FORESTS NSW

NSW Government
Department of Water & Energy

Koondrook-Perricoota Forest Flood Enhancement Works

Preliminary Environmental Assessment

Part 3A Application

Report No. DC09030
April 2009

It is acknowledged that this preliminary environmental assessment has sourced much of its text and information from the *Koondrook-Perricoota Forest Flood Enhancement Works Investment Proposal* (DWE & DPI 2008) submitted to the Murray Darling Basin commission as part of the Living Murray initiative. The Investment Proposal was based on four years of work to develop and refine the project concept in collaboration with several stakeholders.

Table of Contents

Tables

Figures

LIST OF ABBREVIATIONS

Commerce	NSW Department of Commerce
DECC	Department of Environment and Climate Change
DPI	Department of Primary Industries
DWE	Department of Water and Energy
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPI	Environmental planning instrument
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
MDBMC	Murray Darling Basin Ministerial Council
PEO Act	Protection of the Environment Operations Act 1997
PEPO	Preliminary Environmental and Planning Overview
REP	Regional environmental plan
SEPP	State Environmental Planning Policy

1 Introduction

1.1 Introduction

This Preliminary Environmental Assessment has been prepared to accompany the application submitted under Part 3A of the *Environmental Planning and Assessment Act* 1979 for the Koondrook-Perricoota Forest Flood Enhancement Works project. The purpose of this document is to provide a description of the proposed project and an overview of the potential environmental impacts in order to assist the Department of Planning in determining the level and scope required for the detailed environmental assessment.

The Department of Water and Energy and the Department of Primary Industries (Forests NSW) are the joint proponents for the Part 3A application.

1.2 Project Background

The Gunbower-Koondrook-Perricoota Forest is Australia's second largest River Red Gum forest. It covers around 50 000 hectares and is located downstream of Torrumbarry Weir, between Echuca and Koondrook-Barham (see Figure 1-1 and Figure 1-2, *Source: Investment Proposal, October 2008).* The Gunbower-Koondrook-Perricoota River Red Gum Forest is one of six Icon Sites identified under the Murray-Darling Basin Ministerial Council's (MDBMC) Living Murray Initiative. The Living Murray program was established in 2002 by the MDBMC. The initiative is a response to concerns about the environmental and economic health of the Murray River System.

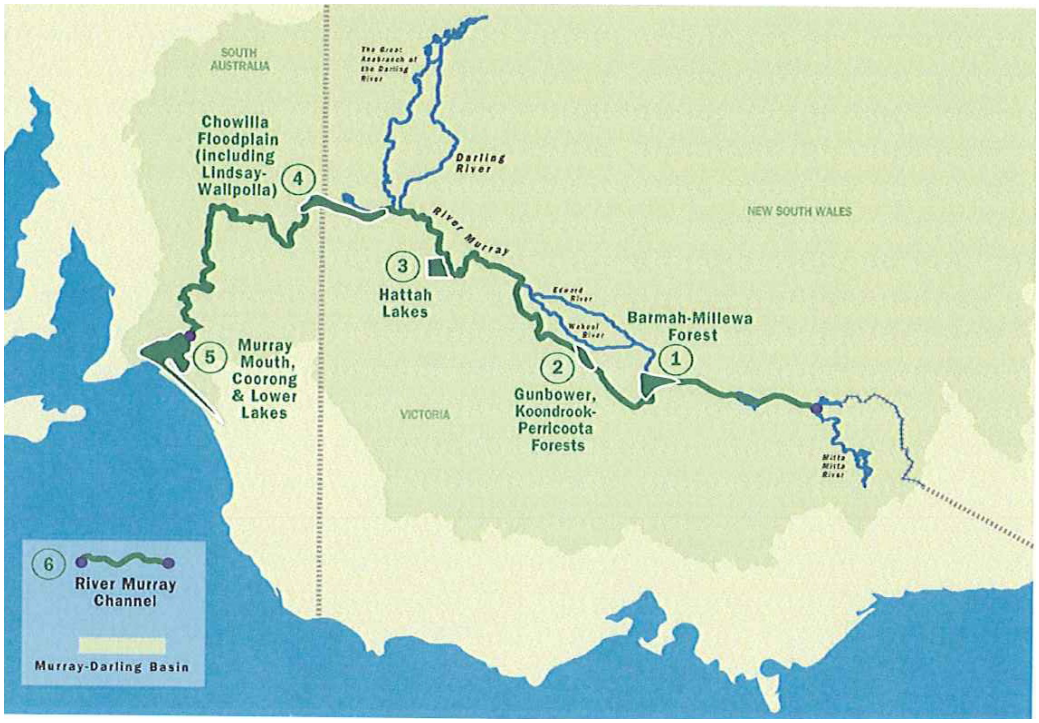
The program focuses on recovering 500 GL for the Murray River and improving six Icon Sites, selected due to their high ecological value. The Icon Sites are (refer to Figure 1.1):

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

The Murray River flows between the forest, with Gunbower on the southern (Victorian) side and Koondrook- Perricoota on the northern (NSW) side (refer to Figure 1-2). The Forest is recognised for its many environmental, social and economic values in particular its cultural significance to Indigenous people and the broader community. The forest is an important breeding ground for colonial waterbirds and is home to many threatened flora and fauna species. The Gunbower-Koondrook-Perricoota Forest is listed as a wetland of international importance under the Ramsar wetland convention.

