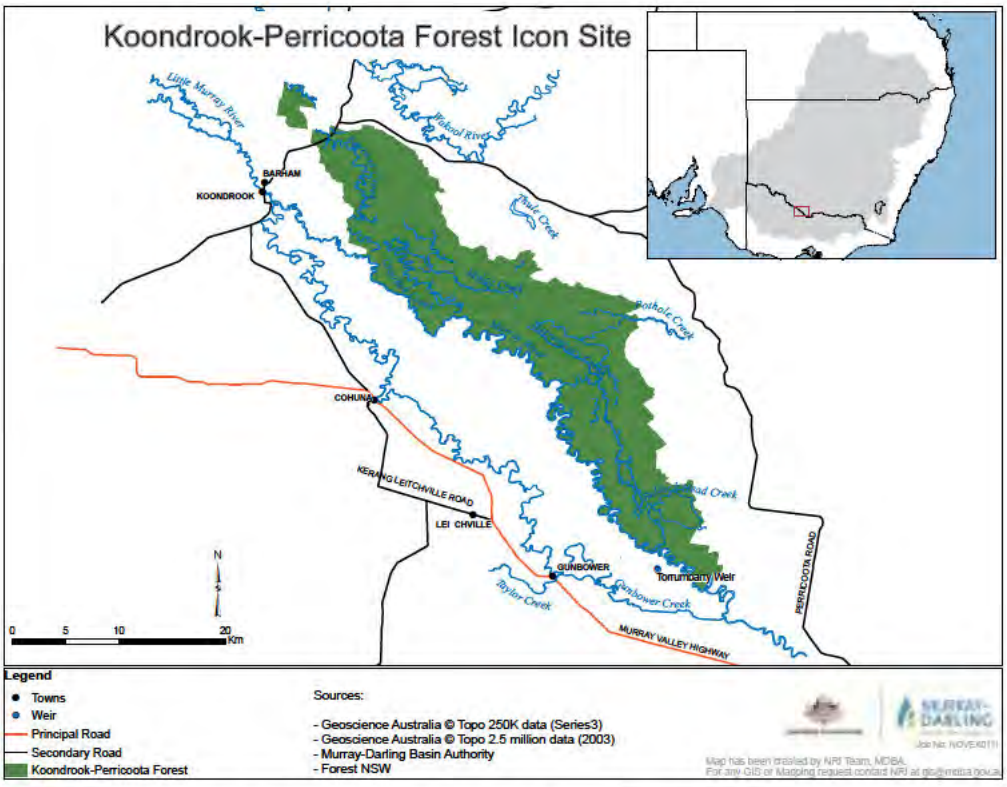

Figure 2.1: Koondrook–Perricoota Forest location and tenure

Description of key ecological assets of the icon site

Koondrook–Perricoota Forest (Figures 2.2a and 2.2b) is a mosaic of river red gum, black box (E. *largiflorens*) and grey box (E. *microcarpa*) communities interspersed by wetland ecosystems at lower elevations. Covering 32,000 ha, the floodplain forms part of the Gunbower–Koondrook–Perricoota icon site along with approximately 19,450 ha of floodplain on the Victorian side of the River Murray (i.e. Gunbower Forest).

Koondrook–Perricoota Forest is a New South Wales Central Murray State Forest Ramsar site, recognised for its genetic and ecological diversity, and for supporting large numbers of waterbirds during flood times.

The Koondrook–Perricoota icon site is included with other New South Wales Central Murray State Forest Ramsar-listed locations because it:

- forms part of the largest complex of tree-dominated floodplain wetlands in southern Australia
- contains rare wetlands types—floodplain lakes, meadows and reed swamps
- provides comparatively high water availability and habitat productivity in a semi-arid rainfall zone
- supports globally and nationally threatened species
- provides a habitat refuge and is part of the habitat network for migratory species
- supports over 20,000 waterbirds
- provides cues for native fish migration, spawning and recruitment during flood times (Leslie 2002).

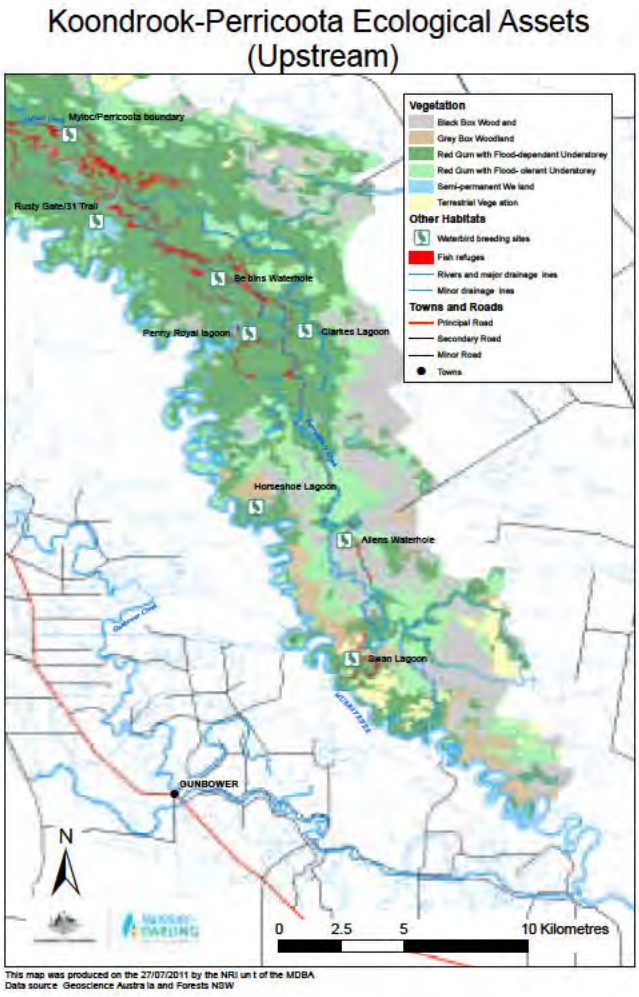

Figure 2.2a Key ecological assets: Koondrook–Perricoota Forest upstream section

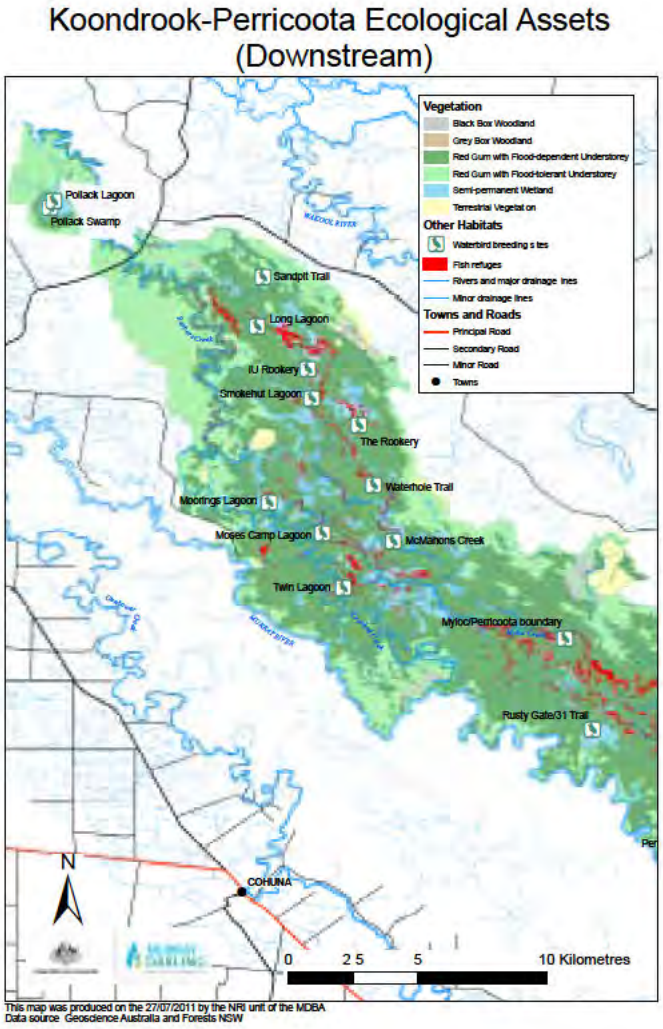

Figure 2.2b Key ecological assets: Koondrook–Perricoota Forest downstream section

Values of the icon site

Ecological values

Flora

River red gum is the predominant over-storey species, which occupies over 80% of Koondrook–Perricoota Forest. It usually forms a pure stand and only occurs with other eucalypt species on less frequently flooded sites. The health of the river red gum forests depends on the frequency of flooding.

Black box communities occur in areas prone to lower frequency, shorter duration flooding. Grey box, yellow box (*E. melliodora*) and white cypress (*Callitris gaucophylla*, also known as Murray pine) occur higher on the floodplain on lighter textured soils and sandhills that are rarely inundated.

Two endangered ecological communities occur in the forest—inland grey box woodland and sandhill pine woodland. There is also potentially suitable habitat and representative species of a third threatened endangered ecological community, buloke (*Allocasuarina luehmannii*) woodland, which may occur in the forest.

Recent surveys of the forest found 147 plant species, of which 86 were native. The forest contains a large number of annual or ephemeral plant species, resulting in diversity fluctuating in response to seasons and local conditions. This includes wetland and aquatic plants species thriving during wet periods (GHD 2010).

Habitat

Various habitats occur throughout Koondrook–Perricoota Forest. Despite their poor vegetative health, the forests and woodlands of Koondrook–Perricoota are generally in good condition regarding their habitat value for native fauna.

Forests and woodlands provide a valuable habitat resource in an otherwise cleared landscape. Shelter and roost sites, foraging habitat and food resources are provided through the presence of nectar- and seed-bearing mature eucalyptus trees and a dense understorey of native shrubs, tussock grasses and herbs. Habitat trees are those with hollows, stags, nests and roost sites. Tree hollows are highly important for native fauna, with an estimated 15% of all terrestrial vertebrate fauna in Australia dependent on hollows. The greatest density of habitat trees in Koondrook–Perricoota occurs along creeks.

Woody debris is common in the forest. It provides shelter and foraging resources for native invertebrates, reptiles, ground-dwelling native birds and small terrestrial mammals.

Wetland habitat in the forest consists of river red gum forests and floodplain marshes. These are naturally intermittent wetland areas that would support wetland plants and aquatic animals (e.g. waterfowl, wading birds and frogs) during flood periods. Areas of more semipermanent wetlands also exist, and these provide a significant refuge for wetland fauna during extended dry periods, enabling their dispersal across the forest during flood events (GHD 2010).

Fauna

Koondrook–Perricoota Forest is home to several internationally threatened fauna species listed by the World Conservation Union. A number of these species are protected under federal and state legislation, with 13 species listed in migratory bird agreements between Australia and Japan (Japan–Australia Migratory Bird Agreement) and China (China–Australia Migratory Bird Agreement).

A total of 12 fauna species are listed as threatened in New South Wales and a further three preliminary-listed species are known, or are highly likely to occur, at the site (e.g. birds, bats and gliders). Two threatened aquatic fauna species are likely to occur in the forest during flood times. These are Murray cod (*Maccullochella peelii*), listed as vulnerable under the federal *Environment Protection and Biodiversity Conservation Act 1999*, and silver perch (*Bidyanus bidyanus*), listed as vulnerable under the New South Wales *Fisheries Management Act 1994*.

Recent surveys (GHD 2010) recorded at least 144 vertebrate fauna species including:

- a high diversity (108 species) of native birds, including four threatened species—Gilberts whistler (*Pachycephala inornata*), hooded robin (*Melanodryas cucullata*), diamond firetail (*Stagonopleura guttata*) and Australasian bittern (*Botaurus poiciloptilus*)—and a further three species that may be listed as threatened in the future—varied sittella (*Daphoenositta chrysoptera*), scarlet robin (*Petroica boodang*) and white-browed wood swallow (*Artamus superciliosus*)
- a high diversity (15 species) of microbats, including possible recordings of the threatened large-footed myotis (Myotis *macropus*) and the little pied bat (*Chalinolobus picatus*)
- a moderate diversity (10 species, three native) of terrestrial mammals
- a moderate diversity (at least three species) of arboreal mammals
- a low diversity (six species) and abundance of reptiles, which was likely caused by cooler weather during these surveys resulting in less reptile activity
- a limited diversity (three species) and low abundance of frogs were recorded, which could have been caused by the cool and dry conditions experienced during the conduct of the surveys, which made frog detection difficult.

Cultural values

A strong cultural link exists between Indigenous and non-Indigenous people with the Koondrook–Perricoota Forest.

Indigenous values

The Barapa Barapa and Yorta Yorta nations are the Traditional Owners of Koondrook–Perricoota Forest. A number of other groups may also have connections and interests in the site, including native title claimants, knowledge-holders such as elders' groups, and Aboriginal corporations.

Local Indigenous communities have long had, and continue to have, a strong connection to the Koondrook–Perricoota region. Many historical accounts exist of Indigenous Australians occupying the lands and using the resources of the River Murray, and the Indigenous community identifies a number of values associated with the forest including:

- Cultural heritage values –mounds and scarred trees.
- Ecological values—associated with wetlands, river red gum forest, open box ridges (black and grey box), open plains, sandhills and white cypress. Wetlands are seen as nurseries and river red gums are seen as the 'guardians' of the river, stabilising the river banks while providing habitat both in and out of the water systems.
- Commodities and/or economic values—associated with medicinal plants, food plants, fish species and edible fauna such as kangaroo (*Macropodidae*), emu (*Dromaius novaehollandiae*) and ducks (*Anatidae*).

Over 300 Indigenous sites have been recorded in the area, including scarred trees from which canoes or shields were cut; stone artefact and shell scatters; sacred or significant sites; and middens, ovens, hearths and burial sites. However, a comprehensive survey has not been undertaken and it is likely that more archaeological sites are present. The locations of many places may not yet be listed on the Aboriginal Heritage Information Management System, but are known to members of local Indigenous communities.

All Indigenous sites, places and objects are protected under federal and state legislation (GHD 2010).

Heritage values

The general Australian community has a strong connection to the River Murray and the surrounding rural landscape because of the region's history of early settlement and explorers opening up inland Australia. The river itself played an important role in the development of towns through its role as a trade route.

Early activities undertaken in the Koondrook–Perricoota Forest included cattle and sheep grazing, logging and sawmilling. Evidence of European heritage can be seen in the forest; it includes six trees exhibiting surveyor marks, a depot and other remains possibly associated with sandmining or forestry operations, an old sawmill site and an old sawmill house.

It is likely that other archaeological sites not available in contemporary records or local oral history are present in the forest.

All registered archaeological sites in New South Wales have legislative protection under the New South Wales *Heritage Act 1977*. Heritage sites are also protected under local environmental plans (GHD 2010).

Social values

Koondrook–Perricoota Forest attracts a high level of recreational use, including four-wheel driving, motorcycling, horse riding, picnicking, camping, swimming, boating, skiing, fishing, orienteering, canoeing, hunting and nature study. It is a popular place to visit during summer but visitor numbers drop significantly during winter. Most areas are readily accessible using an extensive network of dry weather roads. A large number of simple, widely dispersed recreation facilities have been developed, primarily in riverside locations.

The scenic values of the forest are considered to be very high and are an important aspect of the area's overall recreational value (GHD 2010).

Economic values

Koondrook–Perricoota Forest provides a variety of direct and indirect economic values to the local community. The direct economic values include timber production, domestic stock grazing, apiculture (bee-keeping), recreation and tourism.

Commercial timber production is the main land use within the forest. It is undertaken in accordance with the Riverina Ecological Sustainable Forest Management Plan, which ensures that flora, fauna and archaeological values are protected. The local community also receives benefits from the forest through the collection of firewood. This occurs in accordance with permits issued by Forests NSW.

Cattle grazing for economic gain, fuel load reduction, weed management and to promote native understorey species (Lodge & Whalley 1985; Kemp et al. 1996) occurs in the forest. It is managed by Forests NSW through a permit system in line with the Riverine Grazing Strategy.

Apiculture occurs in Koondrook–Perricoota because river red gums are considered to be fairly reliable for the production of heavy blossom, which produces high flows of nectar and large quantities of pollen. Apiculture permits are issued by Forests NSW.

The high number of tourists visiting the forest has resulted in some nearby businesses supplying a range of services and supplies to campers, and becoming dependent on this seasonal income (Sinclair Knight Merz 2009). During peak times, local shop revenue increases by 30% because of tourist activity (Sinclair Knight Merz 2009).

3. Ecological objectives and water requirements

The Living Murray First Step icon site objectives

Based on an understanding of the icon site's characteristics and ecological requirements First Step Decision interim ecological objectives were developed and approved by Murray-Darling Basin Ministerial Council in 2003.

The First Step ecological objectives developed for the Gunbower–Koondrook–Perricoota icon site were to maintain and restore a mosaic of healthy floodplain communities as indicted by;

- 80% of permanent and semipermanent wetlands in healthy condition
- 30% of river red gum forest in healthy condition
- successful breeding of thousands of colonial waterbirds at least three years in 10
- healthy populations of resident native fish in wetlands.

Since these objectives were approved by Ministerial Council in 2003, jurisdictional agencies have continued to review and refine the First Step Decision interim objectives to develop refined ecological objectives for icon sites. These refined ecological objectives reflect eight years of learning's from the delivery of environmental water, monitoring, modelling and consultation activities and scientific research, and enable a clearer, more effective, evaluation of environmental responses to environmental water delivery.

The vision for the Gunbower–Koondrook–Perricoota icon site is to achieve 'an extensive mosaic of healthy floodplain communities connected to the River Murray, supporting a diverse range of wetlands and flora and fauna'.

A draft set of refined ecological objectives for the Gunbower–Koondrook–Perricoota icon site was developed by the Technical Advisory Committee and was released for public comment in May 2007 (MDBC 2007). These objectives include:

- protect and enhance a diverse range of healthy wetlands
- protect and enhance diverse, healthy vegetation communities
- provide for successful waterbird breeding and recruitment events
- protect and enhance viable native fish communities.

These objectives integrate the concepts of 'maintain' (protect) and 'restore' (enhance) into the fish, bird and vegetation focus prescribed by the Murray–Darling Basin Ministerial Council. Together with the vision for the site, the refined objectives provide strong guidance for water management at the icon site.

Water requirements

Relationship between ecology and hydrology

Vegetation

The health of vegetation in the Koondrook–Perricoota Forest is closely tied to the local hydrology. The major vegetation classes have been identified within the Koondrook–Perricoota Forest, each with a specific flow requirement, position in the landscape and species composition (MDBC 2007). These classes have been used to guide target setting under the icon site objectives and include; deep and shallow freshwater marshes, river red gum forests and woodlands, and black box and grey box woodlands.

The distribution of these vegetation classes, shown in **Figure 3.1**, highlights that:

- the wetland areas (marshes) occur in the low lying areas of the lower forest and along the River Murray (lagoons)
- the large majority of the forest is dominated by river red gum communities, with river red gum forest (the most extensive vegetation class) occurring in lower elevations and river red gum woodland occurring in higher elevations
- the higher elevation areas along the forest's boundaries are dominated by box woodlands.

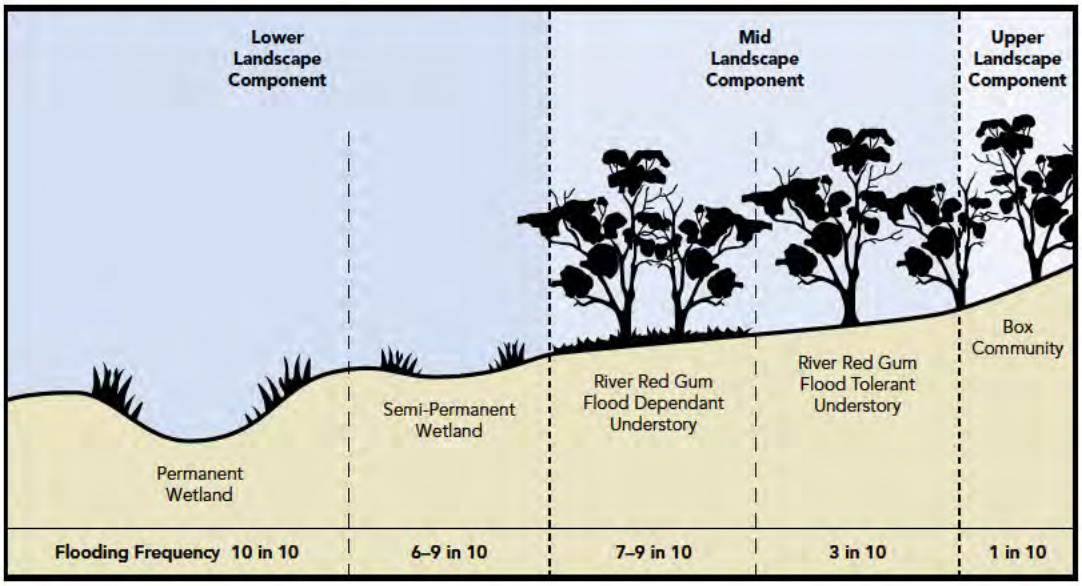

Figure 3.1: Vegetation associations, geomorphic setting and ideal flood regime: Koondrook–Perricoota Forest

Source: Ecological Associates 2002

The varying needs of the different vegetation classes within the Koondrook–Perricoota Forest means they require different water management options. Wetlands (marshes) require the most frequent watering and benefit from more prolonged flooding and the persistence of water in pools and depressions. River red gum forest requires regular inundation to promote the flood-dependent understorey (macrophytes). River red gum woodland requires less frequent watering to forest areas as the understorey is not flood-dependent. Box woodlands require little flooding, especially grey box.

Watering that targets vegetation communities situated higher in the landscape will also water communities at the lower elevations. For example, a flood event designed to water river red gum communities will also water the lower lying wetlands.

Draft targets have been identified which provide a measure of progress towards achieving the ecological objectives. They are based on a balance between what is ideal and what is achievable given the current resources and realities (see **Table 3.1**). Some targets cannot be quantified using existing data and have been described as broad strategies in the interim (MDBC 2007).

Waterbirds

Waterbird breeding events are highly-dependent on environmental cues, the availability of foraging habitat (food resources) and nesting materials (habitat resources). Each of these is closely linked to the hydrological regime.

Annual wetting and drying cycles increase the productivity of the floodplain and wetland environment so that a range of habitat and food types is provided. This promotes waterbird-carrying capacity and breeding success (Ecological Associates 2010).

Diverse conditions are needed for successful waterbird breeding. Flooding should occur from late winter/early spring and persist for a minimum of four months (for rapid breeders such as ducks) to seven months for the successful breeding of most waterbird species. Slow breeders such as eastern great egrets (*Ardea modesta*) require a minimum inundation period of 10 months (seven-month time lag followed by three months for egg-laying, hatching and fledging) (Ecological Associates 2010).

Many waterbird species will not breed in wetlands with highly controlled water regimes where, for example, water levels are held at constant levels for extended periods, or are alternatively subject to rapid and/or erratic changes in depth. Nearly all colonial nesting waterbirds are vulnerable to sudden drops in water level beneath nesting sites or in foraging areas—this can result in waterbirds abandoning their nests and young before they fledge (Ecological Associates 2010).

Timing of inundation and exposure of wetlands over seasonal and annual time frames is also important, as long-term rapid and/or erratic changes in water levels within a wetland can result in low numbers of aquatic invertebrates, the food of many waterbirds (Ecological Associates 2010).

Native fish

The water regime within the Koondrook–Perricoota Forest has implications for native fish communities in the region. Many adult, sub-adult and small native fish enter the floodplain during high flows, usually temporarily, for feeding, residence and breeding, and then return to the river.

Historically, small native fish also resided in deep permanent pools in major flood runners. Regular flooding will reinstate these pools and provide year-round habitat for fish.

Koondrook–Perricoota Forest floodwaters returning to the River Murray, Barbers Creek and Wakool River systems will provide important organic carbon and other nutrients and small invertebrates, which contribute to the increased survival and growth of juvenile fish (Ecological Associates 2009).

Water requirements to meet ecological objectives

The ecological objectives for the Koondrook–Perricoota Forest correlate with the vegetation classes, waterbirds and native fish discussed above. The water requirements for each have been defined by considering the flow requirements for all key flora and fauna communities within them. These water requirements are summarised in **Table 3.1**.

Table 3.1: Objectives and associated water requirements: Koondrook–Perricoota Forest

Vegetation class or behaviour	Target or strategy	Water regime required
Objective 1: protect and enhance a diverse range of healthy wetlands (equivalent First Step Decision objective: 80% of permanent and semipermanent wetlands in healthy condition)		
Deep freshwater marshes	Reinstate 50% of the pre-regulation area of natural deep freshwater marshes. Reinstate habitat quality in deep freshwater marshes so that flora and fauna species typical of these marshes are present.	Frequency: 8–10 years in 10 Duration: 9–12 months Timing: mainly winter/spring/summer, although potentially year round Maximum time between events: 1 year Area inundated: 1% approx.
Shallow freshwater marshes	Restore 50% of shallow freshwater marsh area that has been lost since pre-regulation conditions. Restore habitat quality in shallow freshwater marshes so that flora and fauna species typical of these marshes are present. Increase species diversity in shallow freshwater marshes. Maintain and/or increase the current extent of swamp wallaby (*Wallabia bicolor*) grass.	Frequency: 6–9 years in 10 Duration: 2–8 months Timing: winter/spring/early summer Maximum time between events: 1 year Area inundated: 3% approx.
Objective 2: protect and enhance diverse, healthy vegetation communities (equivalent First Step Decision objective: 30% of river red gum forest[a] in healthy condition)		
River red gum forest (river red gums with flood-dependent understorey)	Restore 50% of the area of river red gum forest that has been lost since river regulation. 80% of the current river red gum forest area in a 'healthy' status (Tree Health Index 4 or above).[b] Less than 20% of current river red gum forest considered 'unhealthy' (Tree Health Index 2 or below).[b]	Frequency: 3–9 years in 10 Duration: 4 months minimum Timing: winter/spring Maximum time between events: 5 years Area inundated: 40% approx.

Vegetation class or behaviour	Target or strategy	Water regime required
River red gum woodland (red gums with flood-tolerant understorey)	Reduce current extent of river red gum woodland.[c] 30% of the current river red gum woodland area in a 'healthy' status (Tree Health Index 4 or above).[b] 70% of current river red gum woodland area maintained at or improved to better than 'unhealthy' (Tree Health Index 2 or below).[b]	Frequency: 1–4 years in 10 Duration: 1–4 months Timing: winter/spring/summer Maximum time between events: 7 years Area inundated: 50% approx.
Black box	Maintain current extent of black box woodland. 50% of the current black box area in a 'healthy' state (Tree Health Index 4 or above).[b]	Frequency: 1–4 years in 10 Duration: 1–4 months Timing: spring/summer Maximum time between events: 7 years Area inundated: unknown.[d]
Objective 3: provide for successful waterbird breeding and recruitment events (equivalent First Step Decision objective: successful breeding of thousands of colonial waterbirds in at least three years out of 10)		
Breeding and recruitment	Successful recruitment of waterbirds at a frequency of at least four years in 10. Records of intermediate egret (*Ardea intermedia*) breeding in at least three years in 10.	Frequency: 4–9 years in 10 Duration: 4–10 months Timing: spring/summer Maximum time between events: 6 years Area inundated: variable. Must maintain sufficient depth under nests.
Objective 4: protect and enhance viable native fish communities (equivalent First Step Decision objective: healthy populations of resident native fish in wetlands)		
Movement	Reduce the barriers to fish passage throughout the floodplain creek system through provision of fishways. Restore populations of cod and perch by providing opportunities for floodplain access.	Frequency: opportunistic, 6–9 years in 10 Duration: 4 months minimum to allow spawning Timing: winter/spring Maximum time between events: 4 years Area inundated: unknown Lagoons and major effluents filled as a minimum.
Breeding and recruitment	Provide for improved recruitment opportunities for small and large bodied native fish.	Frequency: opportunistic, unknown for large bodied fish Duration: 4 months minimum to allow spawning Timing: winter/spring Maximum time between events: unknown. Area inundated: unknown. Lagoons and major effluents filled as a minimum.
	Restore self-sustaining populations of pygmy perch (*Nannoperca vittata*), gudgeons and other small native fish.	Frequency: 6–9 years in 10 Duration: 2–4 months Timing: winter/spring/summer Maximum time between events: 4 years Area inundated: unknown. Lagoons and major effluents filled as a minimum.

Note: since the previous environmental water management plan, the vegetation classes have been reclassified against the targets (data derived from various sources, including MDBC 2007).

[a] River red gum forest in this context is interpreted to include both forest and woodland forms.

[b] Tree Health Index ranges from 0 (dead) to 5 (healthy)

[c] Current extent includes degraded river red gum forest.

[d] Large floods are needed to attract bird breeding, followed by maintenance of water in freshwater marshes and shallow red gum forest areas to ensure successful recruitment.

Current condition

The current condition of the icon site reflects long-term hydrologic conditions. River regulation has modified the natural flood cycle, substantially reducing the frequency, magnitude and duration of winter-spring floods (see Antecedent hydrological conditions). The current flood regime is insufficient to meet the water requirements of the forest ecosystem. This change, compounded by drought, has resulted in the following adverse impacts on the ecological health of the Koondrook–Perricoota Forest:

- a reduction in the frequency and size of waterbird breeding events
- a reduction in the temporarily flooded wetland and forest habitats, and a decline in the number and diversity of associated flora and fauna
- a decline in the condition of vegetation, particularly river red gum tree health and the understorey structure and composition
- reduced connectivity between the river and floodplain forest limiting access to food and habitat for aquatic fauna
- reduced opportunities for recreational activities associated with aquatic areas (e.g. canoeing)
- reduced opportunities for cultural activities associated with flooding events (GHD 2010).

There is evidence of tree mortality across large areas of the forest including large trees and areas of dense regrowth (MDBA 2008). Only isolated areas are reported to be in a relatively healthy condition.

A survey conducted across the entire forest in 2007 indicated that river red gum health had declined since the previous year, and that 19% were healthy, 59% were unhealthy and 22% were severely stressed or dead (Turner & Kathuria 2007).

According to the survey, the poorest condition areas were generally in the Koondrook Forest at higher elevations and at the downstream margins of the forest. The red river gums in **Figure 3.2** are indicative of the poor tree health detected during the survey (GHD 2010). The black box and grey box forests were generally healthier than river red gum forests.

Figure 3.2: River red gums adjacent to Barbers Creek (©MDBA)

The extended lack of adequate flooding has affected floodplain productivity and access to food and habitat by native fauna, leading to a decline in the populations of fauna species (GHD 2010). For example, large colonial waterbird breeding no longer occurs with the frequency and to extent of the past, and this is threatening the viability of existing populations and the resilience of species to additional stressors. Ecological processes required to sustain native fish populations, such as connectivity to the floodplain for breeding and recruitment, have also been hindered (Ecological Associates 2010).

No floodwaters were received in the forest between 1993 and 2010, although small volumes of environmental water were delivered directly to the Pollack Swamp refuge. The September 2010 flood event has proven to be moderate in extent, and wetlands and deep pools are expected to retain water well into autumn, which is expected to provide an opportunity for both wetland and forest vegetation to recover. However, waterbird activity has been minimal because of widespread flooding in the southern Murray–Darling Basin (providing a wide range of available habitat), and high carbon loads have severely reduced the habitat value of the floodplain for fish and other aquatic fauna. Overall, conditions remain poor and continue to decline (GHD 2010).

Climate and rainfall in the Murray–Darling Basin

Historically, the climate of the Murray–Darling Basin has been variable. Climate change science indicates a likely increase in this variability, resulting in more frequent and extreme floods and droughts (MDBA 2010). Consequently, river storages and the use of environmental water will be managed according to these varying river flows.

Between 1996 and 2010, the Murray–Darling Basin was in a drought characterised by below-average rainfall in autumn and winter and few wet periods. This drought was significantly drier than the Federation Drought (mid-1890s to early 1900s) and the droughts of the World War II era (c. 1937–45).

Beginning in spring 2010, and continuing through the summer of 2010–11, widespread, above average rainfall across the Murray–Darling Basin broke the long standing drought. This rainfall was associated with the development, beginning in 2010, of a moderate to strong La Nina event, making 2010 the wettest year on record for the Murray–Darling Basin.

Antecedent hydrological conditions

The Koondrook–Perricoota Forest is located in the Riverina bioregion, which has a warm, semi-arid climate. Summers are very hot and rainfall is consistently low throughout the year, and highly variable between years (Bureau of Meteorology 2009). The past decade has been characterised by a severe drought.

Mean daily evaporation exceeds mean monthly rainfall through the summer months. The average annual rainfall of 404 millimetres and the mean annual deficit between rainfall and evaporation of 1,075 mm mean that floodwater contributions are required to support the moisture requirements of forests and wetlands (Leslie 2001). Vegetation communities primarily depend on soil moisture derived from floodwaters, possibly with some contribution from access to groundwater from prior streams.

Climatic conditions in the catchment for the River Murray and its tributaries are of much greater importance to the Koondrook–Perricoota Forest than local rainfall because they determine the timing, extent and duration of flooding. The most important component is winter and spring rainfall in the upper catchment of the River Murray and in the Goulburn–Broken catchment, which together supply flows for wetland inundation.

The major river systems of the Murray catchment are affected by regulation. A system of dams, weirs and storages has dramatically altered the hydrology of the rivers and associated floodplains to the point where managed releases of water have assumed an increasingly greater influence on the timing and magnitude of river flows than rainfall and runoff (GHD 2010).

Altered water regimes

Regular floods of various sizes are required to maintain healthy and functioning ecological communities in the Koondrook–Perricoota Forest. Regulation of the River Murray has resulted in a reduction in the magnitude, frequency and duration of floods as shown in **Table 3.2** and **Figure 3.3**.

Larger floods that exceed 35,000 ML/d downstream of Torrumbarry Weir result in overbank flooding and widespread inundation of the forest. The frequency and duration of these flows under current regulated conditions have fallen by approximately 60% compared with natural conditions.

Smaller floods (exceeding 18,000 ML/d downstream of Torrumbarry Weir) result in the primary flow points at Swan Lagoon downstream of Torrumbarry Weir being activated. These floods have not declined as dramatically in terms of frequency (30% reduction), but the event duration has still been significantly reduced, by over 60% (GHD 2010).

The current frequency and duration of floods are insufficient to meet the water requirements of the forest ecosystem leading to a decline in vegetation condition, the diversity and abundance of flora species, frequency and size of waterbird breeding events, and connectivity across the floodplain (GHD 2010).

Table 3.2: Frequency and duration of flows: River Murray at Torrumbarry Weir*

River Murray flow threshold value (ML/day)	Average annual duration* (days) that River Murray flows exceed the threshold value			Frequency* (% of years) flow peaks above threshold daily flow rate		
	Natural	Current	Median climate change	Natural	Current	Median climate change
18,000	70	27	24	95	66	61
20,000	63	28	19	90	51	45
25,000	47	21	14	87	44	34
30,000	38	17	10	76	35	28
35,000	29	11	7	65	28	18
40,000	23	8	6	55	23	12
50,000	14	5	3	45	16	9
57,000	4	1	0	23	5	3

Source: GHD 2010

* Data is based on modelled monthly flows from MDBA—the monthly simulation model for flows between 1891 and 1990.

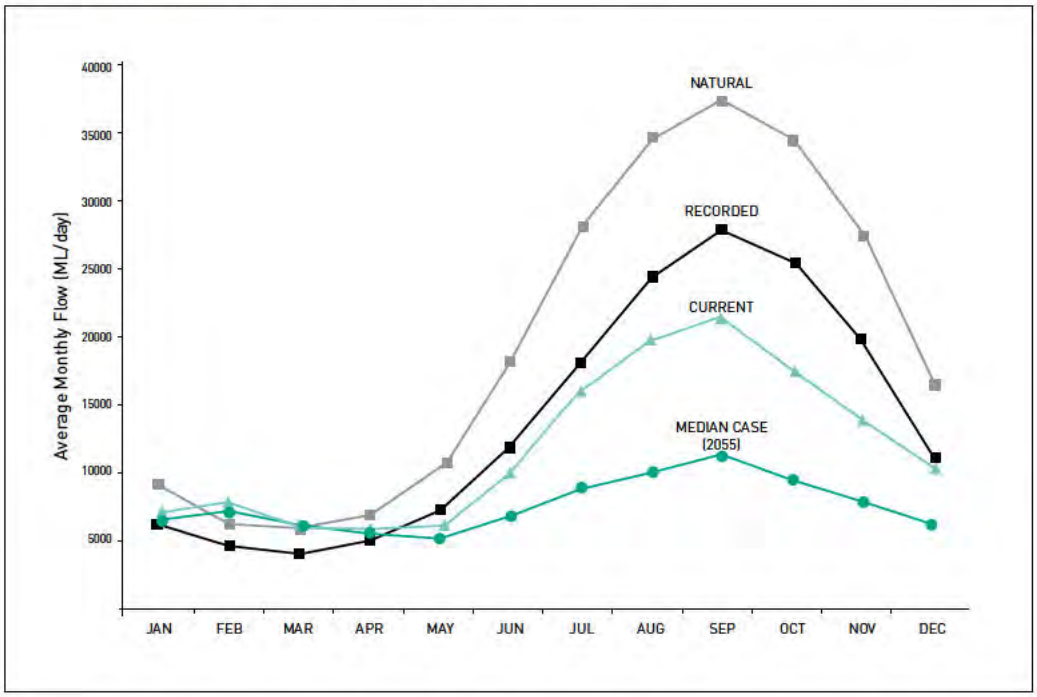

Figure 3.3: Average monthly River Murray flows downstream of Torrumbarry Weir

Source: NSW Department of Water and Energy 2008

Drought

Drought conditions further exacerbate the impacts from river regulation. Extended dry periods are a threat to the flooding regime and therefore the health of flora and fauna within the Koondrook–Perricoota Forest.

Natural inflows to the forest from River Murray floodwaters did not occur between 1993 and 2010. As a result, aquatic communities within the forest were entirely dependent on scarce rainfall, leading to a decline in vegetation condition and decrease in the diversity and abundance of flora and fauna.

Climate change

The pattern of reduced frequency and duration of natural flooding is predicted to worsen under climate change scenarios. Based on modelled data (MDBA 2010), under the 2030 median climate change scenario the frequency of 35,000 ML/d flood events with a duration of one week are expected to occur only 1.8 times every 10 years (MDBA 2010), compared to the natural frequency of six times every 10 years (see **Table 3.2**). Climate change may therefore create further disruptions to the floodplain ecosystems within the Koondrook–Perricoota Forest.

Past management actions and activities

Past management actions have achieved little in terms of recovery and restoration of the ecological condition of the Koondrook–Perricoota Forest. As early as 1948, land managers recognised a decline in the health of the forest as a result of reduced flooding. Intervention is recorded as starting in the 1970s, and a range of minor works have been undertaken to try to mitigate the decline. Desilting of the Swan Lagoon offtakes has occurred from time to time, along with removal of woody debris from this and other major flow paths. Desilting also occurred at approximately 30 minor tertiary flood runners in 1989, but this had only a marginal effect on general forest flooding because of naturally high commence-to-flow rates. Further flood-runner maintenance has similarly had only minimal benefits (Wyatt 1992).

4. Water delivery

Prioritising water requirements

The Living Murray (TLM) Annual Environmental Watering Plan was developed by the Environmental Watering Group. The plan includes a flexible decision framework to guide prioritisation of environmental watering actions, as well as icon site environmental watering proposals, water availability forecasts and management objectives for water resource scenarios (see **Table 4.1**).

Throughout the year the Environmental Watering Group recommends environmental watering actions to the Murray–Darling Basin Authority (MDBA) for approval. These recommendations are based on the Annual Environmental Watering Plan and the volume of water available in TLM's environmental water portfolio.

Priority areas for watering within the Koondrook–Perricoota icon site are based on the degree of threat (deficit in water regime) and conservation value (importance to ecological objectives) associated with each area.

In conjunction with the available water for environmental delivery (and consideration of factors discussed in this chapter under 'Operating regimes for environmental watering actions'), these ecological priorities are used to identify annual priorities for watering and the volumes of water required. An overview of priority areas for watering under different water availability scenarios is provided in **Table 4.1**; however, this does not take into consideration matters such as efficiency of water delivery or building on previous watering investments.

Table 4.1: Vegetation class priorities: Koondrook–Perricoota Forest

Vegetation class	Relevant First Step Decision objectives					Ecological priority for watering
	Maintain and restore a mosaic of healthy floodplain communities	River red gum forest	Floods of sufficient duration and frequency will contribute to this objective		Floods of sufficient duration and frequency will contribute to this objective	
Wetlands (deep freshwater marshes, shallow freshwater marshes)	Frequent flooding of wetlands will contribute to this objective.	Frequent flooding of wetlands will contribute to this objective.		Healthy wetlands flooded for sufficient duration will contribute to this objective.	Deep freshwater marshes retaining floodwaters will support this objective.	Very high
River red gum woodland	Floods of sufficient duration and frequency will contribute to this objective.		Floods of sufficient duration and frequency will contribute to this objective.			Moderate
Black box woodland	Infrequent flooding of short duration may contribute to this objective.					Low
Grey box woodland	Infrequent flooding of short duration may contribute to this objective.					Low

The Living Murray works and water modelling

Modelling completed in 2008 found that the environmental water requirements of the floodplain icon sites (with the exception of Barmah–Millewa and the Lower Lakes, Coorong and Murray Mouth and River Murray Channel icon sites) could largely be met by a combination of the proposed TLM works, the 500 GL of recovered TLM water and 70 GL long-term Cap equivalent (LTCE) of River Murray Increased Flows.

This modelling was based on a number of assumptions including the use of unregulated flow events for environmental watering actions. It was also agreed as a modelling principle that return flows could be used to water at multiple environmental sites. There are a number of constraints to the implementation of this principle which TLM are currently working to resolve.

Further modelling is also planned to allow greater optimisation of works and measures to achieve icon site ecological objectives as we gain a greater understanding of operating

Operating regimes for environmental watering actions

This section of the environmental water management plan provides a broad description of the proposed operating regimes to maximise ecological outcomes from the use of The Living Murray Water portfolio and works. To meet the proposed operating regimes a combination of unregulated and regulated environmental water may be used. While this Plan focuses on the use of environmental water from The Living Murray's Water Portfolio, there may also be other sources of environmental water available to meet the proposed regimes.

Water delivery

Water will be delivered to the Koondrook–Perricoota icon site via a number of mechanisms. The primary method will use the Flood Enhancement Works project (see below) to deliver a range of flows at varying frequencies to meet The Living Murray First Step Decision and refined objectives. In addition, water will continue to be delivered to Pollack Swamp via private irrigation infrastructure, or by pumping from Barber Creek. Approvals have also been secured to allow pumping from the River Murray directly into lagoons alongside the river that will not benefit from the works.

Flood Enhancement Works project

The Koondrook–Perricoota Flood Enhancement Works project was established in 2003 to achieve The Living Murray First Step Decision objectives.

The works involve constructing a channel to allow flows of up to 6,000 ML/d to be diverted from the Torrumbarry Weir pool on the River Murray to the forest's internal network of flood runners. Floodwater can then flow through the icon site, using the forest's unique series of waterways to target inundation towards the natural distribution of vegetation communities.

Outflows can be managed by a levee bank at the downstream end and regulators on outflow points. Floodwater can also exit the forest directly to the River Murray through a return channel. The key infrastructure works associated with the project are shown below, along with their function (**Figure 4.1**) (GHD 2010).

Figure 4.1: Schematic representation of the proposed structures: Koondrook–Perricoota Flood Enhancement Works project

The works are capable of inundating up to 17,800 ha (approximately 50% of the forest), with approximately 16,000 ha capable of being inundated for about 100 days. The most extensively flooded vegetation classes are river red gum forest and wetlands, as shown in **Table 4.2**.

Table 4.2: Vegetation classes inundated through the Flood Enhancement Works project

Vegetation class	Inflow of 6,000 ML/day	
	Hectares	Vegetation class (percentage)
Wetlands (deep freshwater marshes, shallow freshwater marshes)	1,217	75
River red gum forest	12,240	62
River red gum woodland	3,589	51
Black box woodland	1,549	50
Grey box woodland	189	20

Source: Adapted from GHD 2010.
Note: the wetlands and river red gum forest areas intersect.

Operating regime

The operating regime for the site will use all available methods of water delivery to maximise achievement of ecological objectives under the full range of water availability scenarios.

Pumping into discrete wetlands will continue to occur to maintain valuable refuges during periods of low water availability. However, the Flood Enhancement Works will be the primary means to achieve the ecological objectives for the site, especially during medium-to-wet water availability periods. Different event designs will target different environmental outcomes. For example, short duration events will aim to maintain vegetation, while longer duration events will be used to encourage successful bird-breeding.

Modelling suggests that the majority of flood events will be hybrid events—combinations of unregulated flows that may occur in the River Murray system, supplemented with regulated managed inflows. As a result, the operating plan (in prep.—to be appended) will not prescribe particular flood events, but will provide a basis for responsive operational decision-making. The preliminary operating plan is attached as schedule 1.

Operation of the works can generally occur in three possible ways, but in many cases, a combination of these elements over a continuous period of time will constitute the watering event.

- Flow events <18,000 ML/d downstream of Torrumbarry Weir; water can be delivered to the forest via the constructed inlet channel.
- Flow events >18,000 ML/d downstream of Torrumbarry Weir; water can enter the forest through natural effluents, potentially supplemented with water delivered through the inlet channel.
- For larger flow events when substantial flows enter the forest via overbank flow, the project's infrastructure will be set to minimise interference with unregulated flow paths.

The project has a high degree of operational flexibility to deal with the uncertainty around future river flows and the volume of available environmental water. The decision to initiate and continue environmental watering will be based on consideration of water availability, water requirements, watering principles, risk management strategies, and the landscape and local context (Forests NSW 2009).

The high degree of operational flexibility in the works means it is not possible to describe all possible operating scenarios. An example of an operating scenario for an entirely managed flood event, involving the maximum possible inflows of 6,000 ML/d via the inlet channel and maintaining the flood extent at its maximum for a given period, is described below. Such an event would occur approximately every 3 to 4 years, depending on the water requirements and unregulated inflows.

The phases of this fully managed operating scenario include (Forests NSW 2009):

- Phase 1—commence diversion (days 1–5): open the inlet regulator over a period of five days until it is fully open to achieve 6,000 ML/d diversion. Swan Lagoon regulators and the five outflow point regulators are closed.
- Phase 2—rising flood (days 6–45): inlet regulator diverts 6,000 ML/d for 45 days until the maximum inundation (17,800 ha) is reached (i.e. design level for levees is reached).
- Phase 3—steady flood (days 46–100): gates on the inlet regulator are raised to reduce the flow to 3,400 ML/d (to maintain the maximum inundation) for 55 days. The regulator on the return channel is open to allow an outflow of 1,800 ML/d or higher. Barber Creek regulator is opened so that 250 ML/d can exit the forest at the downstream end.
- Phase 4—commence recession (days 101–10): close the inlet regulator for a period (e.g. approximately two weeks) and during this time open and close it (as required) to allow flows to ramp up and down and provide a cue for fish to exit the forest. Gradually open Barber Creek regulator further to maintain 250 ML/d flow exiting the forest.
- Phase 5—flood recession (days 111–220): continue opening the outflow point regulators to empty the flood pool, which could take up to 130 days. Opening the regulators will initially be slow but will increase as the flood level drops.

The modelled extent and depth of inundation arising from the example is shown in **Figure 4.2**.

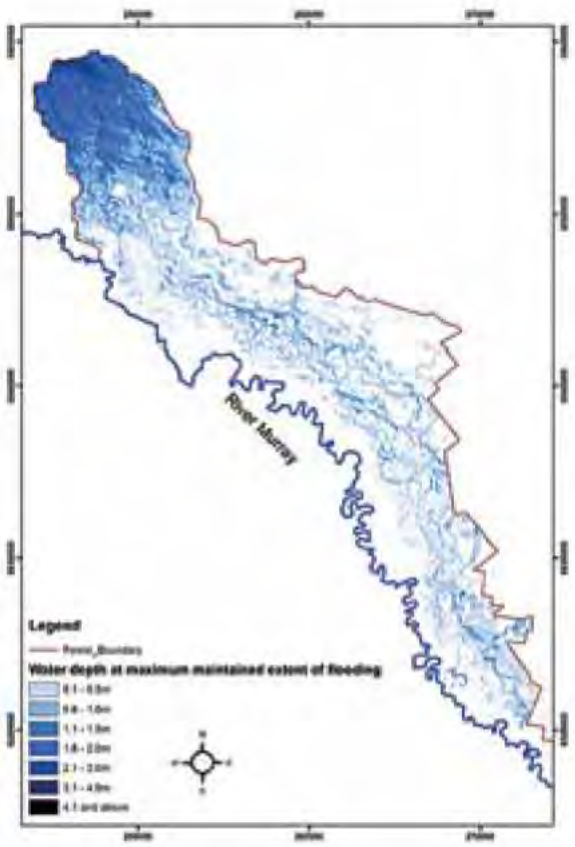

Figure 4.2: Inundation extent and water depth for a fully managed operating scenario

The past operation of the works from 1990 to 2005 has been graphed to demonstrate the various ways in which the scheme might operate over a 15-year-period. Operation was determined using the watering principles outlined in the preliminary operating plan (attached as schedule 1), and consideration of the water available from The Living Murray account and modelled natural inflows. See **Figure 4.3** below.

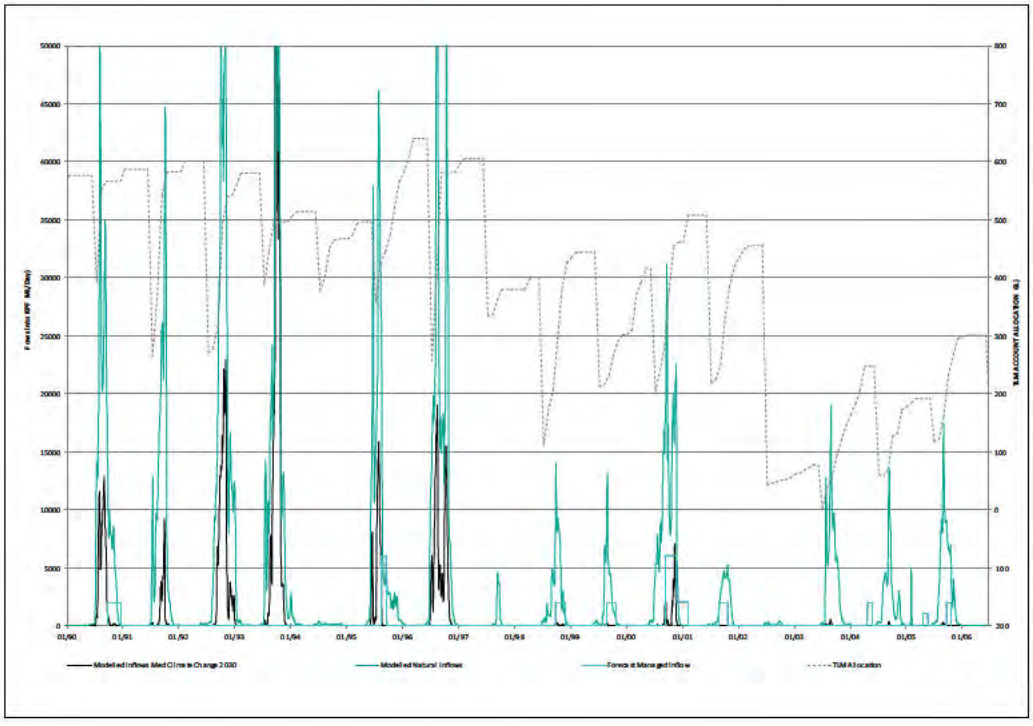

Figure 4.3 Predicted operation of the works, 1990 to 2005

Figure 4.3 demonstrates the variety of events that can be generated by the works, the likely interaction between unregulated and regulated inflows and the influence of The Living Murray account on decision-making. The contribution of varying operating regimes to the achievement of the ecological objectives is detailed further in **Table 4.3**.

Table 4.3: Operating regime's contribution to the ecological objectives

First Step Decision objective	Vegetation community Area inundated * (ha)	Works or other mechanisms to assist meeting objectives	Frequency (Number of years in 10)	Duration (Days)	Water availability scenario	Estimated volume of water required* (GL)	Estimated volume of water used* (GL)
Preferred operating scenario: Maintain and restore a mosaic of healthy floodplain communities							
80% of permanent and semipermanent wetlands in healthy condition	Wetlands, lagoon and flood runners = 1,400 ha	Unregulated flows, supplemented with pumping (lagoons and Pollack Swamp) and/ or Flood Enhancement Works project	6–9 years in 10	2–8 months. Inflows period will vary.	Dry, medium or wet	For example, regulated flows to wetlands via works 2,000 ML/d for 60 days: 120 GL	Minimal returns: 120 GL
30% of river red gum forest in healthy condition	River red gum forest = <13,000 ha (with regulated flow)	Unregulated flows, supplemented by Flood Enhancement Works project	3–9 years in 10	3 months+. Inflow periods will vary.	Medium to wet	For example, fully regulated event, max. inflows for 100 days: 465 GL	Approx. 265 GL
Successful breeding of thousands of colonial waterbirds in at least three years in 10	River red gum forest and wetlands = ~4,000 ha (with regulated flow)	Unregulated flows, supplemented by Flood Enhancement Works project	4–9 years in 10	5–8 months. Inflow periods will vary.	Medium to wet	For example, extend unregulated inflows 2,000ML/d for 90 days: 180 GL	Minimal returns
Healthy populations of resident native fish in wetlands	River red gum forest and wetlands = <10,000 ha (with regulated flow)	Unregulated flows, supplemented by Flood Enhancement Works roject	6–9 years in 10	4 months + (spawning). Permanent pools 12 months. Inflow periods will vary.	Medium to wet	For example, extend unregulated inflows 2,000ML/d for 90 days: 180 GL	Minimal returns
Minimum operating scenario: Maintain and restore a mosaic of healthy floodplain communities							
80% of permanent and semipermanent wetlands in healthy condition	Lagoons and Pollack Swamp = 10–150 ha	Pumping, with or without private irrigation infrastructure	7–8 years in 10	2–5 months. Inflow period = 1 month	Dry, extreme dry	For example, pumping into Pollack Swamp: 900 ML	Nil returns: 900 ML
	Wetlands and flood runners = ~1,000 ha	Flood Enhancement Works project	7–8 years in 10	2–5 months. Inflow period = 1–2 months	Dry	For example, regulated flow to wetlands 1,000 ML/d for 60 days: 60 GL	Minimal returns: 60 GL
30% of river red gum forest in healthy condition	River red gum forest = 2,000–10,000 ha	Flood Enhancement Works project	2–4 years in 10	2–3 months. Inflow period = 1–3 months	Dry	For example, regulated pulse 4,000 ML/d for 1 month: 120 GL	Minimal returns: 120 GL
Successful breeding of thousands of colonial waterbirds in at least three years in 10	Wetlands (maintain habitat only) = ~1,000 ha	Flood Enhancement Works project	7–8 years in 10	2–5 months. Inflow period = 1–2 months.	Dry	For example, regulated flow to wetlands 1,000 ML/d for 60 days: 60 GL	Minimal returns: 60 GL
Healthy populations of resident native fish in wetlands	Permanent pools (+flood runners to deliver water) = ~1,000 ha	Flood Enhancement Works project	7–8 years in 10	12 months. Inflow period =1–2 months.	Dry	For example, regulated flow to wetlands 1,000 ML/d for 60 days: 60 GL	Minimal returns: 60 GL

* Areas and volumes are estimates based on modelled outcomes. For the purposes of the table, each objective has been considered in isolation. The entire area stated may not be inundated for the full duration estimate.

Water accounting and measurement

Water accounting methodology will be developed and agreed in advance by The Living Murray Committee and Basin Officials Committee. Consistency of water accounting methodology will be sought wherever possible. Where relevant, water accounting will be consistent with the Water Accounting Conceptual Framework and the Australian Water Accounting Standards.

The best available, most appropriate and cost-effective measurement technique will be used to determine environmental water use. The appropriateness of the measurement technique is likely to differ from icon site and event. For example, under dry conditions, environmental water pumped into Hattah Lakes is likely to be measured using a meter while return flows will be measured via a gauging station. Under wet conditions, environmental water returning from Barmah–Millewa Forest will need to be modelled.

Specific water measurement arrangements for Koondrook–Perricoota will be developed as part of the monitoring plan and will be attached as a schedule. Water accounting will be as per the methodology agreed between New South Wales and the Murray–Darling Basin Authority.

Evaluation and management of potential risks

To maximise project outcomes, it is essential to identify any risks so that mitigation actions can be adopted. Under New South Wales planning legislation, all major developments undergo a comprehensive environmental risk assessment and must prove that these can be mitigated to the satisfaction of regulatory agencies before development consent is granted. An environmental assessment has been prepared and approved for both construction and operation of the Flood Enhancement Works project, subject to implementation of the proposed mitigation actions.

Generating and releasing hypoxic blackwater during events is one of the greatest risks arising from water management at the site. Mitigation and management of blackwater is therefore a focus of operational planning. Mitigation measures will be detailed in the operating plan. The key risks associated with the operation of the works are summarised in **Table 4.4**.

The environmental assessment and the operating plan have additional information and will be attached as a schedule to this report once complete. Risks associated with construction of the works have also been assessed in the environmental assessment under the *Environmental Planning and Assessment Act 1979* (NSW).

Table 4.4: Summary of key risks identified in the environmental risk analysis

Aspects	Summary of potential adverse impacts	Overall likelihood	Overall consequence	Risk rating	Proposed mitigation	Residual risk rating
Water quality	Blackwater event leads to fish kills in the Forest or downstream waterways	Medium	High	High	Able to be mitigated by targeting watering events to cooler months, and discharging blackwater to the River Murray where it would be diluted.	Medium
Hydrology	The project would result in significant adverse impacts on the hydrology of the River Murray, the Koondrook –Perricoota Forest, or Barbers Creek, leading to impacts on adjacent land use.	Low	High	Medium	Project to be operated in accordance with adaptive management principles to minimise adverse hydrological effects.	Medium
Terrestrial ecology	Removal of areas of inland grey box woodland (an endangered ecological community) that would not benefit from an enhanced flood regime	High	High	High	Impacts on this community offset by the offset strategy.	Low
Aquatic ecology	The project creates barriers to fish passage	Medium	Medium	Medium	Structures designed to enable fish passage. Barbers Creek regulator able to be retrofitted with a fishway if required.	Low
Groundwater	Transfer of solutes and highly saline soils as a result of acid sulfate soils or potentially acid sulfate soil run-off.	Medium	Medium	Medium	Groundwater to be monitored during watering events and the results used to adaptively manage subsequent events.	Low
Spoil and waste management	Vegetation would be removed and disposed of to enable construction.	High	Low	Medium	Where practicable, timber would be recovered and sold commercially to make best use of this construction by-product.	Low
Soil	Significant adverse impacts due to erosion in the vicinity of the structures and downstream areas due to the project	Low	High	Medium	Installation of measures to limit the potential for significant erosion.	Medium

5. Environmental monitoring

Different monitoring methods are used to assess progress toward the icon site ecological objectives. These include River Murray system-scale, icon site condition and intervention monitoring. The Living Murray Outcomes Evaluation Framework (MDBC 2007) outlines the rationale for these monitoring methods, which are summarised below.

River Murray system-scale monitoring

Conducted annually, River Murray system-scale monitoring and evaluation focuses on the system's ecological health, measuring improvements relating to fish, waterbirds and vegetation.

Icon site condition monitoring

Condition monitoring assesses each icon site's condition in relation to its ecological objectives. Condition monitoring is typically conducted on a medium-frequency basis (months to years), depending on the rate of change. Condition monitoring includes standard methodologies for monitoring fish, birds and vegetation, as well as icon site-specific methods for monitoring other ecological objectives. These monitoring activities have been classified into three categories—A, B and O:

- 'A' category monitoring activities are undertaken at all icon sites using agreed standardised methodologies:
  - fish condition monitoring using the MDBA Sustainable Rivers Audit methodology
  - waterbird condition monitoring using a standard on-ground method to link with the annual aerial waterbird survey
  - tree condition monitoring for river red gum and black box using on-ground assessments linked to remote-sensing data.
- 'B' category contains icon site-specific monitoring using locally appropriate methods. This monitoring responds to unique icon site characteristics and is less easily standardised.
- 'O' category uses icon site monitoring related to objectives and is less easily linked to TLM ecological objectives.

A whole-of-icon site condition monitoring program has been established for the Gunbower–Koondrook–Perricoota Forest (see **Schedule 2**). **Table 5.1** summarises the program.

Table 5.1: Monitoring program: Gunbower–Koondrook–Perricoota icon site

Part A—The Living Murray methodologies	
Birds	Event-based ground waterbird surveys
	Quarterly waterbird assessment
	Annual waterbird aerial assessment
	Annual waterbird ground-truthing assessment of aerial results
Fish	Annual fish surveys in Gunbower Creek and the River Murray
Vegetation	Stand condition monitoring
	Tree condition assessment
Part B—Icon site methodologies	
Birds	Quarterly bush bird assessments undertaken every 2–3 years.
Vegetation	Sentinel wetland and understorey surveys.
Part O—Other methodologies	
Groundwater	Groundwater monitoring

The fully implemented icon site monitoring program will provide sufficient information about the long-term response of birds, fish and wetland/floodplain vegetation to water management, and document progress towards achievement of the ecological objectives at the Koondrook–Perricoota Forest.

Intervention monitoring

The complexity of ecological system processes make the results of any management intervention difficult to predict. Therefore, intervention monitoring is a key component of The Living Murray environmental monitoring program. The aim of intervention monitoring is to improve understanding about the causal links between TLM environmental watering and other management actions, and ecological responses at icon sites. This knowledge enables TLM to continually adapt and improve management of icon sites and watering into the future to optimise ecological outcomes.

As TLM works are completed, measuring the volume of water used at icon sites (including timing, volume and quality of any return flows) is essential to account for, and report on, how TLM environmental water is used and managed. This area of monitoring was previously included in the compliance monitoring category in the Outcomes and Evaluation Framework, but is now encompassed within intervention monitoring. This change is to ensure clear linkages between the various information requirements for managing successful watering events and informing the operation of works at icon sites. This includes systems for water measurement and accounting and monitoring risks (previously defined in compliance monitoring) and assessing ecological outcomes resulting from specific watering events or other management actions.

Monitoring for operations informs decision-making on a day-to-day basis and into the longer term, to ensure that the created event meets the event design. Operational monitoring will focus on hydrological parameters such as outflows, flood extent and water depth at specific locations.

Monitoring for risk management

Monitoring of identified risks informs adaptive risk management and assists in avoiding negative outcomes. Risk management monitoring is also fundamental for compliance with legislative and works approval requirements.

It is envisaged that greater scientific rigor and real-time monitoring of a range of parameters to identify and manage risks will be necessary during the first few watering events delivered through the Flood Enhancement Works project. Examples include monitoring of water quality (blackwater) and grey box health during extended periods of inundation. Monitoring data will also assist in managing other key risks such as dispersal of non-native fish into the Koondrook–Perricoota Forest and abandoning of waterbird nests.

The information gathered through monitoring is considered within the adaptive management process (discussed in chapter 8).

6. Community consultation and communication

Providing opportunities for the community to receive information and contribute to water management is a key part of icon site management. The need for consistent information and the development of key messages is outlined in the New South Wales, The Living Murray (TLM) Communication and Community Consultation Plan 2010–11 (for Millewa and Koondrook–Perricoota Forests), attached as schedule 4. This is reinforced, and the relevant responsibilities identified, within the Flood Enhancement Works Construction Consultation Plan (June 2010), which identifies specific tools to be used to facilitate the engagement process as well as drawing on the existing Gunbower–Koondrook–Perricoota Community Reference Group committee which represents the overall icon site.

The provision of opportunities for feedback and input by the community is critical to gain community support. Displays at public events, community information sessions, the establishment of a project information centre and the establishment of specific interest groups such as the Joint Indigenous Group and Community Operational and Planning Advisory Committee help provide this opportunity.

The Community Operational and Planning Advisory Committee has been established as a reference advisory group to provide local experience and advice into the planning and operation of events generated by the works. The group includes representatives from key community groups such as the Wakool Landholders Association. Following completion of the inaugural operation of the works, the group's role will be revised, with a view to establishing suitable consultation arrangements for ongoing water management at the icon site.

The Joint Indigenous Group represents local Indigenous communities; it was established to provide the works project team with advice and recommendations to ensure that the aspirations, interests and contributions of local Indigenous people are recognised and considered in the development of the Koondrook–Perricoota Flood Enhancement project. The Joint Indigenous Group consists of two representatives from each of the Traditional Owner-groups in the area (the people of the Barapa Barapa and Yorta Yorta nations), along with representatives from the Moama and Deniliquin Local Aboriginal land councils (see **chapter 7** for more detail).

The Gunbower–Koondrook–Perricoota Community Reference Group was established in 2006 as a requirement of The Living Murray Business Plan. The Community Reference Group provides a mechanism to seek advice and a community perspective on the communication and engagement activities proposed at the icon site. The Community Reference Group will continue to be engaged as an advisory body for the implementation of communication tools and actions. Membership of the group alternates between the North Central and the Murray Catchment Management Authority boards on an annual basis. The Community Reference Group includes a chair and six representatives from the local community (MDBC 2006).

An icon site communication plan will identify stakeholders common across the Gunbower–Koondrook—Perricoota icon site as well as those specific to individual projects underway in Gunbower and Koondrook–Perricoota. The plan will identify and promote TLM messages and targets identified as Gunbower–Koondrook—Perricoota icon site-specific. Local project-specific plans such as the Flood Enhancement Works Construction Consultation Plan (June 2010), the Community and Stakeholder Involvement Plan and the constructing contractor's own community engagement plan will address local community engagement and awareness during the construction phase.

Engagement and/or consultation tools used for the icon site include:

- development of the Community Operational and Planning Advisory Committee to contribute local experience and advice
- development of the Joint Indigenous Group to ensure Indigenous Australians' awareness and involvement
- landowner workshops to discuss issues and interests in water management
- community and shire newsletters, newspaper articles and fact sheets
- presentations to community groups and local shire councils
- community information sessions
- a project information centre, a prominent shop-front that operates two days a week in Barham
- works project-specific website and DVD

- displays at local events and agricultural shows
  - a hotline telephone number, email facility and contact database to manage stakeholder issues and communications
  - appropriate signage at forest entrances.

Stakeholders and the community will continue to be engaged in a timely manner as water management progresses from construction of works through to water delivery. This will be documented in the Community and Stakeholder Involvement Plan.

Agency consultation

A number of agency stakeholders share responsibility for the successful delivery of the Flood Enhancement Works project, including responsibilities in ongoing water management. Each project partner has a distinct role to play during the planning, design, construction and/or operational phase of the project:

- Forests NSW is the Koondrook–Perricoota icon site TLM manager; it is responsible for the effective operation of the works to achieve the First Step Decision ecological objectives.
- State Water Corporation is a rural bulk-water delivery corporation responsible for the detailed design and construction of the project. Following commissioning of the scheme, the State Water Corporation will also be responsible for the delivery of water and the operation and maintenance of the water delivery structures.
- The Murray–Darling Basin Authority is responsible for planning the integrated management of the water resources of the Murray–Darling Basin; the MDBA coordinates funding and project direction for this initiative.
- The NSW Office of Water within the Office of Environment and Heritage is responsible for the delivery of the works program; it also ensures that water being used by the works is consistent with New South Wales legislation and policy.
- Department of Primary Industries (Fisheries)—NSW Fisheries provides technical advice and expertise for the design of works and the planning and management of TLM watering events.
- The Murray Catchment Management Authority provides technical and financial support to land managers and communities across the Murray catchment to balance natural resource protection with food and fibre production.
- The NSW Office of Environment and Heritage manages natural resources and regulates activities to protect the environment. The department also researches improvements to decision-making and is responsible for environmental water management.

The governance arrangements (detailed in chapter 1) provide an effective mechanism for consultation and communication with these agencies, through committee meetings and workshops.

7. Indigenous engagement

Indigenous people have many social, cultural, customary and economic interests in the water resources of the River Murray.

The Living Murray aims to maximise ecological outcomes through the delivery of environmental water and therefore cannot provide for the commercial economic interests of any of its stakeholders. However, TLM is committed to taking into account Indigenous values and objectives in its environmental water planning and management. As Indigenous communities identify objectives and strategies for achieving these Indigenous objectives they will be incorporated into Environmental Water Management Plans in the future. Indigenous consultation will be reported on in the Annual TLM Environmental Watering Report and Annual TLM Implementation Report.

Indigenous engagement is an important component of the Flood Enhancement Works Project and is required under legislation and policy arrangements—for example, the *Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (NSW Department of Environment and Climate Change 2009).

Indigenous groups with an interest in the Koondrook—Perricoota Forest include the Murray Lower Darling Rivers Indigenous Nations; the Barapa Barapa, Yorta Yorta and Wamba Wamba nations; the Deniliquin and Moama Aboriginal lands council; Murray Aboriginal Advisory Group; and the Yarkuwa Indigenous Knowledge Centre Aboriginal Corporation (GHD 2010).

The icon site manager has appointed a facilitator to assist in communicating with the Indigenous community and encouraging its input to water management.

To ensure that members of the local Indigenous community have the opportunity to input into water management and a chance to raise and identify their cultural and spiritual links to the forest, a Joint Indigenous Group has been established (see **chapter 1** for further information).

By having regular meetings, the Joint Indigenous Group is assisting to develop processes and protocols for Indigenous engagement and involvement in the construction phase of the works project. The Joint Indigenous Group works directly with agency stakeholders to achieve the best possible outcomes for both the local Indigenous community and the project.

Achievements of the Joint Indigenous Group include the development of the Cultural Heritage Management Plan, the selection and training of the cultural heritage monitoring team and the provision of cultural heritage awareness training for the project team.

Local Indigenous groups attend presentations and other engagement events to learn about water management in the forest and to share their own cultural understanding of the forest. Representatives from the Barapa Barapa and Yorta Yorta nations participated in fieldwork as part of the environmental assessment and construction phase (GHD 2010).

The Joint Indigenous Group's terms of reference are currently being extended to include the operational planning phase of the works project. Following review of this arrangement, a suitable consultation mechanism will be developed for the ongoing operational phase and broader icon site management.

8. Adaptive management and reporting

An adaptive approach is critical in managing water-dependent ecosystems because it enables land managers and policy-makers to update strategies based on the outcomes of research and watering actions. This is known as 'learning by doing', and involves designing, implementing, monitoring, reporting and evaluating the work that has been undertaken.

Environmental water management plans are constantly refined by adaptive management, which incorporates outcomes from environmental delivery, ecological monitoring, works, modelling and community consultation.

The Living Murray (TLM) Annual Environmental Watering Plan is developed at the beginning of each watering season and complements the environmental water management plan. As the season progresses, the annual water planning process responds to water availability, opportunities and environmental priorities. A flexible decision-making framework is included in the annual plan so the Environmental Watering Group can assess water priorities throughout the year according to water resource condition.

To highlight and analyse previous activities and outcomes, the Murray–Darling Basin Authority (MDBA) works with icon site managers to produce an annual TLM implementation report (as required under clause 199 of The Living Murray Business Plan), which is used by the Independent Audit Group. An annual external audit is conducted to ensure TLM is implemented at an appropriate level of transparency and accountability, and to promote public confidence in the program's efforts and outcomes. The implementation report and external audit are presented to the Murray–Darling Basin Ministerial Council.

To capture key learning and changing icon site management practices, schedules appended to the environmental watering management plan are updated as required.

The process for adaptive management of water at the icon site will be detailed in the operating plan. The primary mechanism will be the event-based monitoring program (in prep.—to be attached as schedule 3), which will target monitoring so that event design can be informed by real-time outcomes during events and the hypotheses underpinning event design can be improved on an event-to-event basis.

All environmental water delivery in the Koondrook–Perricoota Forest will be managed adaptively in line with the following process (see **Figure 8.1**).

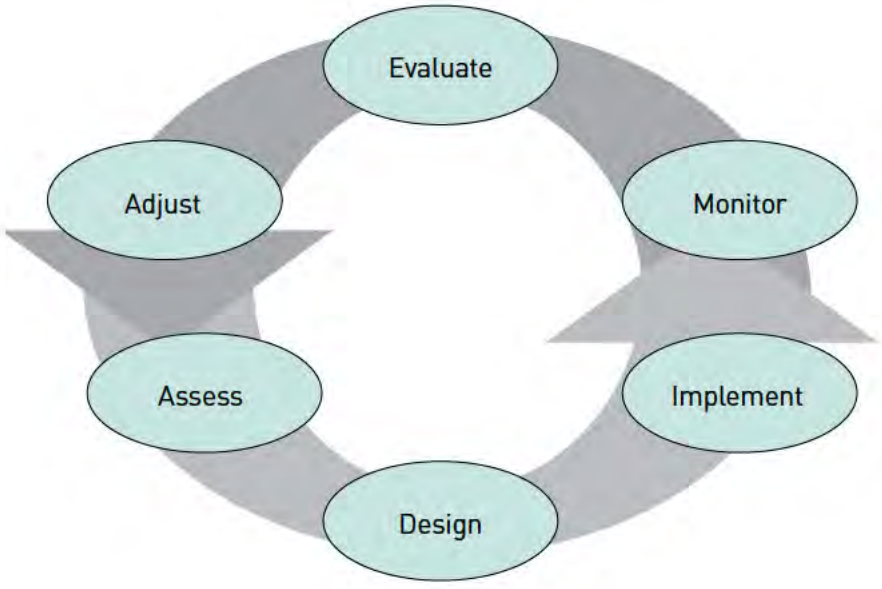

Figure 8.1: Adaptive management cycle

Assess

The ecological issues, objectives, water requirement, priority areas and actions, and associated risks for restoring the floodplain are assessed. This stage requires stakeholder and expert input.

Design

Knowledge on floodplain condition and ecology are used to develop hypotheses in terms of expected responses and set objectives and targets. Interventions are designed, including the proposed package of works and operating rules.

Implementation

The recommended interventions are implemented.

Monitoring

The monitoring program will be coordinated by Forests NSW and delivered as for the event-based monitoring plan (in prep.—to be attached as schedule 3).

Evaluation

The monitoring results will be evaluated in light of the expected ecological and hydrological outcomes. Triggers will be identified to inform whether and how management needs to adjust (e.g. the size of flood event will be adapted depending on water availability). Both short- and long-term triggers will be used; short-term triggers include water movement into or out of structures, and whether specific biota (flora and fauna) begin to appear; and longer-term triggers include more detailed targets for ecological response.

Adjust

The icon site manager and agency stakeholders (the operating committee) will consider the monitoring outcomes and any relevant new knowledge to determine whether changes are required to the operating strategy and to redefine the expected outcomes from the operation.

Assess

Proposed changes will be assessed by the stakeholders to consider if such changes meet their expectations. Additional information provided through this step will be reviewed and considered.

Design

The program then moves back to the design stage where agreed changes are incorporated into the event design (both the current event and future events).

Appendix A: New South Wales legislation applicable to the Koondrook–Perricoota Forest

Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (NSW) forms the statutory framework for planning approval and environmental assessment in that state. The Minister for Planning is responsible for the overall implementation of the Act, which imposes the following requirements for planning approval:

- control of 'major projects'—approval from the Minister for Planning
- control of 'local development'—development consent from the relevant local council
- control of 'activities'—those that do not require approval or development consent through the above.

The need for consent is outlined in environmental planning instruments (State environmental planning policies and local environmental plans) and regulations (e.g. development control plans) under the Environmental Planning and Assessment Act.

Environmental planning instruments relevant to the management of the icon site include:

- State Environmental Planning Policy (Infrastructure) 2007
- Murray Regional Environmental Plan Number 2.
- Local Environmental Plans—Murray Local Environmental Plan 1989 and Wakool Local Environmental Plan 1992 (GHD 2010).

Fisheries Management Act 1994

The *Fisheries Management Act 1994* aims to conserve, develop and share the fishery resources of New South Wales for the benefit of present and future generations. It is administered primarily by the Minister for Primary Industries. The Act is relevant to the construction of a regulator, consideration of fish passage requirements and the notification of dredging and reclamation in a 'waterland' (GHD 2010).

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* regulates noise, air, land and water pollution across New South Wales. Construction activities associated with the project are managed in line with the Act's requirements (GHD 2010).

Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* provides legal status for biota of conservation significance in New South Wales. The Act aims to conserve biological diversity and promote ecologically sustainable development. The effects of development works on threatened species, populations or ecological communities and their habitats listed in the Threatened Species Conservation Act have to be assessed through the Environmental Planning and Assessment Act process (GHD 2010).

National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* protects and manages Indigenous sites and objects in New South Wales. Because the works project is approved under the Environmental Planning and Assessment Act and the environmental assessment includes investigation into the effects on Indigenous archaeological sites, no permits are required under the National Parks and Wildlife Act (GHD 2010).

Water Management Act 2000

The *Water Management Act 2000* protects water resources across New South Wales from adverse impacts. Approvals associated with water use and works on waterways were not required for the works because the environmental assessment and Environmental Planning and Assessment Act process addresses water-related impacts (GHD 2010).

Heritage Act 1977

The *Heritage Act 1977* identifies and protects heritage items; it is administered by the NSW Heritage Council and NSW Heritage Office. Any development that would affect an item listed on the State Heritage Register requires approval. No sites listed on this register were identified in near the proposed works (GHD 2010).

Forestry Act 1916

The *Forestry Act 1916* outlines the powers and duties of Forests NSW (part of Department of Primary Industries). The project is consistent with the Act's goal of maintaining forest health (GHD 2010).

Crown Land Act 1989

The *Crown Land Act 1989* relates to activities being undertaken on Crown land. The project will involve works on creek beds (Crown land) and hence required approval through the New South Wales Department of Lands (GHD 2010).

Native Vegetation Act 2003

The *Native Vegetation Act 2003* regulates the clearing of native vegetation on all land in New South Wales except for land within national parks and other conservation areas, state forests and reserves and urban areas. The Native Vegetation Act does not apply to the construction project (GHD 2010).

Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* provides for the declaration of noxious weeds by the New South Wales Minister for Primary Industries. All private landowners, occupiers, public authorities and councils are required to control noxious weeds on their lands in accordance with the Act (GHD 2010).

Schedules

The following schedules can be viewed at ←www.mdba.gov.au/programs/tlm/icon_sites/emp.→

Schedule 1: Preliminary operating plan

Schedule 2: Condition monitoring plan

Schedule 3: Event-based monitoring plan

Schedule 4: New South Wales communications plan

List of figures and tables

Figures

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Abbreviations and acronyms

EWG	environmental watering group
GL	gigalitres
MDBA	Murray–Darling Basin Authority
ML/d	megalitres per day
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
TLM	The Living Murray

Glossary

Basin Officials Committee	A jurisdictional committee to coordinate the management of Basin water resources between the Australian Government, the Murray–Darling Basin Authority and the Basin states.
Ecological objective	An objective is a statement of the desired condition; it is not necessary to quantify an objective.
Ecological targets	A target is generated from the ecological objective and will ideally be quantitative.
Environmental water	Water available for the environment.
Environmental Watering Group	A jurisdictional committee that develops and implements the annual TLM Environmental Watering Plan. The Environmental Watering Group recommends annual TLM watering priorities and proposals to ensure consistency between icon sites.
Ephemeral	Short-lived, lasting for only a short period of time and leaving no permanent trace.
Flood Enhancement Works project	Works funded through The Living Murray program to allow flows of up to 6,000 ML/d to be diverted and controlled from Torrumbarry Weir pool on the River Murray into the Koondrook–Perricoota Forest to inundate vegetation communities.
Icon Site Environmental Water Management Plan	A plan that details the aims, objectives and management actions at an icon site under The Living Murray program; it complements state-based plans and processes.
Murray–Darling Basin Authority	Murray–Darling Basin Authority absorbed the functions of the former Murray–Darling Basin Commission in 2009.
Murray–Darling Basin Commission	Now the Murray–Darling Basin Authority.
Murray-Darling Basin Ministerial Council	Ministerial council that develops and agrees to the intergovernmental agreements, approves TLM business plan and makes key decisions (e.g. approves Natural Resource Management programs budget in the Corporate Plan).
Objective	See 'Ecological objective'.
Parameter	A measurable or quantifiable characteristic or feature
Ramsar Convention on Wetlands of International Importance (Ramsar Convention)	An international treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands.
River Management Division	A business unit of the Murray-Darling Basin Authority responsible for operating the River Murray system in accordance with the Murray–Darling Basin Intergovernmental Agreement. River Murray Division manages the River Murray system to ensure that the available water is continuously accounted for and distributed to New South Wales, Victoria and South Australia in accordance with the Murray-Darling Basin Agreement.
River Murray Increased Flows	The component of the water recovered under the Snowy Water Inquiry Outcomes Implementation Deed that is returned to the River Murray System as an environmental flow.
Target	See 'Ecological target'
The Living Murray Account	The Living Murray water that is available in the account to be used on an annual basis

The Living Murray Business Plan	Plan prepared by the Murray–Darling Basin Ministerial Council describing how the actions and milestones agreed in the Intergovernmental Agreement 2004 are to be achieved. Last updated May 2007.
The Living Murray Committee	A jurisdictional committee that is responsible for implementation of The Living Murray Business Plan.
Water requirements	Includes the flow, volume, timing, duration, velocity, depth, quality or any other attribute that is required to meet the ecological target.
Unregulated flows	The volume of water that exceeds regulated requirements and determined by the volume of flow in the River Murray exceeding (or predicted to exceed) the inlet channel capacity in Lake Victoria and the entitlement flow for South Australia.

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Australian Government

Koondrook-Perricoota Forest Flood Enhancement Works

Murray-Darling Basin Authority
The Living Murray Program

Operating Plan

VERSION 3.3 – August 2012

FORESTS NSW

NSW GOVERNMENT | Office of Water

This document should be referenced as the Koondrook-Perricoota Forest Flood Enhancement Works, Operating Plan, Version 3.3.

This Plan is part of the Operations Environmental Management Plan for the Scheme, approved by NSW Planning: _____ (date).

Version control

Version	Date	Prepared	Reviewed	Approved
1.0	30/06/2011	[redacted] (NSW PW)	[redacted] (Forests NSW) [redacted] (MDBA) [redacted] (MDBA)	
2.0	05/08/2011	[redacted] (NSW PW)	[redacted] (10 August 2011)	
3.0	Sept. 2011	[redacted] (Forests NSW) [redacted] (State Water) [redacted] (MDBA) [redacted] (State Water)	[redacted] (Forests NSW)	
3.1	15/09/2011	[redacted] (Forests NSW)	Operational Planning Team	
3.2	10/11/2011	NSW Public Works - Project Management	NSW Planning	
3.3	August 2012	NSW Public Works - Project Management	Forests NSW MDBA	

KEY CONTACTS

Icon Site	**Koondrook Perricoota Forest**
Icon Site Coordinator	[redacted], Icon Site Manager [redacted] [redacted] [redacted]
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MDBA – River Murray Operations	Duty Officer GPO Box 1801 Canberra ACT 2601 Phone: (02) 6279 0100

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GLOSSARY OF TERMS & ACRONYMS

ANZECC	Australian and New Zealand Environment and Conservation Council.
AHD	Australian Height Datum
Aquatic ecosystem	Any water environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.
Baseline condition	An environmental quality or condition that is defined at a point in time and used as a benchmark for determining a change in the environmental quality or condition. For The Living Murray the baseline condition is 2003 when the program was announced.
BOC	Basin Officials Committee: A jurisdictional committee to coordinate the management of Basin water resources between the Commonwealth, the Authority and the Basin States.
Blackwater	Water containing a high concentration of organic matter, often accompanied by an initial depletion of oxygen.
BSMS	Basin Salinity Management Strategy
CMA	Catchment Management Authority: Provides technical and financial support to land managers and communities across specific catchments to balance natural resource protection with food and fibre production.
CEWO	Commonwealth Environmental Water Holder
CTP	Compliance Tracking Program
CoA	Conditions of Approval
COPAC	Community Operation and Planning Advisory Committee: A reference advisory group to provide local experience and advice into the planning for operation of events generated by the works
CRG	Community Reference Group: Provides a mechanism to seek advice and a community perspective on the communication and engagement activities proposed for the icon site
DGR	Director-General's Requirements.Requirements for an environmental assessment issued by the Director-General of the NSW Department of Planning in accordance with the Environment Planning and Assessment Act 1979.
Ecological Objectives	An objective is a statement of the desired condition. It is not necessary to quantify an objective.
Ecological Targets	A target is generated from the ecological objective and will ideally be quantitative.
Environmental Management Plan	A document setting out the management, control and monitoring measures to be implemented during construction and/or operation of a development, to avoid or minimise the potential environmental impacts identified during an environmental impact assessment process.
Environmental watering	Provision of water, authorised by an access entitlement, to a location for the achievement of ecological targets and objectives.
EWG	Environmental Watering Group: An MDBA jurisdictional committee that develops and implements the annual TLM Environmental Watering Plan. The EWG recommends annual

	TLM watering priorities and proposals to ensure consistency between icon sites.
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
Fishway	A structure placed in or around a constructed waterway barrier (e.g. regulator, weir or dam) to allow migration of fish.
FPTF	Fish Passage TaskForce – provides advice on fishway design, location and monitoring programs.
FNSW	Forests NSW is within NSW Trade and Investment.
Fully Managed Event	An environmental watering event that allows water into the forest that would not have occurred without the operation of the Scheme structures.
GL	Gigalitres
G-K-P	Gunbower-Koondrook-Perricoota
G-MW	Goulburn-Murray Water
Historically Natural Event	An environmental watering event that would have historically occurred within the forest prior to river regulation.
Hybrid Event	An environmental watering event that utilises any combination of actual overbank flow and water drawn through the Inlet channel.
Icon Site	One of six sites identified under The Living Murray Initiative chosen for their high ecological value — most are listed as internationally significant wetlands under the Ramsar convention — and also for their cultural significance to Indigenous people and the broader community
IGA	Intergovernmental Agreement (Murray-Darling Basin): outlines the governance arrangement for the implementation of TLM.
JIG	Joint Indigenous Group: An advisory group established to ensure the Indigenous community are provided with the opportunity to input into water management and a chance to raise and identify their cultural and spiritual links to the forest. This group is made up of representatives from Traditional Owners (Yorta Yorta and Barapa Barapa Nations) and Local Aboriginal Land Councils.
Managed Event	A watering event that employs the operation of the Scheme structures.
ML	Megalitres
MCoA	Minister's Conditions of Approval
Murray Darling Basin (MDB)	Comprises the catchment of the Murray and Darling Rivers and their many tributaries, extending from north of Roma in Queensland to Goolwa in South Australia.
Murray Darling Basin Authority (MDBA)	The authority responsible for managing the Basin's water resources in the national interest, in cooperation with state authorities, with the aim of ensuring reliable water supplies for all users. (Formerly Murray Darlin Basin Commission – MDBC)
Murray River	The waters of the main channel of the Murray River and its bed and banks.
Murray System storages	Water infrastructure such as dams, weirs, locks, etc associated with the regulation of water in the River Murray

NOW	NSW Office of Water
OEH	Office of Environment & Heritage (NSW).
Overbank Event	Where forest inflows occur via Swan Lagoon and other effluents, primarily downstream of Torrumbarry weir. Overbank events will occur when flows downstream of Torrumbarry Weir exceed 18,000 ML/day
Ramsar listing	A wetland listed under the Ramsar Convention on Wetlands; an intergovernmental treaty providing the framework for national action and international cooperation for the conservation and wise use of wetlands.
RL	Reference Level
River Red Gum	*Eucalyptus camaldulensis* also known as Red Gum.
River regulation	Control of water flow within a river having the aim of ensuring the health of the river as well as ensuring future water supply.
SEWPC	Sustainability, Environment, Water, Population and Communities (Federal Government)
SWC	State Water Corporation: Bulk water supply utility for rural water in NSW.
TLM	The Living Murray initiative: Australia's most significant river restoration program that aims to achieve a healthy working River Murray system for the benefit of all Australians. This includes returning water to the river's environment
Threatened species, populations and ecological communities	Species, populations and ecological communities specified in Schedules 1, 1A and 2 of the *Threatened Species Conservation Act 1995 (NSW)*.
Unregulated Flow	Unregulated flows are normally declared by the Murray-Darling Basin Authority when high flows are forecast to occur that are in excess of that required to meet South Australia's entitlement flow and cannot be captured and re-regulated in Murray System storages.
Water year	An accounting period from 1 July to 30 June, seasonally aligned and corresponding to water allocation policy in the River Murray system.

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EXECUTIVE SUMMARY

The Project

- Koondrook-Perricoota Forest (approximately 32 000 ha) is located on the NSW side of the Murray River and is Australia's second largest River Red Gum Forest. It is listed as a wetland of international importance under the Ramsar convention and is one of six Icon Sites identified under The Living Murray (TLM) Initiative.
- The Koondrook Perricoota Forest is of substantial importance to the local and regional community due to its ecological, social, cultural and economic values. Changes to the flow regime in the Murray River and its tributaries have significantly reduced the ecological health and productivity of the Koondrook-Perricoota Forest. This is primarily due to a reduction in the frequency and magnitude of flooding as a consequence of the long-term effects of river regulation and recent droughts.
- To conserve and enhance the current ecological condition of the Forest, a collective of NSW agencies and the Commonwealth has committed to the Koondrook-Perricoota Forest Flood Enhancement Works (the 'Scheme').

Purpose of the Operating Plan

- The Operating Plan aims to provide the framework for operation of the Scheme to meet key ecological objectives. The Operating Plan is a living document, which will evolve in response to changing site conditions and ongoing knowledge development.

Interactions with other sites

- The Koondrook Perricoota Forest is part of the broader Murray River system, and as such interacts with other sites that form part of this system. Three types of interactions with other sites are likely:
    1. Sites that impact on operations at Koondrook Perricoota, generally located upstream. Key interactions include the Goulburn River which tends to have a greater influence on higher flows at Torrumbarry than the Murray River and the Barmah-Millewa Forest which if flooded may influence quality of water entering the Koondrook Perricoota Forest.
    2. Sites that are impacted upon by operations at Koondrook Perricoota, generally located downstream. Managed flows will be released directly back to the Murray and the Barber Creek system which flows into the Wakool River further downstream. During overbank events, flows will be released with no interference from the Scheme infrastructure into the Barber Creek system, but also into Thule Creek which also flows into the Wakool River.
    3. Sites that can be operated in a complementary manner with Koondrook Perricoota, generally neighbouring sites. Pollack Swamp and Thule Lagoons, in particular, may present opportunity for complementary management via multi-site events. During overbank events Gunbower Forest (located on the Victorian side of the Murray River) will flood when the Koondrook Perricoota Forest floods, however managed events on either side of the river will have little impact on the other.

Governance

- TLM is a joint initiative and is managed collaboratively by partner governments of the Commonwealth, NSW, Vic, SA and ACT. The Murray-Darling Basin Intergovernmental Agreement (IGA 2004) outlines the governance arrangement for the implementation of TLM. The groups with a direct role in TLM governance are Ministerial Council, the Authority, the Basin's Officials Committee (BOC), TLM Committee (TLMC) and the Environmental Watering Group.

- While the MDBA plays a key coordination role at a TLM-wide level, management and delivery of TLM activities at Koondrook Perricoota Forest lies with Forests NSW, the Icon Site Manager.
- The Scheme may draw upon a number of sources of environmental water, however the amount of water available for use depends on the volumes available and the seasonal water allocations. There are various environmental water account managers including TLM (MDBA) Water Manager, the Commonwealth Environmental Water Holder, the States' Environmental Water Managers and, potentially individuals who may deem it appropriate to plan for their entitlements to be used in the Koondrook Perricoota Forest for environmental watering purposes.

The Structures

- The Structures broadly fall into one of two categories of key infrastructure:
  - **Upstream structures** to divert water from the Torrumbarry Weir pool into the Forest. These structures include an inlet channel, inlet regulator and associated infrastructure, as well as regulators at Swan Lagoon to control flows re-entering the Murray River; and
  - **Downstream structures** to control the release of water from the Forest and to maximise return flows back to the Murray River. These structures include a levee to retain water within the Forest, as well as regulators controlling discharge water to downstream waterways.

Key Operational Thresholds

- Operation of the Scheme will generally occur in two modes, as follows:
  1. Operation of the structures primarily for ecological outcomes. This occurs during 'managed' events where all inflows are directed into the forest from the Torrumbarry weir pool via the inlet channel. The flow downstream of Torrumbarry Weir will be <18,000 ML/day.
  2. Operation of the structures to pass flows through the forest. This occurs during 'overbank' events where inflows occur via Swan Lagoon and other effluents, primarily downstream of Torrumbarry weir. Overbank events will occur when flows downstream of Torrumbarry Weir exceed 18,000 ML/day.
- Overbank flows may occur in combination with managed flows. These events are termed 'hybrid' events and operation will need to swap between the two modes. Modelling suggests that the majority of flood events will be hybrid events.
- MDBA has undertaken extensive hydrodynamic modelling of four managed event scenarios, representing water management strategies that target different ecological objectives. Scenario 5 has been modelled to provide guidance for operations during a large hybrid event. A summary of the four managed watering scenarios are detailed in Table 1.

Table 1: Summary statistics for Scenarios 1-4

Scenario	Inflow (ML)	Outflow (ML)	Water use and evaporation (ML)	Maximum Inundation Area (ha)	Maximum downstream water level (m AHD)	Duration (days)
1. Small event 'spring flush'	90,000	48,000 8,000 Return to River Murray via return channel 40,000 to Wakool River via Barber Creek	42,000 (Seepage = 24,900 ML & Evaporation = 17,100 ML) **	8,000 (>5,000 ha inundated for over 34 days)	77.3	118
2. Short, fat 'pulse'	216,000	127,000 64,000 Return to River Murray via return channel 63,000 to Wakool River	89,000 (Seepage = 49,800 ML & Evaporation = 39,200 ML) **	16,000 (>10,000 ha inundated for over 36 days)	78.5	172

Scenario	Inflow (ML)	Outflow (ML)	Water use and evaporation (ML)	Maximum Inundation Area (ha)	Maximum downstream water level (m AHD)	Duration (days)
		via Barber Creek				
3. Long, low bird/fish breed	101,250	75,400 11,600 Return to River Murray via return channel 63,800 to Wakool River via Barber Creek	25,850 (Seepage = 15,500 ML & Evaporation = 10,350 ML) **	6,700 (>5,000 ha inundated for over 76 days)	77.1	177
4. Maximum event	369,100 to 420,000*	226,000 168,000 Return to River Murray via return channel 58,000 to Wakool River via Barber Creek	143,100 to 194,000* (Seepage = 68,000 – 92,000ML & Evaporation = 75,000-102,000 ML)**	16,000 (>10,000 ha inundated for over 90 days)	78.5	220 to 250*
*A range is shown for Scenario 4 to cover the variability in site conditions that impact water use. ** Losses are variable with time and spatial extent/duration.						

- During operation, the proposed event design will be implemented, but the actual outcome will often be determined by the interaction of overbank flow, in combination with the managed component. The sum of these individual events will define the long term watering regime.

Watering Principles

- An Operations Committee will be established and meet weekly to provide feedback on how the operation is progressing and to plan ahead for the following week. A set of Watering Principles (refer to Section 7.1), based on a heuristic rule approach have been established to support the Operations Committee with decision-making related to initiation of watering events and ongoing management of watering events.

Key Risks

- During the design and environmental assessment process, some potential operational risks associated with salinity, hypoxic blackwater, algal blooms, pest fish, stranding of native fish, tolerance of native vegetation (including Grey Box) to proposed flooding regime, nest abandonment by water birds and downstream geomorphology & erosion. Key management and mitigation measures have been developed for each of these key risks, including a monitoring program that supports operational decision-making.

Operational Costs

- The annual operating cost (excluding monitoring costs) is estimated within the range of $115,000 to $245,000, with $115,000 being the indicative cost of a year where there is no operation of the structures.

Communications

- The Community Operational Planning Advisory Committee (COPAC) and the Joint Indigenous Group (JIG) have been established to support operational planning leading up to the initial operational event. These two groups, as well as other community members have contributed to a list of operational issues of concern to the local community. Management and mitigation measures have been developed for each of these key concerns that have been raised. A number of key consultation activities have been specifically developed to address these concerns.

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1 BACKGROUND

The Living Murray (TLM) is one of Australia's most significant river restoration programs. Established in 2002, TLM is a partnership of the New South Wales, Victorian, South Australian, Australian Capital Territory and the Commonwealth governments, coordinated by the Murray-Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working Murray River system for the benefit of all Australians.

Through its First Step water recovery initiative, TLM has acquired a water portfolio consisting of water entitlements for environmental use. As of 2011, there is 477.8 GL long-term cap equivalent (LTCE), of water recovered for TLM[1]. The actual volume of water available against these entitlements at any given time is dependent on the water allocations announced by each State. This portfolio will be used to achieve environmental objectives at the icon sites. Regulating structures, water delivery channels and fishways, known as works and measures, will deliver and manage the environmental water at the icon sites. The success of the environmental watering against the objectives will be monitored using fish, birds and vegetation as an overall indication of the icon site's health.

TLM will seek to align itself to the requirements of the Basin Plan Environmental Watering Plan, once finalised.

TLM aims to improve the environmental health of six icon sites that were chosen for their significant value. The Koondrook-Perricoota Forest, along with Gunbower Forest, is one of these six Icon Sites identified under The Living Murray initiative. The Koondrook-Perricoota Forest is a large (32 000 ha) mosaic of River Red Gum, Black Box and Grey Box communities, interspersed by wetland ecosystems and is listed as a wetland of international importance under the Ramsar convention.

The Forest is of substantial importance to the local and regional community due to its ecological, social, cultural and economic values. Koondrook-Perricoota Forest includes extensive stands of River Red Gum forest as well as foraging and breeding habitat for many regionally and internationally significant fauna species. In addition, the Forest is the traditional homelands of the Barapa Barapa and Yorta Yorta people and contains a wide range of sacred and significant cultural sites.

Changes to the flow regime in the Murray River and its tributaries have significantly reduced the ecological health of the Koondrook-Perricoota State Forest. This is primarily due to a reduction in the frequency and magnitude of flooding as a consequence of the long-term effects of river regulation, compounded by recent drought.

[1] The long term Cap equivalent is a type of average and takes into account different characteristics of water entitlements in New South Wales, Victoria and South Australia and their reliability. The measure of water recovery creates a common unit on measure, thus allowing equitable comparison of a broad range of water recovery measures.

The interim objectives have been refined for the Icon Site Environmental Water Management Plan (MDBA in press). In addition, a set of twelve objectives have been adopted for the Scheme. They represent ecological outcomes which are potentially achieved by flood enhancement and should be optimised over the long term operation of the Scheme. These objectives are detailed in Section 2 of the Event Monitoring Plan and will be central to all watering decisions.

The Scheme utilises engineering structures to direct water to the wetland and forest ecosystems without the dependency on natural high flows or floods. This enables watering of the forest ecosystems at the scale, frequency, timing and duration required to achieve the environmental objectives of TLM. The Scheme has been designed to provide the flexibility to deliver a range of flows to ensure that any one or more of the Scheme's twelve objectives can be targeted.

A range of natural flood events can be mimicked to achieve broad-scale inundation of up to 50% of the forest, including watering River Red Gum communities and wetlands and promoting colonial waterbird breeding events. The scheme comprises two key infrastructure components:

Upstream Structures

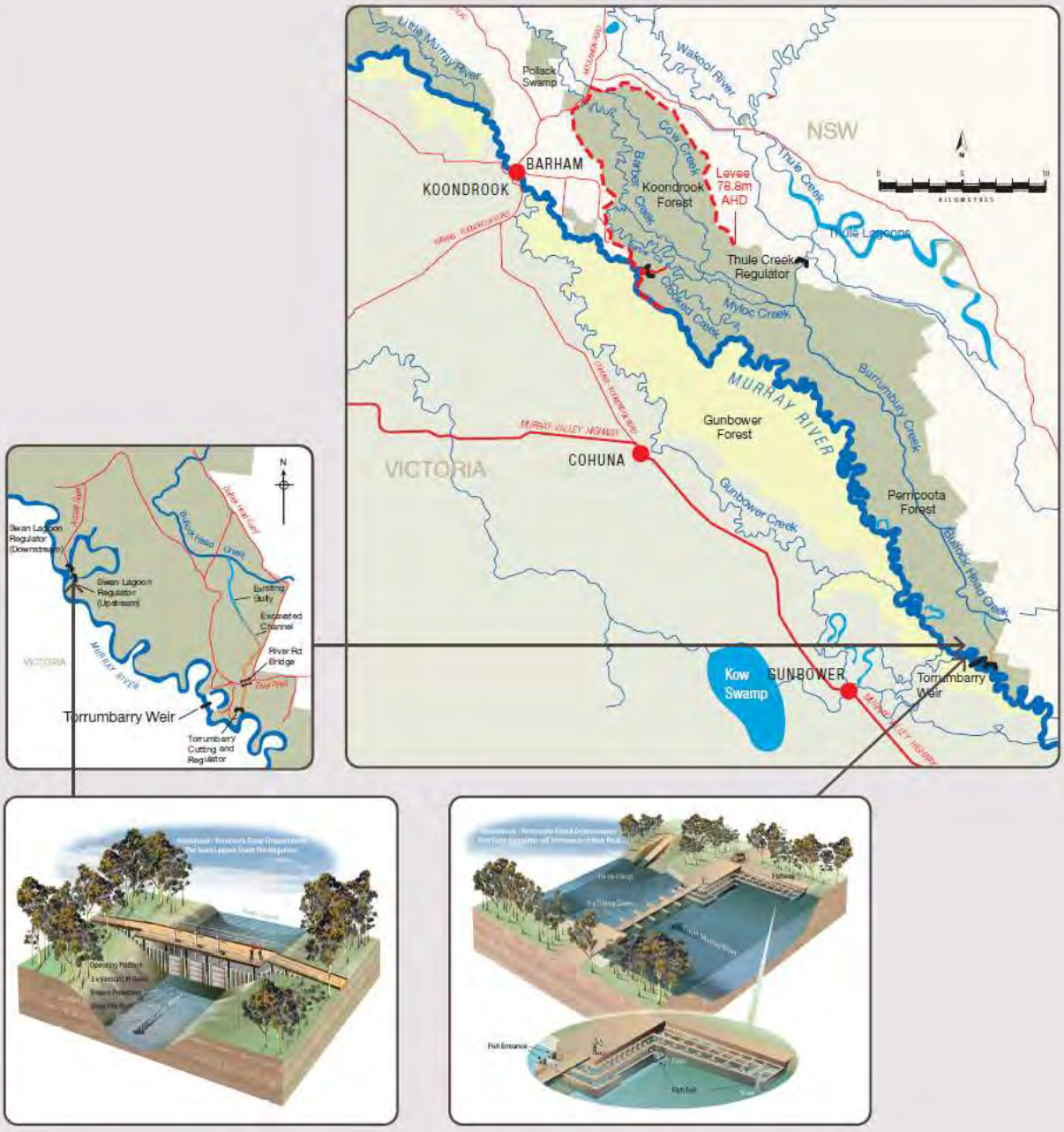
Upstream structures allow diversion of water into the forest from the Torrumbarry Weir pool and escape regulators prevent flows re-entering the Murray River. These structures have been designed to divert and control up to 6 000 ML/day from the Torrumbarry Weir pool and mimic natural flow distribution throughout the forest. Generally, the upstream structures consist of a 3.8 km long excavated channel from the Torrumbarry Weir pool to enable the flow of water into the forest; and escape regulators at Swan Lagoon to prevent flows re-entering the Murray River;

Downstream Structures

Downstream structures enable operators to control outflows for the protection of downstream assets. These structures enable water to be directed back into the Murray River (directly) and/or via Barber Ck, Thule Creek and the Wakool River at prescribed flow rates. The downstream structures comprise 40km of levee to impound flows where inflows exceed prescribed outflows, and six regulators to control outflows during managed or hybrid events. The six regulators include Barber Creek, Thule Creek, Cow Creek, Calf Creek, Runner A and the Return Channel Regulator to the Murray River.