However, changed flow regime, owing mainly to a century of river regulation, exacerbated by the recent prolonged drought, has significantly reduced the ecological health and productivity of the forest. This is primarily due to a reduction in the frequency and magnitude of flooding, such that the flooding regime is inadequate to support flood dependent vegetation communities

As part of the First Step for the Living Murray Initiative, the MDBMC set interim ecological objectives and expected outcomes for each Icon Site. The main First Step objective for the Gunbower Koondrook-Perricoota Icon Site is to maintain and restore a mosaic of healthy floodplain communities. The Koondrook-Perricoota Forest Flood Enhancement Works project has been developed to meet the First Step objectives for the site.



Source: The Gunbower-Koondrook–Perricoota Forest Icon Site Environmental Management Plan 2006-2007Murray-Darling Basin Commission (2006a)

Figure 1-1 Location of the Living Murray Icon Sites

Source: Investment Proposal, October 2008

Figure 1-2 Location of Koondrook-Perricoota Forest

1.3 Proposal Overview

The proposed Koondrook-Perricoota Forest Flood Enhancement Works have been designed to reinstate the critical process of flooding to Koondrook-Perricoota Forest for forest health. This will be achieved through the installation of engineering structures and channels to divert and control flows through the Forest in order to mimic a natural flooding event.

The proposed scheme entails the following suite of works:

- Upstream structures to allow diversion of water into the forest from Torrumbarry Weir and escape regulators to prevent flows re-entering the Murray River;
- Downstream structures to prevent uncontrolled water leaving the forest thus providing for the most efficient use of water

The main structural components of the proposal are summarised as;

- An excavated channel to connect Bullock Head Creek and the Burrumburry Creek System to the Torrumbarry Weir pool to enable the flow of water into the forest;
- Upstream structures to allow diversion of water into the forest from Torrumbarry Weir and escape regulators at Swan Lagoon to prevent flows re-entering the Murray River;
- Downstream structures to prevent water leaving the forest and to maximise return flows back to the Murray River. This will include a return channel to allow return flow back to the Murray River and a floodway to increase water returns to the Murray River.
- Downstream stoplog regulators will be implemented to control the flow of the water out of the forest.
- A levee around the downstream perimeter of the forest is required to protect adjoining properties from flooding.

The proposed operation of the scheme will be flexible. The general operation will involve flooding the Forest every 3 to 4 years for a period of up to 100 days. The project is described in more detail in Section 2.

1.3.1 Project Objectives

The key ecological objective of the project is to provide an adequate water regime to a representative area of the River Red Gum forest that has, or historically supported, a flood dependent understorey.

<u>The First Step Decision objective for the Gunbower-Koondrook-Perricoota Icon Site:</u>

"Maintain and restore and mosaic of healthy floodplain communities.

- 80% of permanent and semi permanent wetlands in healthy condition
- 30% of river red gum forest in health condition
- successful breeding of thousands of colonial waterbirds in at least 3 years in ten
- healthy populations of resident native fish in wetlands.

More recently, a refined set of ecological objectives for the Gunbower-Koondrook-Perricoota Forest documented in the "Work in Progress" Environmental Management Plan (2007),these are;:

- 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.

1.4 Previous studies to date

A number of previous studies have been undertaken to establish the existing conditions of the Forest and to aid in the effective design of the proposed works. Previous studies undertaken for the proposal include;

- *Koondrook-Perricoota Flood Enhancement Project – Ecological Objectives Report* (Forest NSW, 2008)
- *Koondrook-Perricoota Forest Shallow Drilling Completion Report* (Salient Solutions, 2008)
- *Assessment of salinity impacts of enhanced flooding in the Koondrook-Perricoota Forests on the Wakool and Murray Rivers* (Salient Solutions Australia 2007)
- *Koondrook-Perricoota Flood Enhancement Project – Hydraulic Modelling* (DECC, 2008).
- *Koondrook-Perricoota Forest Flood Enhancement Works Investment Proposal* (DWE, 2008)
- *Koondrook-Perricoota Forest Mike Flood Modelling, Final Report* DHI Water and Environment (2007)
- *Assessment of salinity impacts of enhanced flooding in the Koondrook Perricoota Forest on the Wakool and Murray Rivers – Final Report* Evans, R & Barnett, P. 2007. Salient Solutions Australia Pty Ltd.
- *Koondrook-Perricoota Forest Flood Enhancement Works, Concept Design Report, DC 08079* NSW Department of Commerce (2008)

In addition, cultural heritage sites recorded within the Koondrook-Perricoota Forest as part of harvesting assessments are maintained on an internal database by Forests NSW. A comprehensive archaeological survey of the area will be undertaken as part of the environmental assessment for the works.

The Murray Darling Basin Authority has also commissioned an ecological risk assessment, which is currently being undertaken.

1.5 Proposal Justification

The key aim of this project is to provide an adequate water regime to a representative area of the Koondrook-Perricoota Forest that has, or historically supported, a water dependant understorey.

The Murray-Darling Basin Commission has drafted *The Living Murray Icon Site Condition Report* for 2008, outlining the change in condition of Icon Sites since the First Step Decision. The report is based upon available monitoring and investigations and observations at Icon Sites. The condition of the Gunbower-Koondrook–Perricoota Forest Icon Site has been addressed in terms of the Interim Objectives in the report.