Upstream Structures

Generally, upstream structures allow diversion of water into the forest from the Torrumbarry Weir Pool and escape regulators prevent flow re-entering the Murray River. The structures can divert and control up to 6000ML/day from Torrumbarry Weir Pool and mimic natural distribution of flow within the Forest.



Swan Lagoon Regulators

The purpose of the Swan Lagoon Regulators is to prevent loss of diversion flows during a watering event. The Regulators have also been designed to allow fish to evacuate during the close down sequence of a watering event cycle and maintain an acceptable waterway to minimise obstruction to natural floods.

Torrumbarry Cutting and Regulator

The Offtake regulator provides operational flexibility for effective ramp up and ramp down for diversion discharge and acceptable flow characteristics and structure profile for fish passage. The structure consists of 5 aluminium tilting gates and when open provide a maximum of 6000ML/day diversion capacity. A Denil fishway and Vertical Slot fishway facilitates large fish and small fish passage. The Freshwater Turtle Ramp is located on the channel bank 20m downstream of the regulator structure.

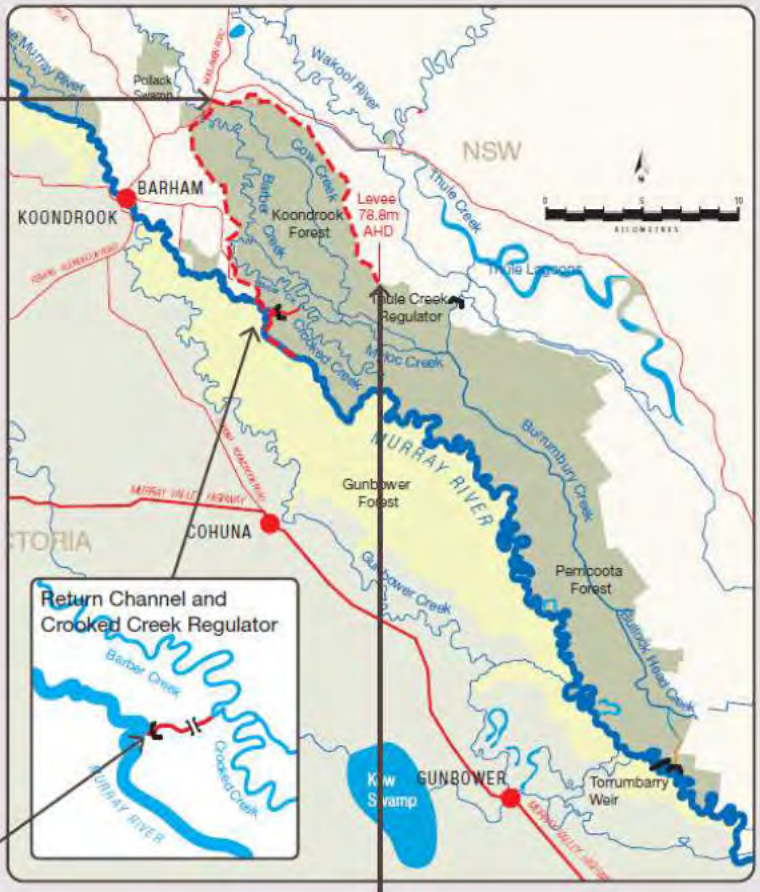
Figure 1: Map of Icon site and location of upstream structures

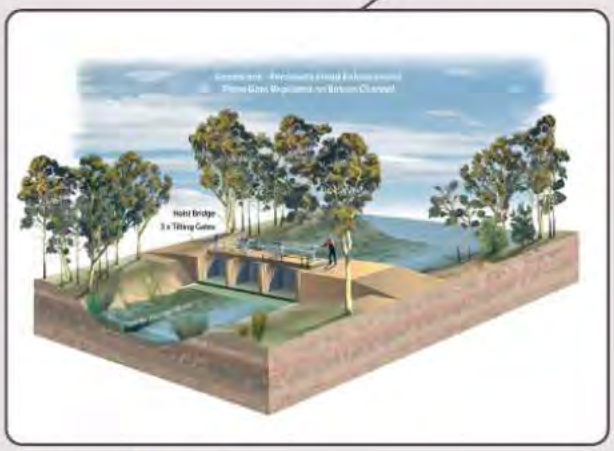
Downstream Structures

Downstream structures prevent uncontrolled water leaving the forest and provide for the most efficient use of water.

Downstream Regulators

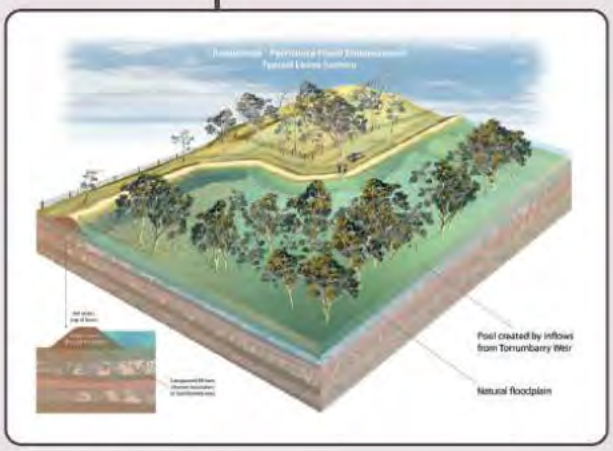
Downstream Regulators are stop log regulators and have a height proportioned for the pool of RL78.5m.





Return Channel

The Return Channel has two functions: To provide water savings via direct return of flow to the Murray River and to provide an overflow/spillway system to protect safety of the downstream structures. The return channel is located as far downstream as possible within the Forest with the shortest connection to the Murray River.



Downstream Levee

The downstream levee contains a pool of RL78.5m, which targets backup flows at the return channel. The height varies from zero to approximately 4 metres above the flood plain and is approximately 43 km in length, with a 4m crest width.

Figure 2: Map of Icon site and location of downstream structures

2 PURPOSE OF THE OPERATING PLAN

This Operating Plan provides the framework for operation of the Scheme's structures to meet key ecological objectives within the broader context of TLM, legislative requirements and the Scheme's governance. Its purpose is to communicate the operational intent of the Proponents to key stakeholders; primarily the land manager, structure operators, river operators, investors (water holders and funding bodies) and regulatory authorities. The Operating Plan documents the implementation of the water regime proposed in the Koondrook-Perricoota Environmental Water Management Plan.

The Operating Plan is a living document, which will evolve in response to changing site conditions and ongoing knowledge development, to enable operational decisions to be based upon the best available knowledge. It is expected the Operating Plan will be reviewed annually by Forests NSW for at least seven years to include key learnings from operation of the Koondrook-Perricoota Scheme and works at other Icon Sites.

The Operating Plan does not prescribe particular watering events or if a watering event is to occur. The intent is to provide assistance in planning watering events and to guide decision making leading up to and during events. Table 2 summarises the intended audience of the Operating Plan and their primary requirements.

Table 2: Intended Audience, Operating Plan

Audience	Key Requirement(s)
Land manager/Icon site manager (Forests NSW)	Achievement of ecological outcomes within legal constraints.
Scheme structure operators (State Water Corporation & River Murray Operations, MDBA)	Operating instructions
Water holder/funding source (MDBA/TLM, CEWO, NSW OEH, SEWPAC)	Accountability
Regulatory authorities and/or Operating Requirements (NSW Planning, SEWPAC, Basin Salinity Management)	Legal compliance

Overview of Operation

Operation of the Scheme will generally occur in two modes, as follows:

1. Operation of the structures primarily for ecological outcomes. This occurs during 'managed' events where all inflows are directed into the forest from the Torrumbarry weir pool via the inlet channel. The flow downstream of Torrumbarry Weir will be <18,0000 ML/day.

2. Operation of the structures to pass flows through the forest. This occurs during 'overbank' events where inflows occur via Swan Lagoon and other effluents, primarily downstream of Torrumbarry weir. Overbank events will occur when flows downstream of Torrumbarry Weir exceed 18,000 ML/day.

Overbank flows may occur in combination with managed flows. These events are termed 'hybrid' events and operation will need to swap between the two modes. Modelling suggests that the majority of flood events will be hybrid events.

The largest managed flood event that the Scheme can generate is described in Chapter 6 as 'Scenario 4' and is the event upon which the Environmental Assessment (GHD, 2010) was based. This event delivers inflows of 6,000 ML/day and is capable of inundating up to 16000 ha (approximately 50% of the forest) as a maximum peak with greater than 10,000 ha inundated for over 90 days. The maximum maintainable managed inundation is approximately 41% of the Forest (around 13,100 ha) for a period of about 100 days. More extensive and/or floods of longer duration may be possible in combination with large overbank events.

Each event will be designed to target specific ecological outcomes. However, the actual outcome will be determined by the interaction of overbank flow, in combination with the managed component. As such, each event will be distinctive from all others, as would have occurred naturally. Different target outcomes include:

- Frequent low flows to maintain the wetland habitats occurring in lagoons, depressions and flood runners;
- Less frequent floods of medium magnitude to maintain the extent of the River Red Gum communities, with larger floods maintaining the extremities, and smaller floods supporting the core areas with flood dependent understorey communities; and
- Flood events of long duration to initiate and facilitate bird breeding.

Adaptive Management

An adaptive management framework has been adopted for the operation of the Scheme. An adaptive approach is critical in managing water dependant ecosystems so both land managers and policy makers can learn and change strategies based on the outcomes of research and watering actions. It is also known as 'learning by doing' through designing, implementing, monitoring, reporting and evaluating our work.

The primary mechanism for adaptive management will be via the event-based monitoring program which targets monitoring such that event design can be informed by real-time outcomes during events, and the hypotheses underpinning event design can be improved on an event-to-event basis. A comprehensive Monitoring Plan, which is part of the Operational Environmental Management Plan (OEMP) suite of documents has been developed for the Scheme.

3 INTERACTIONS WITH OTHER SITES

The Koondrook-Perricoota Forest site is part of the Murray River system and as such interacts with other sites that form part of this system. Figure 3 shows the location of other structures, river systems and sites, and the links between them and this site.

Three types of interactions with other sites are likely:

- Sites that impact on operations at Koondrook-Perricoota. These are generally upstream.
- Sites that are impacted upon by operations at Koondrook-Perricoota. These are generally downstream.
- Sites that can be operated in a complementary manner with Koondrook-Perricoota. These are generally neighbouring sites.

Despite the obvious linkages to other sites via the Murray River system, the Scheme is able to be operated largely in isolation of other sites. This is because inflows are diverted from the Torrumbarry Weir pool at normal operating height, and managed events are contained within the Koondrook-Perricoota Forest. Key interactions are generally related to the discharge of poor quality water from upstream sites or from this site, and the potential for downstream flooding/watering.

3.1 Upstream Sites

Upstream sites have the potential to impact on flows within the River Murray, downstream of Torrumbarry. Key upstream sites include the Goulburn River and the Barmah-Millewa forest.

Goulburn and Campaspe Rivers

The Koondrook-Perricoota Forest floods naturally when high flows from the Goulburn River coincide with medium to high flows from the Murray River. Murray River flows tend to be attenuated as they pass through the Barmah Choke and as a result the Goulburn River tends to have a greater impact on flows at Torrumbarry Weir/Koondrook-Perricoota than the Murray itself. Key impacts at Koondrook-Perricoota include overbank flows during managed events, and poor quality water resulting from flooding in the Goulburn River.

Flows in the Goulburn River should be carefully monitored when operating, as these provide a guide as to the likelihood and timing of any potential overbank flows. Travel time from McCoy's Bridge (lower Goulburn) to Torrumbarry Weir is approximately 2 days. Flows entering the forest from the Goulburn River may be high in organic carbon. See the discussion below for more information on the implications of this.

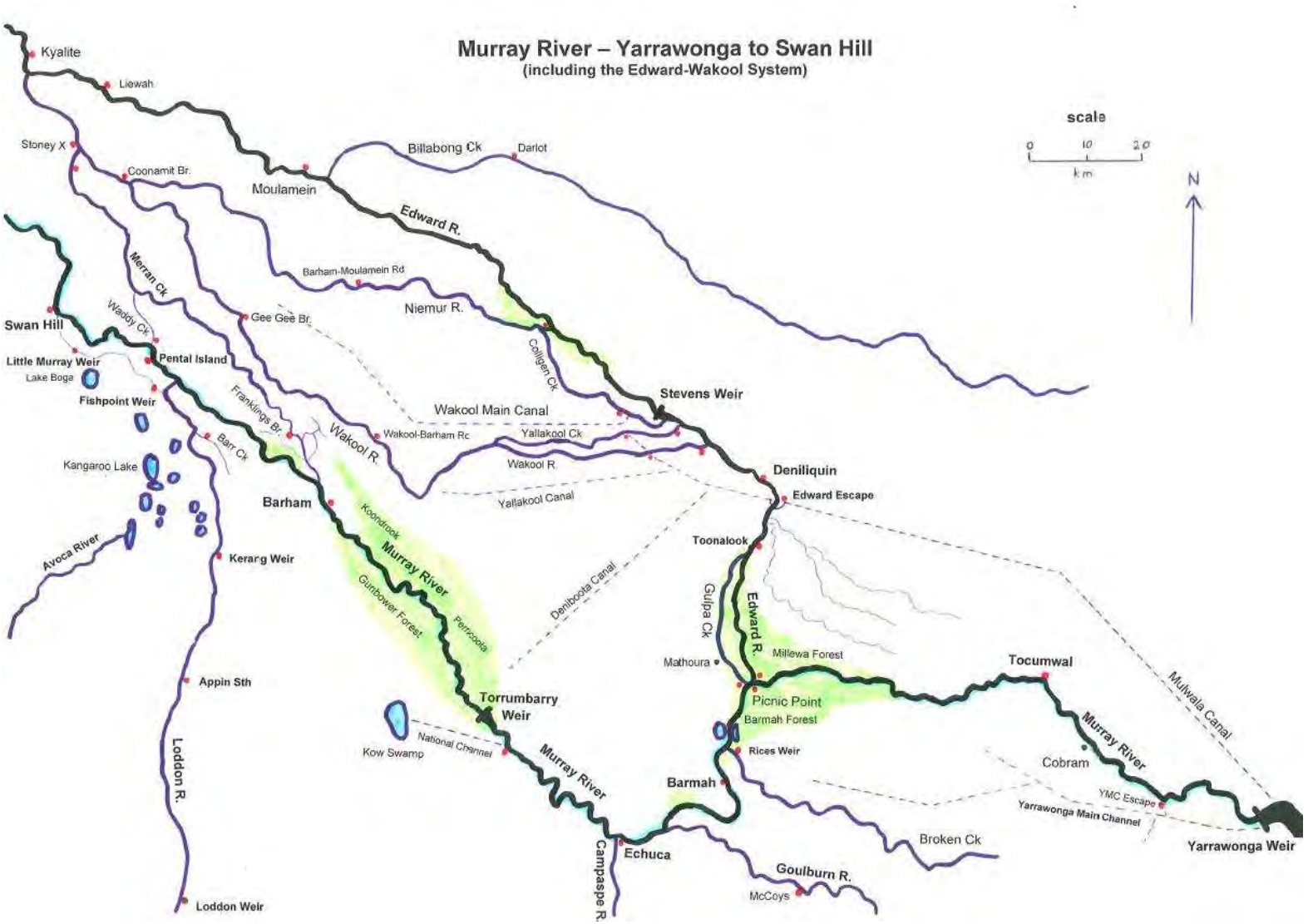


Figure 3: Map of the Murray River system - Yarrawonga to Swan Hill

Flooding in the Barmah-Millewa Forest

The Barmah-Millewa Forest is the largest River Red Gum forest in Australia. It covers approximately 66,000 hectares of floodplain between the townships of Tocumwal, Deniliquin and Echuca. Flooding in the Barmah-Millewa forest typically occurs when medium to high flows from the Upper Murray and/or the Ovens River are temporarily banked up behind the Barmah Choke. Floodwaters flow downstream via Gulpa Creek and the Edward and the Murray Rivers. Flows down the Murray enter the Torrumbarry Weir pool approximately four days later.

Flows coming from Barmah-Millewa floods may contain high levels of organic carbon. This may provide ecological benefits to the Koondrook-Perricoota Forest, but also increases the risk of hypoxic blackwater. Hypoxic blackwater has the potential to kill fish and other aquatic species. Dissolved oxygen levels will be measured at Torrumbarry Weir and will be taken into account when assessing the risk of hypoxic blackwater. See Section 8.2 for more information on management of blackwater.

Figure 4: Map of the Barmah-Millewa Region

3.2 Downstream Sites

Flows exiting the Koondrook-Perricoota Forest naturally flow to the Wakool River, before re-entering the Murray approximately 100km downstream. The Scheme includes regulators on all outflow points to the Wakool River. Managed flows may also be released directly back to the Murray via the Return Channel (See Section 5). Key impacts on downstream sites include flooding and inconvenience to downstream landholders, aquatic impacts associated with the release of poor quality water, and erosion of downstream creeks.

Barber Creek, Thule Creek and Wakool River

There are two primary links between the forest and the Wakool: the Thule Creek and the Barber Creek. However, high flows associated with overbank events can take a myriad of other routes to the Wakool. Figure 5 shows the various flow paths between the forest and the Wakool River. Furthermore, the area is particularly flat and high flows in Wakool can flow 'backward' into the forest.

During overbank events, flows will be released at modelled pre-scheme rates.. Flows will take their natural route across the landscape to the Wakool River. This will have ecological benefits across the landscape for native flora and fauna, especially aquatic species. Operators should be aware of the impact of flows on downstream landholders (see Section 9.7) and on operations in the Wakool River.

During managed events, flows will not be released from the Thule Creek regulator. Releases to the Wakool River will be made via the Barber Creek and are constrained to 250 ML/day. Key impacts associated with the release of water to Barber Creek are as follows:

- Bank erosion in the Barber Creek due to constant flows is a key concern. See Section 8.6 for more information.
- Releases of water with a very low dissolved oxygen content may have an adverse impact on fish in downstream creeks and rivers. For this reason, consideration should be given to timing managed events to coincide with high flows of water with good Dissolved Oxygen levels in the Wakool to provide dilution flows. See Section 8.2 for more information.
- Flow up to 250 ML/day is unlikely to cause flooding downstream, but downstream landholders may be inconvenienced by the flow. See Section 8.7 for more information. Operators should be aware that high flows in the Wakool River may cause localised flooding at the confluence of Barber Creek and the Wakool River.

Murray River

During overbank events, the Return Channel will be closed (or redundant due to very high flows in the Murray) and all flows within the Koondrook-Perricoota Forest will take their natural course towards the Wakool River via the Thule, Barber and Calf Creeks. However, during larger managed events water will be released directly into the Murray River via this structure. Releases will range from 0 – 1850 ML/day. See Sections 5.2 and 6 for more information as to how this structure is to be operated.

Key interactions include an increase in flows in the Murray River, the introduction of nutrient-rich water containing native fish, and the potential risks arising from the release of poor quality water from the forest. Flows in the Murray River are expected to be sufficient to dilute any poor quality water returning from the forest, but operators should be mindful of the possible impact of hypoxic blackwater if flows in the Murray River are low.

3.3 Neighbouring Sites

Neighbouring sites present an opportunity for complementary management via multi-site events. Multi-site events may include forested sites, riparian vegetation, or in-channel flows that benefit aquatic communities. Multi-site watering requires a number of complex high-level approvals and will only be undertaken following detailed planning with the water holder and NSW Office of Water. Nevertheless, watering at Koondrook-Perricoota will be undertaken in conjunction with other sites at times. Key neighbouring sites include Pollack Swamp, the Thule Lagoons, the Edward-Wakool system, and Gunbower forest. Others include Noorong forest (at the confluence of the Barber Creek and Wakool River), the Merran Creek, Campbells Island State Forest and the Little Murray River.

Figure 5: Flow path to the Wakool River via Thule Creek and associated lagoons

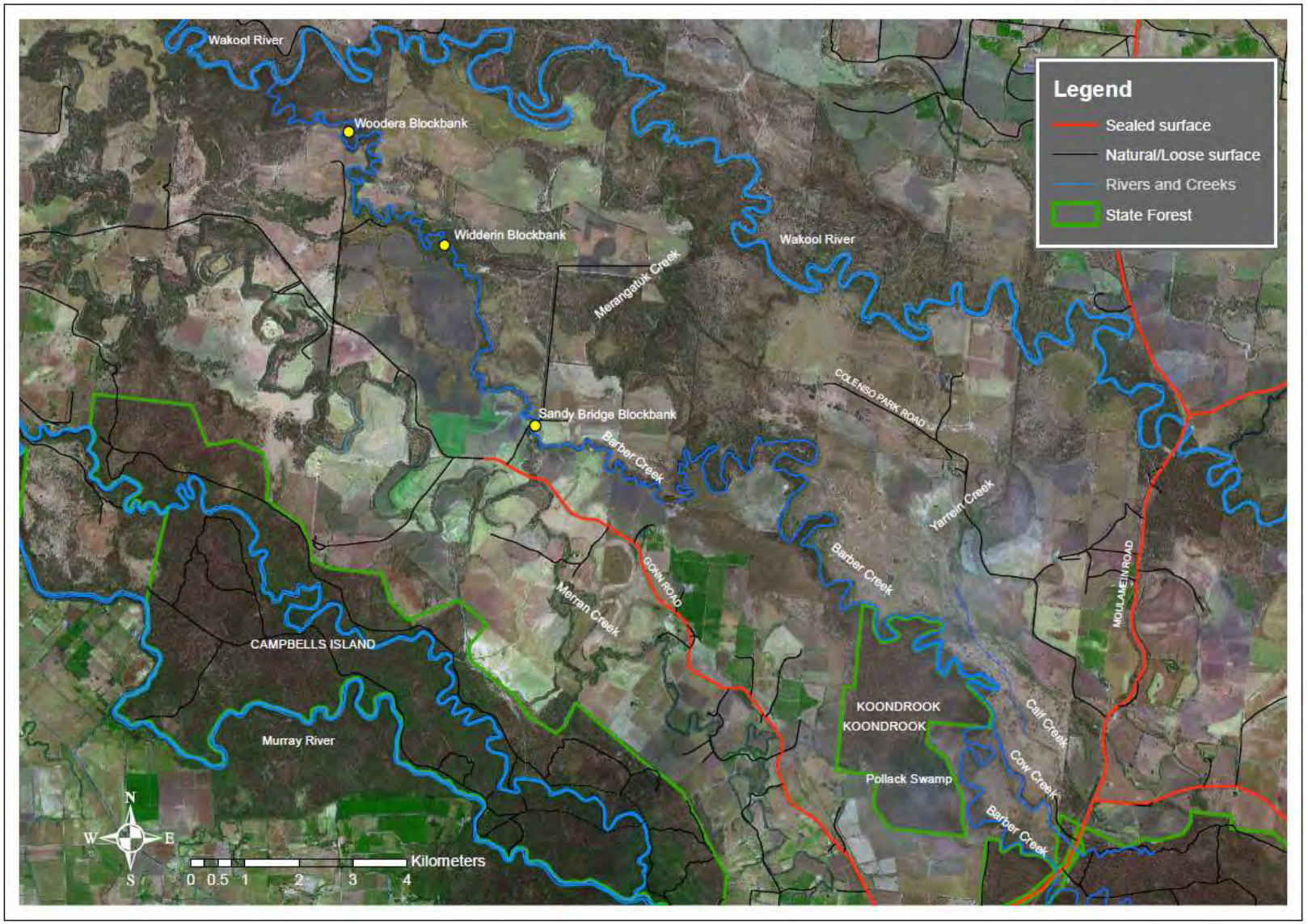


Figure 6: Flow paths to the Wakool via Barber and Calf Creeks.

Pollack Swamp

Pollack Swamp is located immediately downstream of the Koondrook-Perricoota Forest. Pollack Swamp has historically received environmental water directly from the Murray via a private irrigation scheme. Naturally, high flows in the Barber Creek fill Pollack Swamp. There is an opportunity to provide water to Pollack Swamp with high discharge flows from the Koondrook-Perricoota Forest Works such that flows commence to Pollack Swamp via Pollack Creek. Alternatively, it may be possible to pump or otherwise direct managed releases from the forest into Pollack Swamp where environmental water is provided for that purpose.

Thule Lagoons

The Thule Creek/Green Gully lagoon system occupies an area of privately owned or crown land assumed to be the ancestral course of the Murray River prior to the uplift of the Cadell Tilt to the east. The lagoons have an approximate area of 800 ha and flood naturally when flood waters leave the forest. Flows enter firstly via Thule Creek and then via Axe Creek during larger events. The lagoons are managed by a number of adjacent landholders and are used for cropping purposes, but nevertheless retain significant ecological values.

There is a regulator structure located on neighbouring 'Thule' property that manages flows between Thule Creek and Thule Lagoon. This structure is opened by the landholder when flows downstream of Torrumbarry Weir exceed 40,000 ML/day for more than one week, which generally initiates flow in the Axe Creek. Management of the structure is done in consultation with affected neighbours.

The Thule Creek outflow regulator will be closed during managed events. During overbank events, the regulator will remain open and flows will not be impacted. During hybrid events, the regulator will be operated to pass translucent (pre-Scheme) flows. In this situation, it will be necessary to work with the landholder on 'Thule' to coordinate the operation of the Thule Lagoon regulator.

Gunbower Forest

Gunbower Forest Icon Site is located adjacent to Koondrook-Perricoota Forest on the Victorian side of the Murray River. The Gunbower Forest contains 19,500 Ha of river red gum forest. Like Koondrook-Perricoota, when the Murray is high the Gunbower Forest floods naturally via a series of effluents including Deep Creek, Broken Axle Creek, Spur Creek, Yarran Creek and Barham Cut.

Works are currently being designed to provide water to the Gunbower Forest from the Murray upstream of Koondrook-Perricoota via Gunbower Creek. Once the works and measures have been completed there will be a Gunbower Forest Operating Plan that will be available to refer to for a detailed understanding of the Gunbower Icon Site.

During overbank events, both the Gunbower and Koondrook-Perricoota forests will flood. However, managed events on either side of the river will have little impact on the other, except that both will be calling for water from the Torrumbarry Weir pool. Consideration should be given to designing events that coincide to provide stronger ecological cues for fish and birds.

Edward-Wakool System (including Werai Forest)

The Edward River breaks from the River Murray at the Barmah-Millewa Forest and heads north towards Deniliquin and then westward to rejoin the River Murray (via the Wakool River) 500km downstream near Tooleybuc. Between the Edward River and the River Murray is a complex network of distributaries and anabranches, the largest of which is the Wakool River. The Wakool River is connected to the Koondrook-Perricoota Forest via Thule Creek, Barber Creek and Calf Creek.

The Werai Forest covers an area of 12,000 hectares and is a wetland of international significance under the Ramsar Convention. It is located along the floodplain at the intersection of the Edward River, Colligen Creek and Niemur River. The high floodplain areas of this forest are vegetated with River Red Gum. Lower lying areas are typically dominated by Giant Rush, with a dense emergent growth of Water Milfoil, Spike Rush and Mud Grass. The forest contains a large number of Aboriginal sites. When flooded, the forest supports large numbers of waterbirds

Natural floods in the Koondrook-Perricoota forest would have often coincided with floods in the Edward-Wakool and Werai, prior to river regulation. It is therefore likely that there are ecological benefits from timing managed events to coincide with flooding in these systems.

3.4 Travel Times

To gain an understanding of travel times refer to Figure 7. This information will assist during hybrid events, when calling on water from Hume Dam. This also provides an understanding of travel times for larger water actions through the Edward-Wakool System. Note that these travel times are average times during regulated conditions. The Key Travel times associated with the Koondrook Perricoota Forest are provided in Table 3.

Table 3: Key travel times associated with Koondrook-Perricoota forest

Reach	Travel Time (days)
Hume –Torrumbarry Weir	8
Torrumbarry Weir - Barham	2
Barham – Wakool Junction	3.5
Elidon-McCoys Bridge	9
McCoys Bridge-Torrumbarry Weir	2

Travel times for the Edward-Wakool may be relevant during multi-site watering events. Refer to Figure 7 for further information.

3.5 Channel Capacity

The Torrumbarry Weir-Barham Murray River reach typically will commence flowing to the Gunbower and Koondrook-Perricoota Forests once flows exceed 18,000 ML/day downstream of Torrumbarry Weir. To achieve broad scale overbank flow to the forests, flows are required to exceed approximately 30,000ML/day downstream of Torrumbarry Weir. During periods of high flows Barham Bridge flow peaks approximately at 27,000 ML/day and the remaining flow travels overbank through the Koondrook-Perricoota Forest via numerous tributaries towards the Wakool River. When the flow in the Murray is greater than 40,000 ML/day, flows enter the Koondrook-Perricoota Forest upstream of Torrumbarry Weir. See section 6.3 for forest inflows at various River flows.

Flows that overbank the Murray and enter the Gunbower Forest, return to the Murray via the Gunbower Creek at the Township of Koondrook. This location is upstream of the Barham Bridge gauging station.

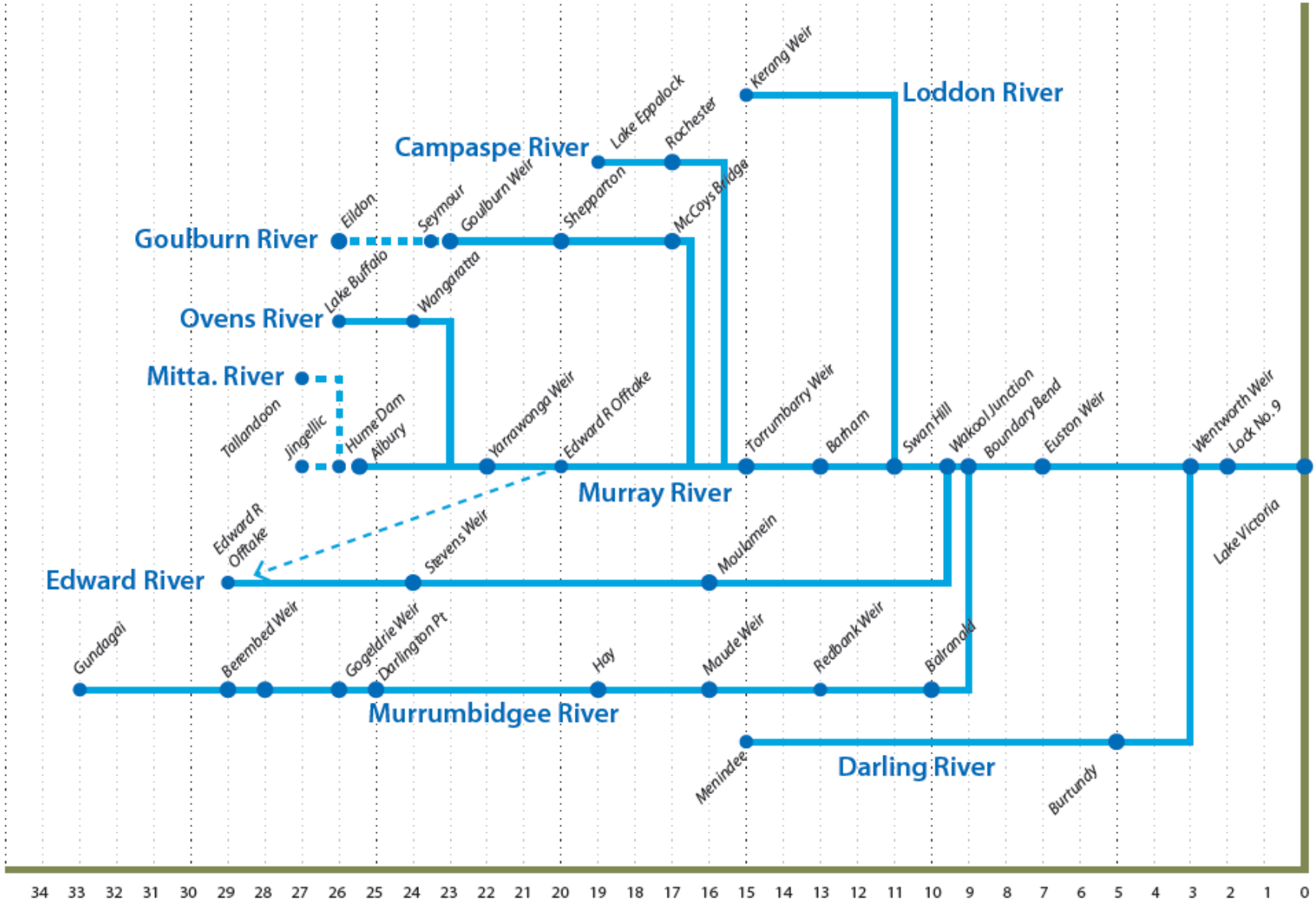


Figure 7: Murray River, System Travel Times for Regulated Flows

Barmah Choke

In times of flood the nominal channel capacity downstream of Yarrawonga Weir is 62,000 ML/day. However the channel capacity further downstream at the Barmah Choke is only about 8,500 ML/day Figure 8 shows the flow split between the Edward River and the River Murray and indicates that as flows increase a greater portion passes through the Edward River system than the Murray. The split in flows is an important consideration for determining the potential for overbank flows. Small to medium flows provides water to the Barmah-Millewa Forest and in periods of high flows the tributaries (such as Bullatale Creek, Native Dog Creek, Tuppal Creek and Taylors Creek) to the north of the River Murray are engaged.

During the irrigation season, regulated releases from Yarrawonga Weir should avoid unseasonal flooding of Barmah-Millewa Forest. As a guide, 10,600 ML/day can be released from Yarrawonga Weir, if about 2,000 ML/day is diverted along the Edward and Gulpa offtakes.

Capacities in the Edward-Wakool system may be relevant during multi-site watering. Refer to River Murray Operations for more information.

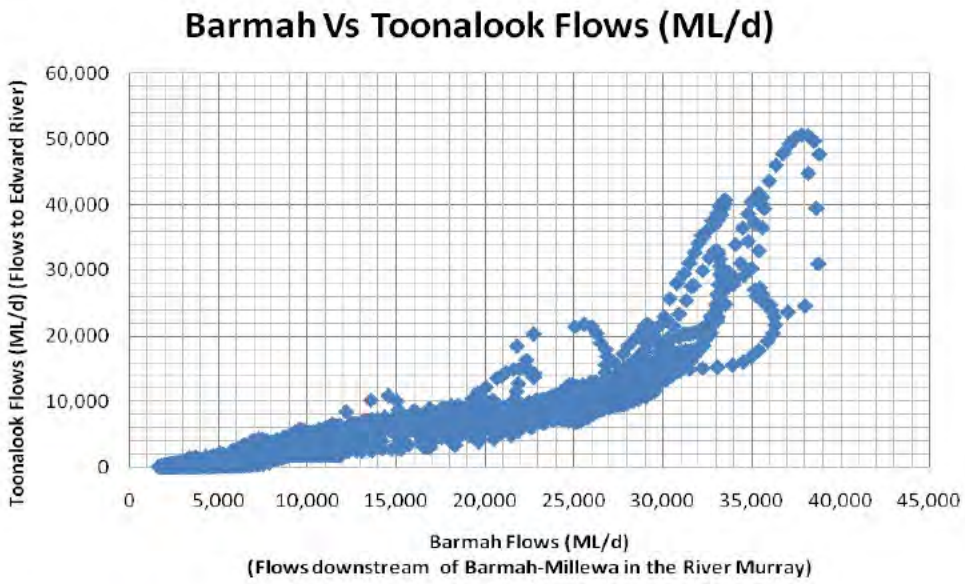


Figure 8: Barmah versus Toonalook flows (ML/d)

3.6 Relationship between River Flow & Inflows

The relationship between river flow and overbank inflows to Koondrook Perricoota Forest are shown in Table 4.

Table 4: Relationship between river flow and overbank inflows to Koondrook-Perricoota Forest (Updated from MDBA – 2012)

River flow ML/day	Inflow to forest ML/day	Inundated area		Evaporation ML/d	Seepage ML/d
		ha	% of total area of the Forest		
15,000	145	577	1.71	13	31
20,000	440	1751	5.19	40	93
25,000	2,250	5371	15.91	116	272
30,000	4,800	8,954	26.53	193	455
35,000	7,700	12,119	35.91	320	779

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4 GOVERNANCE

TLM is a joint initiative and is managed collaboratively by partner governments. The Murray-Darling Basin Intergovernmental Agreement (IGA 2004) outlines the governance arrangement for the implementation of TLM. The IGA 2004 is complemented by the TLM Business Plan which provides operational policies to guide the implementation of TLM, see Figure 9.

The groups with a direct role in TLM governance are Ministerial Council, the Authority, the Basin's Officials Committee (BOC), TLM Committee (TLMC) and the Environmental Watering Group. Detailed Governance and Planning arrangements for use of TLM water is contained within the Koondrook-Perricoota Icon Site Environmental Water Management Plan. See also Figure 9.

While the MDBA plays a key coordination role at a TLM-wide level, management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located. The ultimate responsibility to ensure the icon sites are successfully governed lies with the Icon Site Manager (Forests NSW for Koondrook-Perricoota). Nevertheless, both the MDBA and State Water Corporation will have key roles.

Forests NSW

Forests NSW undertake a number of roles in the operation of the Scheme. The agency is the land manager for the Koondrook and Perricoota State Forests under the *Forestry Act 1916*, is responsible for managing the Koondrook-Perricoota Icon Site for The Living Murray program, and is a co-Proponent for the Scheme, with the NSW Office of Water, under the *Environmental Protection & Assessment Act 1979*. Forests NSW is therefore responsible for sustainably managing the forest to preserve and provide the widest range of benefits to present and future generations. Forests NSW is also responsible for the effective operation of the Scheme in order to achieve the First Step Decision ecological objectives.

River Murray Operations – Murray Darling Basin Authority

The MDBA is responsible for directing operation of the Koondrook-Perricoota structures, as these works are an important component of the River Murray System works. River Murray Operations staff from the MDBA oversee and co-ordinate all water deliveries along the River Murray System. During operation of the Scheme, River Murray Operations staff will issue instructions on a day to day basis regarding flow diversion rates and regulator settings, the same as they do for other major works along the river system. Appropriate arrangements for onsite control of the works (responding to MDBA instructions) will be put in place by State Water.

State Water Corporation – MDBA Sites Manager

State Water is responsible for the operation and maintenance of all structures within the Scheme, (except Torrumbarry Weir) as well as delivery of water to the inlet channel. Operation and maintenance of the structures is undertaken as part of an asset agreement between the MDBA and State Water. Under this agreement, State Water is responsible for *"accounting for the assets, recording, reporting and audit as well as specific high level requirements in relation to construction, maintenance and operation of assets."* (MDB Agreement, Clause 55) It is anticipated that State Water may engage Goulburn Murray Water, Wakool Shire Council or other local contractors to undertake some operation and maintenance activities, if required.

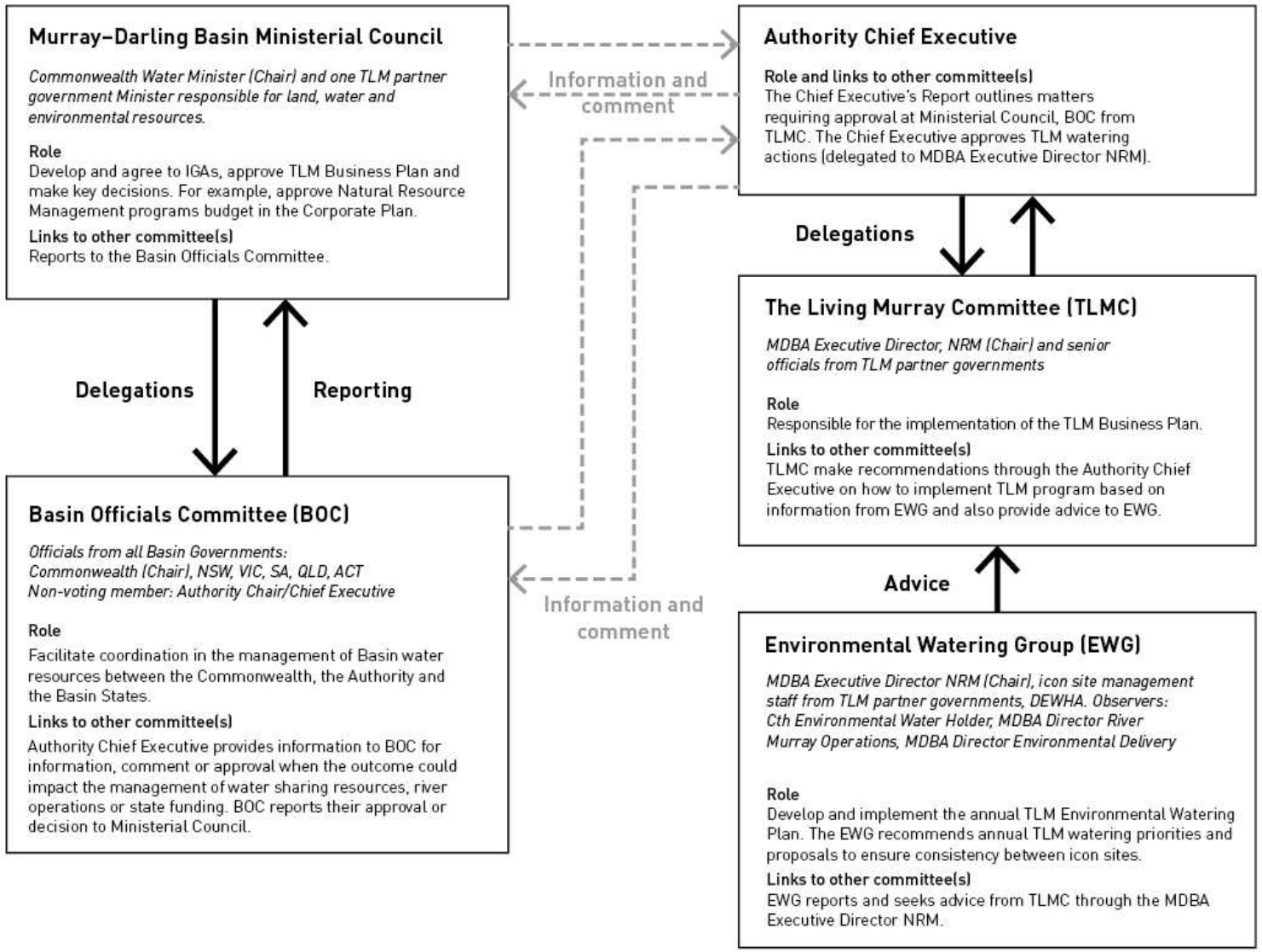


Figure 9: The Living Murray governance structure (source: Murray-Darling Basin Authority

Operations Committee

River Murray Operations will establish a small Operations Committee to provide advice to the MDBA regarding event management and day-to-day management of the structures during an event. Operations Committees will also be established for other sites along the river system as required.

The Operations Committee will include MDBA and jurisdictional representatives, including the persons actually involved in day-to-day management of the structures, MDBA Sites Manager (State Water), the Environmental Manager (Forests NSW) and ex-officio members (Murray CMA and Victorian representatives) as required. The Operations Committee will meet weekly, or as required, to provide feedback on how the operation is going and to plan ahead for the next week. Between these meetings, River Murray Operations will make the operational decisions required to implement the watering plan, taking into consideration the other water requirements along the river system.

One member of the Operations Committee will be responsible for stakeholder management during the event. Specifically, liaising with downstream landholders, informing the wider community and managing media releases. The Environmental Manager (Forests NSW) will be responsible for environmental monitoring, reporting and advice to River Murray Operations. A fish expert will report to the Environmental Manager and will be responsible for providing advice on fish risks and opportunities.

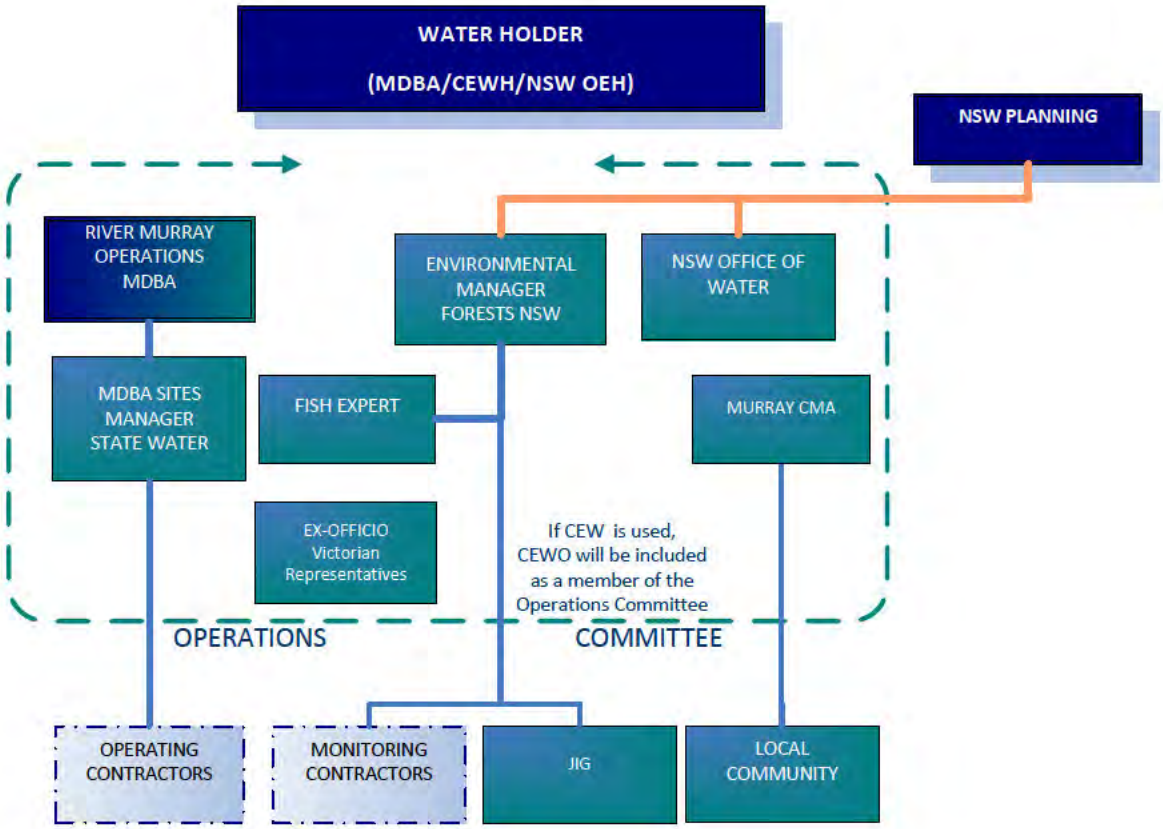


Figure 10: Institutional structure for event implementation

4.1 Planning Sequence

The Icon Site may draw upon a number of sources of regulated water. These include: TLM (MDBA), the Commonwealth environmental water (Commonwealth Environmental Water Holder), NSW Adaptive Environmental water (NSW Office of Environment and Heritage). Additionally NSW has sovereign access to their own Unregulated Flows – flows that are surplus to other requirements as described in the NSW Water Sharing Plans and in the Murray Darling Basin Agreement. There is also an unregulated flow component attached to TLM entitlements. The EWG is currently trialling how to best manage unregulated flow entitlements.

Before watering can commence, water must be made available by one or more water holders. This is generally done via a process of preparing and submitting watering proposals to the relevant water holders who then prioritise the proposals and approve those given high priority. Following approval of a watering proposal, the water holder will transfer water allocation from their portfolio to the Water Access Licence that is linked to the Scheme's Works Approval. Once the transfer is complete, a water order can be placed with State Water, enabling diversion to commence. Figure 11 below shows the approval process.

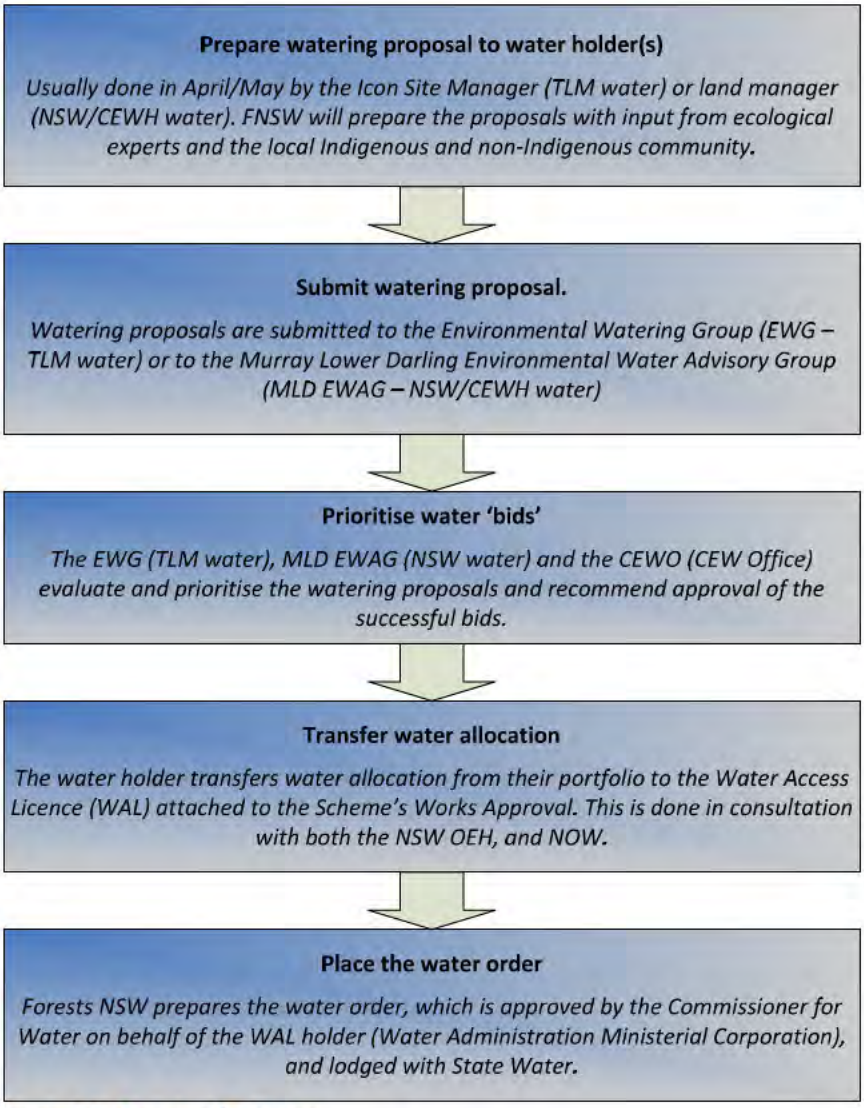


Figure 11: Approval Process

Governance and approval instruments for potential sources of water are summarised in Table 5. More detailed information on the water planning processes for both NSW and Commonwealth water (including TLM) is contained within Appendix A.

Table 5: Summary of statutory and governance arrangements for environmental water

	NSW Unregulated Flows	NSW Adaptive Environmental Water	TLM Water Holdings	Commonwealth Environmental Water
Water Holder	NSW	NSW	Partnership of the MDBA, NSW, Vic and SA	Commonwealth Environmental Water
Instrument	Water Management Act, Murray and Lower Darling Water Sharing Plan	NSW Annual Environmental Water Plan	Annual TLM Environmental Water Plan	Annual Water Use Strategies via the NSW Environmental Water Plan
Governance	Commissioner for Water. TLM/EWG approve access.	Minister for Primary Industries and Minister for the Environment	EWG, TLMC, BOC, MDB Ministerial Council	Commonwealth Environmental Water Office
Reporting requirements	Outcomes Evaluation Framework And Event Completion Report			

4.2 Approvals

Legislative and other required approvals for general operation of the Scheme are described below. These are 'Scheme-level' approvals and do not have to be renewed for each event.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

The project was referred to the Commonwealth on 6 October 2009. The Commonwealth advised on 20 January 2010 that the proposed activity, including operation of the Scheme, is not a controlled EPBC activity.

Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act)

NSW Planning issued Conditions of Approval Part 3A of the NSW *EP&A Act 1979* for construction and operation of the project on 15 August 2010. It is a requirement to submit an Operational Environmental Management Plan (OEMP), Compliance Tracking Program and Biodiversity Operational Plan for approval by NSW Planning. This Operations Plan is part of the OEMP. Any changes to the operational regime must be submitted for further approval.

Section 90 of the *Water Management Act 2000*

Under Section 90 of the *Water Management Act 2000* (WMA) the NSW Office of Water (NOW) requires a Water Supply Works Approval for diversionary works associated with the Scheme. NOW recognises the exemption provided by the approval under Part 3A of the *Environmental Protection and Assessment Act 1979*, but has requested that a Works Approval be sought in order to facilitate future water management activities. A Water Access Licence (most likely a Water Administration Ministerial Corporation Licence) must be linked to the Works Approval before diversion can commence.

As the MDBA Sites Manager, State Water will seek the Works Approval from NOW. Forests NSW, as the land manager, will support the application by providing evidence that State Water is entitled to construct and use the diversionary works.

Murray Darling Basin Agreement

The Scheme has been constructed under Clause 52, 'Part VIII – Construction, Operation and Maintenance of Works" of the Murray Darling Basin (MDB) Agreement (Schedule 1 to the Commonwealth *Water Act 2007*), Clause 66 'Procedures for Operation of Works' states:

> "*The Authority may, from time to time, determine procedures for the operation of works constructed or measures implemented pursuant to this or the former Agreement."*

This clause is further supported by Clause 68 'Operation of Works' which states:

> "*(1)The Contracting Government nominated to operate a work pursuant to paragraph 52(1)(b) must:*
> *(a) operate it in accordance with any procedures determined by the Authority under clause 66;"*

In addition, Clause 64 ' Declaration that Works or Measures are Effective' of the MDB Agreement states:

> *"At any time after construction of any work or implementation of any measure authorised pursuant to sub-clause 56(1) has commenced, the Authority may declare that work or measure to be effective for the purposes of this Agreement.*

Clause 65 'Maintenance of Works' addresses ongoing maintenance as follows:

> *"A Contracting Government nominated to construct a work pursuant to paragraph 52(1)(b) must maintain it and keep it effective for its original purpose, unless it has been declared ineffective pursuant to clause 70."*

Clause 69 'Performance of Joint Duties' will also be applicable to agreements for the operation and maintenance of the works, as follows:

> *"Where Contracting Governments are jointly under a duty to operate or maintain any works or implement any measures or to carry out any operation, any questions as to which Government is to perform that duty or carry out that operation shall be resolved:*
> *(a) by mutual agreement; or*
> *(b) if agreement is not possible, by the Authority."*

4.3 Event Design

The Scheme has been designed to provide the flexibility to divert a range of flows to ensure that specific event-level ecological objectives can be targeted. The adaptive management framework detailed in Figure 12 aligns with the expected delivery of unique events and the ability to re-evaluate and re-adjust during an event and between each event. Operation within this framework will be supported by a robust monitoring and reporting framework. An Event Monitoring Plan has been developed for operation of the Scheme. See Chapter 7 for more information on event design.

4.4 Reporting

Reporting templates (refer to Appendix B) have been developed for the following purposes:

- Event Design Report (Refer 'Event Level' within Figure 12): The Event Design Report represents a "line in the sand" prior to the operation of the Scheme's structures to enable evaluation against, during and on completion of the event. Assists in building the monitoring program based upon the particular event objectives and event hypotheses, in line with the event design process.
- Operational Reports (Refer 'Operations' within Figure 12): Generally, monitoring data will be collated by Forests NSW to produce weekly monitoring reports for consideration by the Operations Committee.
- Event Completion Report: The purpose of the Event Completion report will be to gather all information from the event to inform the adaptive management framework at a Scheme level. Importantly, the Event Completion report will also:
  - Evaluate the ecological response against the objectives for the event; *(SoC 5)*
  - Report on the volume of water diverted into and out of the Forest during each event, and

the hydrological response; *(SoC 7)*

- Report impacts on aquatic ecology to determine whether a fishway is required at the Barber Creek regulator. *(SoC 5)*

Reports will be developed in consultation with key stakeholder agencies, as appropriate.

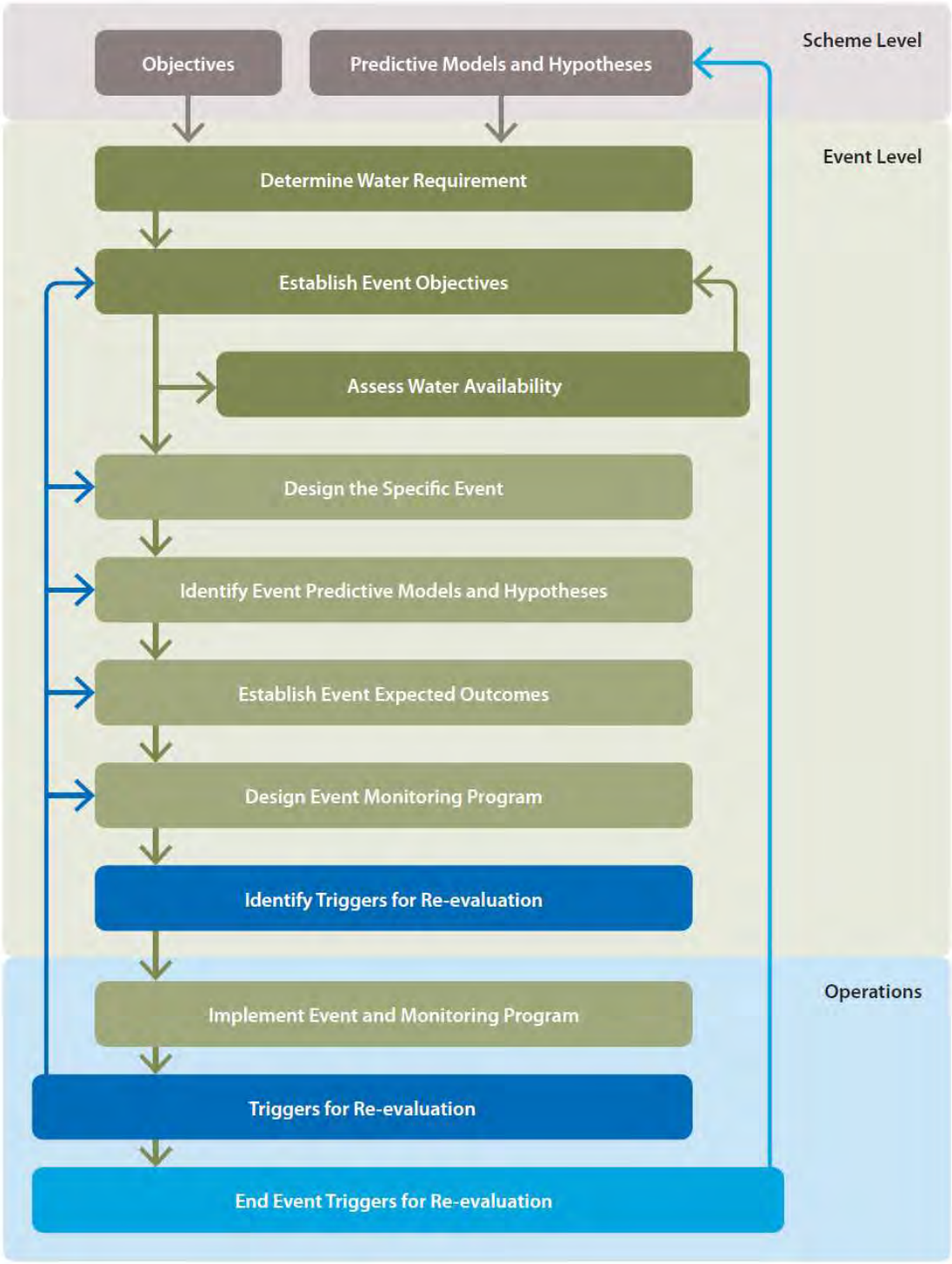


Figure 12: Adaptive Management Framework adopted for operation

5 DETAILS OF STRUCTURES

All infrastructure has been designed for a 100-year design life following precedent design practice developed over many years on similar types of infrastructure throughout NSW. Contemporary design codes have been used to ensure stability, durability and economic operation and maintenance costs. Wherever necessary, as directed by the Fish Passage Task Force, provision for fish passage has been considered.

The structures are divided into three groups determined by function; upstream inlet structures, downstream water retaining and outlet structures and the third group being a number of ancillary structures.

The upstream structures include the main inlet regulator and associated fishway and turtle ramp, inlet canal, two regulators on Swan Lagoon, River Road Bridge and the cut off wall at the downstream end of the canal.

The downstream group of structures include the main levee, the Return regulator and associated channels, Thule Creek regulator, Calf, Cow, Barber Creek and Runner A outlet regulators.

Ancillary structures comprise a number of gated culverts through the levee and three by wash structures on Barber Creek downstream of the forest. Risks here will be minimal and therefore not specifically addressed in the Operating Plan.

Note that some structures are capable of operating outside the approved regime. This section details the physical capabilities of the structures. See Chapter 6 for details of the approved operating constraints.

5.1 Upstream Structures

The upstream structures comprise the inlet channel, fishway and a number of regulators as follows.

Inlet Regulator and associated Fishways

The Inlet Regulator is a reinforced concrete structure sitting on a sheet pile cut off wall foundation. This structure regulates inflows into the forest from the Torrumbarry weir pool. It achieves this through the use of five overshot aluminium tilting gates approximately 3.6m by 3.9m. These gates have been incorporated due to lower morbidity for fish passage as well as low operation and maintenance costs.

The Inlet Regulator was designed to deliver up to 6,000 ML/day from Torrumbarry Weir pool with a design pool level of RL86.05 m AHD +/- 0.05m. Sensitivity is provided within the design for higher flows through the inlet channel depending on its roughness conditions. It is expected that a general level of maintenance will control vegetation growth within the Inlet Channel and it will therefore modestly provide 6,000 ML/day. Subject to confirmation with manufacturer AMWA, regarding the design of the gates, contingency within the hydraulic and structural design also allows for operation to 86.55 m AHD, which is above the flood of record. However the regulator is not designed to pass large debris for flood operation due to the restricted clearance to the hoist bridge.

Minimum flow occurs at the cease to flow levels for the Inlet Regulator which is RL83.18 m AHD;

the level of the top gate sill and downstream control on the Inlet Channel.

Delivery of flows through the Inlet Regulator is determined by ecological objectives. No constraints are imposed on flows within the range from 0 – 6,000 ML/day other than deciding on the best operating sequence for the gates when not all fully open to provide the best downstream flow conditions for the attraction of fish to the entrances of the fishways. It is expected that fish will move into the Forest during inflow periods. As flows reduce fish will be cued to make their way back upstream to exit the Forest. A dual fishway has been provided to facilitate this movement.

The dual 'vertical slot' and 'Denil' structure provides functionality both for small fish which are expected from spawning events promoted by the watering of the Forest plus sufficient attraction flows through the Denil structure to allow the larger fish to also exit. The fishway will operate over a tailwater range of RL83.752 to RL85.643 m AHD with the maximum upstream pool level of RL86.1 m AHD. Of this range, the small fish vertical slot fishway will cover tailwater levels RL83.752 to RL84.752 m AHD with equivalent flows of approximately 0 to 1,100 ML/day. The large fish Denil fishway will operate in tailwater range from RL84.635 to RL85.643 m AHD and equivalent flows of approximately 800 to 6,000 ML/day. The above is seen to meet requirements for small and large fish passage over the range of operational flows during a watering event.

A turtle ramp has been provided to enable the escape of turtles trapped downstream of the regulator as flows cease. No operational flow requirements have been set for the turtle ramp and this will need to be examined when watering trials are being carried out.

The gates are devoid of all permanently installed electrical operating gear and will be operated using a portable electric power pack both to reduce cost and the possibility of loss through vandalism.

Inlet channel

The inlet channel carries inflow 4km into the Forest where it intersects Bullock Head Creek, which then conveys water through the Forest into the many smaller creeks, runners and channels. The channel is designed to convey a maximum of 6000 ML/day, and is also designed to shed water into the Forest north (downstream) of the River Road bridge to promote further distribution of flows to the Forest. The channel achieves this by reducing in width over its length together with rising in a reverse grade against the direction of flow.

Water depths within the inlet channel for various flow rates are shown below in Figure 13.

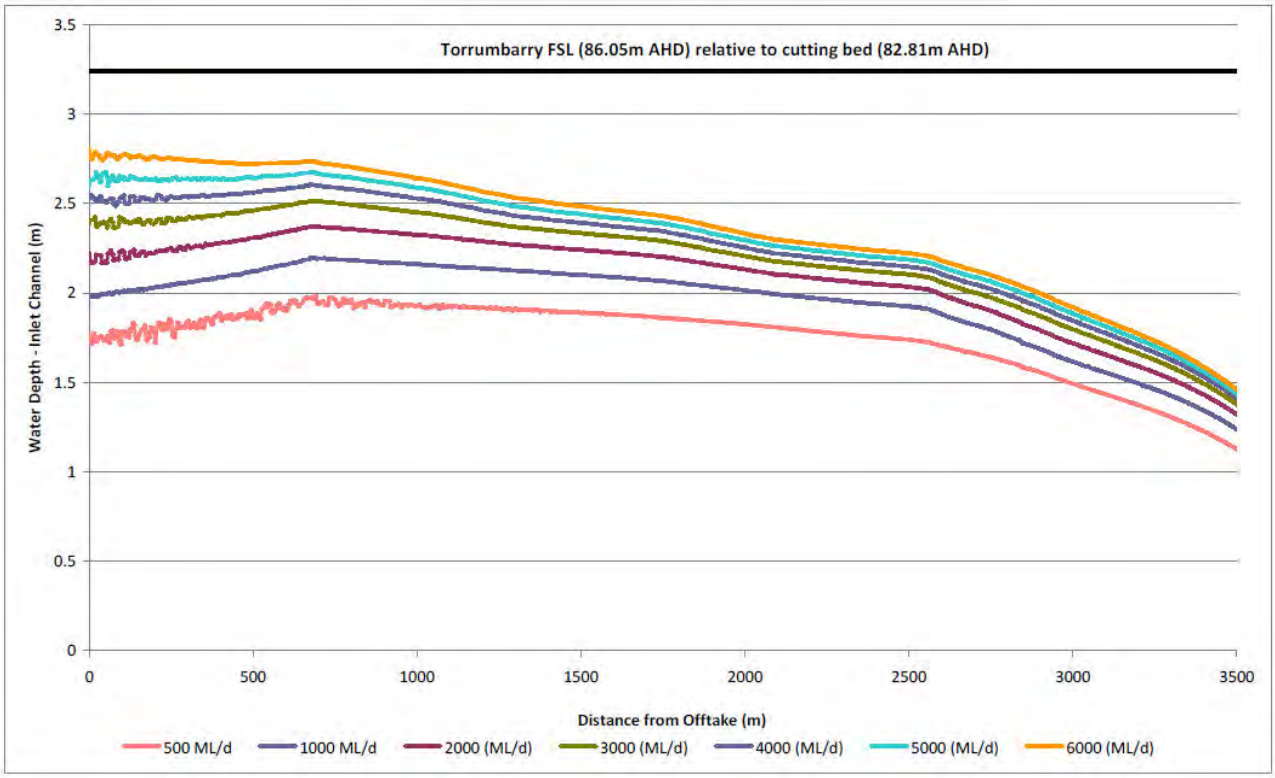


Figure 13: Water depth within the inlet the channel.

Swan Lagoon Regulators

During a flood Swan Lagoon is the first natural inflow point to the Forest downstream of Torumbarry Weir. It is also the first location where water would discharge from the Forest into the Murray River during a managed watering event if these regulators were not in place. Swan Lagoon structures consist of two regulators:

- Swan Lagoon Upstream – forms a control at its upstream connection to the Murray River
- Swan Lagoon Downstream – forms a control at its downstream connection to the Murray River

These regulators are simple and economic structures based on a driven sheet pile wall, steel operating deck and simple aluminium vertical lift gates. One gate features an under and overshot combination gate to facilitate the safe discharge of fish into the river should they become trapped in the lagoon.

Many such regulators have been successfully constructed in recent years along the Murray River. The structures will be operated with a portable power pack to minimise costs and loss through vandalism. Access will be via boat from Torrumbarry Weir.

The operation of Swan Lagoon is expected to vary dependant on conditions predicated in the Murray River. It is designed with the intent to adaptively manage its operation dependant on ecological and hydrological conditions. The design was carried out such that overbank flows in flood events could pass with an acceptable small restriction through each regulator on lifting of the gates. It is anticipated that the gates will always be fully open, except during a managed watering event, to allow the passage of natural flood inflows into the Forest from the Murray River.

It is anticipated that the gates will be closed prior to a managed watering event. Opening of the dual leaf gate will be carried out at a stage within the recession of operation. In terms of the operational constraints to minimise injury to fish and the potential for erosion on the Murray River side of the structures, initially it is suggested the upper leaf on each central gate should not be lowered until the pool in the Forest behind the regulators has lowered to RL83 and RL82.4 m AHD for the downstream and upstream regulators respectively. Each overshot leaf should be opened 0.3m below the above pool levels, that is, top of gate RL82.7 m AHD for the downstream regulator and RL82.1 m AHD for the upstream regulator. The 0.3m gate openings should be carried out in steps as quickly as possible, while allowing the tailwater level on the Murray River side to build up with each step. Following this, the top central gate leafs can be fully opened and then the central gates fully raised, in turn followed by fully raising the side sluice gates when the forest pool level has fully dropped.

5.2 Downstream Structures

The downstream structures comprise the levee, stoplog regulators across Thule Creek and the creeks flowing downstream across the Barham-Moulamein Road, and the return regulator and channel conveying water back to the Murray River.

Return regulator and channel

This is a similar structure to the inlet regulator comprising three aluminium tilting gates, an integrated road bridge carrying River Road over the return channel and a drop structure providing safe discharge from the forest floor down into the river channel. Operation is as for the other similar structures by a portable power pack.

The Return Channel design capacity flow is 1,850 ML/day subject to flows of at least 2,000 ML/day over Torrumbarry Weir. If flows in the Murray River are less than the design flow of 2,000 ML/day, flows through the Return Channel would need to be throttled down. On the basis of advice during the design, it is expected that a Murray River flow of 2,000 ML/day is a minimum flow at times of operation. Flows through the return channel are governed by the bed level of RL77.32 at the upstream end of the Return Channel, the operation of the Return Channel Regulator gates and/or the water levels in the Murray River. Table 6 contains a summary of the theoretical minimum pre-existing Torrumbarry Weir flows required for various return channel flows.

Table 6: Theoretical Minimum Pre-existing Torrumbarry Weir Flows Required for Various Return Channel Flows

Return Channel Flow (ML/d)	Required Tailwater Level in Murray River (AHD)	Total Combined Flow – Return Channel plus Torrumbarry Weir[1] (ML/d)	Minimum Required Pre-existing Torrumbarry Weir Flow[2] (ML/d)
280	RL74.92	2,200	2,020
792	RL75.31	3,850	3,060
997	RL75.4	4,250	3,250
1,219	RL75.55	4,900	3,680
1,454	RL75.66	5,300	3,850
1,850	RL75.81	5,950	4,100

Notes:

1. Rounded to the nearest 50 ML/d
2. Rounded to nearest 10 ML/d

It is expected that the Return channel will be managed to the design rating throughout its operation cycle. The Return Channel rating curve is provided in Figure 14 below. Return Channel flows may be influenced during flood events and will cease to flow when water levels in the Murray River exceed those in the forest, this is expected to occur at around 27,000 ML/d downstream of Torrumbarry. Under no circumstances should water flow from the Murray River into the Forest via the Return Channel.

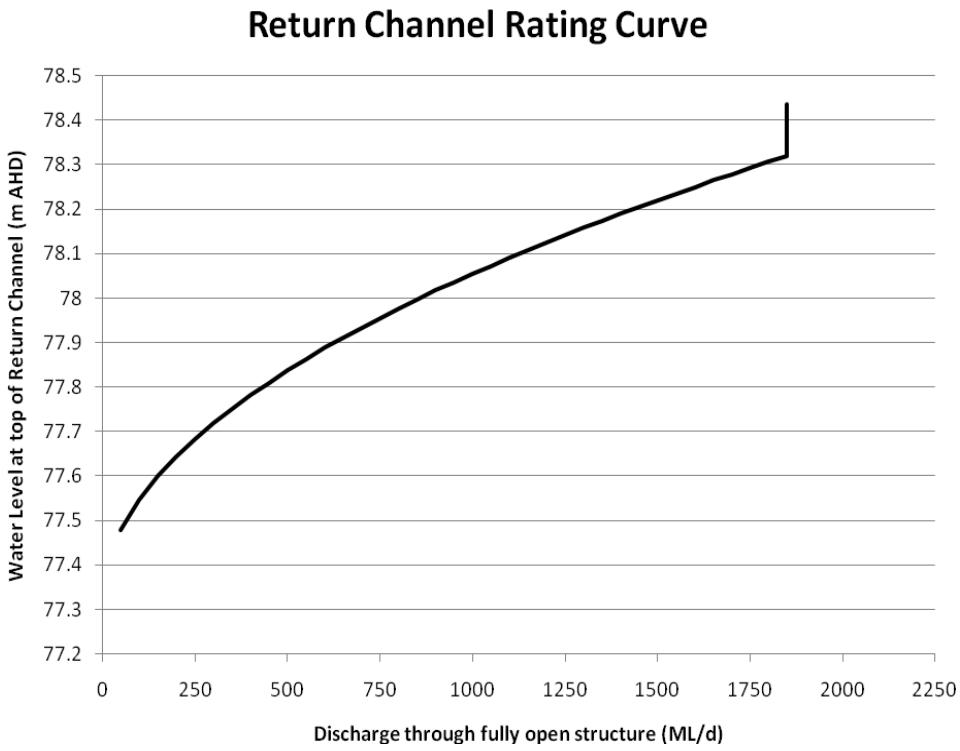


Figure 14: Return Channel Rating Curve

Stoplog Regulators

Four stoplog regulators are provided at the Moulamein Road and one on Thule Creek. Stoplog regulators include:

- Barber Creek
- Cow Creek
- Calf Creek
- Runner A
- Thule Creek

These structures assist in controlling outflows to meet downstream constraints. The design of these structures is based on the most economical strategy to close off access across the downstream floodways whilst still maximising sufficient water flow area for a natural flood so as not to disadvantage the passing of that flood and create an unacceptable afflux.

Piers are designed to provide flow characteristics that facilitate upstream fish passage in low velocity flow by providing small adjacent rest areas.

The structures are reinforced concrete abutments, apron slabs and piers constructed on sheet pile cut off foundation walls. The multi-bayed structures close off the flow area by the introduction of vertical concrete stop logs spanning between vertical slots in the piers. The bays are approximately

5.5m wide with a maximum height of 7m at Barber Creek and minimum height of 3.5m at Calf Creek.

The concrete logs are installed or removed with the use of a normal cable crane and the use of a latching beam that engages the logs. Such a technique removes the need for an expensive specialist crane and allows a local crane to be hired at low cost to facilitate the operation. A duplicate latching beam will be produced to facilitate more rapid operations should the need arise.

The maximum operational design pool level for all the stoplog regulators adjacent to Moulamein Road is RL78.5 m AHD. This water level is governed by the design freeboard allowance of 0.3m for the levee. The design pool level for the Thule Creek Regulator is 79.45 m AHD.

During operation outside of an overbank flood event, downstream flows were designed to be limited to 250 ML/day through Barber Creek Regulator. However, whilst the design was progressing there was awareness that flows out of the forest may need to increase through Barber Creek Regulator and flexibility has been incorporated within the design of that structure for increased flows via a gated outlet. For this purpose, the Barber Creek structure has combination vertical lift gates to facilitate flow regulation. It was seen as an operational advantage to provide a gated outlet to meet variable downstream flow requirements through the Barber Creek Regulator, rather than via the more difficult operation using stop log removal.

The Barber Creek structure is designed to facilitate downstream fish passage through the gated outlet. This has been achieved by the provision of a plunge pool downstream of the outlet. The plunge pool has been designed to provide adequate tailwater depth for the protection of fish at a minimum discharge of 250ML/day via the gated outlet. This is estimated to correspond to a 0.72m opening of the upper leaf of the combination gate below the design pool level of RL78.5 AHD that is, corresponding to a top of gate of RL77.78 m AHD. Below 250ML/day and with the pool at the design level of RL78.5 m AHD, some injury to fish passing over the gate can be expected until the tailwater level and corresponding plunge pool depth has been established for this minimum design discharge. Operationally therefore in terms of downstream fish passage, it is suggested the combination gate be initially left fully open at the commencement of a watering event and then gradually closed maintaining a flow of approximately 250ML/day as the pool level behind the regulator rises.

It is noted that once plunge pool tailwater conditions for the minimum design flow of 250ML/day have been established, there are no further restrictions that are currently foreseen on the operation of the combination gate in regard to safe downstream fish passage and downstream erosion potential. It is expected that the combination gate should be able to be opened to any discharge, with the pool at the maximum design level of RL78.5 or lower, up to an estimated maximum outflow of approximately 7,500ML/day when fully opened (at maximum upstream pool RL78.5). This ignores the impact of such a large flow on out of bank flooding, damage to block banks and/or damage to other property in the downstream Barber Creek system.

The intention of the design is that all regulators apart from Barber Creek Regulator will not be operating (ie closed), with the exception of periods of overbank floods where it is envisaged that all the stoplog regulators would be fully open. The design allows for flood flows to be discharged through the stoplog regulators via uncontrolled translucent through-flows (that is flows in equalling flows out).

On all stoplog regulators, the design of the concrete aprons and erosion protection downstream of the stop log bays caters for the stripping of the top stop logs through any single bay to achieve as

close as possible to a 250ML/day flow (but not less than 250ML/day) with the maximum design pool level upstream of the structure. With the design pool level on the upstream side this limits the maximum permissible flow through a single stoplog bay to the discharges shown at Table 7 below. These are the maximum flows through each structure at maximum design pool RL78.5 m AHD with a single stop log bay operating.

There was no requirement for the design to cater for safe downstream fish passage under these conditions with the stop log bays operating. Consequently fish injuries and fatalities could be expected due to insufficient tailwater depths above the concrete aprons. Total discharges through each structure can be increased beyond these values by operating adjacent bays and then further stripping stop logs across the bays at the particular structure to achieve increased flows steps corresponding to Table 7.

Table 7: Single bay flow limitations & suggested incremental flow steps for stop log operation

Regulator				
Barber Creek	Cow Creek	Calf Creek	Runner A	Thule Creek
250 ML/day	409 ML/day	280 ML/day	486 ML/day	405 ML/day

Levee

The levee extends for approximately 40km from the Thule regulator on the northern boundary around the downstream end of the forest and returns back upstream on the western boundary to approximately the Return regulator.

The levee is an average height of 1.5 metre high with a 4-metre crest width, 1 in 2.5 batters and 4 metre wide maintenance strips at either side of the batters. It is constructed from material borrowed from adjacent pits. The crest will be topped with gravel across the 5km downstream regulator section to facilitate crane access otherwise it is topsoiled and mulched on the outside batter with tub ground material from cleared trees.

The position of the downstream levee was selected to maximise the area of forest that will be inundated, and minimise the area of private property affected. The western portion of the levee is located in the vicinity of the existing licensed levee protecting the town of Barham from floodwaters. As such, Barham is now provided with an improved level of flood protection as the downstream levee has a higher standard of construction and maintenance relative to the existing levee.

By-washes

Three by-washes are required on small block banks downstream of the levee on Barber Creek. As the existing block banks would not survive discharge of more than 200ML/day the by washes assist in conveying flows up to 500ML day around the existing structures. They consist of excavated channels in the current creek bank around the banks plus concrete aprons and a small number of stop logs where required. The stop logs will be removed prior to initiating a managed event, and will be reinstated during the recession phase.

5.3 Risks Associated with Structures

The risks inherent in the operation of each structure are categorised as:

- Occupational health and safety risks to operators (OH&S)
- Risks to the condition and stability of the structures (Structure)
- Risk to members of the public (3rd Party)

Table 8: Risk Assessment - Structures

Risk	Mitigation Measure
Occupational, Health & Safety	
Operation and maintenance risks	Safe work method statements will be developed for all structure operations and maintenance activities
Structure	
Damage to operating plant due to inappropriate operations	Operation and maintenance manuals will be produced for each structure
Instability caused by erosion	Regular inspection of the structures will include an examination of areas of erosion caused by flows and remediation will be expedited
3rd Party	
Forest visitors affected by rising flows	Forests NSW will put in place a warning system using media and/or patrols to ensure that members of the public are informed of watering events
Falling from structures	Appropriate levels of fencing and gates will be used where required
Unexpected regulated flows passing down Barber Creek	Managed watering events organised by the Icon site manager will have no natural link to weather conditions. Flows are restricted to 250ML/day downstream of the Scheme and into Barber Creek, so flooding will not be a problem. However due to the unexpected nature of the flows it will be necessary to inform riparian landholders. Operators will inform these landholders prior to releases commencing.
Overbank flows passing down Barber, Calf and Thule Creeks	When a managed event is overcome by overbank flows it will be necessary to pass increased flows into Barber, Calf and Thule Creeks. Operators will inform landholders of these increased flows prior to releases commencing even though there is a link to natural weather and river flow conditions.

Erosion has been identified as a risk in and around all the inlet and outlet structures. Regular inspections following a watering event will monitor any erosion which may contribute to the security of the structures in a following event. The work crew involved in this type of work will be able to access geofabric and rock rip rap to repair any significant erosion prior to any future event.

5.4 Rehabilitation of Construction Sites

A Rehabilitation Plan has been developed that ensures temporary disturbance areas are rehabilitated. All areas that have been temporarily disturbed by construction activities have been rehabilitated to a condition reflecting the natural conditions of adjacent areas. Generally, disturbed areas have been allowed to regenerate naturally and it is expected that the passage of floodwaters would deposit sediment and seeds that would assist this process.

Monitoring plots, including baseline condition monitoring plots will be established within the borrow pit areas. Baseline monitoring plots would be established to monitor change in Forest condition after environmental watering. The condition would be recorded through the ongoing monitoring program and would report separately on improvement in the condition of the borrow pit sites achieved.

In addition, Forests NSW will select and apply weed control measures consistent with currently recognised best practices, in accordance with Principles of Environmental Care and with State policies, procedures and approved usage. Weed control will be guided by the *Noxious and Environmental Weed Control Handbook 2004/2005*.

5.5 Summary of Structures

Table 9 provides a summary of the Scheme's structures.

Table 9: Summary of structures

	Purpose of Structure	Description	Minimum Capacity	Maximum Capacity
UPSTREAM STRUCTURES				
Inlet Channel	Diverts and distributes water into the forest	4 km channel with reducing width over it's length with reverse grade against the direction of flow	NA	Up to 6000 ML/d
Inlet Regulator	Regulates inflows into the forest	Five overshot aluminium tilting gates approximately 3.6m by 3.9m.	No restriction on minimum flow. Cease to flow level of RL 83.18m AHD	Up to 6000 ML/d with a design weir pool level of RL 86.05m AHD
Dual Fishway	Allow Fish Passage as inflows reduce	Vertical slot and Denil Structure	Vertical slot (small fish): Tailwater range for operation is 0 ML/s (RL83.752m) – 1,103 ML/d (84.752 m AHD). (RL83.18 is the sill level of the offtake regulator not cease-to-flow) Denil (large fish): Tailwater range for operation is RL84.635 - 85.643m AHD.	
Swan Lagoon Regulators	Control discharge to the Murray River	Aluminium vertical lift gates including one under and overshot gate.	NA	NA
DOWNSTREAM STRUCTURES				
Return Channel & Regulator	Return water to the Murray River	3 aluminium tilting gates	Flows up to 1850 ML/d provided flows @ Torrumbarry Weir > 2000 ML/d	
Levee	Allow control of outflows	40 km from the Thule Regulator around the d/s end of the forest and back u/s on the western boundary of the forest.	RL 78.8m AHD with average height of 1.5 m high with 4 m crest width and 1 in 2.5 batters. Designed to operate up to RL 78.5m AHD with 300mm freeboard.	
StopLog Regulators	Close access across downstream floodways, but maximise water area for a natural flood.	Multi-bay structure wth vertical concrete stop logs with each bay approximately 5.5 m wide with operational design pool level of RL78.5m AHD. Barber Creek Regulator has combination vertical lift gates	Minimum height of 3.5 m @ Calf Creek.	Maximum height of 7 m @ Barber Creek. Refer to Table 7 for single bay flow limitations
Bywashes	Assist in conveying flows around three existing blockbank structures.	Excavated channel within the creek bank with concrete aprons & a small number of stop logs where required.	Conveys flows up to 500 ML/d without damage to blockbanks	

6 KEY OPERATIONAL THRESHOLDS

6.1 Summary of operation types

There are two distinct types of flood events that occur at Koondrook-Perricoota. These are:

1. 'Managed' events where all inflows are directed into the forest from the Torrumbarry weir pool via the inlet channel.

2. 'Overbank' events where inflows occur via Swan Lagoon and other effluents, primarily downstream of Torrumbarry weir. Overbank flows may occur in combination with managed flows. These events are termed 'Hybrid' events.

6.1.1 Managed Events

Managed events use water that has a legal entitlement for environmental purposes, for example those entitlements administered by TLM, CEWO or NSW. These entitlements consist of water that can be called from storages and/or from declared unregulated flows. The use of water with an environmental entitlement means that managed events will be subject to a high level of scrutiny by water holders and the broader community, and monitoring for water accounting and ecological response is particularly important. Environmental risks are higher under managed operation because the timing, extent and depth may differ from natural events.

Managed events can be planned in advance and both inflows and outflows prescribed. Operation of the structures will be similar in all managed events as follows:

- Inlet regulator open to achieve the desired inflow;
- Swan Lagoon regulators closed to avoid direct flow back to the river channel;
- The return channel regulator will be open to return as much water to the Murray as possible and to assist with managing the level of the pool in the forest;
- Thule Creek regulator will be closed as per the Project Approval; and,
- Downstream regulators will be managed to release 250 ML/d (or less) as per the current Project Approval. This will most likely be released from the Barber Creek regulator, with the others closed.

Managed events will be individually designed in response to the condition of the forest, water availability and learnings from previous events (see Chapter 7). In consultation with key agencies, Forests NSW/ Icon Site Manager has developed a variety of operational scenarios that target key ecological outcomes dependent on water availability. The MDBA has undertaken extensive hydrodynamic modelling simulation of each scenario with the MikeFlood modelling software.
Table 10 summarises the four managed scenarios which are detailed below.

Scenario 1:

This scenario is a low flow scenario targetting wetland health. This is likely to be the most frequently used managed scenario, occuring typically from August whenever environmental water is available and overbank flows have not recently occurred. This scenario may also be used during dry periods to sustain refugia, when larger volumes are required but not available. Frequency of ponding at the downstream end of the forest creates the greatest risk arising from this scenario, with some ecological communities receiving flows more frequently than desired.

Scenario 1 consists of a peak inflow of 2,000 ML/day for 6 weeks with ramp up and ramp down periods of 3 days. The modelled maximum indundation area is 8,000 hectares, with greater than 5,000 hectares inundated for 34 days. Outflows directly to the Murray River via the return channel peak at 500-600 ML/d. Barber Creek outflows continue for 120 days. Water is expected to remain in the wetlands for up to 3 months. This scenario is modelled to consume approximately 42 GL, with a maximum downstream water level of 77.3m AHD.

The inflow and outflow hydrographs for Scenario 1 are shown in the figures below. Map of inundation extent, duration and key depth profiles are provided in Appendix D.

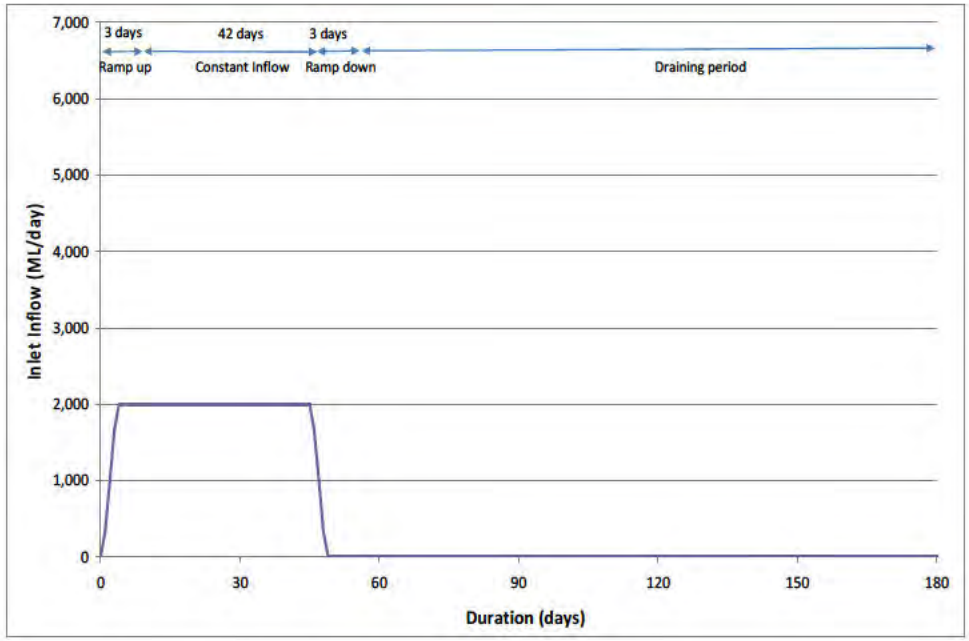


Figure 15: Scenario 1 – Inflow Hydrograph

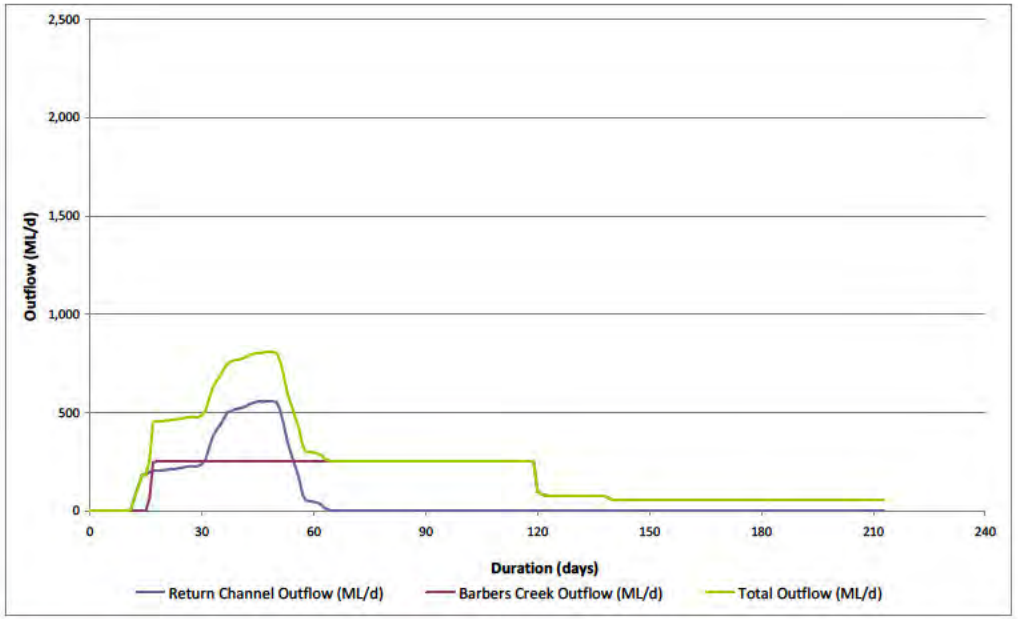


Figure 16: Scenario 1 – Outflow Hydrograph

Scenario 2:

Scenario 2 is a pulse of water, aimed at providing emergency watering to River Red Gum communities, and recruitment opportunities for River Red Gum. Wetlands will also benefit from this scenario. This scenario will be used infrequently, following extended periods without broad scale flooding, or when water is unavailable to deliver the preferred '100 day flood' (Scenario 4). This scenario may be used to pre-wet the forest in anticipation of a short overbank event. The ramp down period is likely to be staged in order to facilitate the exit of native fish from the forest.

This scenario was modelled with a peak inflow of 6,000 ML/d for 26 days with ramp up and ramp down periods of 10 days. Modelled extent peaks at 16,000 hectares with greater than 10,000 hectares inundated for 36 days. The return channel flows at full capacity (1850 ML/d) for approximately 10-15 days. Outflows via Barber Creek occur for around 190 days. Wetlands are expected to retain water for at least 6 months. Modelled water consumption is 90 GL. The maximum downstream water level is 78.5m (full pool level).

Risks arising from this scenario include those associated with pooling to the design height against the downstream levees. Recruitment of River Red Gum seedlings may fail if not followed by local Spring rain.

The inflow and outflow hydrographs for Scenario 2 are shown below. Map of inundation extent, duration and key depth profiles are provided in Appendix D.

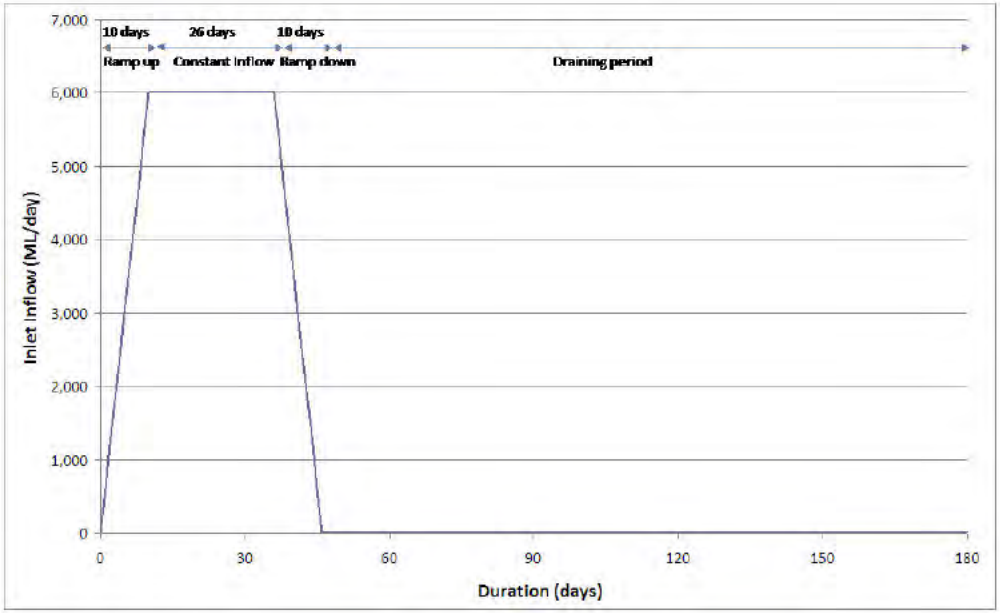


Figure 17: Scenario 2 – Inflow Hydrograph

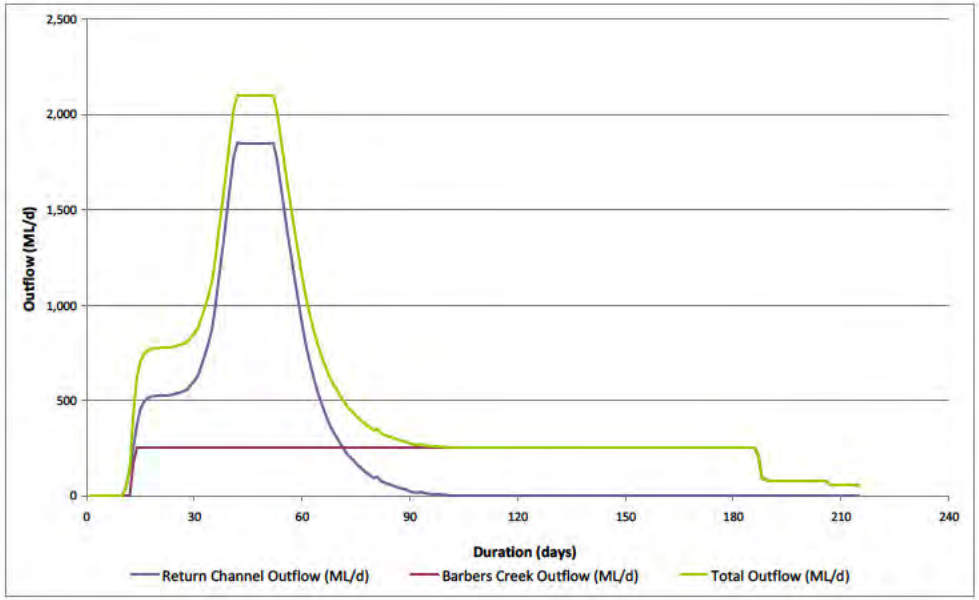


Figure 18: Scenario 2 – Outflow Hydrograph

Scenario 3:

Scenario 3 is a low flow scenario aimed at providing extended duration of flooding. This is expected to benefit breeding of waterbirds and may assist with achieving spawning of native fish. This scenario may be used in isolation but is most likely to be used to extend short duration overbank events in order to facilitate successful fledging of breeding waterbirds if a breeding event is triggered. This scenario has the benefit of providing extended flows to wetlands while minimising development of a pool at the downstream end of the forest.

Scenario 3 has a peak inflow of 2,000 ML/d for 30 days and a subsequent inflow of 500 ML/d for a further 60 days. Maximum inundation area is modelled at 6,700 hectares, with greater than 5,000 hectares inundated for 76 days. The return channel is engaged for approximately 90 days at very low flows (65 days @ <100 ML/d and the remaining 25 days @ < 250 ML/d). Outflows via Barber Creek are expected to continue until around day 150. Water is expected to remain in the wetlands for around 5 months. Modelled water consumption is approximately 26 GL. The maximum downstream water level is expected to be 77.1m.

The inflow and outflow hydrographs for Scenario 3 are shown below. Map of inundation extent, duration and key depth profiles are provided in Appendix D.

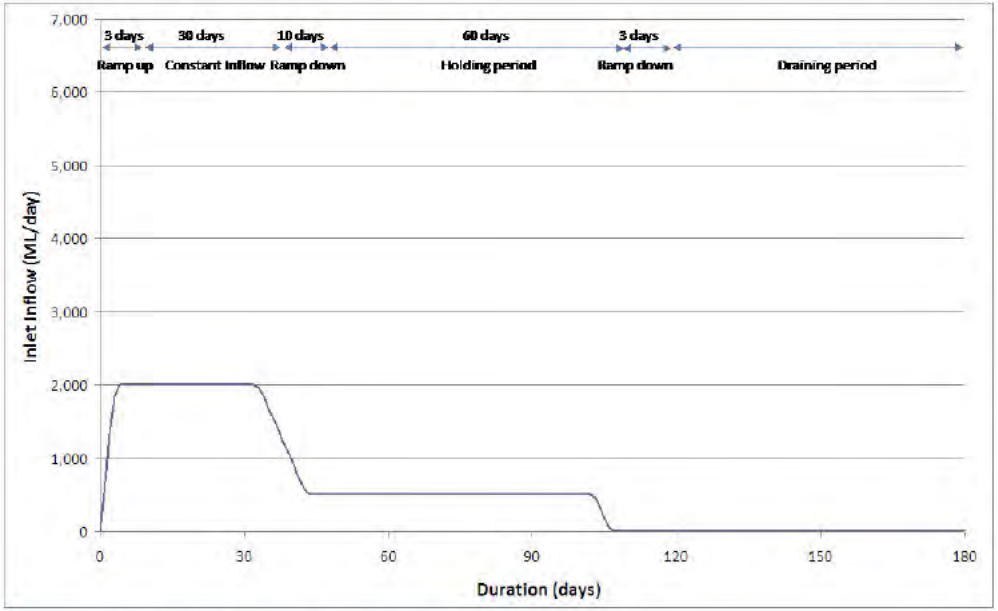


Figure 19: Scenario 3 – Inflow Hydrograph

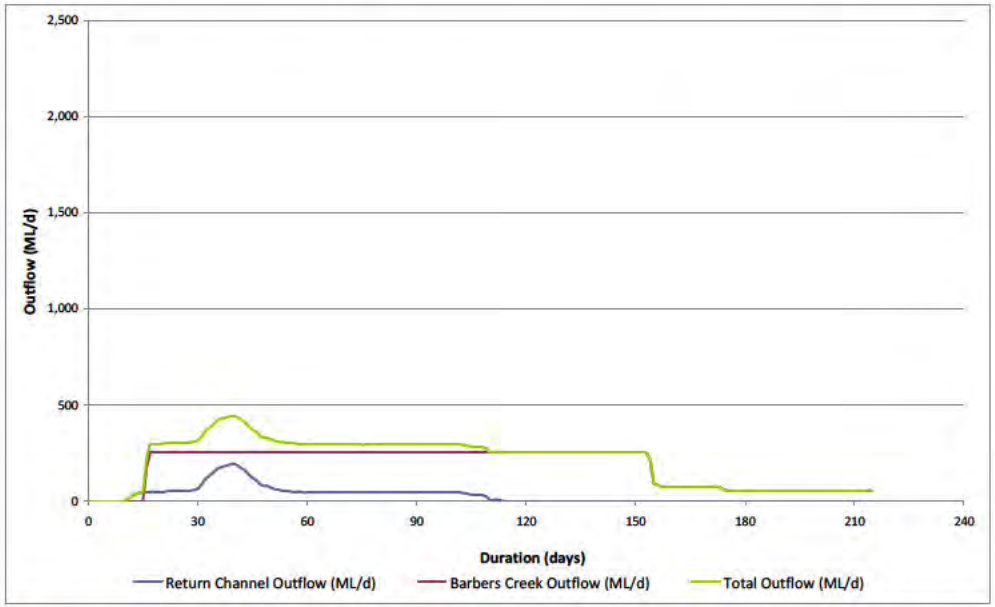


Figure 20: Scenario 3 – Outflow Hydrograph

Scenario 4:

Scenario 4 is the peak event that the scheme can generate. The aim of this scenario is to provide a '100 day flood' to the area of the forest that historically supported a flood-dependent understorey. The scheme is unable to deliver the full 100 day to flood to the entire target area because of downstream constraints, but will nevertheless deliver substantial benefits to a large area of River Red Gum communities (including understorey plants) and wetlands. This scenario is expected to be used whenever a similar extent has not been achieved in the previous 2 to 3 years, and sufficient environmental water is available. Contrary to the modelled scenario, the ramp down periods are likely to be staged to provide opportunity for native fish to exit the forest.

Scenario 4 has a peak inflow of 6,000 ML/d followed by a lower inflow of 2,600 ML/d (maximum maintainable inflow at full Torrumbarry pool level). The modelled flood extent peaks at 16,000 hectares with greater than 10,000 hectares inundated for over 90 days. The return channel is used to full capacity for around 65 days. Outflows via Barber Creek occur for over 200 days. Water is expected to remain in the wetlands for 8 months. The downstream water level is maintained at full pool level for around 65 days. Modelled water consumption is approximately 115 GL. This scenario has a number of inherent risks, including:

- Overwatering of grey box communities due to the long inflow period
- Overwatering of downstream communities due to the extended, deep, ponding period
- Water quality risks arising from ponding into summer
- Risks arising from managing the large pool of water (eg levee damage, seepage to neighbours, groundwater rise).

The inflow and outflow hydrographs for Scenario 4 are shown below. Map of inundation extent, duration and key depth profiles are provided in Appendix D.