The Murray-Darling Basin Commission published the previous *The Living Murray Icon Site Condition Report* in October 2007. A survey conducted across the Icon Site in 2006 indicated that there had been decline in River Red Gum Health since the previous survey in 2005. Results from the 2006 forest health survey (Turner and Kathuria 2007) indicated that of the River Red Gums:

• 19% were healthy

• 59% were unhealthy

• 22% were severely stressed/dead.

The Black Box and Grey Box stands were generally much healthier than River Red gum stands. Overall the majority of the River Red gum sites (87%) have an unhealthy or average health status.

Signs of severe stress have been evident in a large proportion of River Red Gums for several years, including dead and dying limbs, loss of leaf cover, and epicormic growth. There is evidence of tree death across large areas of the Koondrook- Perricoota Forest. This includes large dominant trees, as well as areas of dense regrowth. Only isolated areas were reported to be in a relatively healthy condition (MDBC 2007a), as can be seen in Figure 1-3. The areas in the poorest condition were primarily in the Koondrook Forest at higher elevations, that is, along the high riverbank, and at the far margin of the forest. No floodwaters have been received at he Koondrook-Perricoota forest since the 2006 assessment. Recent observations of the forest canopy reveal some leaf growth following small rain events, but overall condition remains poor, and is continuing to decline (see Figure 1-5 **Figure 1-5**).

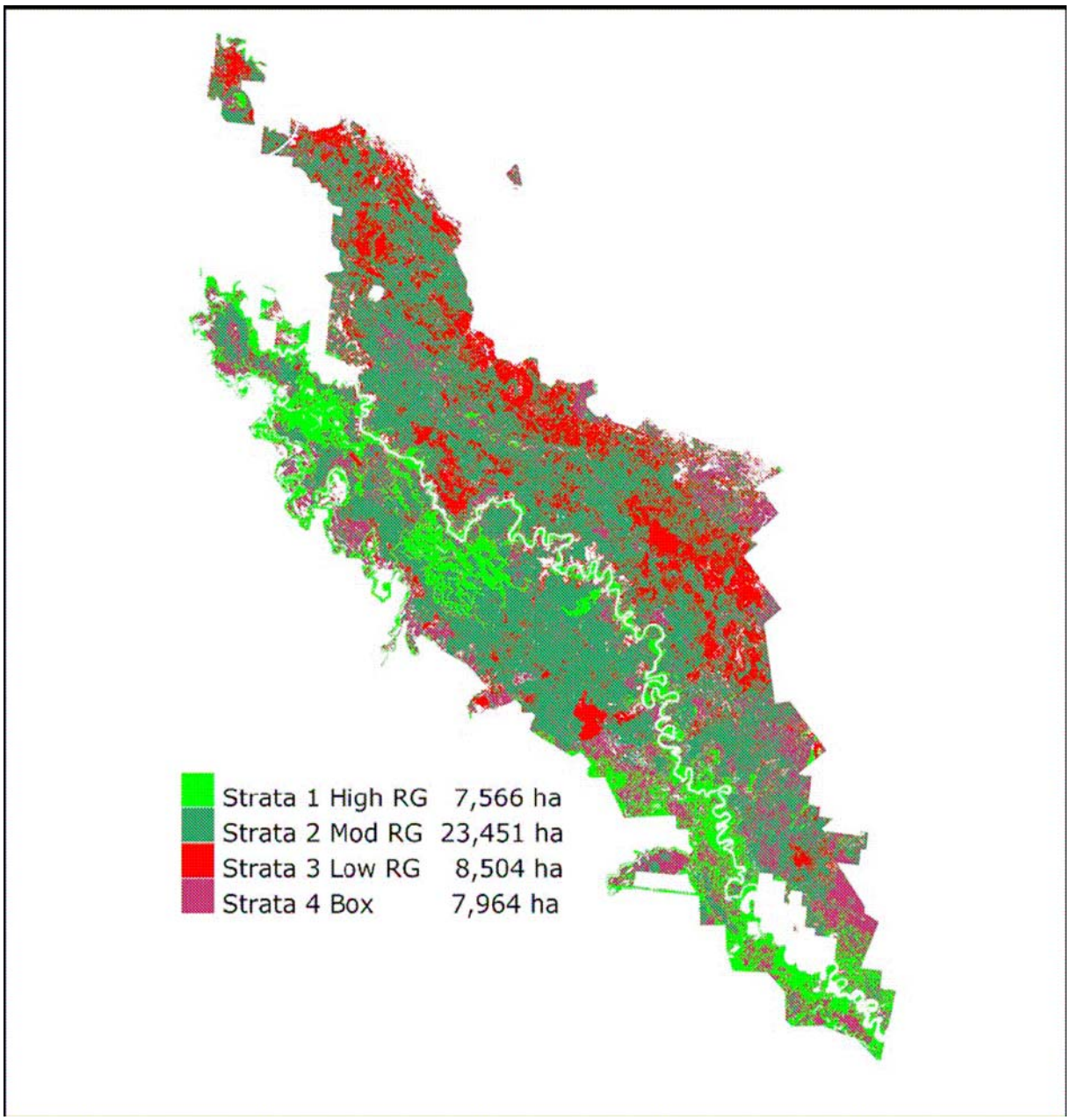


Figure 1-3: Derived Stratification Map of the Study Area 9 (*Source forests NSW in preparation)*

Figure 1-4 shows the average monthly flow downstream of Torrumbarry Weir, for modelled natural flow (MDBC MSM simulator, 119 years), actual recorded flow (113 years), modelled current flow (119 years) and predicted flow under the CSIRO Median Climate Change scenario[1]. The figure shows the average reduction in magnitude in late winter/spring flows. Average flows for September have dropped from approximately 37 000ML/day to approximately 28 000ML/day, and are predicted to fall to approximately 21 000ML/day without climate change, as the impact of river regulation takes its' affect on the long-term average. Average flows for September are predicted to fall to approximately 12 000ML/day under the influence of climate change. However the average timing (seasonality) of the peak has not changed.