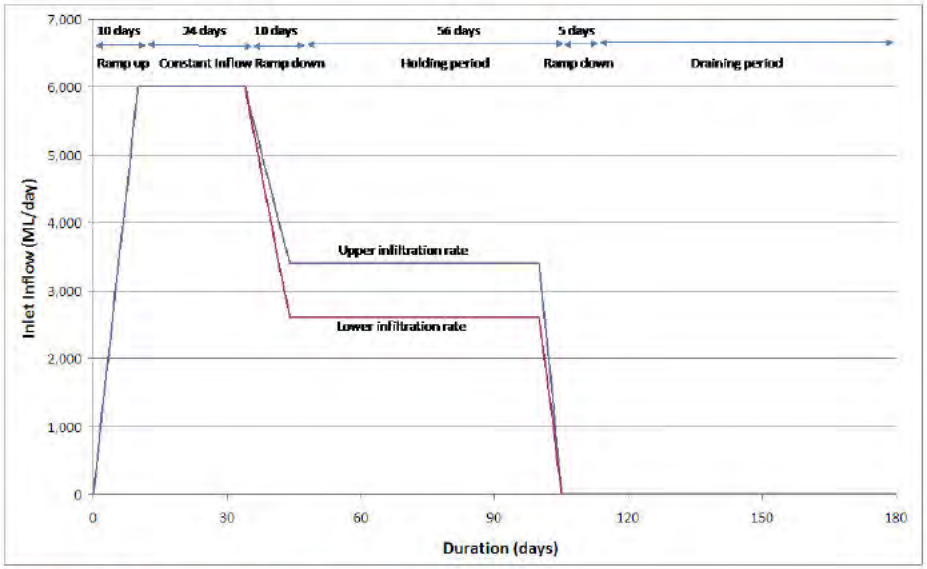


Figure 21: Scenario 4 – Inflow Hydrograph

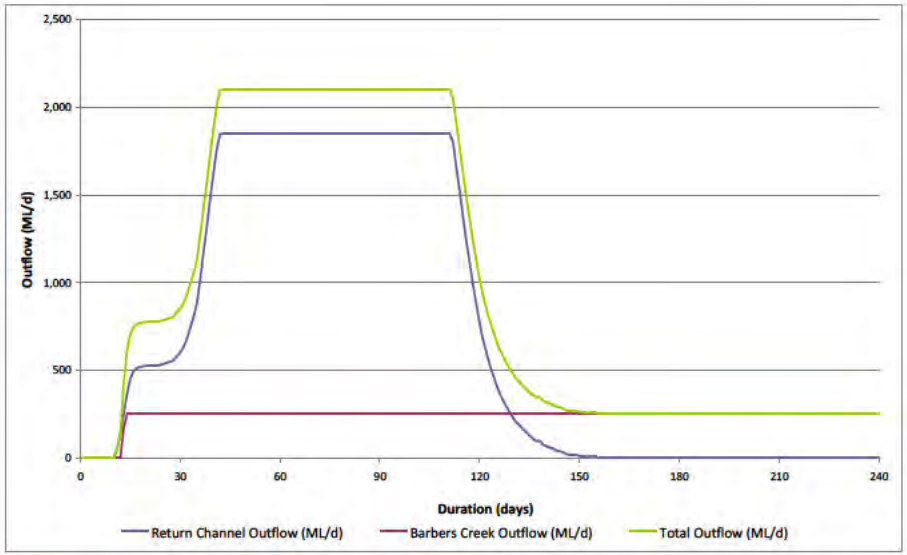


Figure 22: Scenario 4 – Outflow Hydrograph

Table 10: Summary statistics for Modelled Scenarios 1-4

	Ecological profile		Hydrological profile					
Scenario	**Key event objectives and target community**	**Relevant TLM objective(s)**	**Inflow (ML)**	**Outflow (ML)**	**Water use and evaporation (ML)**	**Maximum Inundation Area (ha)**	**Maximum ds water level (m AHD)**	**Duration (days)**
1 - Small event 'spring flush'	Maintain or improve wetland health. Create refugia during dry periods.	80% of permanent and semi-permanent wetlands in healthy condition. Healthy populations of resident native fish in wetlands.	90,000	48,000 8,000 Return to River Murray via return channel 40,000 to Wakool River via Barber Creek	42,000 (Seepage = 24,900 ML & Evaporation = 17,100 ML) **	8,000 (>5,000 ha inundated for over 34 days)	77.3	118 Start 1st Aug End 27th Nov
2 - Short 'pulse'	Sustain River Red Gum communities. Create recruitment opportunities for River Red Gum.	30% of River red gum forest in healthy condition.	216,000	127,000 64,000 Return to River Murray via return channel 63,000 to Wakool River via Barber Creek	89,000 (Seepage = 49,800 ML & Evaporation = 39,200 ML) **	16,000 (>10,000 ha inundated for over 36 days)	78.5	172 Start 1st July End 20th Dec
3 - Long duration bird/fish breed	Support successful fledging of breeding waterbirds.	Successful breeding of thousands of colonial waterbirds in at least three years in ten.	101,250	75,400 11,600 Return to River Murray via return channel 63,800 to Wakool River via Barber Creek	25,850 (Seepage = 15,500 ML & Evaporation = 10,350 ML) **	6,700 (>5,000 ha inundated for over 76 days)	77.1	177 Start 1st July End 25th Dec

	Ecological profile		Hydrological profile					
Scenario	**Key event objectives and target community**	**Relevant TLM objective(s)**	**Inflow (ML)**	**Outflow (ML)**	**Water use and evaporation (ML)**	**Maximum Inundation Area (ha)**	**Maximum ds water level (m AHD)**	**Duration (days)**
4 - Maximum event "100 day flood"	Maintain or improve overstorey and understorey health in River Red Gum communities.	Maintain and restore a mosaic of healthy floodplain communities. 80% of permanent and semi-permanent wetlands in healthy condition. 30% of River red gum forest in healthy condition. Successful breeding of thousands of colonial waterbirds in at least three years in ten. Healthy populations of resident native fish in wetlands.	369,100 to 420,000 *	226,000 168,000 Return to River Murray via return channel 58,000 to Wakool River via Barber Creek	143,100 to 194,000* (Seepage = 68,000 – 92,000ML & Evaporation = 75,000-102,000 ML)**	16,000 (>10,000 ha inundated for over 90 days)	78.5	220 to 250* Start 1st July End 6th Feb
*A range is shown for Scenario 4 to cover the variability in site conditions that impact water use. ** Losses are variable with time and spatial extent/duration.								

6.1.2 Overbank Events

Overbank events take place when inflows occur independently of the inlet regulator and channel. Inflows enter the forest initially via Swan Lagoon, and then via Horseshoe Lagoon, Dead River, Thule Creek[2] and other secondary and tertiary effluents, including locations upstream of Torrumbarry Weir. Overbank events will be managed in accordance with the key principle of "no impact on natural events, in terms of flow into receiving waterways". That is, management will strive to not influence the passage of overbank events. This has both social and ecological benefits.

Overbank events require little planning and operation is relatively simple. Water accounting is not necessary for overbank events, although it may be necessary to demonstrate that the flows have not been significantly influenced by the Scheme. Operation of the structures will be similar for all overbank events as follows:

- Inlet regulator closed
- Swan Lagoon regulators open to allow the passage of overbank flows
- The return channel closed
- Thule Creek regulator open to allow the passage of flows
- Downstream regulators open to allow the passage of flows.

Hybrid events

Overbank flows may occur in combination with managed flows. These events are termed 'hybrid' events. Two hybrid scenarios have been identified:

- A managed event is initiated, and then overbank flows occur
- Overbanks flows occur and a managed event is subsequently initiated.

Any combination of these two scenarios is also possible, for example an overbank 'spike' may interrupt a managed event which then continues following the recession of the River.

Operation of the structures during hybrid events can be complex, as the key focus of the event shifts between ecological objectives and flood management priorities. Water accounting is likely to be complex, requiring a combination of gauged and modelled approaches. The most difficult hybrid scenario to operate or manage occurs when overbank flows enter the forest whilst managed flows are pooled in the downstream area of the forest. This has been modelled as 'Scenario 5'.

Scenario 5

Scenario 5 simulated a managed event to full downstream pool level (78.5m AHD) followed by the overbank flow event of 2010. The purpose of the modelling was to:

1. examine the influence of passing overbank event discharge on the downstream pool level, and;
2. estimate the additional downstream discharge required (above the overbank event discharge rate) to maintain the maximum pool level of 78.5m AHD.

[2] Refers to the Thule Creek effluent linking the River Murray with the forest. Not to be confused with the Thule Creek which links the forest with the Wakool River.

Key points from the modelling of scenario 5 included:

- The 2010 overbank event peaked around 48,000 ML/d (Torrumbarry downstream);
- Modelled inflows to Koondrook forest peaked around 14,000 ML/d while modelled outflows from the forest peaked around 9,500 ML/d (combined outflow to Barber overflow, Barber, Cow and Calf Creeks) and approx. 4,200 ML/d to Thule Creek;
- Total modelled inflow to the forest during the 2010 overbank event was approx. 300GL and total modelled outflow was around 263GL. Thus, the estimated water consumption due to evaporation, infiltration and storage was 37GL;
- When the 2010 overbank event followed a full managed event, the water consumption was reduced due to the wetted forest condition (ie. reduced infiltration);
- If the 2010 overbank outflow was used for this scenario, the downstream pool level increased by around 0.1m due to the reduced water consumption;
- To avoid exceeding the maximum pool level of 78.5m AHD, the downstream discharge was increased by approximately 11.5GL. If this additional discharge was applied during a 4 week period, the downstream discharge would be increased by approx. 400 ML/d (less than 5% of the peak downstream discharge);
- During the managed event followed by the 2010 overbank event, the return channel ceased to operate when the water level in the River Murray exceeded the maximum downstream pool level of 78.5m AHD and corresponded to approx. 30,000 ML/d Torrumbarry downstream.

Operation of the structures during hybrid events may be quite complex. Further details can be found in Section 6.3.

6.2 Long term operating regime

The decision-making process underpinning the design of an individual event is described in Section 7. Annual considerations are:

- The water requirement as determined from known ecological needs, the condition of the site, the log of recent watering events, and TLM ecological objectives.
- Water availability as determined by TLM and other regulated environmental water holdings, and the predicted presence or absence of overbank flow.

During operation, the proposed event design will be implemented, but the actual outcome will often be determined by the interaction of overbank flow, in combination with the managed component. The sum of these individual events will define the long term watering regime.

In order to demonstrate what the long term regime might look like, individual events based on the climatic conditions encountered between 1990 – 2005 have been designed and collated. Modelled river flows were superimposed upon the event designs to graph the actual outcomes. The years 1990 – 2005 were used as it encompasses relatively wet and dry periods.

Inflows were predicted using the CSIRO Median Climate Change Scenario 2030 (which equates to a slightly dryer climate than would have been experienced and therefore represents a more conservative approach as to what may have been able to be achieved) and river flows were predicted using the BIGMOD-MSM model. The outcomes are shown below in Table 11 and Figure 23. Table 11 also shows the broad TLM ecological targets that would have been met from the various events.

Table 11: Summary of Hypothetical Operations 1990-2005

Year	Type of operation	Hypothetical environmental aater used within the Forest	Ecological Target Met (Main Objectives)			
			Indicative Total ha inundated	Wetlands	Bird Breeding	River Red Gum
1990	Extend natural inflows for bird breeding	180 GL	8,000 - 16,000	✓	✓	✓
1991	Natural event waters wetlands, some redgum watering	Nil	-	✓	×	✓
1992	Natural event waters all	Nil	-	✓	✓	✓
1993	Natural event waters all	Nil	-	✓	✓	✓
1994	Do nothing, dry year	Nil	-	×	×	×
1995	Fill gap, extend to complete redgum	180 GL	16,000	✓	×	✓
1996	Fill gap for bird breeding	180 GL	16,000	✓	✓	✓
1997	Do nothing, dry year	Nil	-	×	×	×
1998	Water wetlands	120 GL	8,000	✓	×	×
1999	Water wetlands	120 GL	8,000	✓	×	×
2000	Fill gap and extend natural inflows for bird breeding	392 GL	6,000 – 12,000	✓	✓	✓
2001	Water wetlands	120 GL	6,000	✓	×	×
2002	Do nothing, dry year	Nil	-	×	×	×
2003	Late autumn small wetland watering	120 GL	8,000	✓	×	×
2004	Late autumn small wetland watering	60 GL	8,000	✓	×	×
2005	Small wetland watering	90 GL	8,000	✓	×	×
Annual Average		**98 GL**				
% of years Ecological Target met				**81%**	**31%**	**44%**

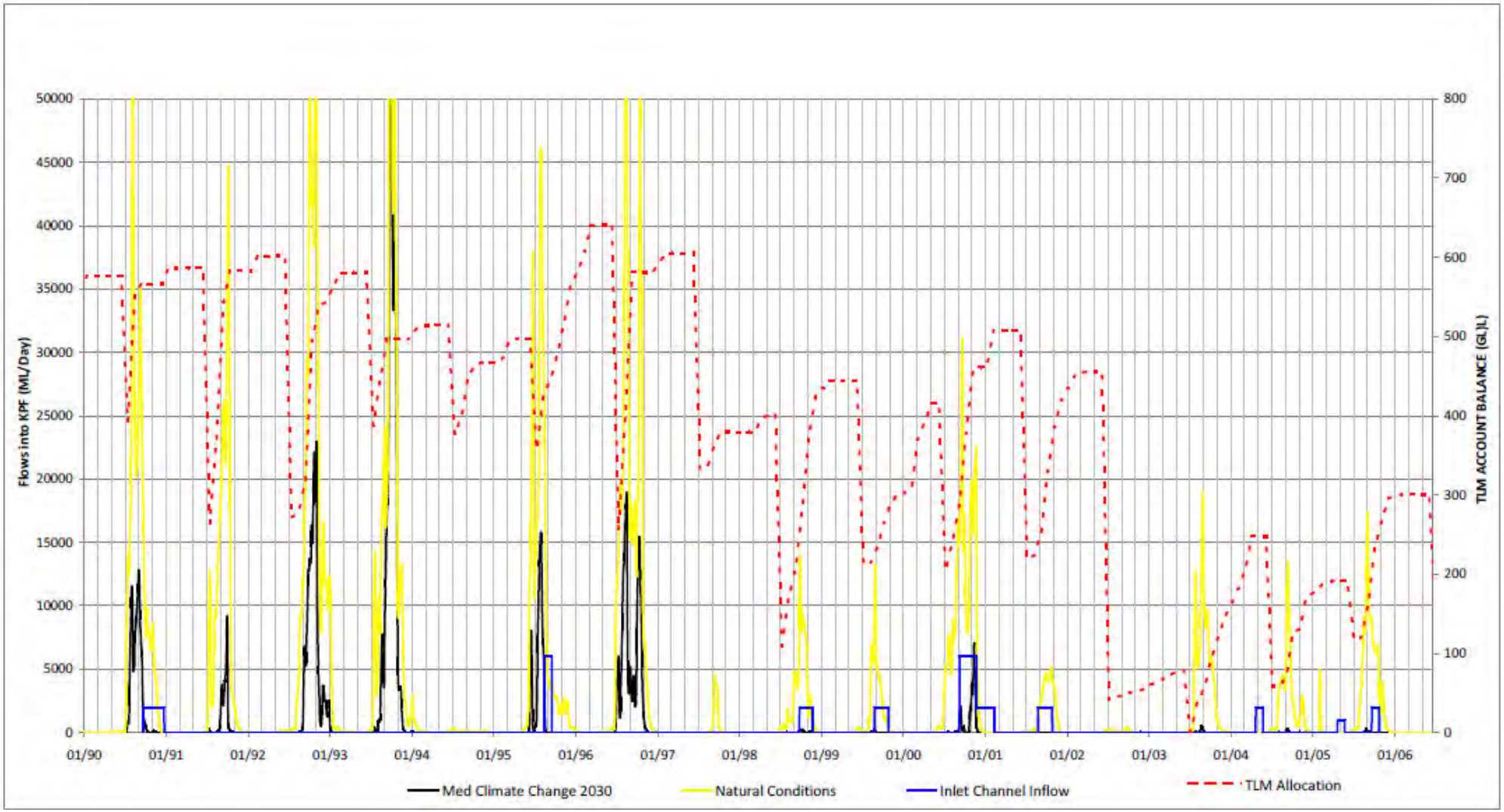


Figure 23: Hypothetical Operations 1990 - 2006

6.3 Managed Events with Overbank Flows

This Section is intended to provide advice and an understanding of operations during periods when the Scheme manages overbank events.

As a general principle, downstream creek systems must not be denied their current flow regimes. That is, any flows that enter the forest from the Murray River via Swan Lagoon or other natural inflow points, must be passed downstream (this includes Thule Creek as a discharge tributary). The default position of the structures (refer below) ensures that overbank events are passed downstream.

Upstream Structures

Inlet Regulator – Closed

Swan Lagoon Regulators –Open

Downstream Structures

Thule Creek Regulator – Open

Barber Creek Overflow Regulator – Open

Barber Creek Regulator – Open

Cow Creek Regulator – Open

Calf Creek Regulator – Open

Return Channel Regulator – Closed

A hydraulic model of the forest has been developed by the MDBA. The model will determine, from a relationship with flows downstream of Torrumbarry, the overbank flows that enter the forest via Swan Lagoon and other natural inflow points. The model will account for water use ('losses') in the forest (particularly infiltration) which may be less if the forest has already been wetted up from managed water. An estimate of the flows entering the forest is shown below in Table 12.

Table 12: Relationship of flows downstream of Torrumbarry and modelled flows entering the forest

Torrumbarry Downstream Flow (ML/day)	Torrumbarry Downstream Level (m AHD)	Estimated flow into Forest (ML/day)
10,000	81.612	0
15,000	82.773	145
20,000	83.759	540
25,000	84.581	2,079
30,000	85.108	4,632
35,000	85.491	7,493
40,000	85.772	10,353
45,000	85.971	12,717
50,000	86.136	15,170
55,000	86.284	17,368
60,000	86.401	19,709

The managed component of the watering event will be dependent on the watering objectives for the event. With this in mind, the operation will be adaptively managed (refer to Chapter 4, Governance)

and may be altered during the period of operation as a result of ecological responses in the forest and flows within the Murray.
During watering of the forest there will be times when operation will be based on:

1. Only managed flows,
2. Combination of managed and overbank flows, and,
3. Only overbank flows.

Management of Inflows to the Forest

The inlet regulator will provide managed water up to a flow of 6,000 ML/day. The Swan Lagoon regulator will be closed during managed flow operations to stop managed flows exiting the forest to the River Murray. During hybrid events, head differentials may occur at the Swan Lagoon regulators, which may result in operational constraints at this location. Operations should be managed to prevent managed flows discharging from the forest.

In the scenario that overbank water is entering via Swan Lagoon, the inflows at the inlet regulator will be adjusted so that the sum of the combined flows is sufficient to meet the event design. There will be occurrences when overbank flows entering via Swan Lagoon exceed the event design. In this case the inlet regulator will be closed. Note that there may be operational consideration of allowing the overbank flows to enter the inlet regulator and closing the Swan Lagoon regulators, with due consideration of the ecological implications.

Management of Discharges from the Forest

With the passing of overbank flows downstream, the intent is to replicate the flows that would have occurred prior to construction of the Scheme. A hydraulic model of the forest will assist in determining the overbank flows to the forest and account for normal water use ('losses', that is infiltration and evaporation) through the forest and estimate the discharge flows from the forest via Runner A, Barber Creek, Cow Creek, Calf Creek and Thule Creek. When there is capacity within the downstream pool the losses will be retained within the pool. When there is capacity, losses that would naturally occur within the forest will be retained in the Scheme's downstream pool. In the event that the Scheme is at full capacity, flows will be discharged to ensure that the pool's design maximum water surface level is not exceeded

During overbank events the Murray flows will rise and may result in the Return Channel becoming redundant due to equalisation of head across the structure. As a result all flows will discharge through the natural forest drainage course downstream.

6.4 Natural Flood Preparations

This Section is intended to provide advice and an understanding of overbank flood preparations for the Scheme. During managed waterings of the Koondrook-Perricoota Forest the downstream discharges are restricted to 250ML/day in the Barber Creek, as per NSW Department of Planning approval. Options to release at greater levels and reduce pool level prior to flood peak are dependent on the critical nature of risks to the safety of structures or to areas downstream of the forest. For further details refer to State Water's Emergency Management Plan for the Scheme.

Depending on the origin of the overbank flood, the Koondrook-Perricoota Forest may have 3-10 days warning of actual flows and possibly additional time if including forecasting from the Australian Government Bureau of Meteorology. To reduce the downstream pool level, whilst taking into consideration critical ecological inflow demands, the inflows may be reduced or stopped.

The 'natural flood' discharges will be undertaken as outlined in Chapter 6.3 for overbank events.

7 WATER USE

7.1 Watering principles

The Operating Committee will meet weekly, or as required, to provide feedback on how the operation is progressing and to plan ahead for the following week. (See Chapter 4 for more information on the Operating Committee.) Figure 24 shows the adaptive management process and the key parameters that will be considered during operation. A set of Watering Principles, based on a heuristic rule approach have been established to support the Operating Committee with decision-making related to design of watering events and ongoing management of watering events.

Initiation

The decision to initiate watering is based on considerations and constraints of the operating environment.

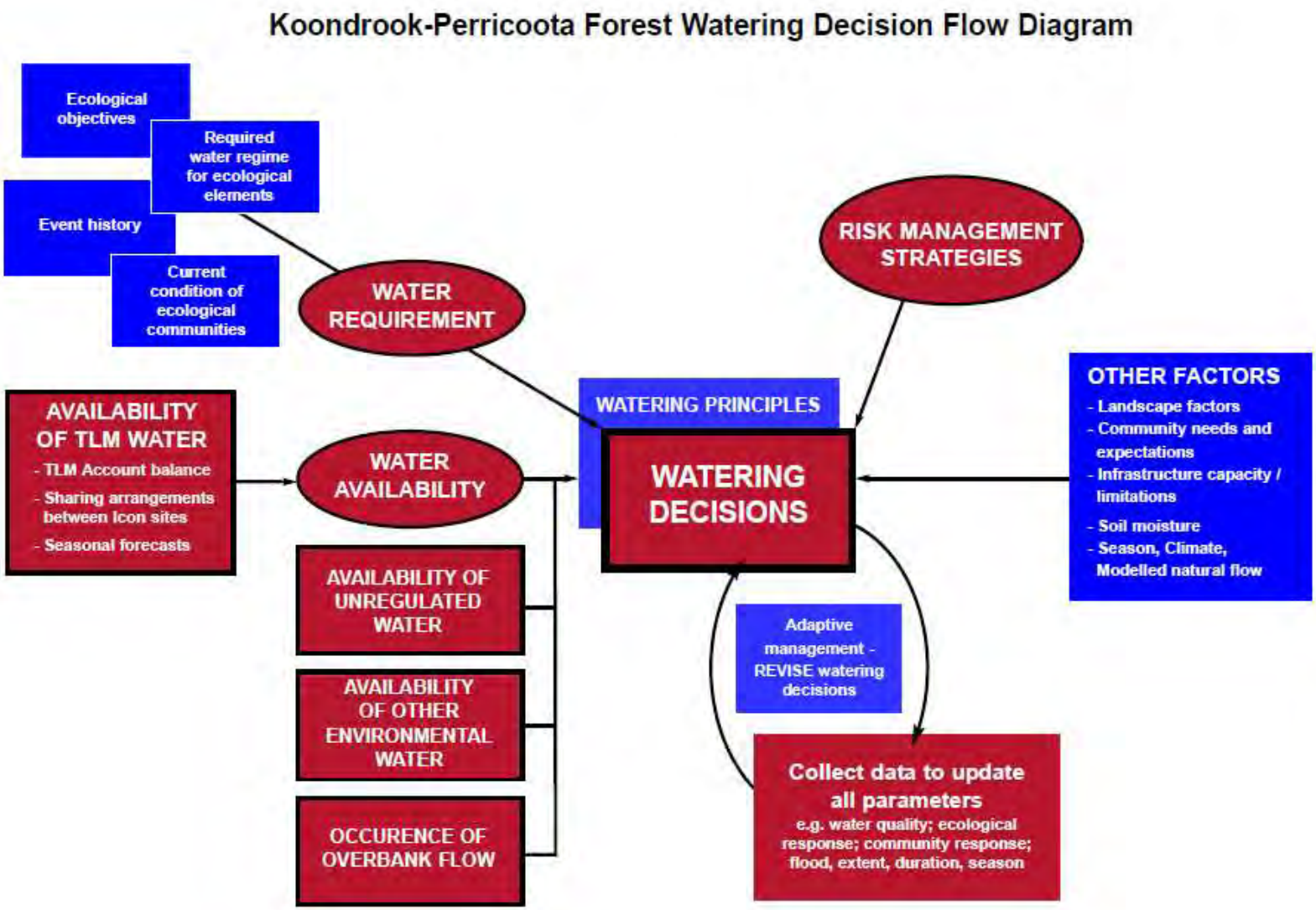
- Water availability and water requirement are the foundations for the decision to initiate a watering event.
- Clear ecological targets will be defined before initiating a watering event.
- Watering events will aim to maximise net environmental benefits.
- Early watering during cooler months (winter and early spring) will be favoured over summer watering.
- Large watering events will not commence beyond October.
- Overbank flows will be favoured as a cue for initiating watering.
- Unregulated water will be used when beneficial.
- Autumn watering will be considered if environmental water is not made available until late in the season.

Management

The management of a watering event will be based on the following principles:

- The initial ecological target will be pursued for as long as practicable.
- Modelled natural hydrographs will be used as a guide during the management of an event.
- Where beneficial, managed watering will prolong or enhance overbank flow.
- Downstream regulators will only be used to the extent needed to achieve the required objectives.
- Watering operations will aim to minimise impacts to third party property.
- The protection of watering infrastructure overrides meeting environmental targets.
- Inflows through Swan Lagoon will be favoured over equivalent inflows through the inlet channel.
- Use of Barber Creek will be maximised, where possible.

Figure 24: Watering Decision Flow Diagram



7.2 Measurement for water use

Measurement of flows through the Koondrook-Perricoota Forest is required for a number of reasons:

- water accounting – this is a legal requirement
- operations – to calculate and verify downstream releases
- accountability – to demonstrate to regulatory authorities and the community that overbank flows have been passed
- planning – to inform future watering proposals, and
- calibration of measurement tools (including hydraulic models).

This Chapter is not intended to resolve accounting issues but to identify the flow measurement methods to be used at the Koondrook-Perricoota Forest Icon Site. Until jurisdictional policies have been resolved, water accounting will be undertaken using an agreed position, negotiated at the time of watering. Parameters to be measured for water use are detailed in the Section 8.2 and the Event Monitoring Plan, Attachment A-1.

Measurement Methods

There are many different devices that may be used to measure the inflows and outflows to the Koondrook-Perricoota Forest. Gauge boards, hydrographic stations that incorporate water quality measurement (temperature, Dissolved Oxygen and Electric Conductivity) and hydraulic models have been considered. Site/event specific loggers may also be installed to monitor particular events. For example, automatic water level loggers may be used for monitoring within wetlands during bird breeding events.

Watering types and requirements

Two distinct types of flood events are described in Section 6.1. These are 'managed' events, where water is delivered via the inlet channel, and 'overbank' events where water enters via Swan Lagoon. Hybrid events occur when both types occur in combination.

Measurement using hydrographic stations and gauge boards will be carried out during a managed event to meet accounting and other requirements.

The Koondrook-Perricoota Forest is a complex site which has many locations where overbank flows enter the Forest. It is impractical to install measurement devices along the River Murray at every point where overbank flows occur and accurately undertake calibration. Therefore a model has been developed to reasonably determine the inflows and outflows during hybrid (modelling has shown that hybrid events are the most common that will occur) or overbank flow events.

The model is based on MSM-Bigmod and Koondrook-Perricoota Forest 2-Dimensional Hydraulic Model. The model outputs will form part of the event reports. It is intended that there will be event based monitoring to obtain data to assist in the calibration of the Koondrook-Perricoota Forest hydraulic models. The model will be amply supported by the number of flow measurements undertaken across the Scheme as summarised within Table 13. While this will be a continued iterative process, the combination of the flow measurement network and the model will provide accurate assessment of the volume of overbank flow.

During an overbank event (that does not form a Hybrid event) there is no need to measure the water for accounting purposes as there is no requirement to account for water. However, available measurements will be used to inform operations, demonstrate translucent operations, and possibly to calibrate hydraulic models.

Measurements will be utilised during hybrid events to assist in determining any components of

environmental entitlement water used in an event even if it is not possible to measure the total amount of water in an overbank event. Measurements of water use during the hybrid events will also assist in informing how ecological objectives can be best met (area of inundation, depth and rates of rise and fall) within the forest.

Measurement Locations

The measurement types and locations for the Scheme are outlined in Table 13 and Figure 25. Note that water quality will also be measured at many of these locations.

Table 13: Location of measurement sites

Site	Flow measurement	Purpose
Torrumbarry Weir	Existing gauge (Vic.)	To model downstream releases during overbank events.
Inlet Channel	Height and Acoustic Doppler Velocimeters (ADV) flow, telemetry	Water accounting, future planning and model calibration. For use during managed events.
Swan Lagoon	No flow – use Torrumbarry Gauge.	NA
Thule Creek at Lower Thule Road	Height and ADV flow, telemetry	Verify downstream release during overbank events. Model calibration.
Barber Creek regulator	No flow – see Sandy Bridge site	NA
Cow Creek regulator	No flow (see Sandy Bridge site)	NA
Barber/Cow Creek at Sandy Bridge	Height and ADV flow, telemetry	Verify downstream release during overbank events. Model calibration.
Calf Creek regulator	Gauge board and rating table	Verify downstream release during overbank events. Model calibration.
Runner A regulator	Gauge board	General information.
Return channel regulator	Height and ADV flow, telemetry	Water accounting, future planning and model calibration. For use during managed events.
Barham	Existing gauge (NSW)	Model calibration during overbank events.
Wakool River at Wakool-Deni Road (u/s Thule and Bookit/Merribit)	Height and rating table, telemetry	River operations.
Wakool River at Gee Gee Bridge (d/s Barber)	Height and ADV flow, telemetry	River operations.

7.3 Gross and Net Water Requirement by Operation Type

The design of the Scheme allows for flexibility in the delivery of watering events. The managed scenarios that have been modelled are a spring flush, short pulse, long durations (for bird or fish breeding) and a large scale water event (See Section 6.1 for a full description of these scenarios). The modelled scenarios and indicative volumes for the Scheme are shown in Table 12. The volumes have been determined using a hydraulic model and are approximate volumes only. It is important to note that the volumes are dependent on antecedent conditions. Linkages between the modelled scenarios and indicative volumes shown in Table 12 to the ecological monitoring for the Scheme are detailed within the Event Monitoring Plan.

The gross water requirement is the amount of water diverted to conduct an event; a component of this may be returned to the Murray River or an anabranch. The net water requirement is the amount of water consumed during the event within the Icon Site. Net water use includes evaporation, transpiration and water stored either in wetlands or within the soil profile.

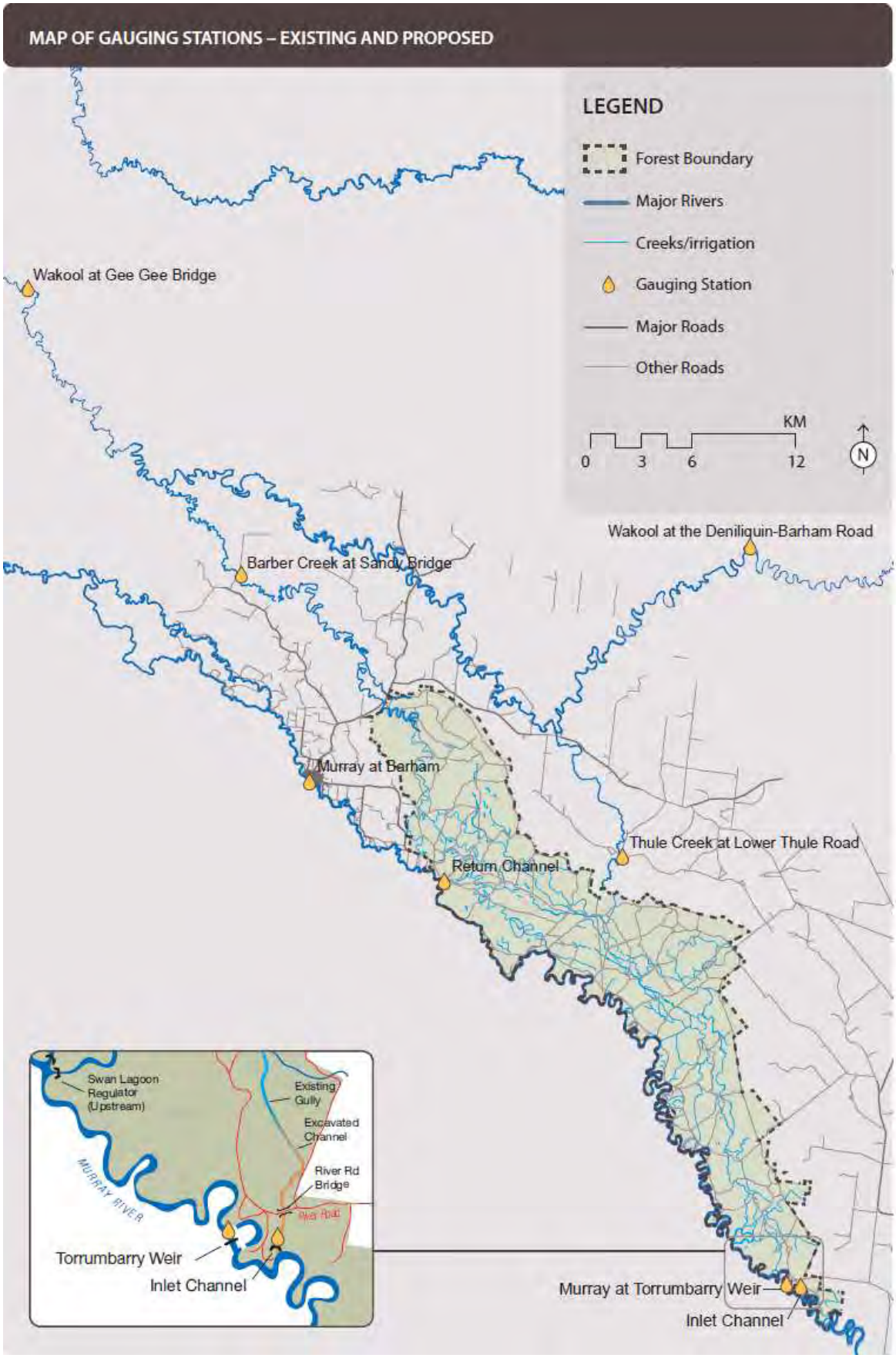


Figure 25: Location of Measurement sites

Table 14: Modelled Water Use

Operation Type	Gross Water (ML)	Water Used in Forest (ML)	Outflow (ML)	Timeframe
1. Small Event 'spring flush'	90,000	42,000	48,000 8,000 Return Channel to the Murray River 40,000 Barber Creek	118 Start 1st Aug End 27th Nov
2. Short, fat 'pulse'	216,000	89,000	127,000 64,000 Return Channel to the Murray River 63,000 Barber Creek	172 Start 1st July End 20th Dec
3. Long, low bird/fish breed	101,250	25,850	75,400 11,600 Return Channel to the Murray River 63,800 Barber Creek	177 Start 1st July End 25th Dec
4. Maximum event	369,100 to 420,000	143,100 to 194,000	226,000 168,000 Return Channel to the Murray River 58,000 Barber Creek	220 to 250* Start 1st July End 6th Feb

*A range is shown for Scenario 4 to cover the variability in site conditions that impact water use

To assist in the understanding of the gross and net water volume requirements of the forest for watering scenarios outside of the above scenarios, the KPFEW hydraulic model may be used. This model is managed by the MDBA.

Hydrographs of Inflows, outflows to the forest and relationship of volume and surface area are also shown below in Section 6.1.

8 Operating Risks and Mitigation Measures

The primary purpose of the Scheme is to deliver a positive environmental impact to the site. In this sense, environmental impacts are a positive outcome. However, the Scheme is unable to accurately replicate all natural processes and as such has the potential for environmental side-effects, or risks of adverse outcomes. Operation of the scheme also represents a change to the current flood regime and therefore is expected to have some social/third party impacts that operators must be aware of.

A comprehensive risk assessment has been undertaken as part of the project approval process (refer Environmental Assessment, GHD 2010). This includes risks arising from construction and operating risks. Construction risks have been addressed during the construction phase. Operating risks fall into two categories:

- Event level risks - risks arising from the operation of an individual event.
- Scheme level risks - risks arising from the long term watering regime.

This chapter addresses both 'event level risks' and 'scheme level risks'. Note that risks arising from the long term watering regime are also partially addressed via adaptive management, supported by a comprehensive monitoring program (refer Monitoring Plan appended for more detail).

Summary of key event-level risks

The key risks to be aware of during operation of the Scheme are as follows:

- Development of poor quality water;
- Stranding of native fish and turtles;
- Mass abortion of waterbird breeding;
- Erosion of Barber Creek banks; and,
- Impacts to neighbours and downstream landholders.

These are further described in Table 15 below, along with key mitigation measures and constraints.

Table 15: Key event-level operating risks and mitigation measures.

Risk	Location and timing	Risk Management	Constraints
Development of poor water quality conditions (blue-green algae and hypoxic blackwater) within the forest such that receiving streams or within-forest ecologies are affected.	Most likely to occur following warm weather and extended pooling of water within the forest as part of a managed event. Barber Creek and the Wakool River may be affected, as well as sites within the forest.	Avoid by designing the managed event to avoid pooling into summer. Monitor for early detection as per the Event Monitoring Plan. Mitigate by limiting flows to receiving systems with little dilution capacity. Provide dilution flows to receiving systems. Warn downstream users.	Outflows during a managed event are limited to 250 ML/d, making ponding necessary at times. The return channel can only be used until the ponded level falls below the invert of the channel (77.32m AHD)). Dilution flows can only be provided if suitable water quality and quantity can be delivered.
Stranding of large-bodied native fish and turtles such that they are likely to die as a result of operations.	Stranding is most likely to occur upon recession of managed events, within the inlet channel, behind the Swan Lagoon regulators, and possibly at the Thule regulator.	Avoid by designing the recession such that fish are cued to exit the forest. Proper operation and maintenance of the fishway and turtleway on the inlet channel. Monitor for early detection. Consider relocation of fish if accumulation is ecologically significant.	Fishway ceases to operate for large-bodied fish at inflows below 800 ML/d. Thule regulator can not be used to pass flows during a managed event.
Mass abortion of waterbird breeding events, leading to loss of fledgelings and wasted energy investment.	Generally associated with poorly timed flood recession during managed events, especially sudden drops in water level in critical wetlands, during breeding.	Avoid by designing the recession such that bird breeding is not interrupted. Monitor to inform operations.	Water availability will dictate how long inflows can continue during a bird breeding event.
'Notching' of Barber Creek banks as a result of managed outflows.	Exposure to constant outflows for more than a week or frequently, from the Cow/Barber/Runner A regulators, as is likely during managed events.	Avoid by varying the outflows within permitted limits, particularly while the return channel is operating. Monitor to inform future events.	Maximum outflow to the Barber Creek is 250 ML/d during managed events. Event durations will increase when introducing variable flows < 250 ML/d. Injury to fish may occur when releasing < 200 ML/d (see Section 5.2).
Flooding impacts to nearby properties arising from operations.	Neighbouring and downstream properties on the Barber and Thule Creeks are most likely to be affected, particularly when passing overbank flows on top of a managed event.	Overbank flows should not be passed at significantly higher flows or more quickly than would have occurred prior to construction of the works. Landholders will be advised in advance whenever releases are likely to affect landholders as per the Communications Plan within Section 10.	Overbank flows may result in slightly higher than modelled outflows due to the impact of a wet forest (see Section 6.1.2)

8.1 Salinity

Risk description	Export of salt via surface washoff or groundwater rise.
Risk level	Scheme level
Risk rating	Low
Key mitigation measures	Nil required unless monitoring demonstrates requirement.

The risk of the project substantially increasing salinity in the river is considered to be low. Salt wash off is likely to be responsible for the delivery of salt loads returning to the surface water as a result of forest flooding (Salient Solutions 2008). Previous assessments of the risk of salinisation from groundwater have concluded that the Forest area appears to be primarily a groundwater recharge area rather than a discharge area (Evans and Barnett 2007, Salient Solutions 2008). Consequently there is little risk of the seepage of saline groundwater from the area entering either the Murray River or other streams in the area.

In April 2010 the long-term salinity impact from the proposed environmental watering regime was examined and at that time was determined that the proposal did not constitute an accountable action under the definition of Schedule B (Basin Salinity Management Strategy - BSMS) of the *Water Act* 2007. The proposal may require five-yearly impact assessment, particularly where ongoing monitoring provides additional or new data that could potentially improve the confidence of or test the assumptions in the assessment.

Surface Water

There are 3 existing and 4 new surface water quality monitoring sites (as identified within Section 8.2) will be used to collect Electrical Conductivity samples on a daily basis. The monitoring sites are located both upstream and downstream of the works, with sampling conducted at both Torrumbarry Weir and Barham all year round. The Event Monitoring Plan includes maps that show locations of the sites.

Groundwater

A total of 31 piezometers have been constructed within the forest to depths of 11 to 30 m. Groundwater levels (as depth below ground, and AHD) and groundwater quality (TDS in mg/L) were measured during July 2007. In July 2011, continuous water level monitoring (logger) devices were installed in 28 of the 31 piezometers located within the forest, with the remaining 3 expected to be installed in the Summer of 2011/12. Data being collected by the loggers will provide a clear set of baseline data, which can be used to further refine the hydrogeological understanding of the Koondrook-Perricoota Forest.

In addition to in-forest monitoring, Murray Irrigation Limited (MIL) maintain an extensive network of bores on private land in NSW, including land adjacent to the Koondrook-Perricoota Forest, in compliance with their Combined Approval from the NSW Office of Water (NOW). Groundwater levels are taken from these bores every 12 months, and the data is reported in MIL's annual Compliance report. The bores are airlifted every three years, at which time samples are taken to record salinity levels. (MIL Annual Compliance Report 09/10; Michael Pisasale pers. Comm.). NOW also maintain and monitor 50 bores adjacent and downstream to the forest.

Monitoring data from MIL and NOW will be collated to inform operation of the Scheme. In addition, a further 3 bores have been identified by landholders adjacent to the forest as important monitoring sites for groundwater, and will be added to the monitoring program. A total of 116

piezometers located around the bottom edge of the forest on adjacent property will be monitored on an annual basis for both groundwater depth and Electrical Conductivity. The monitoring program will incorporate MIL's and NOW's monitoring program where possible and appropriate.

Mitigation

Nil required unless monitoring demonstrates that salt export via surface runoff exceeds 800µs/cm EC, or groundwater rise interacts with the river bed or ground surface.

8.2 Water Quality

Risk description	Development of poor water quality, specifically algal blooms and hypoxic blackwater.
Risk level	Event level
Risk rating	Low – algal blooms High – hypoxic blackwater (in warmer parts of the season and with high Dissolved Organic Carbon (DOC) loads
Key mitigation measures	Prevention by watering during cooler months and limiting ponding. Discharge into the Murray River in preference to Barber Creek. Retain very poor water within the forest. Provide dilution flows for receiving systems if suitable volumes and quality can be delivered.

During operation both spatially and temporarily, a number of key processes impacting on water quality are expected to take place, not all of a negative nature. This section only summarises parameters that are considered key risks during operation of the project.

Hypoxic Blackwater

(extracted in part from Understanding Blackwater generated from the Koondrook-Perricoota Forest, MDFRC, 2011)

Periodic flooding of riparian floodplains is vital for floodplain health and for the transfer of carbon from the floodplain to the river. In particular, longer duration floods are necessary for the long term survival of floodplains in semi-arid regions. However, flooding of forested floodplains carries with it the risk of hypoxic blackwater generation. Under certain conditions, return of this organic-rich, oxygen-depleted water to the river system can have detrimental effects on downstream ecosystems, including fish deaths.

The onset of hypoxia will depend on a number of factors – including but not limited to the standing stock of organic material on the floodplain and the water temperature, and water volume (in terms of capacity to cope with microbial activity). The litter loading is likely to be related to immediate tree condition rather than period of time of litter accumulation. Water temperatures higher than 15 or 20°C may greatly increase the rate of carbon leaching, decomposition and associated deoxygenation.

Algal Blooms

Algal blooms downstream of the project site are considered a low risk. Inundation of the floodplain is likely to result in the release of dissolved organic carbon from the leaf litter and stain the water with tannins, which has an effect of reducing light within the water column. In open water bodies, this may competitively advantage blue-green algae such as Microcystis and Anabaena that can regulate their buoyancy. However, the Forest is predominantly covered by woodland and forest, which, even in conditions of tree stress, provides canopy and a reduction in light reaching the water's surface, which reduces light for all algal species. This leaves only

relatively small areas of open wetland, which may be susceptible to algal blooms. Flood events will be targeted towards winter and spring events and will minimise the likelihood of algal blooms occurring.

As Blue-Green algae are commonly found in most freshwater bodies the problem situation arises when there is dominance or "bloom" is brought on by the particular requirement of warm water, plenty of sunlight and relatively high levels of available phosphorous in the water column. The combination of these conditions is unlikely to occur in a flooded forest but small open wetlands may meet these criteria in summer.

Mitigation

To minimise the likelihood of hypoxic blackwater during managed events the timing of floods (both the timing of the flood onset and the time a given body of water stays on the floodplain) will be managed to minimise unseasonal inundation during warm conditions, especially when litter buildup is high. Flow-through scenarios will be implemented where practicable, with due regard to downstream constraints in the Barber Creek and trade-offs with the ecological cost of reduced flood duration and/or extent in the Forests.

An extensive monitoring program to inform an adaptive management approach for operation has been adopted. Seven sampling sites have been identified as key sites for the sampling and collection of water quality data, as follows:

- Torrumbarry Weir
- Barham
- Wakool River at Gee Gee Bridge
- Wakool on Wakool-Deniliquin Road (u/s Thule & Bookit/Merribit)
- Thule Creek d/s of Regulator
- Downstream Pool u/s of Regulators
- Return Channel u/s of Regulator

If hypoxic blackwater is detected, discharge from the forest will be targeted to receiving systems with an adequate dilution capacity. Flow rates in the Wakool and Murray Rivers may be manipulated to provide diluting flows to minimise potential impacts to downstream systems where suitable quality and quantity of water is available. Cessation of releases into Barber Creek will be considered if impacts cannot be adequately mitigated.

Monitoring of the outfall points for algae would be used to determine if the levels are sufficiently high enough to require mitigation measures. Mitigation for receiving environments would be based on dilution or in extreme case ceasing releases.

8.3 Fish

Risk description	Introduced species, especially Carp will breed in response to operation of the Scheme and re-enter the River. Large-bodied fish (cod, perch etc) will be trapped on the floodplain following operation of the structures.
Risk level	Carp – Scheme and Event level Fish stranding - Event level
Risk rating	High – carp spawning and re-entry Medium – fish stranding

Key mitigation measures	Carp spawning – Few effective measures available. Fish stranding – Recession design to ensure suitable cues for native fish to leave the forest. (Note that the design of the scheme includes fishways on inlet channel for upstream passage and a dissipation pool for downstream passage at Barber Creek Regulator)

The response of the fish community to the operation of the Scheme is not precisely known. A number of native fish will use inundated floodplain habitats, in addition, the increased productivity in the floodplain following inundation is expected to be beneficial to some native fish species. The operational phase of the project will inundate a number of habitats within the system, including channels and waterways, open water bodies, floodplain wetlands and marshes and inundated forest areas as well as a significant amount of woody debris in localised areas. It is expected that this will provide a diversity of habitat for both spawning and foraging of native fish.

Exotic species, especially carp (*Cyprinus carpio*), are a large component of fish populations in the Murray River. Carp are consistently more abundant in off stream habitats compared with the Murray River (Jones, 2006).The Barmah-Millewa forest, upstream of the Koondrook-Perricoota Forest, has previously been noted for the abundance of carp, which utilise the inundated floodplains for spawning and recruitment (Stuart and Jones, 2006). Carp have been implicated in the decline of native fish populations and the degradation of river systems. Floodplains and especially frequently inundated marshes support large breeding populations of the carp and may have a negative effect on the Murray River fish population through recruitment (Macdonald and Crook, 2006; Jones and Stuart, 2007).

Ecological Associates (2009) assessed the risk of trapping large large-bodied native fish within the floodplain as a moderate risk. Species at risk include the nationally threatened Murray Cod, which is present in the Murray River adjoining the Forest and may move onto the floodplain, and potentially breed during flood events. The Fish Passage Task Force (FPTF) reviewed the Project and provided recommendations on fish passage that have been incorporated into the present design. The recommendations involve the provision of structures specifically designed to ensure that large-bodied native fish, including Murray Cod, can enter and leave the floodplain, including:

- At the inlet regulator: Overshot gates, denil fishway and vertical-slot fishway; and,
- At the outlet regulators: Overshot passage, dissipation pool at Barber Creek regulator.

Mitigation

The recession stage of managed events will be planned to provide cues for large-bodied native fish to exit the forest. The fishway will be monitored to ensure proper functioning. Manual fish relocation should be considered if fish accumulate behind structures such that unacceptable ecological impacts are likely.

The frequency and seasonal management of managed flood events, along with adaptive management measures based on ongoing monitoring program will ensure that impacts on native species are minimised and reduced to the maximum extent practical.

The adaptive management approach will involve monitoring of fish populations and Carp spawning in the region during a managed event. Where necessary, the operation of the flooding structures may be altered during operations and from one operation to another, depending on what is most appropriate in response to monitoring results.

8.4 Vegetation

Risk description	Flood tolerance (duration and/or frequency) of Inland Grey Box communities may be exceeded upstream of Swan Lagoon. Flood tolerance of understorey communities may be exceeded in the pooled area that develops at the downstream end of the forest during managed events.
Risk level	Scheme level
Risk rating	Low - Medium
Key mitigation measures	Avoid by designing events such that they stay within the tolerances of at-risk communities.

Risks to vegetation are most likely to arise in those parts of the forest that are outside of the natural inundation pattern for similar-sized overbank events. The extent of managed events will depart from the natural pattern in two key locations: upstream of Swan Lagoon, and the area at the downstream end of the forest where water is ponded.

A risk assessment for vegetation was conducted by GHD in 2010 and is summarised below. This assessment specifically considered the impacts arising from the 'fully managed event', that is Scenario 4 (see Section 6 for a detailed description of this scenario).

The majority of the Forest is covered by native vegetation. Broad vegetation types recorded at the Forest include:

- Inland Grey Box Woodland
- Black Box Woodlands
- River Red Gum Forests
- River Red Gum Woodlands
- Floodplain Marshes
- Sandhill Woodlands

Inland Grey Box woodland

The project was previously referred under the EPBC Act (2009/5115) and subsequently determined a non-controlled action in January 2010 and therefore did not require assessment and approval under the EPBC Act. However, in April 2010, Grey Box Woodland Community was subsequently listed under the EPBC Act.

The Inland Grey Box is located on the higher elevations of the forest where it is less frequently flooded for shorter durations. The hydraulic model indicates that approximately 20% (180 Ha) of Inland Grey Box Woodland in the Koondrook-Perricoota Forest will be inundated for more than 30 days under a fully managed (Scenario 4) watering option. Inland Grey Box Woodland is intolerant to prolonged water logging (GHD, 2010). Exceedence of these tolerances can lead to decreased health; death of individuals and changes in community composition and extent; depending on the degree to which these tolerances are exceeded.

Ecological Associates related aerial photographs and mapped flood extents to vegetation mapping to infer patterns of flood tolerance in the Victorian Gunbower forests (Cooling, M., Ecological Associates, pers. comm.). The authors found that Inland Grey Box Woodland appeared to have a similar distribution relative to historical flood extents, and therefore similar tolerance of

inundation, to Black Box Woodland (Cooling, M., Ecological Associates, pers. comm.). Based on comparisons with known tolerances of Black Box, it can be inferred that Inland Grey Box Woodland can tolerate inundation for < 4 months, i.e. 120 days (Roberts and Marston, 2000), with a maximum tolerance of up to 180 days (Murray Flow Assessment Tool – MFAT; MDBA, 2009). Based on DHI (2008) modelling of the fully managed scenario, no Inland Grey Box Woodland at the Forest will be inundated for greater than 120 days. Therefore the proposed inundation is unlikely to result in significant or irreversible impacts on local populations of Inland Grey Box Woodland.

Black Box – Lignum woodland

Hydrological modelling indicates that a total of 1,550 hectares of this community will be inundated, for a maximum duration of 180 days for a fully managed event. This is within the tolerance of this plant community (MFAT; MDBC, 2009) and as such the effects to this community are expected to be beneficial, with no predicted negative impacts.

River Red Gum forests

Hydrological modelling indicates that over 13,000 hectares of River Red Gum forest and woodland will be inundated in a fully managed (Scenario 4) event. The duration of the flood would be between 30 and 200 days for the majority of the area, which is considered optimum for this species (MFAT; MDBC, 2009). Although Ecological Associates (2009) indicated a risk from inundation of stressed mature trees, evidence from elsewhere has indicated that even severely stressed trees with little canopy benefit from flooding

It is predicted that the impacts to this community would be beneficial with little or no negative impacts compared with current conditions.

Understorey communities

Impacts to understorey communities have been studied in similar systems. In Chowilla, environmental watering resulted in a change in community composition in floodplain understorey from terrestrial species to flood tolerant or wetland species (Nicol et al., 2009). While this may be seen as an impact to the terrestrial phase of these communities, under natural flooding conditions, it would be expected that during inundation wetland species would emerge; with species composition cycling with wet and dry water regimes. Any shift towards a more natural regime is considered as generally positive.

Floodplain marsh communities

Hydrological modelling indicates that over 1,200 hectares of floodplain marsh will be inundated for varying durations. As this community is dominated by wetland species, the only negative impacts that could be expected may be from areas that are not inundated for a sufficient period of time to allow for the completion of lifecycles of non-perennial species. Approximately 100 ha would be inundated for < 60 days, which may be insufficient for all species within these areas to flower and set seed. However, the vast majority of these communities would be inundated for > 60 days and over 400 ha would be inundated for more than 120 days. As such the majority of the effects to this community are expected to be beneficial.

Mitigation

Risks can be mitigated by avoiding using the inlet channel when overbank flows via Swan Lagoon are sufficient for forest flooding, and by using managed scenarios that minimise the build-up of the downstream pool (eg Scenario 3 – see Section 6). Vegetation monitoring will include the areas most likely to be overwatered in order to provide early warning of environmental impacts.

8.5 Bird Breeding Events

Risk description	Mass abortion of waterbird breeding event.
Risk level	Event level
Risk rating	Medium
Key mitigation measures	Avoid by designing the managed flood recession such that bird breeding is not interrupted, whenever sufficient water is available.

The expected beneficial impacts to waterbirds are in terms of both breeding and foraging habitat. Waterbird nesting requirements for species previously recorded breeding within the Forest indicate that the vast majority of birds require inundated woody vegetation to a minimum depth of 30 cm for 3 to 4 months. Modelling of Scenario 4 (see Section 6) indicates that over 9000 hectares of woody vegetation would be inundated to a depth of greater than 30 cm and some 4000 hectares would remain inundated for over four months. A spring / summer flood event not only would provide optimum timing for waterbird breeding within this inundated area, but due to increased temperatures and therefore productivity, require less of a lag time for waterbird breeding events to commence (MDBC, 2009).

Foraging habitats for waterbirds are based on food preferences, bill shape and morphology and size of the waterbird (Kingsford and Norman, 2002). Wading species of birds generally require inundated foraging areas with a water depth of < 30 cm (Jaensch, 2002). At the peak of the flood event approximately 7 000 hectares of the Forest would be inundated to a depth of < 30cm. This would include large areas under canopy as well as smaller, open areas, providing for feeding and foraging of a number of waterbird species (including international migratory wading species).

Deeper areas on the floodplain and in the channels provide foraging habitat for dabbling ducks and diving species of birds such as cormorants, gulls and terns. At peak inundation, over 5 000 hectares would be inundated to a depth of > 1m, providing foraging habitat for a number of water bird species. The pulse of productivity expected upon inundation would enhance feeding and foraging.

Risks

There is a risk that drying would occur prior to the completion of lifecycle stages such as breeding.

Once breeding has commenced, many Australian waterbirds require surface water to remain in and around nesting sites until offspring are independent feeders (Jaensch, 2002). Drying prior to this can lead to abandonment of nests and young by parents or insufficient food resources for successful fledging. It is suggested that inundation for a minimum of four months would be required to allow for courting/mating, nest site selection and building, incubation and raising of young to independence (Jaensch, 2002).

There is little recent information regarding nesting waterbirds within the Forest (Webster, 2008), but historical records provide an indication of the suite of species for which breeding could be supported in a flood event. Preferred nesting sites and required inundation requirements for waterbird species previously recorded breeding in the Forest are similar and the Forest predominantly supports birds that nest in trees or shrubs. There would be large areas of woodland and forest that would remain inundated for a sufficient time to allow for successful waterbird breeding. Over 13,000 hectares of River Red Gum forest and woodland would be inundated for

more than 3 months, of which over 4000 hectares would remain inundated for 4 months. Smaller areas (approximately 600 hectares) would remain inundated for approximately 6 months.

Given the multiple lines and levels of evidence (empirical studies, case studies and a suite of species) it is considered very unlikely that the operational phase of the project would result in a net negative impact on waterbirds compared to the current condition.

Mitigation

Avoid by designing the managed flood recession such that bird breeding is not interrupted. This will include predicting likely bird behaviour and discouraging breeding if a long recession is not possible due to limited available water. Management will be supported by monitoring of bird behaviour and water levels (to the extent possible given access difficulties).

8.6 Geomorphology and Erosion

Risk description	Notching in Barber Creek as a result of constant releases for extended periods.
Risk level	Event level
Risk rating	High
Key mitigation measures	Vary total release rate to the Barber Creek, between 0 and 250 ML/day.

The primary drainage system for the downstream end of the Forest comprises Barber Creek, Runner A, Cow Creek and Calf Creek. About 2 km downstream of Moulamein Road these creeks with the exception of Calf Creek enter a large floodplain, with only Barber Creek remaining as a defined carrier. From there, Barber Creek flows in a north-westerly direction to the confluence with the Wakool River. The total length of Barber Creek from Moulamein Road to the Wakool River is approximately 58 km.

The cross section of Barber Creek is relatively uniform over its length, with a bed width of around 20 m and steep tree lined banks. Bank heights range between 3 to 4m, with the left bank generally higher than the right bank. NSW Water Solutions (2008) undertook an investigation into the hydraulic capacity of Barber Creek downstream of the Forest and demonstrated that the natural in-bank capacity of Barber Creek ranged from 1,270 ML/day to 2,300 ML/day.

Three privately managed blockbanks pond water in the Barber Creek for stock and domestic water supply. “Bywashes” or small floodways have been installed on the block banks to control overbank flows and prevent damage to the banks during controlled releases.

The Project Approval limits outflows via the four downstream Creeks to total of 250 ML/day during managed watering events.

Erosion impacts to upstream structures are not expected as all constructed channels have been designed to ensure that velocity of flow is below 0.6m/s; the normal threshold below which scour is not expected to occur in earthen channels. In addition, regular inspections of the infrastructure will be carried out and any required repairs made with rock rip rap.

Risks

According to Gippel (2010), the proposed flow regime in Barber Creek under operation of the Koondrook-Perricoota Flood Enhancement Works does not resemble the natural flow regime. One of the proposed regulated flow regimes involves long periods (up to 220 days for Scenario 4) of constant flow (250 ML/d). The natural regime would have had constantly varying flows. Thus, the issue with stability of Barber Creek under a future regulated scenario with the Koondrook-Perricoota Flood Enhancement Works operational is not one of instantaneous velocity or shear stress, or the frequency of events, but the constancy of flows.

Martin and Hamilton (2010) investigated the risk to hydraulic conveyance from the presence of River Red Gum regrowth in the Barber Creek. The authors concluded that regrowth is unlikely to persist in the Barber Creek channel due to natural mortality following high flows. In any case, the likely impact of the presence of River Red Gum regrowth was determined to be small during managed releases.

Mitigation

Gippel (2010) recommended that a regime of variable flows, more consistent with natural flow patterns, be implemented. Upon further investigation, Martin and Hamilton (2011) recommended that flows should not remain constant for more than one week, and that flows should be varied over the entire available range, ie 0 – 250 ML/day. The benefits of varying the flows will be weighed up against the disbenefits associated with prolonging the duration of the discharge when determining optimum flows.

Mitigation of River Red Gum regrowth is not required.

8.7 Downstream/Third Party

Risk description	Enhanced flooding of downstream properties during hybrid events.
Risk level	Event level
Risk rating	Low
Key mitigation measures	Avoid by passing flows as they would have without the structures in place.

There are few, if any, risks to downstream landholders during managed events, from the maximum discharge rate of 250 ML/day into Barber Creek. The nominal capacity of the creek is modelled to be approximately 500 ML/day because of the presence of the blockbanks. There may be some inconvenience to landholders who wish to cross the creek.

Overbank events will be managed in accordance with the key principle of “no impact on natural events, in terms of flow into receiving waterways”. That is, overbank flows entering the forest will pass down into Barber Creek as was the case before the construction of the infrastructure. Modelling will be employed by the Operators to determine the required ouflow rates at each of the Thule, Calf and Barber regulators, to ensure overbank flows are passed unhindered.

It is recognised that the impoundment of up to 90GL of water by a levee could present a risk if the levee fails. Whilst the depth of water is up to seven metres at some of the deeper creek structures the general depth of impounded water is in the order of three metres at the downstream end of the impoundment. The NSW Dam Safety Committee has indicated that in its assessment the levee is not a prescribed structure under its legislation as the risk to life and property are negligible.

Mitigation

Operators are to establish a protocol whereby downstream landholders who are directly affected by the release of this water through the scheme are informed before it occurs. During the development of operation procedures for the infrastructure these landholders will be contacted to develop appropriate methods of disseminating the information.

Regular inspections must take place whenever the levees are impounding water, to ensure no seepage is occurring which could lead to a piping failure. The employees engaged in these inspections will be appropriately trained in the surveillance of such structures. A plan will be prepared to put in place procedures to deal with an indication that a structural problem is occurring. The plan will be developed at least 3 months prior to operation and will detail not only remedial action to the structure but also a communication plan to inform any downstream landholders who may be affected.

8.8 Structures

The physical limitations of the structures are discussed in Section 5. There are no perculiarities that preclude operation of the structures to their full designed intent.

8.9 Social and Economic Issues

Risk description	Social and economic impacts arising from reduced access to the forest due to flooding.
Risk level	Event level
Risk rating	Low
Key mitigation measures	Mitigate by maintaining good communication links with the public and the timber industry.

A number of positive impacts are expected as a result of operation of the works, primarily due to expected improvements in the ecological condition of the Forest, including enhanced visual amenity for tourists and recreational users, recreational activities such as bird watching and water sports, and a modest increase in employment and economic activity.

Potential negative impacts during operation of the project include restricted access to the Forest during flooding events and the potential for some reduced visual amenity for adjacent landowners. However, the Forest is often inaccessible by road following heavy rain or natural flooding and in addition several alternative sites also exist where community members could undertake recreational activities.

There would be potential negative financial impacts to commercial timber harvesters from not being able to access the forest at certain times of the year, depending on the extent of inundation. As operational events would be planned well in advance, Forests NSW would schedule activities such that harvesting operations are not planned to occur at the same time the area is inundated. This impact is therefore able to be mitigated by integrating planning for harvesting events and operation of the project.

Ongoing consultation with private land owners, commercial landowners and the public would be undertaken to ensure the results of the operating system are being communicated in a transparent manner. Ongoing consultation is also necessary to address any concerns that may arise relating to flooding or water resource management within and between properties.

8.10 **Noise** (Extract Environmental Assessment, GHD, 2010)

Risk description	Noise associated with operation of the structures may be intrusive or reduce amenity for neighbours.
Risk level	Event level
Risk rating	Very low
Key mitigation measures	Maximising machine use during standard hours, however maintaining the right to operate in response to rain events and any unpredicted flood response. In addition, normal complaints process to State Water Corporation would apply.

The acoustic environment in the proximity of structures is considered to be typical of rural areas, with the main noise sources likely to be associated with vehicle movements along the transport network, operation of agricultural plant and machinery, and fauna. Activities undertaken within the Forest, such as timber harvesting, also affect the background noise environment at individual locations on an occasional basis. Noise generated by harvesting operations is localised and transient in nature. Figure 26 and Figure 27 show the downstream and upstream noise receptors to key infrastructure.

The Industrial Noise Policy (INP) provides guidance on the assessment of operational noise impacts. The guidelines include both intrusive and amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver.

Intrusive noise limits set by the INP control the relative audibility of operational noise compared to the background level. The amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and, in the case of steady noise sources, the lower of the two in each time period normally apply. For noise sources with intermittent characteristics both noise criteria should be assessed independently.

Amenity criteria are determined based on the overall acoustic characteristics of the receiver area and the existing level of noise excluding other noises that are uncharacteristic of the usual noise environment. Residential receiver areas are characterised into ‘urban’, ‘suburban’, ‘rural’ or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic.

The INP classifies the rural receivers as *an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic*.

Given the characteristics of the land use in the vicinity of the study area, all receivers for the project would be classified as ‘rural’ under the INP.

The intrusive criteria are determined by a 5 decibels addition to the adopted background level with a minimum of 35 dB(A). The INP recommends that for the intrusive noise goals, the evening period should not exceed the daytime period and the night-time period should not exceed the evening period.

The minimum INP noise goal of 35 dB(A) has been adopted for this operational noise assessment due to the low background noise levels in the area. There are no available noise management measures, however, there are no operational sources of noise and vibration that would be expected to cause significant impacts external to the site. A crane will be used to place stoplogs

during infrequent operation of the regulators and would generate low levels of noise. There would also be low levels of vehicle movements associated with ecological monitoring and maintenance inspections. Based on this, operational noise and vibration impacts are likely to be infrequent and negligible.

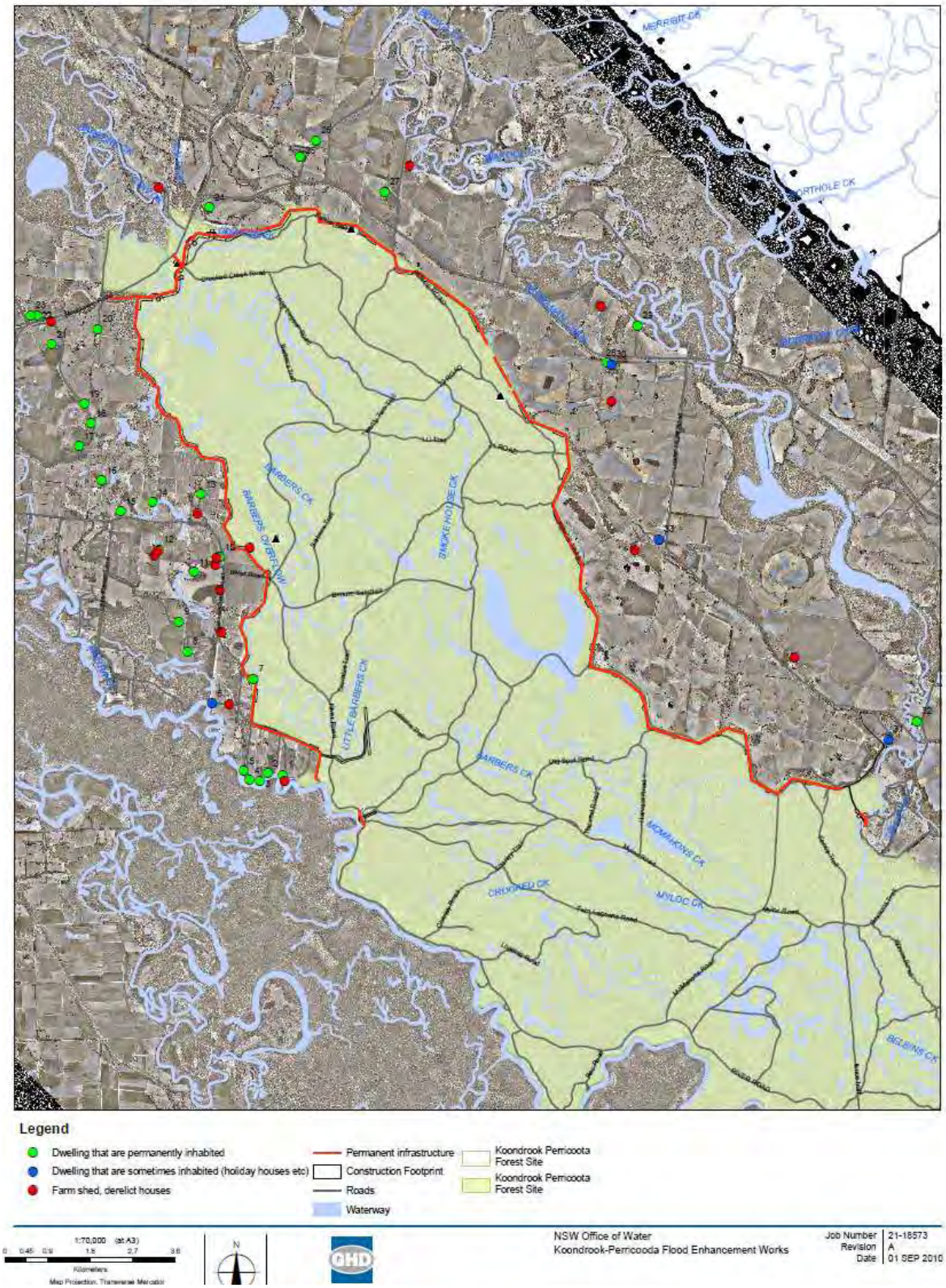


Figure 26: Downstream Noise Receptors

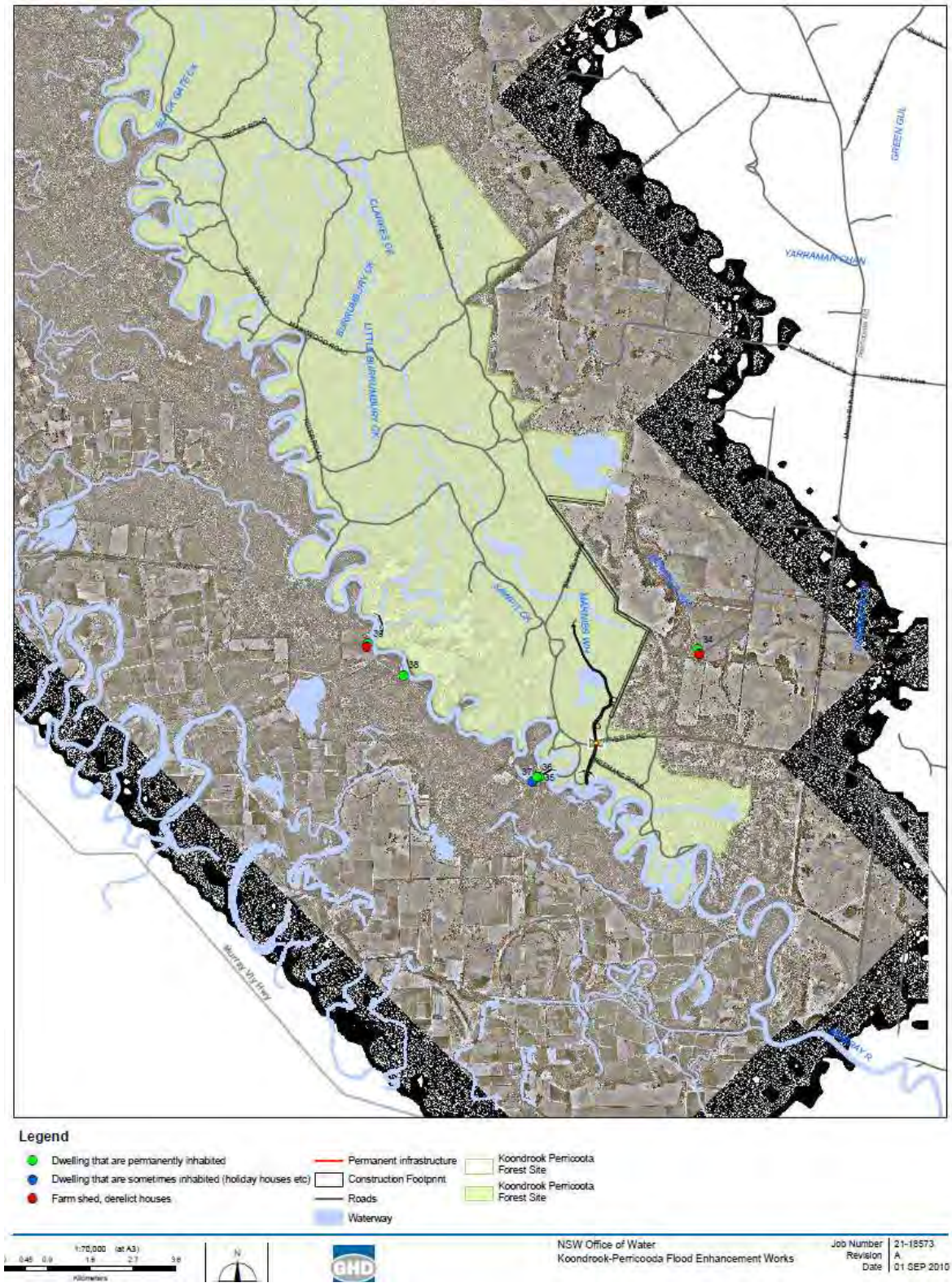


Figure 27: Upstream Noise Receptors

9 OPERATIONAL COSTS

State Water is responsible for the ongoing operation and maintenance of the project, at the request of the MDBA River Operations group. This section does not include costs of monitoring activities undertaken by Forests NSW, which is detailed in the Monitoring Plan.

State Water is responsible for delivery of the following key operational tasks:

1. Operating regulators to control the admission and discharge of water through the project, during a watering event;
2. Liaising with MDBA and other key agencies on operation of the Works primarily associated with planning and running a watering event;
3. Oversight on all aspects of operations including data gathering and general observations primarily associated with a watering event;
4. Implementation of remedial actions when required;
5. Structure safety surveillance monitoring on all structures, levees, channels and associated items, which will occur, at variable levels, irrespective of whether the project is dry or during a watering event;
6. Routine (scheduled) maintenance of structures and levees, including general administration. The demand for which will be partly regularly scheduled irrespective of whether the project is dry or during a watering event; and,
7. Condition based maintenance of structures and levees. The level of condition based maintenance will be dependent on rainfall, water levels, and other variables.

State Water will claim the full cost of operating the structures from the MDBA as it does for operating costs incurred at other structures on the Murray River that are operated under the River Murray Agreement. The administrative processes and relationships that will be required to process these claims are already established.

9.1 Operating cost overview

Key points to note relating to operating costs:

- The annual cost will vary dramatically as a result of the operating pattern for the project;
- Typically, in a 'dry' year when the forest is not watered by either a managed event or overbank flooding, very little cost will be incurred against task 1 to 4 above, and less than average costs will incur against task 5. Costs associated with task 6 and 7 may actually be higher in such a year, due to the ability to conduct civil and mechanical maintenance without water levels hindering activity;
- Conversely, in a year when there is significant watering by either overbank or managed flows, the overall cost may be considerably higher due to activities in task 1 to 4, and much higher than average for task 5. Costs against task 6 and 7 are likely to be lower due to inability to conduct some maintenance due to water levels and operational demands;
- The operation of the project contains almost zero regular fixed costs, such as electricity supply, maintenance of fixed plant, or site based staffing. Virtually all costs incurred are variable;
- The provision of staff to operate the project is accomplished by utilisation of staff who are engaged in activities in the entire Edward Murray Wakool system area, of which the project is but one part. In other words, staffing will be provided as required. There are no staff allocated to the project specifically; and,
- The provision of plant and equipment will be done by utilising some associated with the

staff noted in the above point, in addition to significant use of hired plant on a needs be basis, thus avoiding the costs of maintaining plant and equipment specific for the project.

9.2 Indicative operating costs

Table 16 outlines estimated annual costs of operating the project. Note that the figures are estimates, based on experience with similar State Water activities. A more accurate indication of costs can only be developed over time.

Table 16: Estimated Annual Costs (as of December 2011)

Task	Year involving no watering event	Year involving significant watering event(s)
Operations, as described in tasks 1, 2, 3 and 4 above.	$0	$120K
Surveillance, as described in task 5 above.	$25K	$55K
Routine Maintenance, as described as task 6 above.	$60K	$50K
Condition based Maintenance, as described as task 7 above.	$30K	$20K
Total	**$115K**	**$245K**

Using a period of 15 years of operation, with an assumption that watering occurs once in three years, the above table indicates an average annual operating cost of 158k.

10 COMMUNICATIONS

Establishing sound mechanisms for stakeholder and community consultation will be crucial to the operation of the Scheme. In order to achieve this, consultation activities will need to take place prior to, during and following an event. Guiding principles adopted by Forests NSW and the broader Operations Committee include:

- Engage positively and effectively with the community to ensure stakeholder issues are addressed;
- Provide consistent, timely and accurate information;
- Define the aspects of the project where community and stakeholder input is possible (i.e. negotiable and non-negotiables) and ensure expectations are managed in line with these;
- Facilitate a coordinated approach with other government authorities to ensure messages to the community are clear and consistent and that issues are responded to and managed by the appropriate authority and in a timely manner;
- Use consultation techniques that effectively and meaningfully engage the community and stakeholders; and,
- Build and maintain trust between stakeholders and the community, facilitate open and transparent discussions, and incorporate local knowledge to make changes to the project where this is possible.

10.1 Community consultation

The Community has registered a strong interest in the project and has requested ongoing engagement during operation of the Scheme. Conversely, there is significant generational experience and knowledge within the community that would benefit the development of Operations. As such, the Icon Site manager (FNSW) is committed to establishing and maintaining strong relationships within the local community during operation of the Scheme.

Community Operation and Planning Advisory Committee (COPAC)

The Community Operation and Planning Advisory Committee (COPAC) has been established as a reference advisory group to provide local experience and advice into the planning for operation of events generated by the works. The group includes representatives from key community groups such as the Wakool Landholders Association. It is intended that the role of this group will be revised following completion of the inaugural operation of the works, with a view to establishing suitable consultation arrangements for ongoing water management at the Icon site.

Joint Indigenous Group (JIG)

To ensure the Indigenous community are provided opportunity for input into water management and a chance to raise and identify their cultural and spiritual links to the forest, a Joint Indigenous Group (JIG) has been established. This group is made up of representatives from the two local Traditional Owners (Yorta Yorta and Barapa Barapa Nations) and the Moama and Deniliquin Local Aboriginal Land Councils. These representatives, chiefly CEOs and Elders, ensure cultural heritage and values are considered and incorporated by the Icon Site manager, and the distribution of information out into the aboriginal communities. The JIG provides a valuable single source for Indigenous engagement, advice, input and recommendation.

Other Indigenous groups with an interest in the Koondrook-Perricoota Forest include the Murray Lower Darling Rivers Indigenous Nations (MLDRIN), Wamba Wamba Nation, Murray Aboriginal advisory group and the Yarkuwa Indigenous Knowledge Centre Aboriginal Corporation (GHD 2010).

Downstream Landholders

In May 2011, meetings were conducted with landholders downstream of the Scheme on Barber Creek. A key concern of landholders was receiving early and continued advice prior to operation and during operation. Individual downstream landholders who are directly affected by the release of this water through the scheme will be informed before it occurs. Individual landholders will be contacted by State Water for their preferred methods of disseminating the information.

10.2 Stakeholder Groups

A comprehensive list of stakeholders, both external and internal has been developed. Stakeholder groups have different levels of interest and responsibilities, both within and between groups. To ensure the consultation with each group is effective, the groups have been split into three levels based on interest, responsibility and the potential level of influence over the project.
Each of these levels are described below:

Level 1: Stakeholders who are directly involved in the decision making process during the operation phase of the project.

Level 2: Stakeholders who may influence operational outcomes, but who may not necessarily influence the decision making processes during operation.

Level 3: Stakeholders who need to be kept informed of operation of the project and the issues that may arise during operation.

Table 17: Stakeholder Groups

Category	Stakeholder
Level 1	
Scheme Proponents	Primary Industries – Forests NSW Primary Industries – NSW Office of Water
Operators	State Water Corporation Murray Darling Basin Authority – River Murray Operations
Water Holders	The Living Murray Office of Environment & Heritage (NSW) Commonwealth Environmental Water (CEWO)
Regulatory Authorities	NSW Planning Office of Environment & Heritage (NSW) Primary Industries – Fisheries NSW Primary Industries – NSW Office of Water
Community Representative Groups	Community Operation & Planning Advisory Committee (COPAC)
Joint Indigenous Group	Yorta Yorta Nation Barapa Barapa Nation Deniliquin Local Aboriginal Land Council Moama Local Aboriginal Land Council
Level 2	
TLM Environmental Water Group	Department of Sustainability and Environment (Victoria) South Australian Department for Water Department of Sustainability, Environment, Water, Population & Communities (Australian Government) Office of Environment & Heritage (NSW) Primary Industries - NSW Office of Water
Local Landholders	Neighbouring landholders Barber Creek and Thule Creek riparian landholders
Local councils	Wakool Shire Council Murray Shire Council

Category	Stakeholder
	Gannawarra Shire Council (Vic.)
Indigenous organisations other than those represented on the JIG	Yarkuwa Indigenous Knowledge Centre Murray Lower Darling Rivers Indigenous Nations
Other Government agencies	Murray Catchment Management Authority North Central Catchment Management Authority (Vic.)
Murray Darling Fish Passage Taskforce	The Murray Darling Fish Passage Taskforce is made up of specialist freshwater fish scientists, including Dr Martin Mallen-Cooper (Fishway Consulting Services), Dr Lee Baumgartner (NSW Industry and Investment - NSW Fisheries) and Dr Ivor Stuart (Senior Scientist Arthur Rylah Institute Victoria).
Local members of parliament	State Member for Murray Darling: John Williams Federal Member for Farrer: Sussan Ley
Level 3	
Local Landholders	Barham landholders East Barham landholders Wakool Landholders Association Wakool River Association Womboota landholders Bunnaloo landholders Caldwell landholders
Historical and cultural organisations	Barham-Koondrook Historical Society Inc Echuca Historical Society Inc Colbinabbin & District Historical Society
Environmental groups	NSW NPA Environment Victoria Australian Conservation Foundation
Business organisations	Barham/Koondrook Chamber of Commerce Echuca/Moama Business and Trades Association Echuca/Moama and District Agricultural and Pastoral Society Mathoura Chamber of Commerce.
Media organisations	Barham Bridge Local Radio Stations Riverine Herald Radio stations 3SH amd 2QN Win TV

10.3 Community Issues

Key operational impacts of most concern to the community have been raised by community members, which have been broadly captured within Table 18.

Table 18: Community Issues – Operation

Forum	Issue	Description	Management/Mitigation Measures
Community Operation & Planning Advisory Committee	**Water Quality**	The production of blackwater and the impact on downstream aquatic communities. The ability to utilise dilution flows within the Wakool River is viewed as a key mitigation measure for blackwater.	- Development of a blackwater model to support operational decision-making. - Extensive monitoring program. - Consideration to allocation of water for dilution flows.
	Existing Licensed Levees	The works may cause damage to licensed levee network, maintained by adjacent landholders.	- Extensive hydraulic modelling and communication of results to the community. - Modification of culvert/levee design.

Forum	Issue	Description	Management/Mitigation Measures
			- Surveillance during operation.
	Overbank Flood Restriction	The potential hindrance of overbank flows from reduced waterway areas through downstream structures. Overbank events may impact neighbouring properties. Buildup of debris at structures, restricting downstream flows.	- Structures design to allow maximum waterway area within available budget. - Extensive hydraulic modelling and communication of results to the community. - Surveillance and maintenance during operation.
	Management of Overbank Event on top of Managed Event	Overbank flooding occurring during a managed event may exacerbate flooding impact on adjacent landholders' property. Insufficient time to remove stoplogs.	- The scenario has been modelled and presented to the COPAC. - Manage as per Chapters 6.3 and 6.4 - Stoplogs will require minimal time to remove.
	Monitoring Parameters	Ensure parameters are captured within the monitoring program including stream pH, groundwater salinity & watertable depth on adjacent properties.	- Parameters have been captured within the Monitoring Plan.
	Communication	Concern regarding sufficient input by the community to decisions regarding timing of watering. Ensuring cooperation/coordination amongst key government agencies.	- COPAC & JIG will continue to completion of the inaugural operation of the Scheme. - Development of ongoing consultation mechanisms.
	Regrowth	Regrowth downstream altering flood patterns and causing flooding of adjacent properties.	- Unlikely as overbank events will kill regrowth.
	Upstream Hydrology	Inundation of unprotected private property at upstream end of forest.	- State Water & NOW negotiating resolution of the issue with landholders.
	Thule Creek Levee	Breeching of the project levee by an overbank event at Thule Creek and trapping water between the project levee and existing private levee.	- State Water & NOW examining resolution of the issue.
Joint Indigenous Group	**Protection of Cultural Heritage**	Protection of cultural heritage items and places of significance from flood damage, and from operation and maintenance activities.	- A Monitoring program is to be established for the protection of culturally significant items and places of significance. - State Water to take account of sites in Operations and Maintenance Manuals.
	Employment	Employment opportunities for Indigenous people may arise during operation of the Scheme.	- The JIG will be part of ongoing consultation to identify and realise opportunities.
	Cultural Flows	Interaction of cultural flows and environmental flows.	- To be adressed if/when cultural flows become available.

Forum	Issue	Description	Management/Mitigation Measures
Environmental Assessment	**Public Access**	Disruptions to Forest access during operation that may limit recreational amenity.	- The Forest is often inaccessible by road following heavy rain or natural flooding and so there is no real change in access conditions. - Several alternative sites exist where community members can undertake recreational activities.
	Commercial Timber Harvesting	Disruptions to harvesting operations due to limited access.	- Forests NSW will integrate planning for harvesting events and operation of the project.
	Non-Indigenous Heritage	Impact to nine historic heritage sites were identified within the Forest during the field survey for the project. Historical sites comprise six surveyor-marked trees (K-PH1, K-PH2, K-PH4, K-PH5, K-PH6 and KPH9), a structure and other remains possibly associated with the sand mine or with forestry operations (K-PH3), the location of an old sawmill (K-PH7), and an old sawmill house (K-PH8).	Forests NSW will establish set photopoints for each of the non-indigenous heritage items found during the Environmental Assessment and take a photo one month after the completion of every operation of the Scheme's structures. Following five operations a decision will be made on whether an Archival Record should be completed if the particular item is degrading to a significant extent.

10.4 Consultation Activities

Table 19 details the proposed consultation activities that will be implemented to ensure that the community is provided with accurate information about, and are involved to an appropriate degree in, the operation of the project.

Table 19: Consultation activities

Activity	Detail	Responsibility	Timing
COPAC Meetings	Monthly meetings of the COPAC to conclusion of the inaugural event. Consultation to be continued with a revised Terms of Reference after inaugural event.	*Forests NSW*	Prior to and during operation
JIG Meetings	Ongoing consultation mechanism will be determined prior to the dissolution of the JIG. This mechanism will follow the principles for consultation outlined within the Indigenous Partnerships Agreement, including mutual respect and informed consent.	*Forests NSW*	Continued to the conclusion of the inaugural event
Landowner letters	A courtesy letter will be sent to landowners adjacent to the forest and Barber Creek to inform them of the commencement of operation and offering to meet with them personally to discuss any issues they may have.	*Forests NSW*	6 weeks prior to operation
Community briefings / information sessions	Briefings with key landholders and community groups will continue on a regular basis throughout the inaugural operation as required to address issues arising and to gather feedback.	*Forests NSW, State Water*	As required, prior to and during operation
Public displays	Project updates to advise on operation will be available at Council offices and the Project	*Forests NSW*	Throughout operation

Activity	Detail	Responsibility	Timing
	Information Centre (whilever it remains in use).		
Local newspaper advertorials and updates	Prior to and during inaugural operation, advertorials/updates will appear in local newspapers on a monthly basis. These will provide updates on operational activities and topics of community interest, including access issues.	*Forests NSW*	Prior to and during inaugural operation
Regional and metropolitan media	Operation and Forest access restrictions will be advertised to the broader community including but not limited to Melbourne, Bendigo etc via appropriate websites.	*Forests NSW*	Prior to and during inaugural operation
Community notifications - media releases	Media releases will be prepared and issued in consultation with water holders as required. The purpose of these is to ensure that the community and key stakeholders are aware of the nature and status of operation and associated activities, and the implications of these for the general community. Media releases will also promote 'good news stories' about operation and mitigate any potential negative publicity.	*Forests NSW*	Prior to and during operation
Fact sheets	A fact sheet on operation will be prepared that targets operational issues of concern to the community. These sheets will be distributed via the public displays at Council and the Project Information Centre.	*Forests NSW*	Prior to and during operation
Contact cards	Contact cards will be distributed as required to all landholders and neighbouring residences. This will ensure that local landholders can contact representatives of the Operational team to obtain information on the project or register a complaint.	*Forests NSW*	Prior to and during operation
Landholder Register	A register will be established comprising contact details of landholders adjacent to the Forest and Barber Creek to allow early warning of operation, provide regular weekly updates and updates of changes in release rates, as required. Preferred methods of communication (i.e. email, phone, letter) will be requested of landholders, recorded and utilised during operation.	*Forests NSW, State Water*	Prior to and during operation.
Operations Committee	Operations Committee members will be informed throughout the operation via email, and at regular meetings.	*Forests NSW*	Throughout operation
Website update	The existing project website will be updated to announce the commencement of operation and regularly updated during operation so that the community and stakeholders are kept informed. All printed material and publicly released materials will be uploaded on the website. The website will also contain a copy of approvals, licences or permits that the Minister's Condition of Approval requires be publicly available.	*Forests NSW*	Prior to and during operation
Community complaints management procedure	A community complaint procedure has been developed based on the framework provided in Section 10.5. This procedure will ensure a consistent approach in responding to issues	*Forests NSW*	Prior to and during operation

Activity	Detail	Responsibility	Timing
	raised and ensure that feedback is provided in a thorough and timely manner. A database will be established to record all community comments and complaints.		
Council Meetings	State Water and/or Forests NSW will attend Wakool and Murray Shire Council meetings prior to each operation to address issues of concern.	*Forests NSW & State Water*	Prior to operation
Project signage	Signboards will be erected at the main public entrances to the Forest to provide information on the project.	*Forests NSW*	Prior to operation

10.5 Complaints and enquiries

The Complaints Procedure for the operation of the Scheme will generally be in accordance with the Complaints Procedure developed by Forests NSW. Forests NSW maintain a Forest Management System (FMS) that captures and records complaints electronically, and this will be used as a register. Forests NSW will provide a report to the Operations Committee regarding the complaints register.

In accordance with MCoA 5.2, the following will be available for community complaints until the completion of four complete flood events of the project (or as otherwise varied by the Director-General of NSW Planning):

a) a telephone number on which complaints about any issues relating to the proposal at the site may be registered;
b) a postal address to which written complaints may be sent; and
c) an email address to which electronic complaints may be transmitted.

It is acknowledged that complaints may be received by a number of methods and routes, and therefore a Complaints Report form has been developed for operation of the Scheme. The Complaints report captures the following data:

a) the date and time, where relevant, of the complaint;
b) the means by which the complaint was made (telephone, mail or email);
c) any personal details of the complainant that were provided, or if no details were provided, a note to that effect;
d) the nature of the complaint;
e) any action(s) taken by Forests NSW or appropriate stakeholder agency in relation to the complaint, including any follow-up contact with the complainant; and
f) if no action was taken by the Forests NSW or appropriate stakeholder agency in relation to the complaint, the reason(s) why no action was taken.

Closure of the issue of complaint and any actions that are required to be taken arising from it, must be approved by the Icon Site Manager, Forests NSW. In approving closure of the issue, the Icon Site Manager will be approving that the corrective actions of the complaint:

- are appropriate and adequate;
- have been undertaken;
- have successfully addressed the compliant non-conformance; and,
- that the follow-up and feedback actions have been completed.

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APPENDIX A WATER PLANNING

1. MANAGING ENVIRONMENTAL WATER TO IMPROVE RIVER AND WETLAND HEALTH IN NSW

2. TLM PLANNING FRAMEWORK

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Managing Environmental Water to improve River and Wetland Health in NSW

Purpose

This document proposes a framework for environmental water management in NSW. It explores guiding statements, key accountabilities and coordinating mechanisms to ensure *that by 2015 there will be an improvement in the condition of riverine ecosystems and important wetlands, and the extent of those wetlands will be maintained* (State Plan 2006).

Context

Environmental water includes:

- environmental water allocations made available under Water Sharing Plans (planned environmental water); and
- adaptive environmental water licences arising from both the purchase of entitlements from willing sellers and the recovery of water savings by infrastructure projects.

The NSW Government has determined that the Department of Environment and Climate Change (DECC) is the lead agency for management of *'water that has been allocated to the environment and river health'*. Other partners with significant roles are Catchment Management Authorities (CMA), environmental flow advisory groups (eFAGs), Department of Water and Energy (DWE), State Water Corporation (SWC), Department of Primary Industries (DPI), Natural Resources Commission (NRC) and Sydney Catchment Authority (SCA).

The administrative arrangements now established in NSW are consistent with expectations of the Australian Government as outlined in the National Water Initiative (NWI), the Commonwealth *Water Act 2007*, and various funding agreements. The Australian Government expects a state environmental water manager to provide a single point of interaction with the Commonwealth Environmental Water Holder, to have clear accountability and authority (both statutory and in terms of community recognition and acceptance), to be independent of water regulation and water allocation functions, and to have sufficient financial and technical capacity to enable them to perform their role. The NWI also requires each jurisdiction to have an independent audit of environmental outcomes, a role performed in NSW by the Natural Resources Commission.

Guiding statements

1. Achieving the State targets for wetlands and rivers requires an effective partnership between DECC, CMAs and DWE, based on clearly defined roles and responsibilities.
2. Accountability through a single body for management of Government-owned environmental water, and market participation by Government, is essential to meet NWI requirements, improve efficiencies, eliminate potential confusion and provide transparency.
3. Monitoring and reporting on the condition of NSW's important wetlands is critical to demonstrate progress in the chosen approach.
4. Coordinating advice on the application of environmental water management is best achieved at the catchment scale, incorporating local expertise through

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advisory groups convened under Water Sharing Plans, or other arrangements as appropriate.

Key accountabilities

Specific roles and responsibilities for each partner are listed in **Attachment A**.

As the lead agency for environmental water management and environmental water recovery programs, DECC is **accountable** to Government for ensuring a robust planning and operational framework for environmental water and maximizing environmental outcomes through the coordinated management of all Government held environmental water. DECC will lead the recovery of environmental water where necessary, provide a single point of Government participation in water markets (single desk function), interact with the Commonwealth Environmental Water Holder in planning water recovery and use, and monitor and report on the status and use of environmental water holdings and environmental outcomes.

Environmental Flow Advisory Groups convened under Water Sharing Plans, or other reference groups as appropriate, will support DECC at a catchment scale in planning, monitoring and reporting on environmental water use. CMAs, in addition to their participation in these groups, have a key role in assisting DECC with the development of Environmental Water Management Plans (EWMP), including through facilitating community engagement. DWE and SWC will ensure Water Sharing Plan environmental water provisions are implemented, including the delivery of rules based environmental water (eg translucent dam or end-of-system flows) and the accurate accrual of environmental water allocations.

Watering decisions are strongly influenced by the volumes environmental water available, particularly when there is flexibility to combine sources. An **environmental water register** will be maintained by DECC that will consolidate and regularly update information on the volumes of water held in environmental water accounts under Water Sharing Plans and adaptive environmental licences. The register will also track the use of all sources of Government-held environmental water, any trading of water accruing to adaptive environmental water licences, and other information relevant to the governance of the environmental water portfolio.

Monitoring is essential to measure progress towards objectives. It is critical for adaptive management. However, it is often poorly designed, inadequately resourced and rarely connected to subsequent changes in management. Monitoring can be expensive so needs careful thought to ensure both measurable progress towards relevant management objectives and to avoid wasted effort. The Environmental Water Management Plan will coordinate monitoring efforts of various agencies to meet the objectives established at each target asset. Monitoring at the catchment scale will also take account of the existing state-wide monitoring, evaluation and reporting strategy, seeking efficiencies wherever possible.

Monitoring to improve management is a long-term commitment, not an end point. To be effective, its outputs also need to be communicated to and understood by a variety of audiences. **Communication** is fundamental for establishing the validity of environmental flow management, for consolidating experience gained over time and to allow as many interested people as possible to share the journey. A communication strategy will be an important component of EWMPs.

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Coordinating mechanisms

Figure 1 outlines the relationship between sources of environmental water and the planning requirements to ensure each source contributes to meeting the State targets. Several types of plan exist, leaving scope to refine and simplify, particularly where duplication exists, for example, in functions such as monitoring and communication. There is substantial progress for many plans but there is no integrating framework. 'Environmental Water Management Plans' are proposed to fill this gap at a catchment scale. A brief outline of each 'type' of plan follows.

1. Environmental water management plan

Environmental Water Management Plans (EWMPs) are the integrating plans that connect planning efforts for individual wetlands and/or under individual programmes within a catchment. EWMPs can apply at the specific wetland scale (for large wetland complexes) or at the catchment scale. The State Plan commits DECC to establishing EWMPs for NSW's significant wetlands by December 2008 (Milestone 41). EWMPs are already in preparation for the Macquarie Marshes and Gwydir Wetlands, under the NSW Wetland Recovery Programme. Initially, plans will be developed for other valleys where environmental water allocations exist.

When applied at the **wetland scale**, EWMPs:

- define specific ecological assets (e.g. endangered ecological communities, threatened species habitats, colonial waterbird breeding sites etc.) for protection;
- define desired ecological outcomes;
- identify water needs (volume, timing and security) to meet ecological outcomes;
- establish benchmarks of condition;
- identify opportunities to realise environmental water to meet identified watering needs;
- address the effects of land and water management practices on the wetlands, in particular diversion banks, channels, grazing and cultivation;
- determine other actions required in order to achieve adaptive management and ecological outcomes; and
- begin the process of developing a shared understanding of the system as a whole, and integrating a wide range of disciplines so that they are addressed in a connected way.

Implementation of recommended actions requires substantial technical information to allow the best decision at the time and to report on achievements. Therefore a strong science input is necessary to provide confidence in the conceptual basis for the EWMP and to ensure constant improvement in management.

For valleys containing several significant wetlands or environmental assets, an overall strategy to coordinate environmental water management is required. At the **catchment scale** therefore, an EWMP should:

- provide a transparent process, and decision criteria, for the application of environmental water to maximise the environmental outcomes;
- demonstrate the prioritisation process between assets which will enable environmental outcomes to be maximised;

- demonstrate adaptability in management of environmental water;
- integrate with other environmental water application plans such as those developed for TLM Icon Sites or the Murray Darling Basin Environmental Water Plan;
- integrate water recovery initiatives and water application programmes; and
- supplement the CAP strategic direction and address nominated priority assets identified in the CAP.

Development of EWMPs is best managed by a partnership between DECC and CMAs, with appropriate input from other agencies. This partnership acknowledges the importance of scale (state and regional) and different accountabilities. A key role for CMAs is to facilitate community engagement.

2. Water Sharing Plan

Water Sharing Plans are the statutory basis under the *Water Management Act 2000* for allocating water between the environment and other users, and between water users, for a given water source. Amongst other things, the Water Sharing Plan:

- provides a proportion of water for the environment – planned environmental water;
- allows licensed water to be committed for the environment – adaptive environmental water;
- determines how water is shared between water users under different circumstances;
- specifies rules for water trading; and
- sets out monitoring and reporting requirements.

Water sharing plans are in place for most regulated rivers and some unregulated rivers, with the remainder due for completion by December 2009 (State Plan, Milestone 39). DWE leads their preparation. The plans exist for ten years and can then be changed or continued on advice from the Natural Resources Commission.

3. Water use plan

Water use plans are being prepared by NSW RiverBank as the basis for management of adaptive environmental water licences. The plans are approved by DWE under the *Water Management Act 2000* and are linked to licences via an adaptive environmental water condition imposed on the licence. A plan is typically prepared for each valley and water licences are linked to the plan as acquired. The water use plan specifies the targets for water application, demonstrates consistency with objectives of the water sharing plan and details accounting rules for use of water.

Water use plans prepared by DECC have been approved for the Macquarie and Lachlan water management areas and a Gwydir plan has been submitted to DWE for approval. A Murrumbidgee plan is in preparation. All Government-owned adaptive environmental water within a valley should link to a single water use plan, or otherwise DECC will be responsible for assuring multiple plans are consistent or complimentary.

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4. Implementation and/or annual release plan

Environmental flow advisory groups may prepare implementation plans which define the target assets and objectives for use of planned environmental water where EWMPs do not already fulfil this function. Implementation plans have been prepared by the Gwydir Environmental Contingency Allowance Operations Advisory Committee (ECAOAC) and the Macquarie-Cudgegong Environmental Flows Reference Group (EFRG) to date.

Environmental flow advisory groups will also prepare annual release plans which specify the priorities for watering in the short-term based on anticipated likely scenarios, taking into account available planned and/or adaptive environmental water available, probabilities of additional water accruing, sources of other environmental water (eg. dam spills, tributary inflows), recent history of environmental water management and condition of target assets.

The ECAOAC and EFRG have prepared annual release plans which may be revised as conditions change during the year. Similarly, DECC identifies priority targets for adaptive environmental water held by NSW RiverBank in its annual release plans, which are also revised as conditions change.

Implementation

The above planning framework will allow for targeted, transparent and efficient management of environmental water if accountabilities are well defined, information is sufficient to understand and prioritise environmental outcomes, and monitoring and communication of outcomes is well designed and resourced.

Outstanding issues to address in the implementation of this framework include:

1. finalisation of the format of environmental water management plans (DECC lead in consultation with CMAs)
2. nominating staff to lead development of catchment EWMPs (DECC and CMAs)
3. confirming roles, membership and resourcing of existing environmental flow advisory groups and form others where necessary (DECC lead in consultation with existing groups)
4. develop environmental water register (DECC)
5. complete water sharing plans (DWE)
6. develop water trading systems and strategy (DECC).

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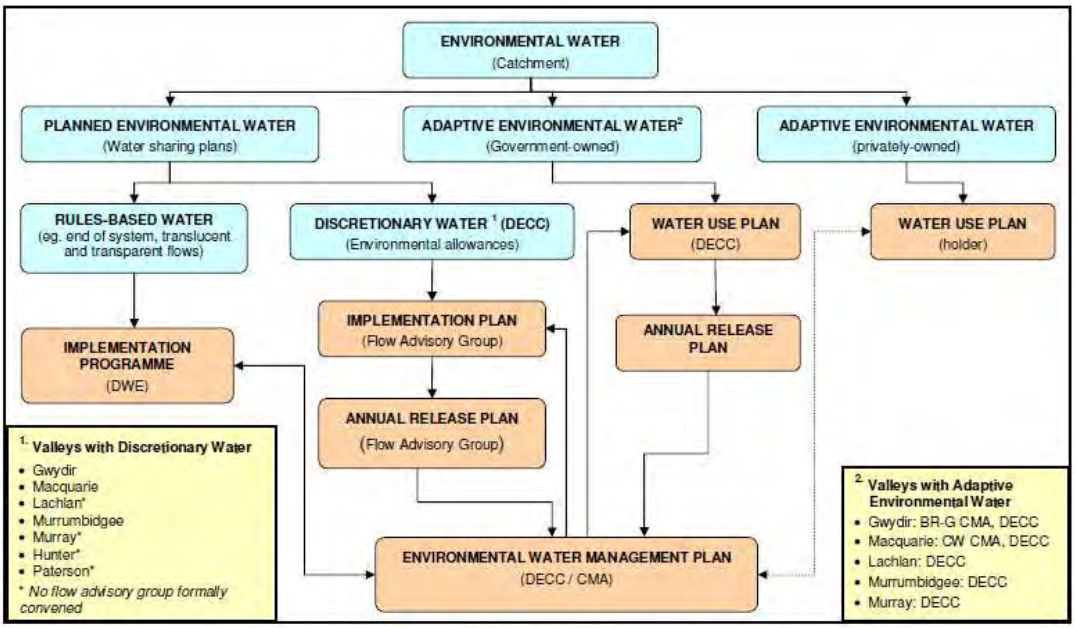

Figure 1: Sources of environmental water and relationships between associated plans

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Attachment A: Roles and responsibilities of NSW agencies for management of environmental water

LEAD AGENCY	ROLE
Department of Environment and Climate Change	1. Ensure all Government owned environmental water licences (adaptive environmental water) are managed in accordance with relevant statutory plans; 2. Perform all market-based environmental water activity on behalf of Government; 3. Lead the recovery of environmental water through relevant programmes including the NSW RiverBank Programme, the NSW Wetlands Recovery Programme and The Living Murray Initiative; 4. Lead the development of Environmental Water Management Plans for NSW's significant wetlands in cooperation / partnership with CMAs; 5. Lead NSW input to the development of the Environmental Watering Plan under the Murray-Darling Basin Plan, consistent with EWMPs; 6. Manage adaptive environmental water licences assigned to DECC by the Minister for Climate Change, Environment and Water, including through the use and trading of water to support specific priority environmental assets and values; 7. Advise the Minister on the management of environmental water allocations made available under water sharing plans, using advice from environmental flow advisory groups where established, and order the delivery of environmental water allocations consistent with approved plans; 8. Coordinate, evaluate and resource the operation of environmental flow advisory groups established under water sharing plans to ensure appropriate community input to decisions; 9. Track and report on the status and use of all environmental water (whether derived from licence or accruing through water sharing plans) within each water source; 10. Monitor the delivery of, and ecological responses to, the application of environmental water in cooperation with DWE.