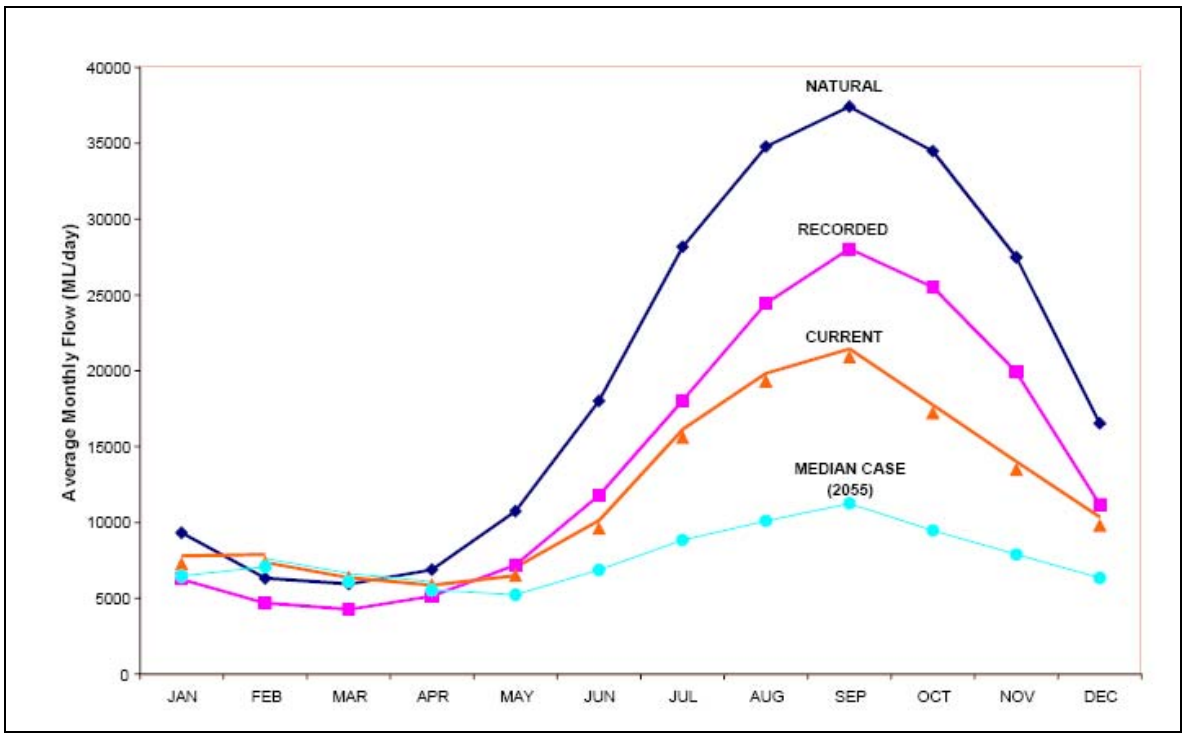


Figure 1-4 Average monthly recorded, modelled natural, current and median climate change (2055) river flows downstream of Turrumbarry Weir

Source: Investment Proposal, October 2008

Figure 1-5: River Red Gum in Koondrook-Perricoota

Source: Forests NSW

The restoration of a natural flooding regime is required to meet the interim ecological objectives established for the Gunbower Koondrook-Perricoota Forest. Unless action is taken to restore extensive flooding to the forest, the ecological condition of the NSW component of the Gunbower Koondrook-Perricoota Forest will continue to decline. Without the proposed works, low to medium floods are predicted to occur, however these will not be able to provide the necessary frequency, volume or duration of flows to provide for the water requirements of significant areas of the forest. The proposed works are the most effective means of achieving inundation and forest health to meet the objectives for the site, while optimising water use efficiency and also maximising return of flows to the Murray River.

Watering the forest will enhance the ecological processes on which the forest depends. Flooding will fill semi-permanent wetlands and allow the passage of native fish into the forest and wetland areas to breed. This will provide the necessary breeding trigger for colonial waterbirds with the forest able to provide essential habitat and food requirements.

Maintaining the ecological health of the forest is essential for retaining the cultural, social and economic values for which Gunbower-Koondrook-Perricoota Forest is recognised.

The project proponents have developed the proposed option through the understanding of the scheme's capacity to deliver against The Living Murray Program objectives and understanding of the potential consequences for operators, water use figures, the impacts to communities, salinity impact and other considerations.

Given the reliance of the site on the water regime, and the substantial decrease in frequency and magnitude of flood events, the 'do nothing' option is unlikely to see any long-term improvement in the condition of the site. Further decline is likely, as the full impacts of current river operations continue to emerge. The emerging evidence of climate change is cause for further concern, with further reductions in inflows predicted.