Prepared by DECC as basis for discussion to confirm environmental water management responsibilities within NSW agencies

Department of Water and Energy	1. Determine water availability through the making of available water determinations in accordance with the water sharing plans (WSP) and the *Water Management Act 2000*, and advise DECC on water accrued to WSP environmental water allocations. 2. Establish adaptive environmental water entitlements and approve management plans for adaptive environmental water licences under the *Water Management Act 2000*. 3. Implement environmental water provisions in water sharing plans, including the delivery of rules-based environmental water (eg. translucent dam or end-of-system flows) and the accrual of environmental water allocations (noting that decisions on the timing and volume environmental water allocation releases will be made by DECC). 4. Regulate water extraction to ensure environmental water is not illegally diverted. 5. Provide modelling analysis for environmental water management and / or water recovery scenarios. 6. Monitor the performance of WSPs against objectives, including through the Integrated Monitoring of Environmental Flows programme.
Catchment Management Authorities	1. Manage adaptive environmental water licences assigned to them by the Minister for Climate Change, Environment and Water in partnership with DECC and other organisations with environmental water responsibilities and in accordance with approved statutory Water Use Plans (prepared under s.8E(7) of the *Water Management Act 2000*) and Environmental Water Management Plans; 2. Facilitate and negotiate community engagement in the development of Environmental Water Management Plans in partnership with DECC. 3. Monitor and report progress to the NRC on achieving standards and targets in catchment action plans relating to environmental water management, including the operation of water sharing plans. 4. Coordinate community engagement into the development of strategies for water recovery. 5. Manage approved water recovery and innovation projects on a case-by-case basis.

State Water Corporation	1. Responsible for river operations and water delivery in regulated river systems, including the delivery of adaptive environmental water and environmental water allocations ordered by DECC. 2. Responsible for monitoring of extraction and diversions, accounting of water use, meeting water orders and billing water users. 3. Operation and maintenance of government-owned water supply infrastructure in NSW, including major dams and weirs. 4. Must be consulted on and concur with water recovery from system losses that impact on river operations and timing of water delivery.
Department of Primary Industries	1. Provide specialist technical and policy advice to water recovery and environmental water use projects and plans, particularly in the areas of on-farm water use efficiency, floodplain forest and wetland management, and fisheries management. 2. Coordinate development of and implement TLM Asset Management Plans for Millewa and Koondrook-Perricoota Forests.
Natural Resources Commission	1. Recommend state-wide standards for natural resource management and targets for natural resource condition. 2. Assess the extent to which Water Sharing Plans have contributed to the achievement of (or the failure to achieve) the state-wide natural resource management standard and targets in the relevant catchment area. 3. Audit of outcomes achieved under Water Sharing Plans. 4. Assess whether changes to Water Sharing Plans are warranted.

TLM Planning Framework

1 The Living Murray Business Plan and Environmental Watering Plan

The Living Murray Business Plan and overarching Environmental Watering Plan set the policy context for the TLM program. Amongst other things, the documents set out how environmental watering decisions are made, how water use is accounted, and how the outcomes are to be reported. As TLM is moving from a phase of water recovery and small scale watering activities, into a longer term program of large scale watering activities, both of these documents are to be reviewed in 2009.

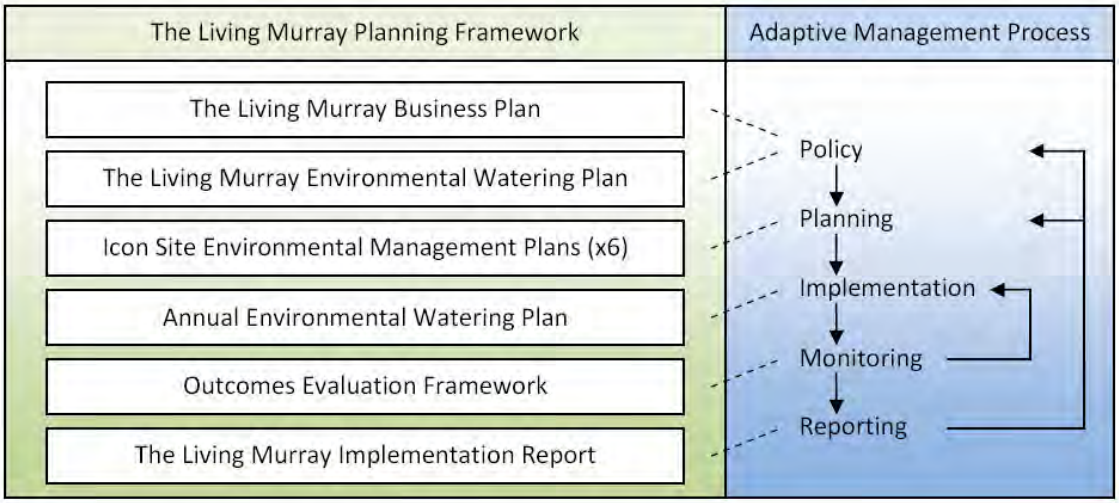

Figure 1: The Living Murray planning framework and links to typical adaptive management process

2 Icon Site Environmental Water Management Plans

Each icon site has an Environmental Water Management Plan. The document sets out land management responsibilities, environmental objectives and targets, activities to be undertaken to achieve those objectives, consultation arrangements, complementary actions, and the monitoring framework for the site.

Since the first plans were written there has been substantial progress on the development of the proposed environmental works and measures. It is now clear that these will become the major mechanism to achieve the environmental objectives at most sites. The Icon Site Environmental Management Water Plans were reviewed and updated in 2011. A focus of the review was to include the development of operating plans for the proposed works, including the adaptive management and monitoring framework.

3. Annual Environmental Watering Plan

An Annual Environmental Watering plan is prepared at the beginning of each 'water' year (the water year is from July to June, aligning with the seasons and water allocation policy in the River Murray system). The plan is typically prepared around May/June for the forthcoming year. It sets the environmental watering priorities under TLM for the next 12 month period by:

- Considering current and likely water availability for the forthcoming year;
- Considering the need and priority of watering activities at the icon sites; and

- Establishing a decision making framework for watering actions for the forthcoming year, based on water availability and unfolding conditions at the icon sites.

The Annual Environmental Water plan is built up from inputs from the Icon Site Managers. The need and priority of watering activities for the individual sites considers the condition of the sites, recent watering history, ecological outcomes to be targeted in that year, and other conditions, particularly related to environmental and third-party risks.

The relative priority of the proposed watering activities across the icon sites is then compared and a hierarchy of watering actions is developed aligning with water availability thresholds and other implementation criteria. A decision making structure is established so that rapid decisions can be made during the water year as it unfolds and water becomes available.

4. Implementation of Watering Actions

The Annual Environmental Watering Plan is deliberately structured to be adaptive in response to water availability and other environmental conditions. Implementation of the associated watering activities is also adaptive. Implementation commences in June-July but would continue for the whole watering year.

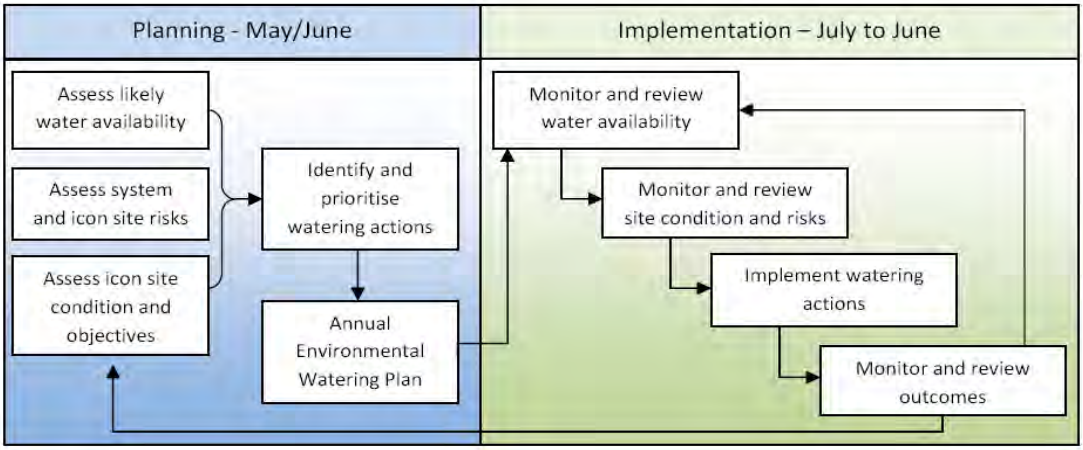

Figure 2 : TLM environmental water planning and implementation

On an ongoing basis the MDBA and EWG review the Annual Environmental Watering Plan against the availability of environmental water. Actions are selected and approval is sought for the use of the associated water. Approval to utilise TLM water is provided by the MDBA, while the use of unregulated flows may need approval from State agencies. The EWG is currently trialling the prioritisation of Unregulated flows in the Environmental Entitlement.

5. Environmental Watering Group

It is envisaged that the Environmental Watering Group (EWG) would oversee the implementation of the environmental watering plan for the River Murray System each year. EWG would meet as required to provide advice and feedback to MDBA and jurisdictions regarding how environmental operations for the overall River Murray System were proceeding, as well as event planning and prioritisation for the coming weeks and months as appropriate.

6 Outcomes Evaluation Framework

The Outcomes Evaluation Framework (OEF) is the framework for monitoring and evaluating the outcomes of environmental watering and the achievement of the icon site objectives under TLM. The current framework was finalised in 2007. It has led to the development of condition monitoring plans for the icon sites (which feed into the annual icon site condition reports) and

investment in many intervention monitoring projects that have improving understanding of ecosystem processes and the specific outcomes of watering actions.

APPENDIX B REPORTING TEMPLATES

EVENT DESIGN REPORT

Watering Year

Report No:

The report will be allocated a report after it has been reviewed and approved. The numbering system involves placing the reports into categories (e.g.Event Design (ED), Event Completion Report (EC) with a sequential number applied in each category.

Prepared by

Identifies the personnel who prepared the Report. The first author listed will be the author to which correspondence/enquiries will be directed unless otherwise indicated. Name, Role/Position, Organisation/Branch, Address

Prepared for

Operations Committee – Koondrook Perricoota Forest Flood Enhancement Works

Version

The version number is allocated when the Report is approved. Minor changes will increase the version number incrementally by hundredths (e.g. version 1.1, version 1.2, …etc). Major revisions should be designated with the next whole number (e.g. version 2.0, 3.0, 4.0).

Revision history log

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Revision History Log			
Version #	Revision Date	Author	Changes

Approved by

Identity of the Forests NSW personnel approving the Report for distribution and use.

Acknowledgements

Lists any other personnel (e.g. reviewers) or documents which aided in the preparation of the Report.

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arrangements;

- Unregulated or pre-regulated water;
- NSW Environmental Water;
- CEWO Environmental Water; and,
- Summary of water availability.

4. Monitoring – Event Design

4.1 Water Quality

Summary of water quality results – 2 months prior at key sites Murray River at Torrumbarry, Murray River at Barham, Wakool River at Kyalite and/or Gee Gee Bridge, Barber Creek confluence (for unreg events only) and within forest. Key water quality risks should be identified and mitigation/management measures discussed.

4.2 Salinity & Groundwater

Summary of groundwater quality and depth results, and identification of key risks.

4.3 Water Bird breeding

A review of appropriateness of historic water bird breeding sites from previous events, if waterbird breeding may be targeted.

5. Event Design

5.1 Event Objective

Identify key event objectives – ecological, operational and risk management objectives.

Discuss operationally the inundation, depths, etc required to achieve ecological objectives. Discuss why some risks may have a low or high likelihood and consequence.

5.2 Event Hypotheses

Reproduce applicable event hypotheses from the Monitoring Plan Discuss operationally the inundation, depths, etc required to achieve ecological objectives.

5.3 Monitoring Program

Develop the monitoring program in line with the event objectives and hypotheses.

5.4 Review of Watering Principles

Review Watering Principles – Event Initiation :

- *Water availability and water requirement are the foundations for the decision to initiate a watering event.*
- *Overbank flows will be favoured as a cue for initiating watering.*
- *Unregulated water will be used when beneficial.*
- *Autumn watering will be considered if environmental water is not made available until late in the season.*
- *Clear ecological targets will be defined before initiating a watering event.*
- *Watering events will aim to maximise net environmental benefits.*
- *Early watering during cooler months (Winter and early Spring) will be favoured over Summer watering.*
- *Large watering events will not commence beyond October.*

5.5 Licensing & Approval Considerations

This section covers any issues that the Operations Committee will need to consider to ensure that the Project Proponents have put in place any necessary licensing or approvals.

6. Operational Management

6.1 Competencies and Approvals

In this section, details of all permits, licenses and experience which personnel must have prior to the procedure being carried out should be provided. This ensures personnel are trained and experienced in the procedure and identifies where training is required.

6.2 Health and Safety Considerations

This section outlines all the hazards and risks (e.g. chemical, physical, biological, radiation) specific to the procedure along with treatments and solutions on how to avoid or minimise these risks (e.g. personal protective equipment etc). Refer to any MSDS sheets which are available for any chemicals used.

6.3 Additional Resource Requirements (Equipment, human resources, etc)

Note any additional resource needs and justification.

6.4 Cost Estimates

Provide a cost estimate of activities related to monitoring.

7. Further reading

List any other reports referenced in the document or related to the Report. Other recommended reading may also be suggested in this section.

References

Any material taken from other peoples work must be acknowledged in this section.

WEEKLY EVENT OPERATIONAL REPORTING TEMPLATE

Koondrook Perricoota Weekly Report

For the week ending _____

Report Ref:

1. HYDROLOGY (MDBA)

1.1 Inflows (MDBA)

Discussion on inflows to date and forecast into the forest – regulated and unregulated.

GRAPH: INFLOW HYDROGRAPH, Actual & Forecast.

1.2 Outflows (MDBA)

Discussion on outflows from all Regulators – regulated and unregulated.

GRAPH: OUTFLOW HYDROGRAPHS, Actual & Forecast.

1.3 Water Accounting (MDBA)

Discussion broadly on water balance and specifically water accounting.

TABLE: Type of Water, Inflow, Outflow & "Account balance"

1.4 Inundation extent (Forests NSW)

Attach satellite imagery (if available) and any information gathered through aerial surveys or ground-based monitoring.

2. WATER QUALITY

2.1 Inflow Water Quality (MDBA)

Discussion on inflow water quality to date and forecast water quality issues.

TABLE: Summary table of inflow water quality

2.2 In-forest Water Quality (Forests NSW)

Discussion on in-forest water quality to date and forecast water quality issues.

TABLE: Summary table of inforest water quality

2.3 Discharge Water Quality (NOW)

Discussion on discharge water quality to date and forecast water quality issues.

TABLE: Summary table of discharge water quality

3. ECOLOGICAL

3.1 Aquatic Ecology (Fisheries NSW)

Discussion on aquatic ecology monitoring program.

TABLE: Summary table of aquatic ecology monitoring (if applicable)

3.2 Vegetation (Forests NSW)

Note any issues.

3.3. Water Bird Breeding (if applicable) (Forests NSW)

Summarise waterbird breeding monitoring outcomes, and discuss.

3.3. Frogs (Forests NSW)

Summarise frog monitoring outcomes (if appropriate).

4. COMMUNITY/THIRD PARTY

4.1. Complaints Register (Forests NSW)

TABLE: Complaints Register which is a compilation of all complaints throughout the event, including details on actions undertaken to close out the complaint.

4.2. Consultation (Forests NSW)

Summary of Community/Third Party Consultation undertaken during the week.

5. ISSUES

5.1. Critical Trigger Register (Forests NSW)

TABLE: Critical Trigger Register which is a compilation of all critical triggers throughout the event, detail the dates critical trigger reached and most recent relevant data relating to the parameter.

5.2. Issues/Risks Register (Forests NSW)

TABLE: Event Issues/Risk Register which is a compilation of all standing issues/risks throughout the event, detail the dates reached and most recent relevant data relating to the parameter.

EVENT COMPLETION REPORT

Watering Year

Report No:

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The purpose of the Event Completion report will be to gather all information from the event to inform the adaptive management framework at a scheme level and an event level. It is envisaged that the report will incorporate all event information, including budget, resources as well decision-making and outcomes. The final event report should also inform any changes as a result of adaptive management.

This section should summarise the initial Event Design Report. Include details of inflow hydrographs, inundation extent, season/dates, ecological outcomes and risks, and include the following sub-headings:

Attach inflow hydrograph for the Inlet Regulator and Swan Lagoon (if applicable), and outflow hydrographs for downstream regulators. Include volume of water diverted into and out of the forest.

Attach inundation extent and depth maps as necessary.

Discuss the results of post-condition monitoring, include a discussion on impact to Grey

Box.

3.4 Water Bird Breeding

Discuss the results of waterbird breeding (if applicable) monitoring.

3.5 Frogs

Discuss the results of frog monitoring.

3.6 Water Quality

Discuss the results of water quality monitoring. Include graphs of parameters over the event period as appropriate.

3.7 Salinity & groundwater

Discuss the results of monitoring of groundwater pre, during and post the event. Include graphs of parameters over specific periods as appropriate.

4. Event

4.1 Objectives

Discuss whether the initial event objectives were reached, and what changes had to be made to objectives and why. Attach applicable Operational Reports and Operations Committee Minutes of Meeting as appropriate. Include final calculation/determination of water use. Discuss any changes recommended to the Monitoring Plan.

4.2 Hypotheses

Discuss the event hypotheses, and in particular whether there is a need to revise hypotheses. What changes had to be made to hypotheses during the event and why. Attach applicable Operational Reports and Operations Committee Minutes of Meeting as appropriate. Discuss any changes recommended to the Monitoring Plan.

4.3 Monitoring

Discuss the adequacy of the event monitoring in determining if objectives were reached and whether the monitoring program was sufficient to test hypotheses. Attach applicable. Operational Reports and Operations Committee Minutes of Meeting as appropriate. Discuss resources – personnel & equipment/installation. Discuss critical triggers reached

during the event. Discuss any changes recommended to the Monitoring Plan.

5. Scheme

5.1 Objectives

Evaluation of achievement or progress towards the ecological objectives for the event and TLM objectives. (SOC 5).

5.2 Hypotheses

Evaluate whether any other hypotheses (i.e. hypotheses unrelated to the particular event) need to be re-evaluated as a result of this event.

5.3 Monitoring

Evaluate whether monitoring program (i.e. hypotheses not specific to this particular event) need to be re-evaluated as a result of this event.

5.5 Review of Watering Principles

Review Watering Principles – Event Initiation & Event Management

6. Recommendations

List recommendations together with cost estimate of changes and action plan.

7. Further reading

List any other reports referenced in the document or related to the Report. Other recommended reading may also be suggested in this section.

References

Any material taken from other peoples work must be acknowledged in this section as well as cited within the SOP using the standard referencing format.

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APPENDIX C DUAL FISHWAY & TURTLE RAMP OPERATING PLAN

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APPENDIX D HYDRAULIC MODEL – KEY OUTPUTS

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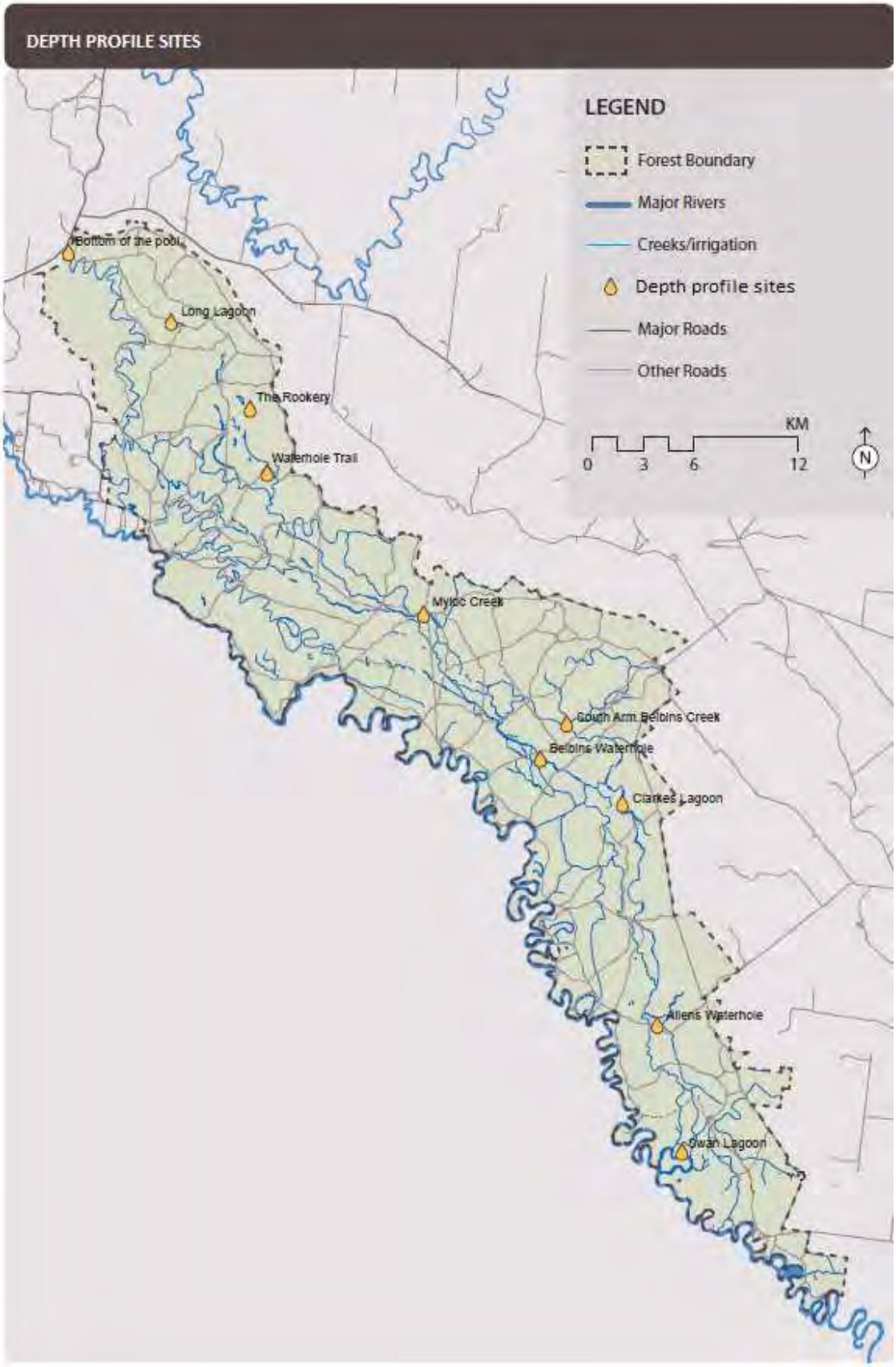

Location of In-Forest Depth Profile Sites

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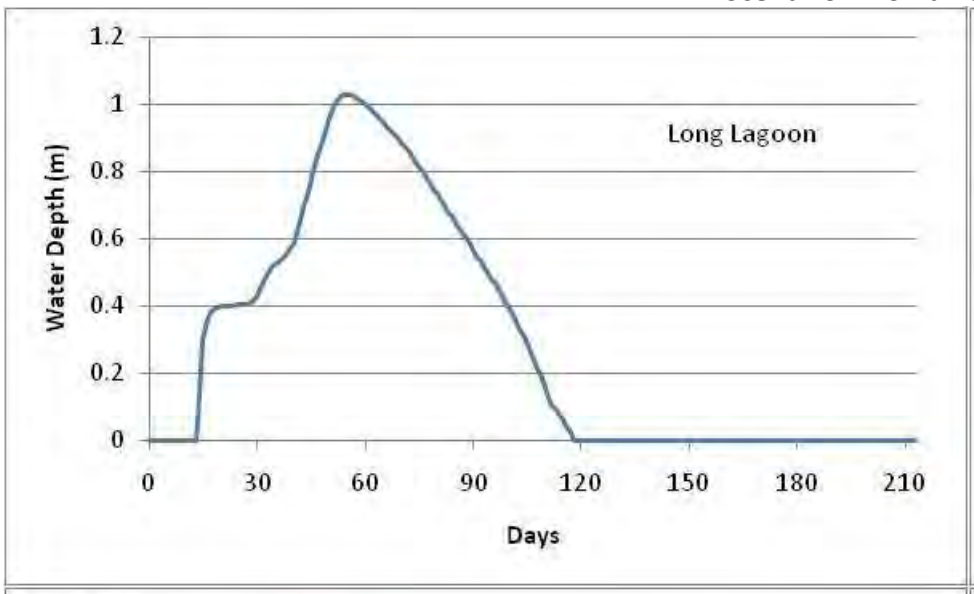
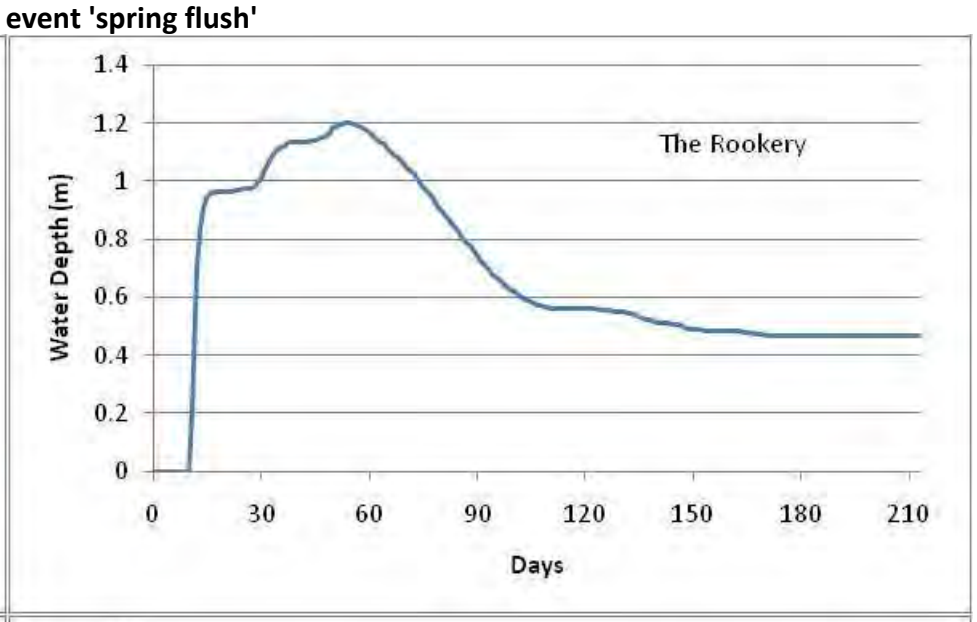
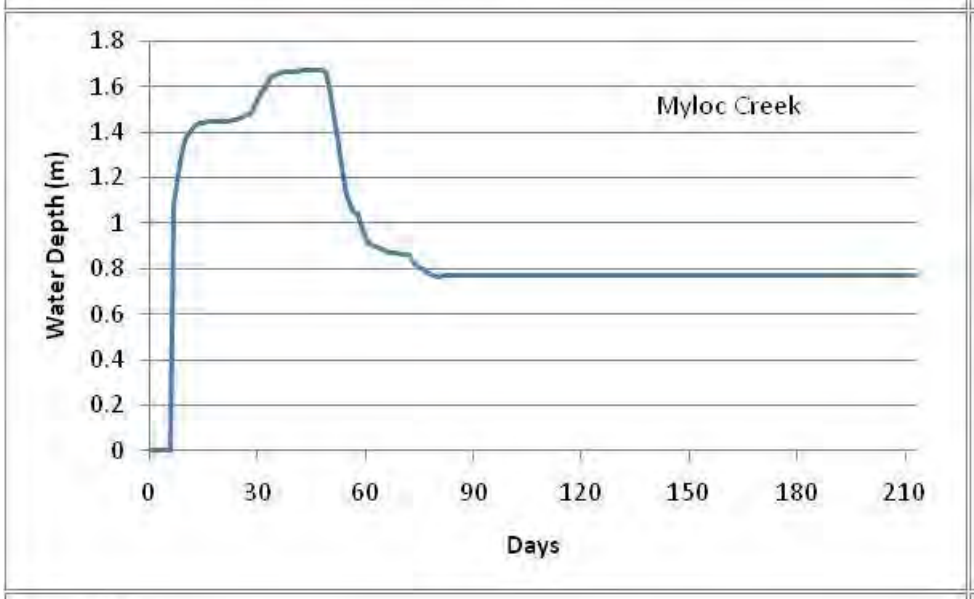
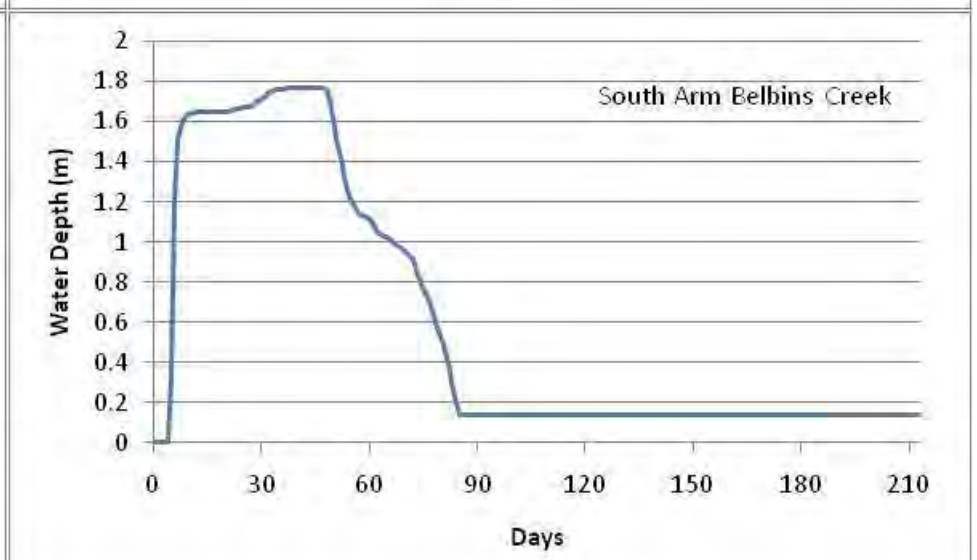
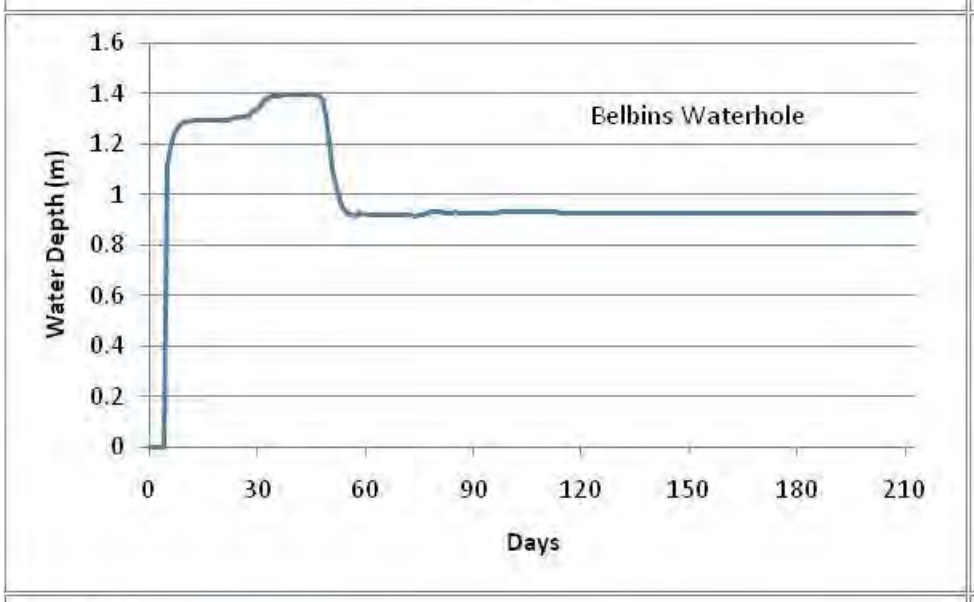
Scenario 1 - Small event 'spring flush'

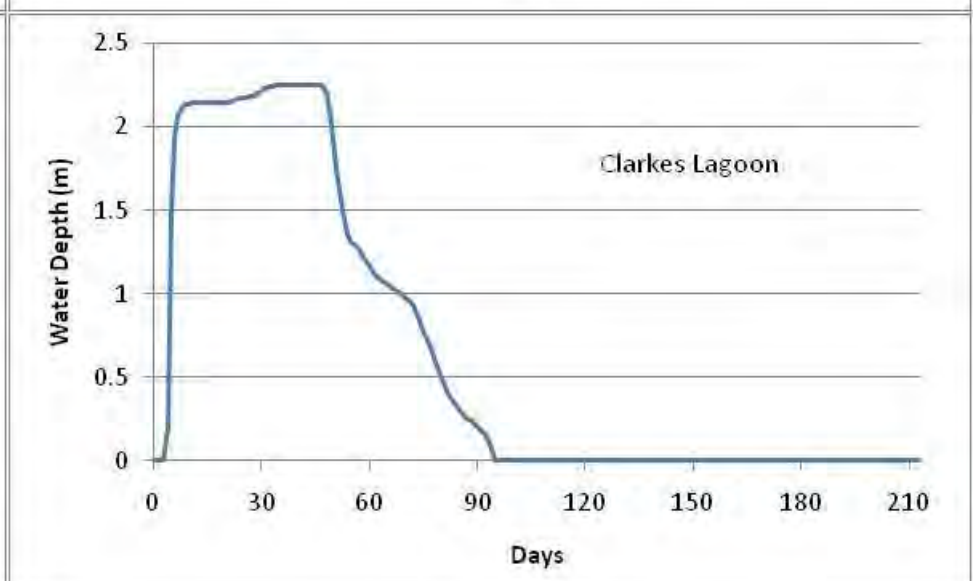


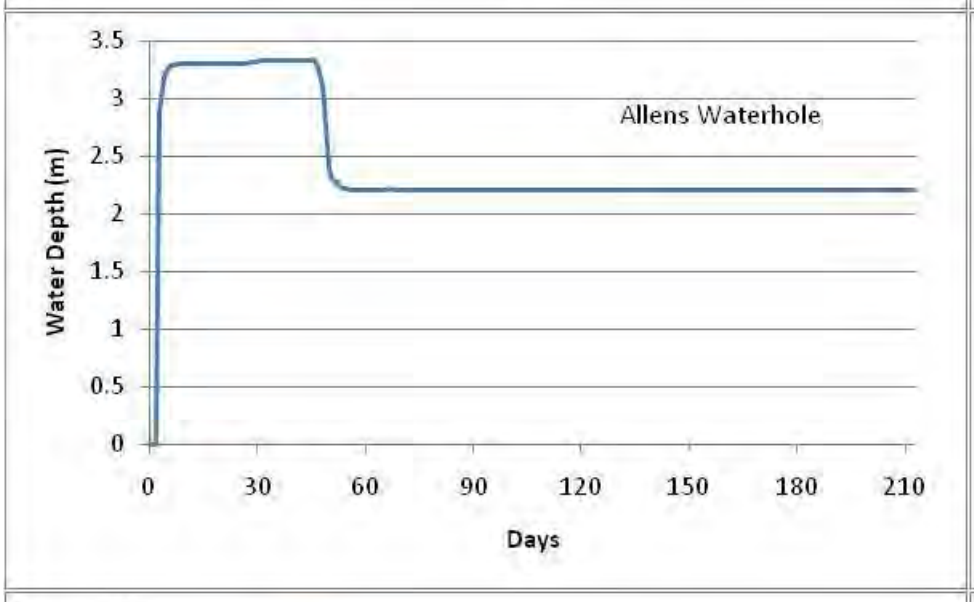


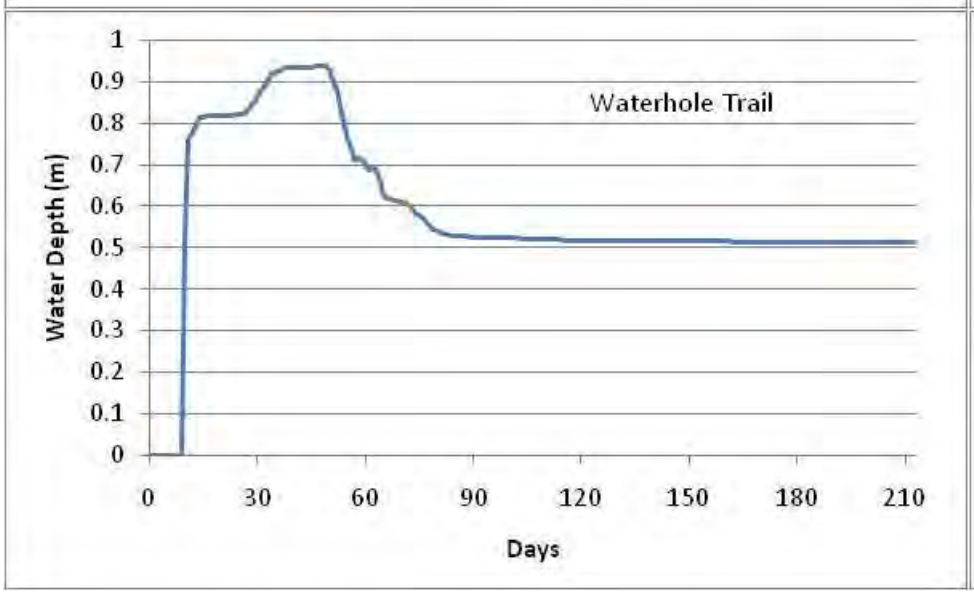


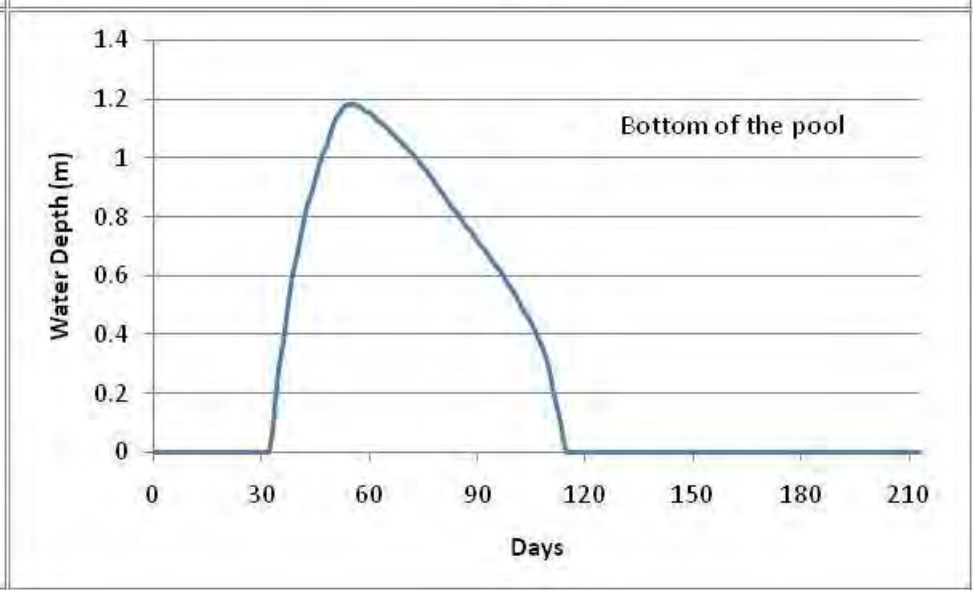




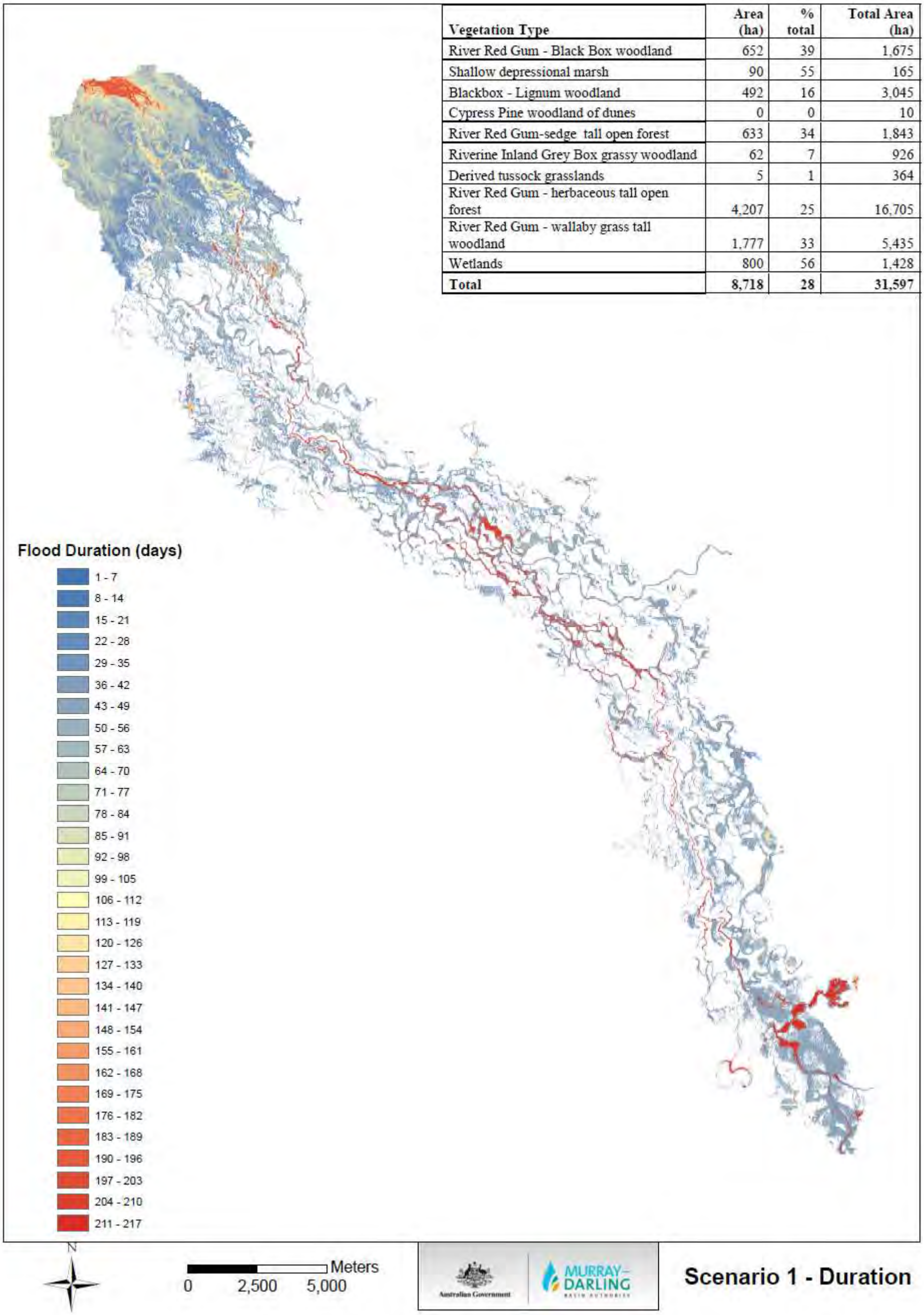




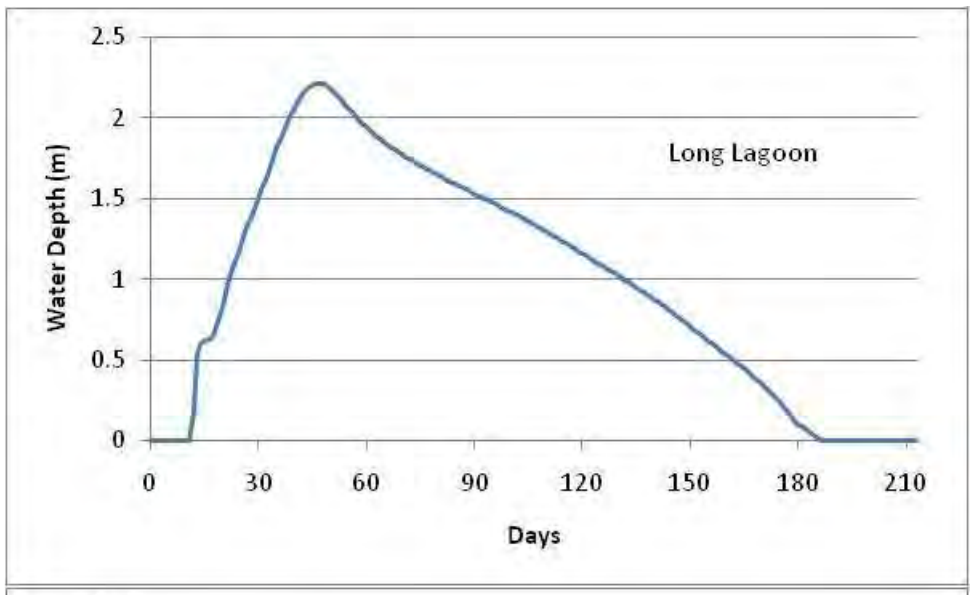


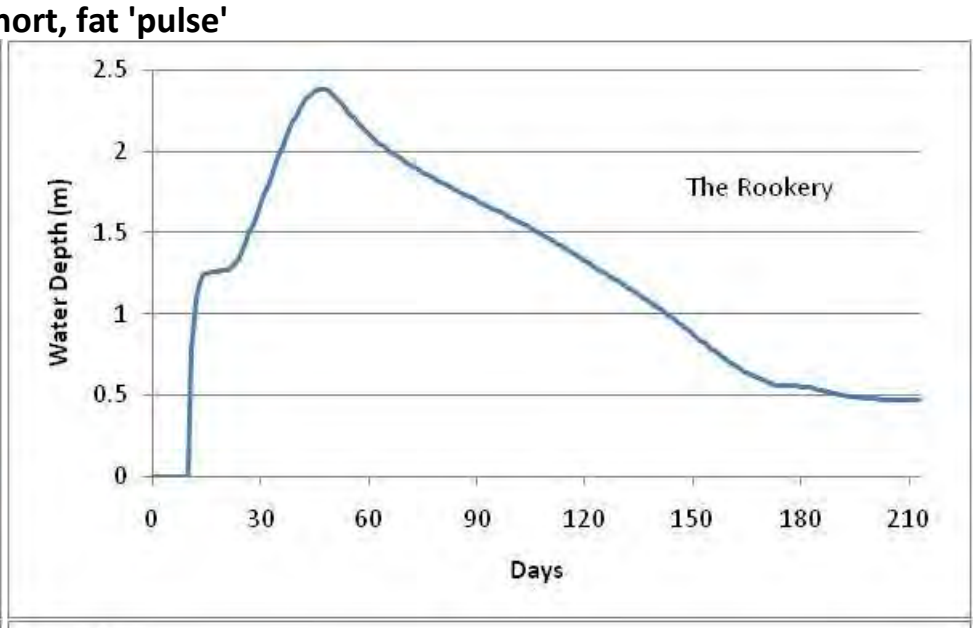


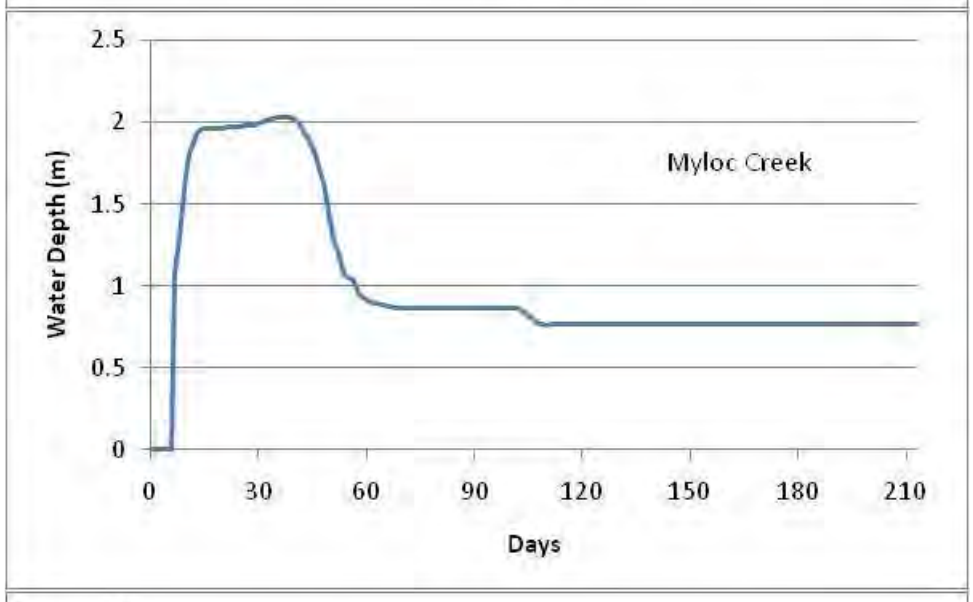
Vegetation Type	Area (ha)	% total	Total Area (ha)
River Red Gum - Black Box woodland	652	39	1,675
Shallow depressional marsh	90	55	165
Blackbox - Lignum woodland	492	16	3,045
Cypress Pine woodland of dunes	0	0	10
River Red Gum-sedge tall open forest	633	34	1,843
Riverine Inland Grey Box grassy woodland	62	7	926
Derived tussock grasslands	5	1	364
River Red Gum - herbaceous tall open forest	4,207	25	16,705
River Red Gum - wallaby grass tall woodland	1,777	33	5,435
Wetlands	800	56	1,428
Total	**8,718**	**28**	**31,597**