The impacts of such extreme change in the flooding regime are not known. However, it is reasonable to assume that these frequencies will be unable to provide the water needed to support wetlands, flood-dependent understorey, or even River Red Gum communities, leading to the loss of these communities, and replacement with more terrestrial communities.

2 Proposal Description

2.1 Site Location

The Gunbower-Koondrook-Perricoota Forest covers an area of around 50 000 hectares and is located downstream of Torrumbarry Weir, between Echuca and Koondrook-Barham (see Figure 1-1 and Figure 1-2, *Source: Investment Proposal, October 2008)*. The Koondrook-Perricoota Forest is located on the NSW side of the River Murray and covers an area of approximately 32 000ha.

2.2 Description of the Proposed Works

Overview

The Koondrook–Perricoota Forest Flood Enhancement Project involves the construction of a diversion channel and engineering structures to divert environmental flows from the Murray River to the Koondrook-Perricoota Forest. The scheme will be operated so as to mimic as best as possible and feasible, a natural flood regime and as such has been designed to allow regular flooding of the forest, diverting for a period of approximately 100 days.

This works can be summarised as:

- Upstream structures to allow diversion of water into the forest from Torrumbarry Weir and escape regulators at Swan Lagoon to prevent flows re-entering the Murray River
- Downstream structures to prevent uncontrolled water leaving the forest and to maximise return flows back to the Murray River. This includes a return channel to allow return flow back to the Murray River and a floodway to increase water returns to the Murray River. Downstream stop-log regulators are required tocontrol the flow of the water out of the forest. A levee around the downstream perimeter of the forest is required to protect adjoining properties from flooding.

The Project Steering Committee has developed a concept for the structures. A summary of the engineering works for the proposed Koondrook-Perricoota Forest Flood Enhancement project are provided below and locations shown in The project would be subject to a detailed design process and as a result some aspects of the project listed below may be refined or modified.

- Construction of a 3.8 km long earth channel extending north from the Torrumbarry Weir pool on the Murray River to Bullock Head Creek;
- Construction of a gated regulator structure and a fishway within the channel approximately 200 m from the Murray River;
- Construction of an access bridge across the channel at River Road;
- Erosion protection works at Bullock Head Creek;
- Two escape regulators and associated works at Swan Lagoon;
- Five downstream stop log regulators at Barbers, Cow, Calf and Thule Creeks;
- Two regulators at Little Barbers Creek;
- Construction of a return channel from Crooked Creek to allow return flow back to the Murray River;

- A gated regulator structure and potential fishway within the return channel from Crooked Creek to the Murray River;
- Floodway to enhance return flows to the Murray River;
- Provision of a new levee around the downstream perimeter of the Forest and connecting four of the above regulators (Barbers, Barbers overflow gully, Cow and Calf Creeks).
- A drop down structure and potential fishway at the entry of the drainage channel with the Murray River.

Further details of the above works are provided below.

Figure 2-1 Schematic representation of the proposed structures for the Koondrook-Perricoota Flood Enhancement Works

Source: Investment Proposal, October 2008

2.2.1 Upstream Works

Upstream Channel

The upstream channel will divert water from the Torrumbarry Weir pool on the Murray River to Bullock Head Creek. It will be approximately 3.8 km and will generally follow the low points through the Forest. It will be designed for a maximum velocity of 0.6 m/s.

Off-take Regulator

The off-take regulator will be a reinforced concrete design, with five tilting aluminium gates, approximately 3.4 m high by 3.6m wide. The regulator will be designed to:

- Allow a 6,000ML/day diversion capacity with safety margins
- Allow diversion and isolation up to RL 86.55 m AHD (the flood of record level)
- Provide operational flexibility for:
    - Effective ramp up and ramp down for diversion discharge
    - Acceptable flow characteristics and structure profile for downstream fish passage
    - Acceptable flow characteristics for upstream fish passage (via fishways).

Dual Fishway

A dual fishway will be provided on the main regulator to allow fish to escape the forest on the recession cycle of flow diversion. The fishway arrangement will consist of the Denil fishway for large fish and the vertical slot fishway for small fish. The fishway design has been selected in consultation with the DPI Fish Passage Task Force (FPTF).

Freshwater Turtle Ramp

The turtle ramp will be located approximately 20m downstream of the regulator structure where there is a low turbulence and low velocity. The ramp will be constructed of rock for erosion protection.

River Road Bridge

The River Road Bridge will be constructed as a two lane, three span bridge, with Cast-In-Situ Reinforced Concrete (CIS RC) piers and footings. It will be designed in accordance with relevant Australian Standards and will cater for a heavy timber road train and withstand up to 147 tonnes of total vehicle load on the deck.

Swan Lagoon Regulators

Two regulators are proposed at Swan Lagoon. The purpose of the Swan Lagoon regulators is to prevent the loss of diversion flows during flooding events, allow fish to evacuate during the close down sequence of the flooding cycle, and maintain an acceptable waterway to minimise obstruction to natural floods. Design of these regulators have taken into account the FPTF fish evacuation criteria, which specify a maximum velocity of 10m/s, a minimum depth of 300mm and erosion protection on the upstream and downstream side to prevent fish damage. These regulators will be sheet pile walls with vertical lift gates, with regulator gates to be operated by electric actuators.

2.2.2 Downstream Works

Stop Log Regulators

Five stop log regulators are proposed on Barbers, Cow, Calf and Thule Creeks to maintain flows within the forest during a flooding event.

Little Barbers Creek Regulators

Two regulators are proposed on Little Barbers Creek to retain the design pool RL 78.5, where the creek crosses the existing forest boundary. Similar structures to the stop-log regulators are proposed.

Levee

The main objectives of the downstream levee will be to prevent uncontrolled flows leaving the Forest during flooding events, to contain the design pool at RL 78.5 and provide a back-up pool to the return channel. The height of the levee varies from zero to 4m above the floodplain, with the maximum height at the downstream regulators. It will be approximately 60km long and 4m wide at the crest, with a total current required fill volume of approximately 1,100 000m^3. It will be widened on both sides at each downstream regulator for a stop-log storage area and vehicle turning circle. The exact location of the levee is currently being investigated.

Return Channel

The return channel has two basic functions; to provide water savings via the return of flow to the Murray River, and as an emergency overflow/release system to assist the security of downstream levee system. It is currently proposed to be located at the shortest connection to the Murray River, junctioning with Crooked Creek at its upstream end. It will comprise a 350m long channel fully located within the Forest boundary. Studies are being carried out to examine maximising the return flow to the Murray River. Modelling has indicated a flow of 1 800ML/day or potentially higher flow will be returned to the Murray River when a floodway is incorporated into the scheme.

Return Channel Regulator

The return channel regulator will be a small reinforced concrete structure that provides a degree of operational flexibility to the scheme to assist the maintenance of the correct water balance. A fishway may be required. This will be confirmed with the FPTF.

Floodway

A floodway will be created to maximise the return of flows to the Murray River and flooding in the forest. The natural surface of the land will be modified by shallow excavation to achieve a slight lowering. A relatively small alteration of topography on the floodplain influences the return flow. The floodway is likely to cover an area of approximately 25ha (approximately 1km long by 250m wide), to the north of return channel.

Murray River Drop-down Structure

A drop down structure into the Murray River is expected to be necessary at the downstream end of the return channel. As the water level in the Murray River is likely to be several metres below the return channel bed, the drop down structure will safely convey flow from the return channel into the river. Options for this structure include a standard concrete chute structure, a chute protected with rockfill or rock mattresses and terraced sheet pile or gabion type structure. A fishway may be required as part of this structure, however this is to be advised by the FPTF.

2.3 Operation

The Koondrook-Perricoota Flood Enhancement Works have been designed to reinstate the critical process of flooding for forest health. This will be achieved by utilising the Torrumbarry Weir to divert water into the forest at the upstream end, with the water to take a similar course to natural floodwaters through the forest. The scheme will be operated to mimic as best as possible and feasible a natural flood.

An operating strategy for the proposal has been developed based on a combination of inundation events that will be used to supplement natural flooding of the Koondrook-Perricoota Forest with the aim of bringing the flood frequencies up to those prescribed in the Environmental Management Plan.

2.3.1 Operation and Water Use

The proposed scheme is designed to enable flexibility. Diversion of a range of flows is possible, ranging from as little as 2 000 ML/day, up to a design capacity of 6 000 ML/day. Frequency of operation will vary with the availability of water, and the requirements of the forest.

It is expected that capacity events will be delivered every three to four years, with smaller floods delivered more regularly. The duration of diversion is also variable, depending on the required ecological outcomes. Operation is expected to coincide with natural high flow events. Inflow of up to 100 days duration is expected to be adequate for the successful breeding of waterbirds.

The preferred frequency is one year in three, with a maximum period between events of 4 years.

It is expected that the preferred events will be supplemented by smaller events when flows exceed the channel capacity downstream of Torrumbarry Weir, and possibly with additional environmental water, should this become available.

A hydraulic model has been developed for the flood enhancement scheme to assist in identifying water use, predicting flood coverage and determining environmental benefit to be gained from the flooding. The proposal requires initial inflows of 6 000ML/day, which are then reduced to flows of 3 400ML/day after 50 days. This results in the diversion of 466GL into the forest. An estimated 222GL will be returned directly to the Murray River. It is predicted that a total cycle of flooding and recession will occur over approximately 235 days. However, it is estimated that the full flooding objective will only occur for approximately 100 days of the cycle. The balance of the remainder of the time will be the time taken for the water to enter and flow to the lower end of the forest and then the time taken for the water to recede out of the forest.

Table 2-1 details the water use of the proposed option for the Koondrook-Perricoota Forest Flood Enhancement Project (Option 1) and compares it with a second option of 'no downstream structures' (Option 2). Approximately 200GL of additional water would be required under the 'no downstream structures' option to achieve a lesser area of forest watered. Approximately 100GL of this additional water would be lost in the Barbers Creek/Wakool River system.

The proposed option (Option 1) achieves a greater area of forest watered (an additional 6 400 ha) with approximately 20% less water. Furthermore an assessment of water use efficiency, as measured in gross water requirement per hectare of forest watered, shows the proposed option requiring half the gross water requirement per hectare (15ML/ha) compared to the 'no downstream structures' option (31ML/ha).