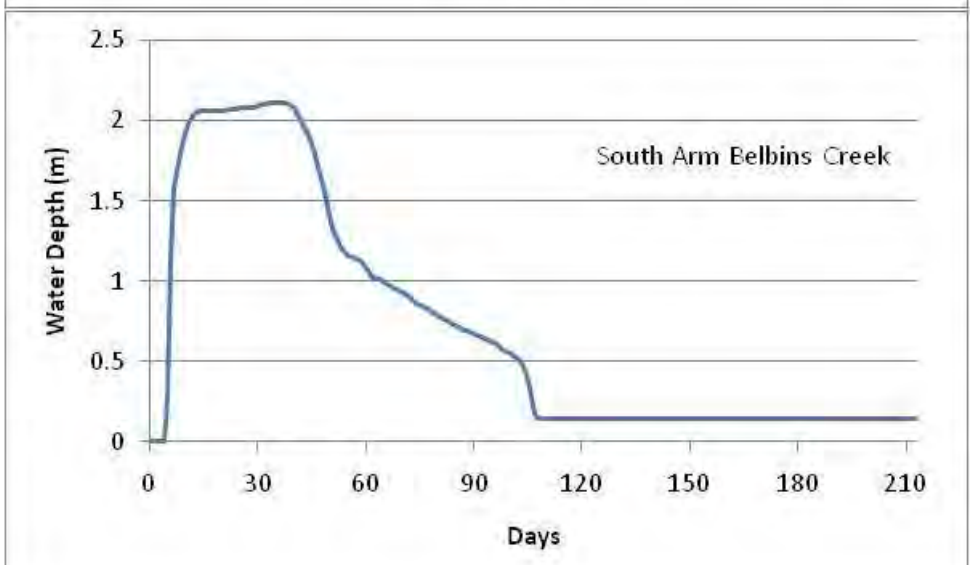


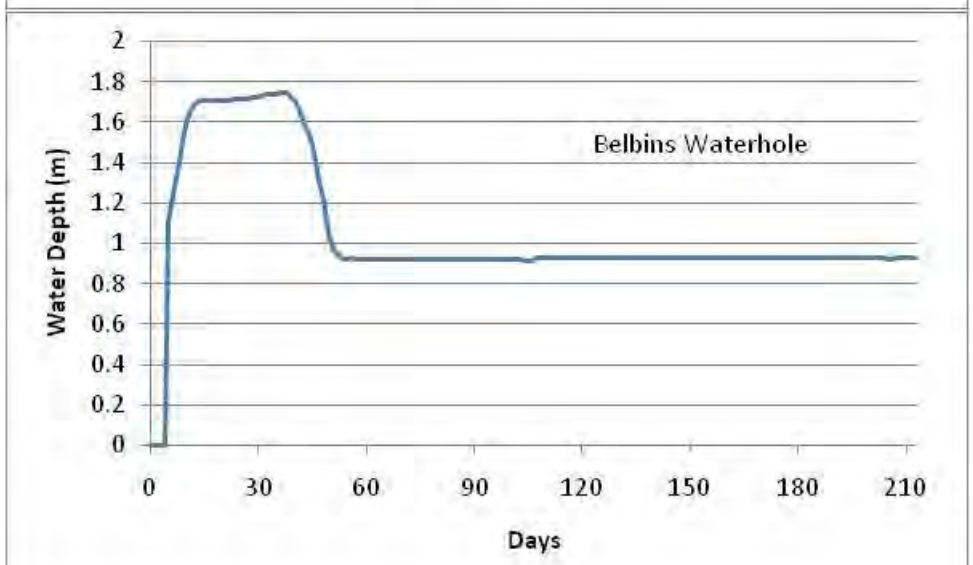
Scenario 2 - Short, fat 'pulse'

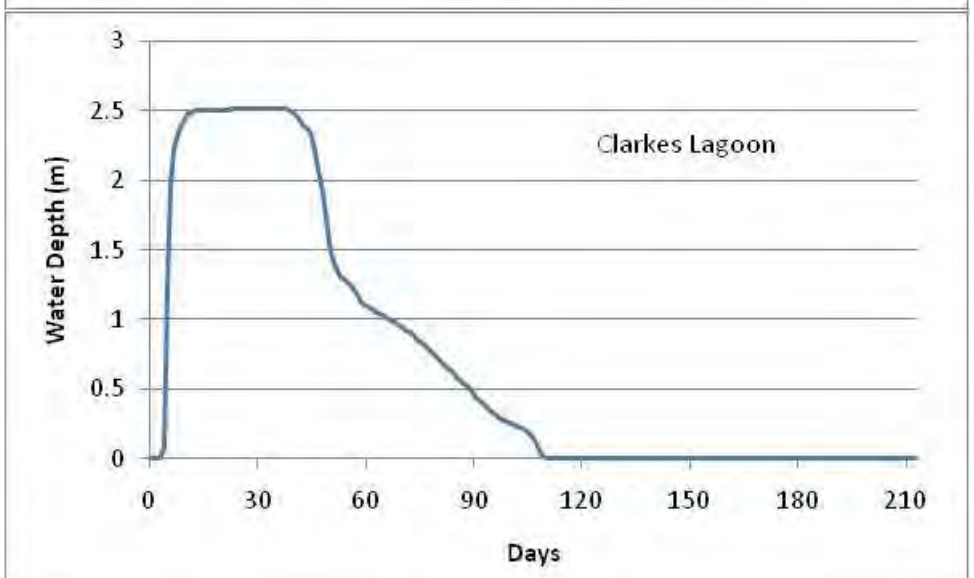


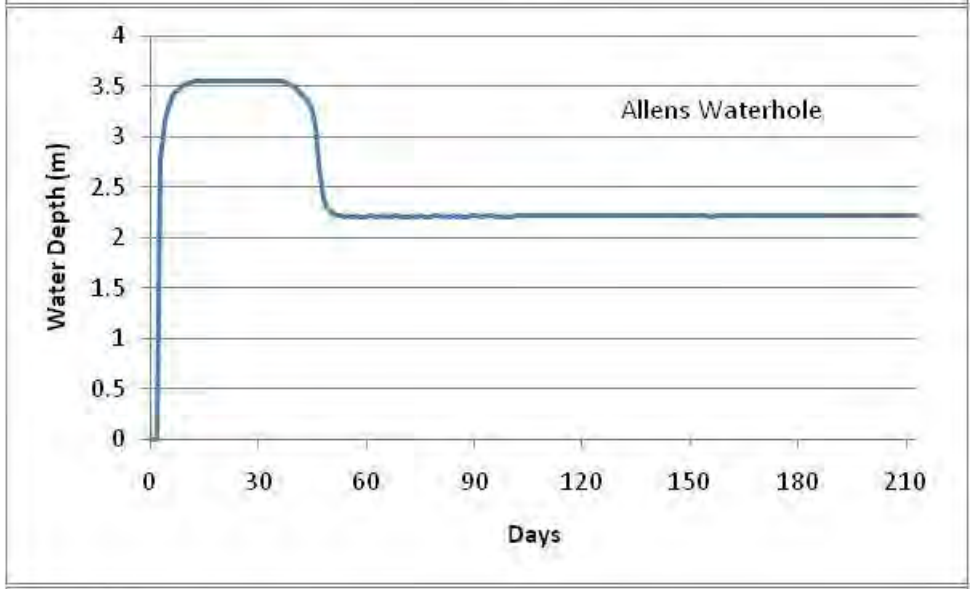


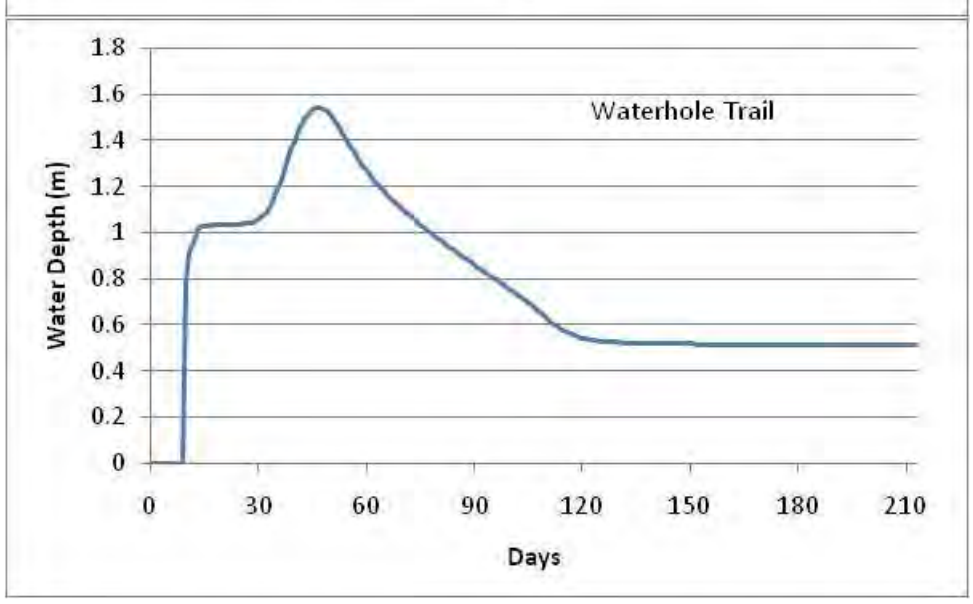


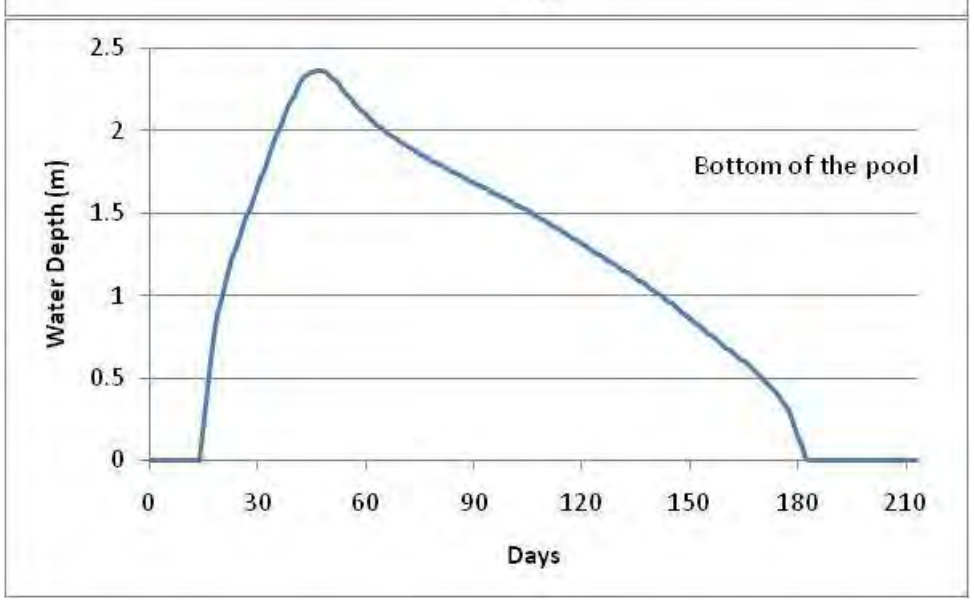




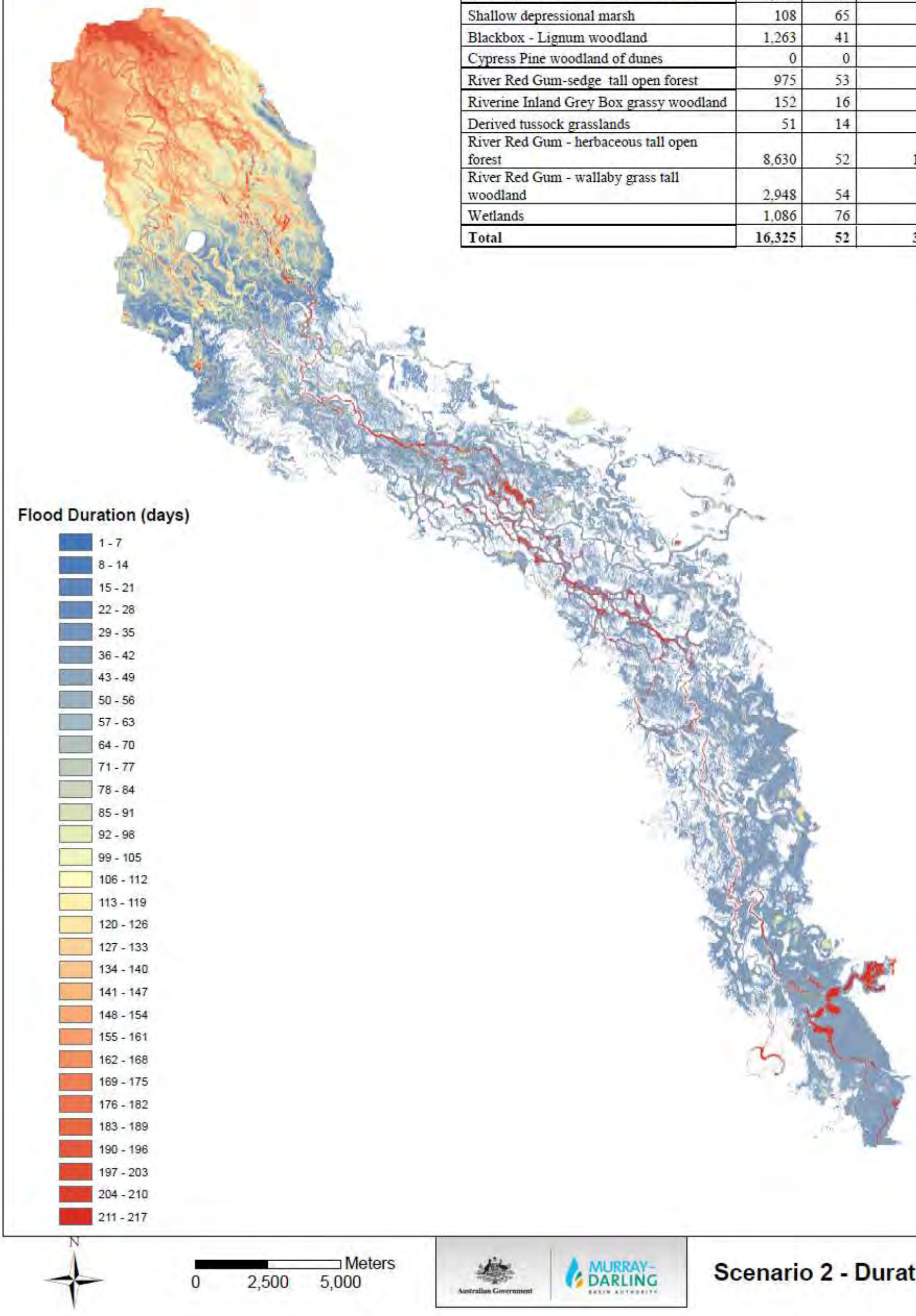






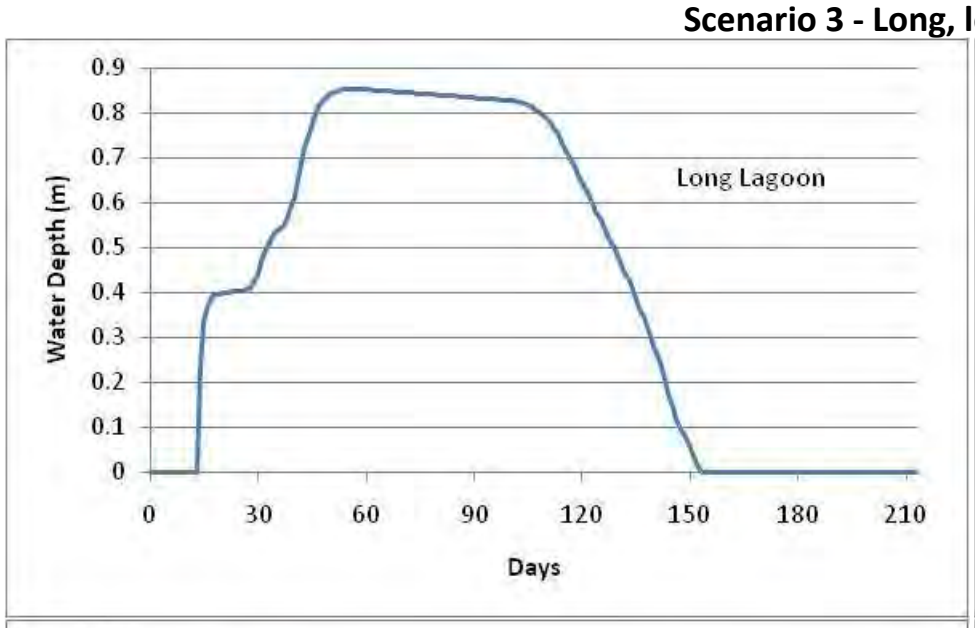


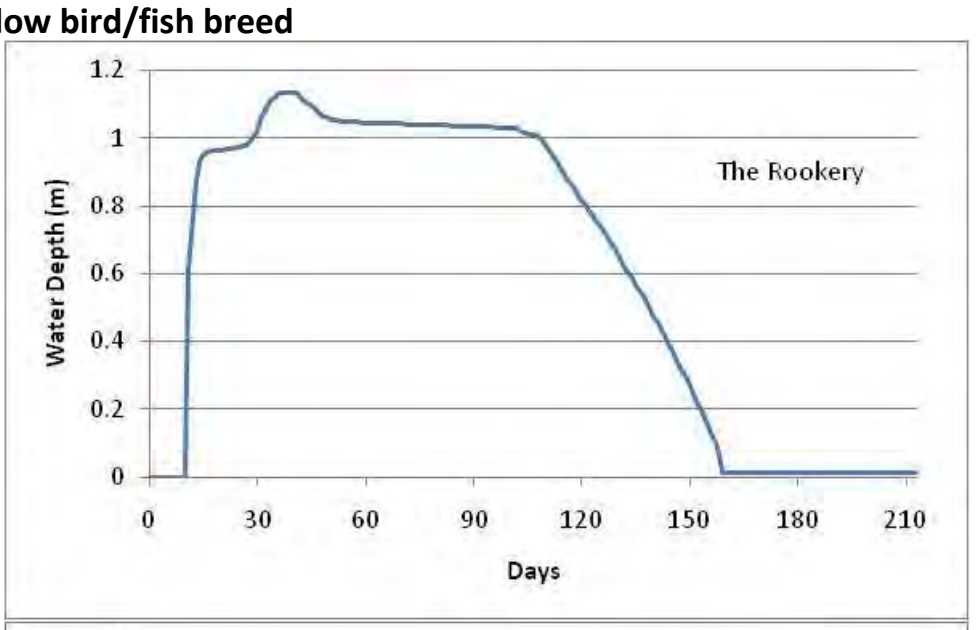
Vegetation Type	Area (ha)	% total	Total Area (ha)
River Red Gum - Black Box woodland	1,112	66	1,675
Shallow depressional marsh	108	65	165
Blackbox - Lignum woodland	1,263	41	3,045
Cypress Pine woodland of dunes	0	0	10
River Red Gum-sedge tall open forest	975	53	1,843
Riverine Inland Grey Box grassy woodland	152	16	926
Derived tussock grasslands	51	14	364
River Red Gum - herbaceous tall open forest	8,630	52	16,705
River Red Gum - wallaby grass tall woodland	2,948	54	5,435
Wetlands	1,086	76	1,428
Total	**16,325**	**52**	**31,597**

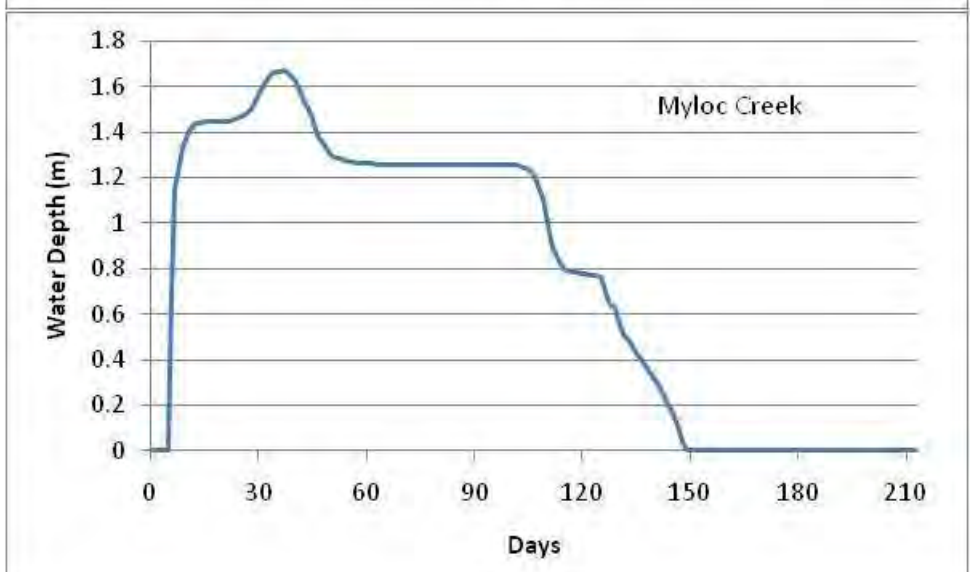


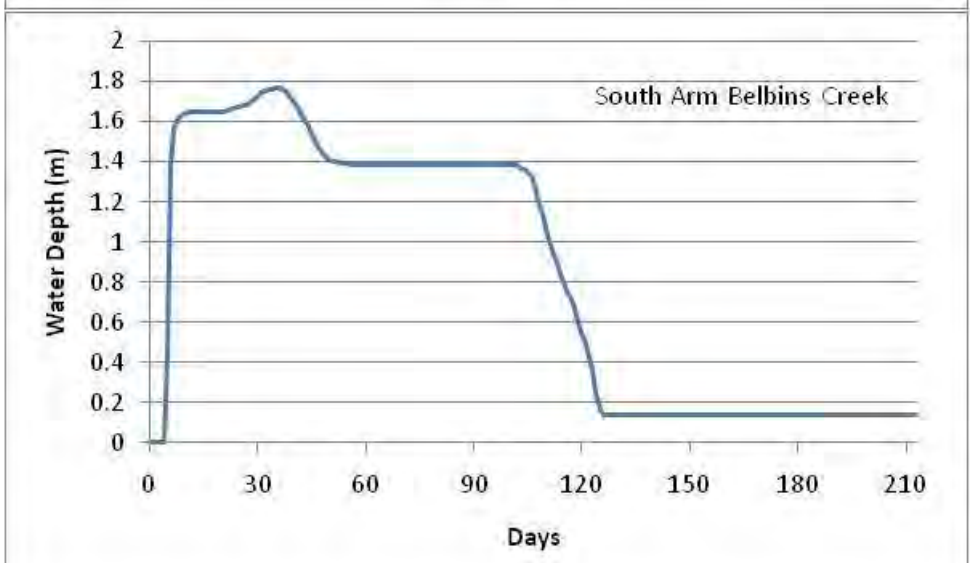
Scenario 2 - Duration

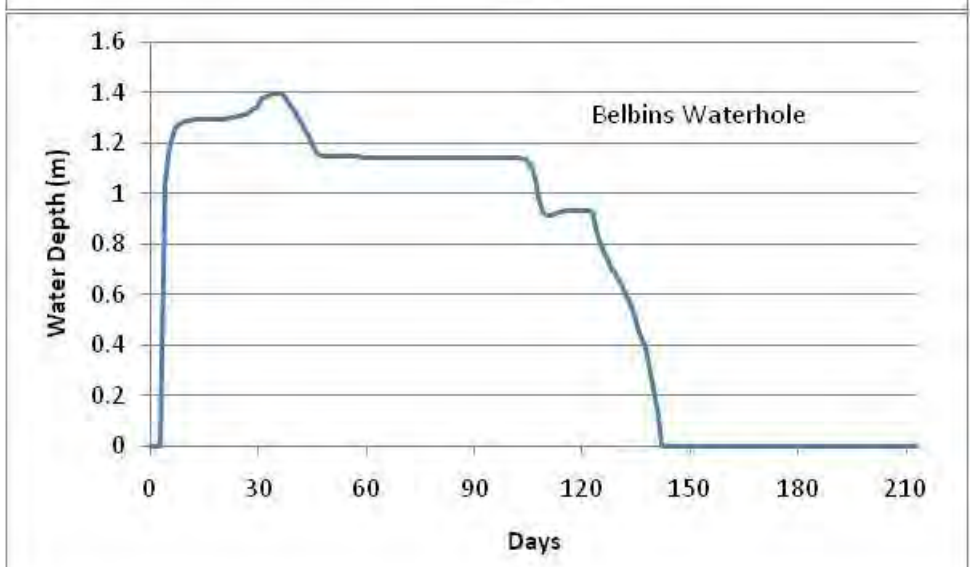
Scenario 3 - Long, low bird/fish breed

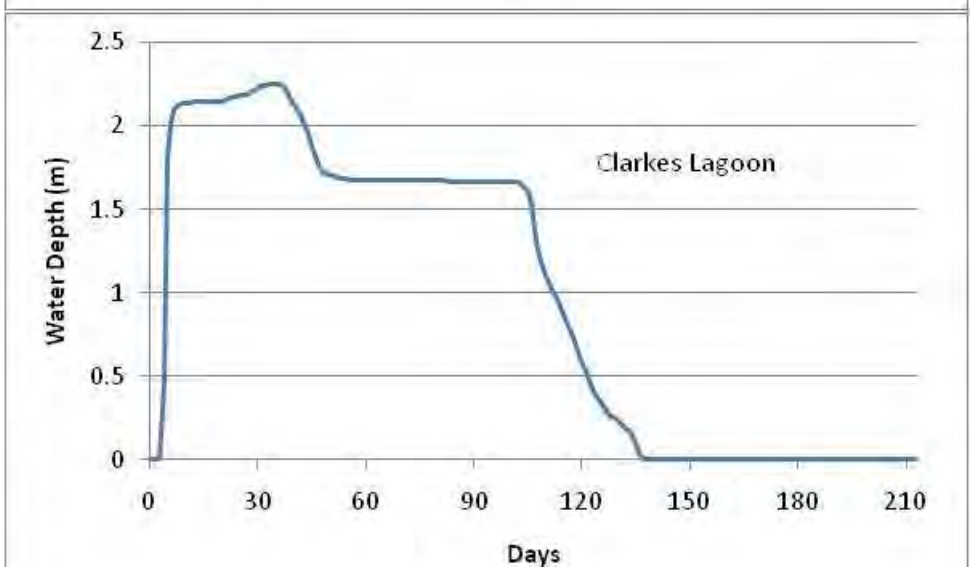


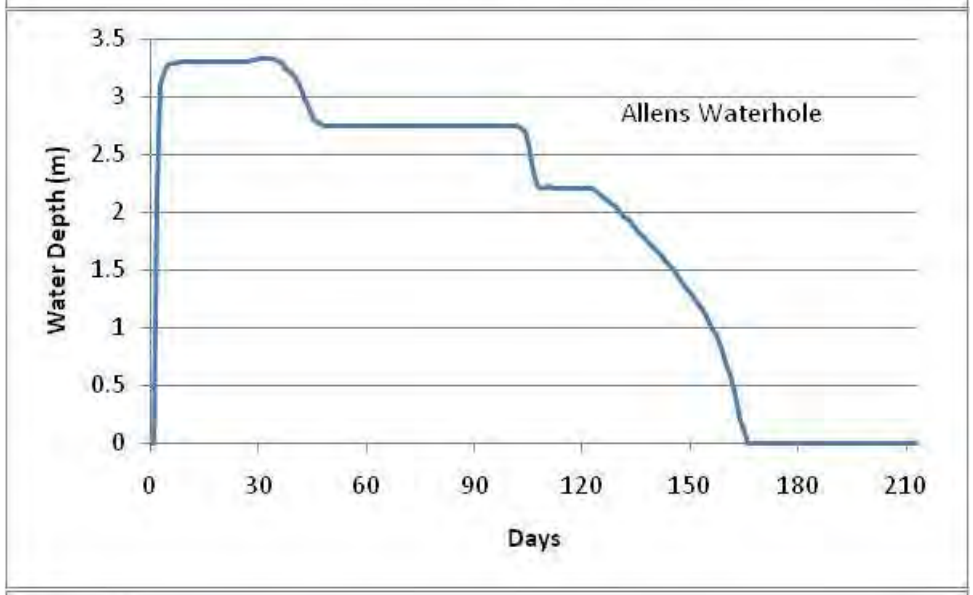


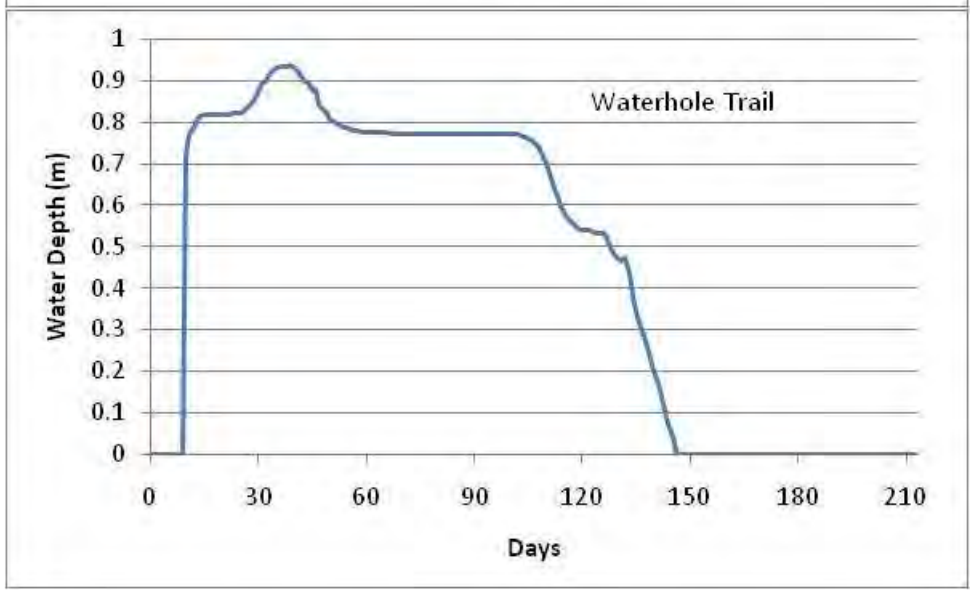


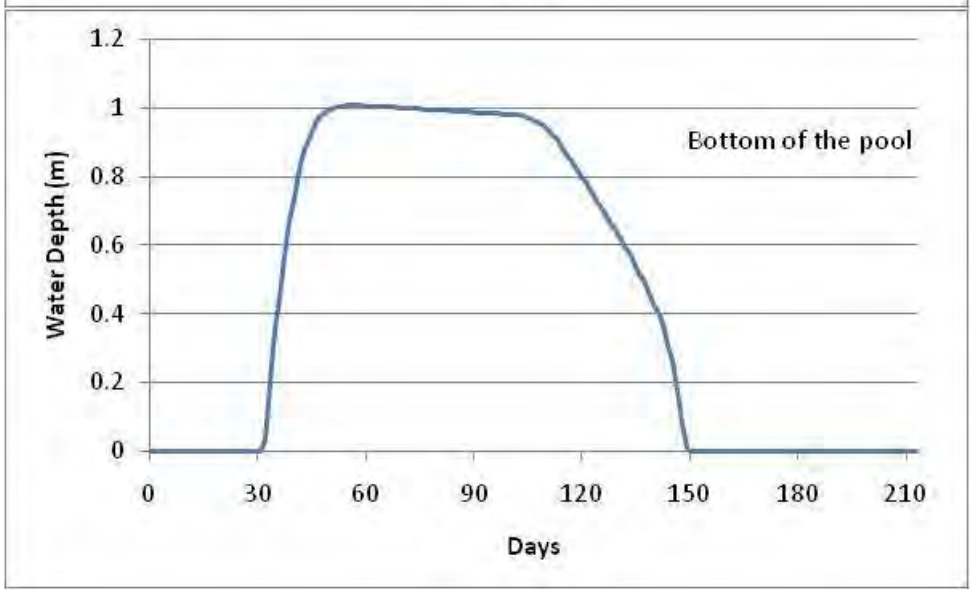




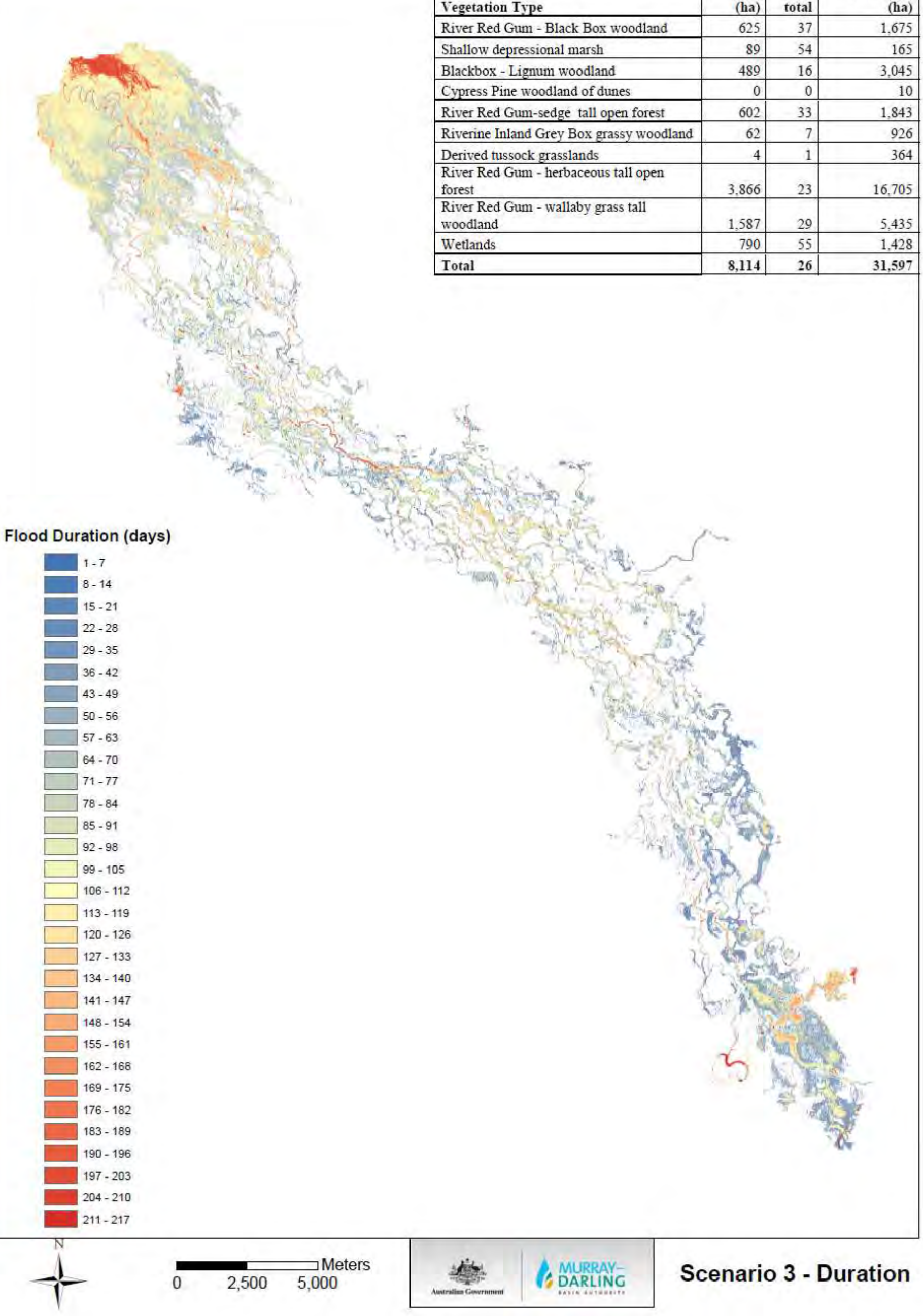






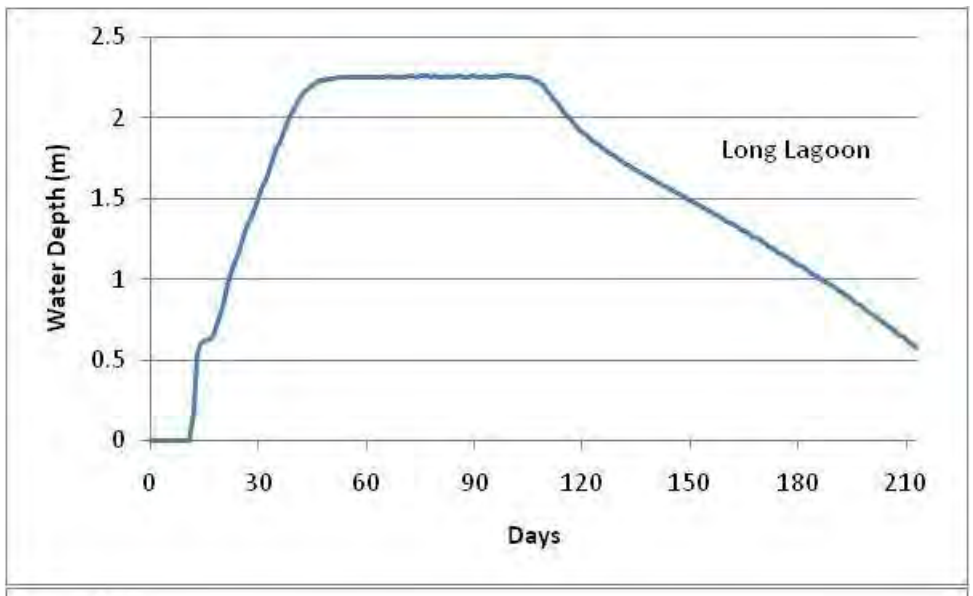


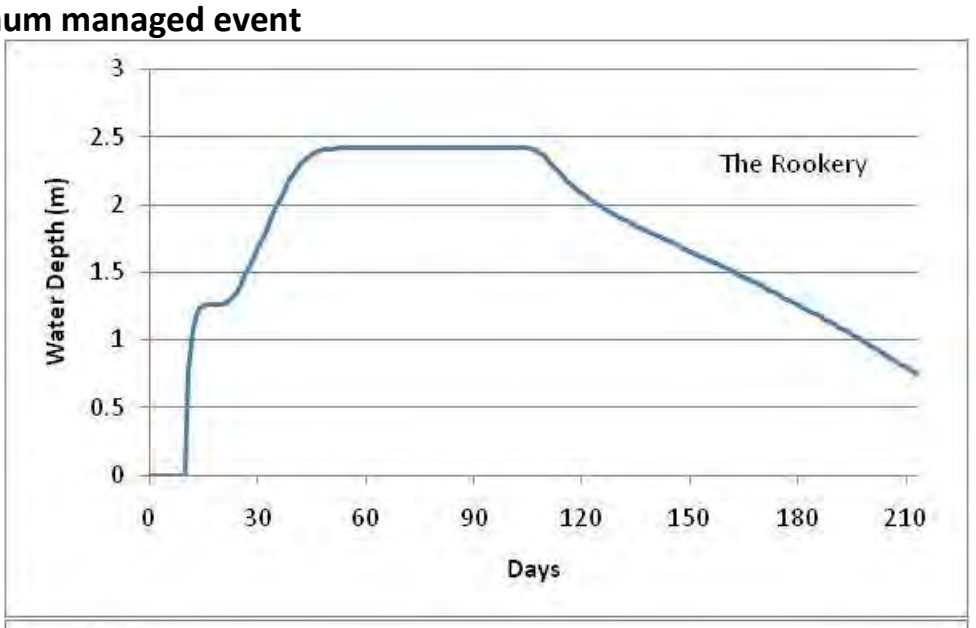
Vegetation Type	Area (ha)	% total	Total Area (ha)
River Red Gum - Black Box woodland	625	37	1,675
Shallow depressional marsh	89	54	165
Blackbox - Lignum woodland	489	16	3,045
Cypress Pine woodland of dunes	0	0	10
River Red Gum-sedge tall open forest	602	33	1,843
Riverine Inland Grey Box grassy woodland	62	7	926
Derived tussock grasslands	4	1	364
River Red Gum - herbaceous tall open forest	3,866	23	16,705
River Red Gum - wallaby grass tall woodland	1,587	29	5,435
Wetlands	790	55	1,428
Total	**8,114**	**26**	**31,597**

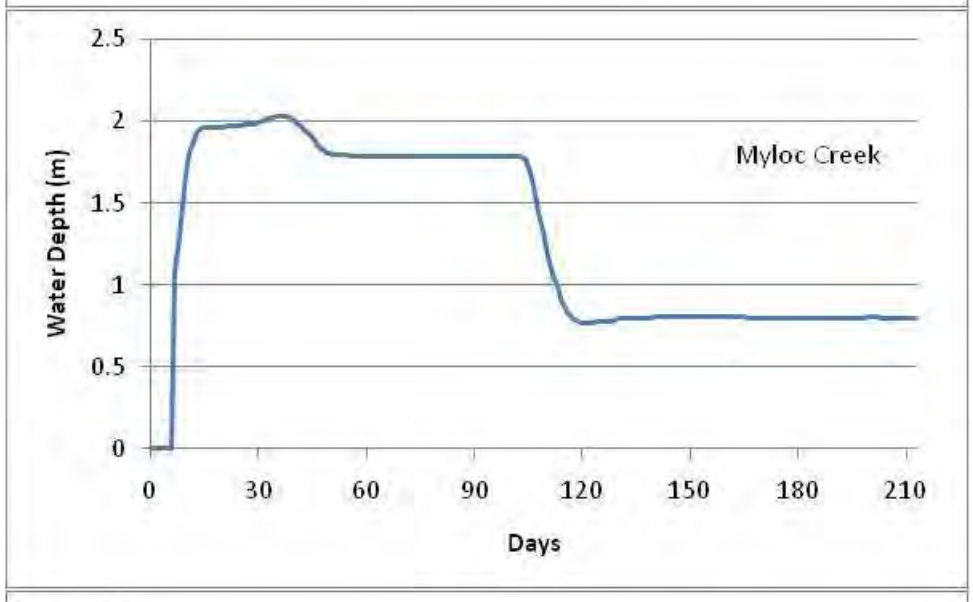


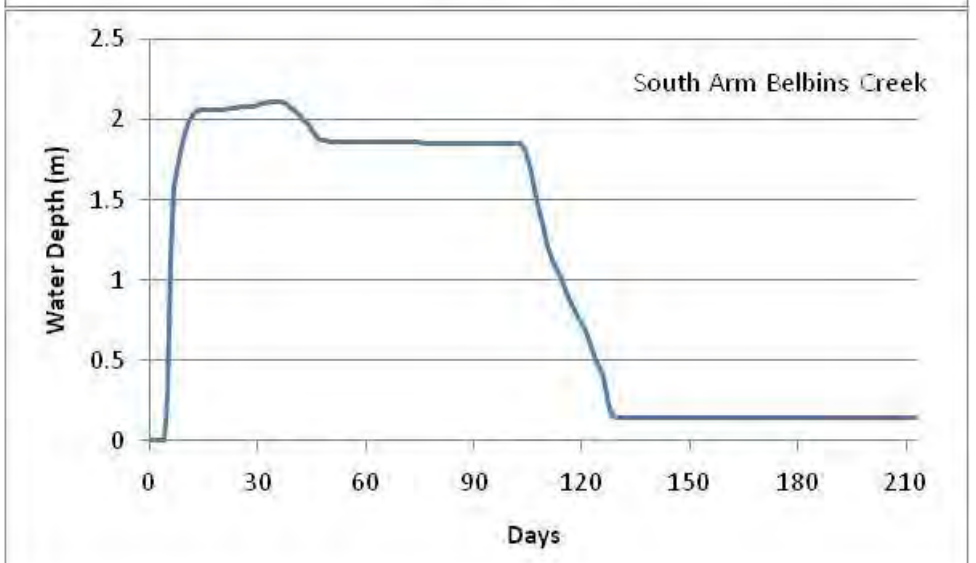
Scenario 3 - Duration

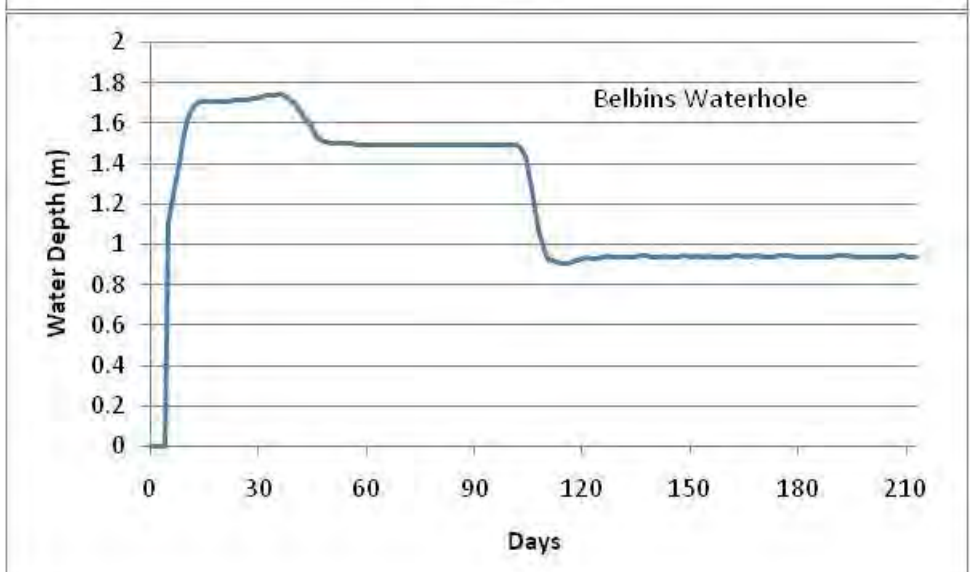
Scenario 4 - Maximum managed event

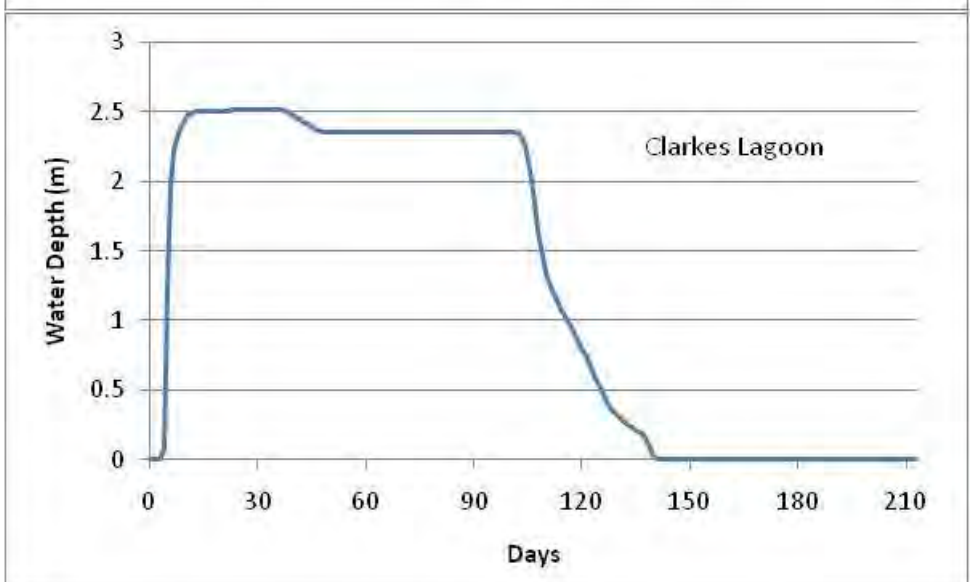


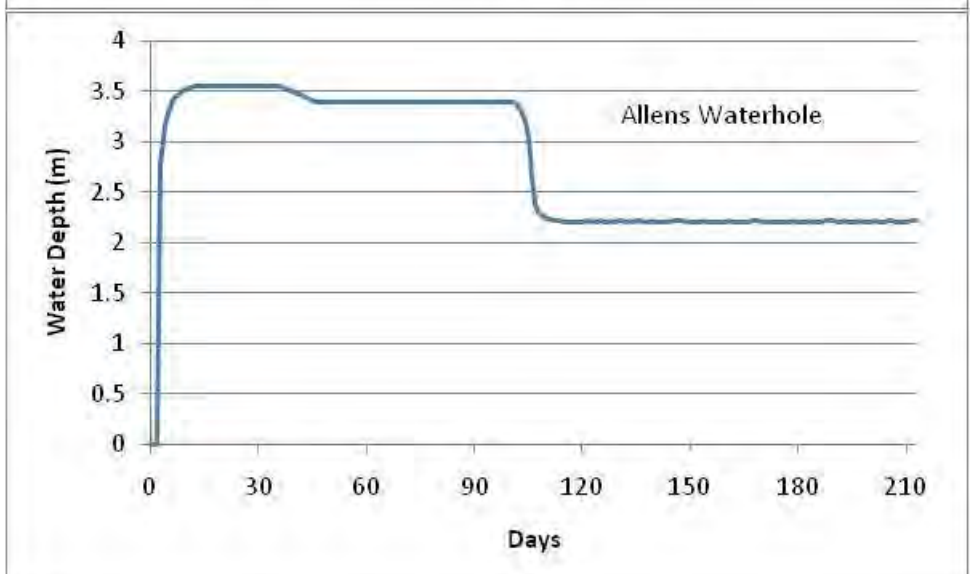


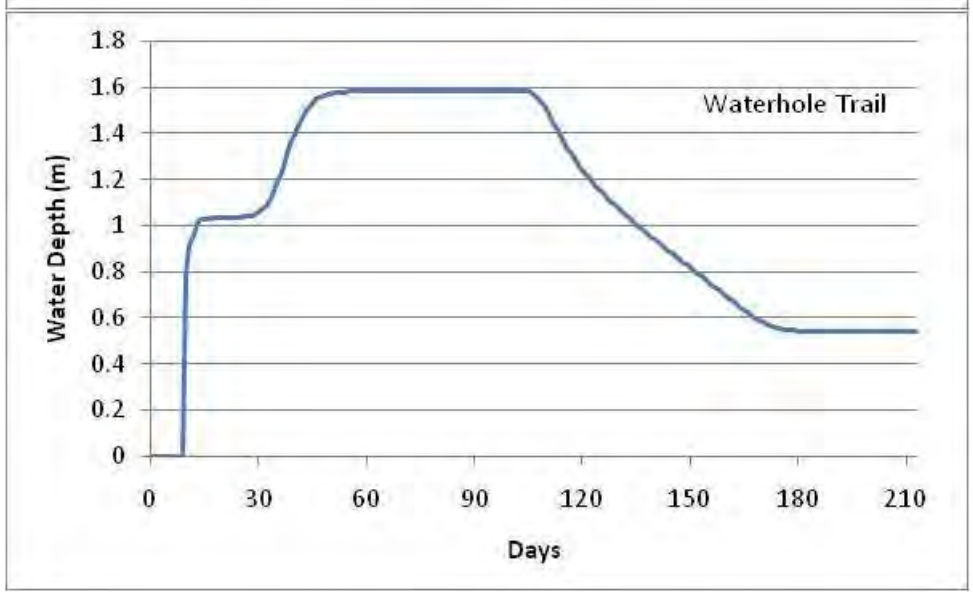


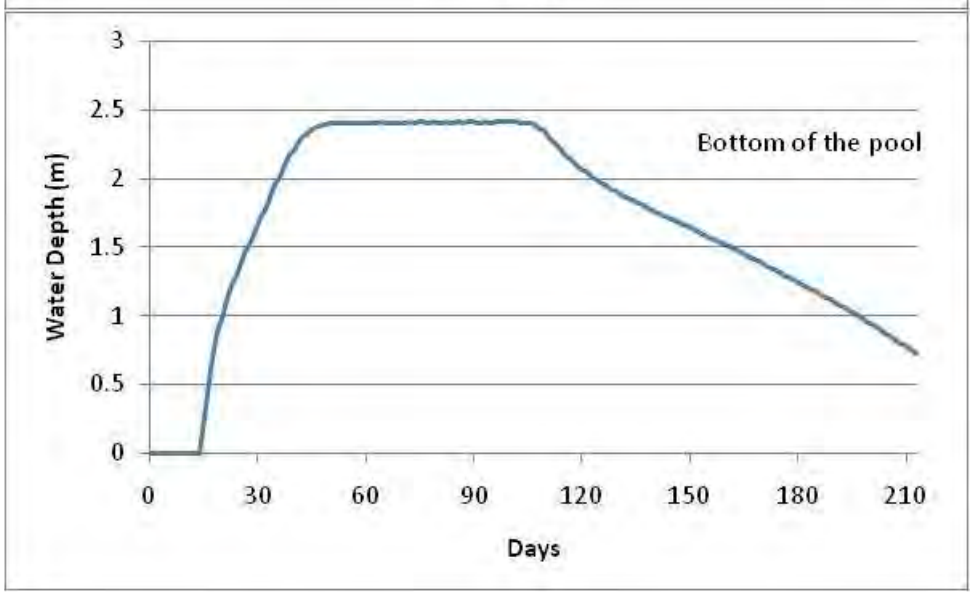












Vegetation Type	Area (ha)	% total	Total Area (ha)
River Red Gum - Black Box woodland	1,112	66	1,675
Shallow depressional marsh	108	65	165
Blackbox - Lignum woodland	1,262	41	3,045
Cypress Pine woodland of dunes	0	0	10
River Red Gum-sedge tall open forest	981	53	1,843
Riverine Inland Grey Box grassy woodland	152	16	926
Derived tussock grasslands	52	14	364
River Red Gum - herbaceous tall open forest	8,676	52	16,705
River Red Gum - wallaby grass tall woodland	2,964	55	5,435
Wetlands	1,088	76	1,428
Total	**16,395**	**52**	**31,597**