Table 2-1 Forest water use assessment per design capacity

Aspect	Option 1	Option 2	Difference Option 1 over 2 (GL)	Data Origin and Assumptions
	Proposed Option (GL)	No d/s regulators (GL)		
Total assumed water requirement (Gross Water Use)	466	660	-194	Option 1 from DHI Modelling. Option 2 from Commerce interpretation of DECC modelling
Total forest water use (Evaporation & Infiltration)	225	180	45	Option 2 usage taken as 20% reduction on Option 1 based on reduced area watered.
Koondrook-Perricoota Forest area watered	up to 50% or ~16,000ha	< 30% or ~9 600ha		From DHI modelling and Commerce interpretation of DECC modelling. Note: The area of inundation under Option 2 would be minimal up to flows of ~5 000ML/day (effluent flow only)
Downstream flow via Barbers Creek/Wakool River system	62	480	-418	Inferred from DoC interpretation of DHI and DECC Modelling
Losses from Barbers Creek/Wakool River system (25% Transmission Loss Assumption)	16	120	-105	25% transmission loss assumption in the Barbers Creek/Wakool River system based upon DECC floodplain engineer assessment of 20- 30% depending upon seasonal factors, regulated versus unregulated flows. It includes evaporation, infiltration and unregulated diversions
Return Flow to Murray River via Barbers Creek/Wakool River system	47	360	-314	No assessment has been made of down stream losses once returned to Murray River at Wakool junction as either regulated or unregulated flow
Return flow direct to Murray River via Crooked Creek cutting	179	0		Assumes the return flows from Swan Lagoon would be similar for both options. Given the conservative nature of the assessment they have not been included
Losses in Murray River from Barham to Wakool River junction	4	0		MSMBigMOD modelled losses (evaporation off 873ha) of 10GL per annum under regulated conditions (A Close, pers comm. 2008). Conservative estimate of Koondrook-Perricoota event losses of 2% of return flow
Total return flow to Murray River per event	222	360	-138	
Comparative Results				**Conclusions based on water requirements and use**
Gross water requirement from TLM Account plus any unregulated flow diversion	466	660	-194	Approximately 200GL of additional water would be required under the 'no down stream structures' option to achieve a lesser area of forest watered. Approximately 100GL of this additional water would be lost in the Barbers and Wakool systems
Net water use per event	244	300	-56	The proposed option achieves a greater area watered (6 400ha) with ~20% less water
Gross water requirement per hectare of forest watered	15 ML/ha	31 ML/ha	-16 ML/ha	Measure of water use efficiency per option showing the proposed option requiring half the gross water requirement per hectare compared to the 'no down stream structures' option.

Source: Investment Proposal, October 2008

Operational Flexibility

The design of the scheme provides the flexibility to operate within a range of flows. This ensures that it can deliver effective and measurable environmental outcomes across a broad range of available water. This is particularly important in delivering environmental outcomes following the impact of climate change on water availability.

The proposed structures have been designed to create a major flood event; however they can also manage smaller flows that can be used to maintain core wetland areas, or medium flows of variable volume and duration that can be manipulated to either provide a quick fresh across the forest or be drawn out to ensure successful recruitment of wetland species.

The structures will be operated using adaptive management techniques, where learnings will be incorporated into the decision making process, both during diversions, and from event to event. It is expected that the operation of the structures will vary from operation to operation, depending on factors such as the antecedent soil conditions, rainfall and availability of unregulated flows. The operation will also be fine-tuned as improvements to the practical operation of the structures are made, and as ecological responses are monitored and evaluated.

Operational Outcomes

The proposed scheme is capable of achieving inundation of up to 52% of the forest and maintaining inundation of up to extent is 41%, with this reducing quickly during the flood recession. This meets the Environmental Management Plan's (EMP's) interim objective of maintaining 30% of River Red Gum forest in healthy condition.

The flooding will result in numerous ecological benefits such as improved forest health and encouraging bird and fish breeding. Ecological benefits are discussed further in Section 4.7.

One Possible Operating Scenario

A preliminary possible operating sequence has been developed. It is noted that modelling is still in progress, and is still subject to further modelling outputs. The operating regime outlined below, is an example of one scenario only. The design of the flood enhancement scheme enables a range of flexibility on how the forest is flooded and will cater for a range of flooding scenarios. This includes much small flooding events than the one described below.

Phase 1

The initial phase will include opening of the off-take regulator over a period of five days to achieve 6 000ML/day diversion capacity. In this phase:

- The return regulator will be fully open
- Swan Lagoon structures will be fully closed
- Downstream stop-log regulator structures will be closed (stop-logs will be in place to deliver 50ML/day per structure or 200 to 250ML/day through one structure at Design Pool RL 78.5).

Phase 2

The off-take regulator will discharge at 6 000ML/day, with the downstream Forest section to be filled to the design operating level of RL 78.5. Theoretical modelling runs indicate that this process will take 45 days.

Phase 3

The gates of the off-take regulator will be raised to reduce flow (e.g to 3 400ML/day) with the design pool operating level RL 78.5 maintained. This diversion flow of 3 400ML/day will be maintained for 55 days. Modelling has indicated that other surface flows may include:

- Return channel at a flow of 1 800ML/day or higher; and

- Downstream stop-log structures at a flow of 250ML/day (combined flow).

Phase 4

The off-take regulator will be shut down, for example for a two week period, and flows ramped up and down (if required) to facilitate fish exit. Stop-logs will gradually be removed from one downstream structure bay, possibly Cow Creek, as the deepest structure, to maintain the 250ML/day flow.

Phase 5

Stop-logs will continue to be removed from the downstream structure bay to empty the pool. The emptying could theoretically take 130 days. A total of 542 stop-logs from all downstream structures will be stripped and stored. Stop-log removal will initially be slow; however this will gain momentum as the pool drops.

2.3.2 Fish Passage

Fish passage requirements have been determined in consultation with DPI Fish Passage Task Force (FPTF).

During flooding it is envisaged that fish will move into the Forest and then vacate with the recession sequence of the flow diversion. A particular operating protocol is expected to be necessary for the recession phase to ensure that fish of different size and species will have time to vacate the Forest as water depths recede.

From the advice of the FPTF the following is proposed:

- A suitable fishway at the upstream off-take regulator to allow fish to move out of the Forest either during or at the end of the flow diversion.
- Swan Lagoon Structures that will permit fish (expected to be mainly juveniles) to pass through back to the Murray River at the end of the flow diversion.
- Potential fishways at the regulator within the return channel and at the drop down structure on the Murray River to allow fish to move in (or out) of the Forest during or at the end of the flow diversion.
- Provision for downstream fish passage via one or two of the stop-log regulators during the flood recession phase.

No specific fishway provisions for upstream fish migration have been requested at the downstream stop-log regulators. Further discussions and advice from the FPTF will be necessary when the design for these structures have been finalised.

2.4 Determining the Proposed Option

The conclusion derived from the investigations and concept designs undertaken for the proposal overwhelmingly supports the NSW Government's proposal for the Koondrook-Perricoota Forest Flood Enhancement Works including the downstream regulating structures and return channel to the Murray River.

Initially it was assumed that the threat of significant downstream impacts to private and public lands and infrastructure, resulting in significant costs in easement attainment, structural works and compensation, would be the issue adding the greatest support to the argument for the downstream structures. Notwithstanding that it is a very significant issue with possibly the greatest level of uncertainty and unassessed risk to the proponents, it became evident through the assessment of water use, operational flexibility and environmental outcomes that the benefits ascribed to the downstream structures far exceeded in both market and non-market benefits the option of proceeding with a flow through scheme with no downstream regulation.

Some of the major findings arrived at through the investigations include, but are not limited to:

- The proposed option including both the downstream regulators and return channel afford the operational flexibility and efficiency to both maximise the environmental benefits (within and downstream of the icon site) and mitigate any risks to private or public land and infrastructure from the uncontrolled release under a 'no downstream structures' option.

- Benefits, although largely unquantifiable without the proposed MDBC Stage II Blueprints modelling, have been identified by both State Water and MDBCO under both a flow through and regulated operation, however the flexibility provided by regulation has the potential to deliver far greater operational and water saving benefits.

- In times of significant resource constraints and uncertainty around long-term water availability, both for consumptive and environmental use, a scheme comprising downstream structures that delivers a greater environmental return per Megalitre and affords significantly greater operational flexibility over a range of flow conditions would appear far superior to the alternate flow through system.

- When considering the availability and cost of water to achieve the desired outcomes the capital cost of the downstream regulators is far smaller that the cost of securing the additional flow required under a flow through system.

- From the assessment of possible down stream impacts it could be concluded that a system with no downstream control and a downstream flow of say 1 500ML/day could negate the need for the return channel to the Murray River. This scenario would however require considerable expense on works and measures within the Barbers Creek system and the upstream diversion to be throttled to a volume significantly less than the 6000ML/day required to achieve the desired 30% inundation resulting in a significantly reduced area of forest watered.

2.5 Construction Issues

The proposed works will require substantial excavation and earth works for the construction of the channels, levee and floodway. It is estimated that 257 000 m^3 of spoil will be excavated for the upstream inlet channel and a further 5 000 m^3 for the other upstream structures. Excavated spoil will be transported to the downstream levee.

The levee will require excavation and placement of approximately 766 000m^3 of locally sourced material (including approximately 60 000 m^3 of topsoil). It is estimated that material excavated for the floodway and the upstream channel can also be used in the levee construction. The return channel will require excavation of approximately 13 400m^3. The floodway will require excavation of approximately 123 000 m^3 through the reshaping of the topography. The excavated material will be used for the construction of the levee.

Vegetation clearing required for both the upstream and downstream structures. Clearing is predicted to be approximately 90 ha in upstream areas and 110 ha. Seed trees will remain. Clearing requirements and opportunities for revegetation and/or rehabilitation of cleared areas will be identified for the project.

Potential construction issues are discussed further in Section 4.

2.5.1 Construction Timeframe

Construction of the project will take approximately 18 months.

2.5.2 Capital Costs

The estimated cost of the proposed works is $50.7 million.

3 Statutory and Planning Considerations

The following section provides a summary of relevant legislation and environmental planning instruments applicable to the proposal.

3.1 Environmental Planning Instruments

3.1.1 State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (SEPP (Infrastructure) 2007) aims to assist in the effective delivery of public infrastructure throughout the State by improving certainty and regulatory efficiency through a consistent planning assessment and approvals regime for public infrastructure and services across NSW. The SEPP provides clear definition of environmental assessment and approval process for public infrastructure and services facilities.

The Koondrook-Perricoota Forest Flood Enhancement Works is considered to fall under Division 8 Forestry and Division 24 Water Supply Systems of *State Environmental Planning Policy (Infrastructure) 2007* (SEPP). Division 8 Forestry states that *Development for the purposes of forestry may be carried out by or on behalf of a public authority without consent on land in Zone RU3 Forestry or an equivalent land use zone*. Development for the purposes of Forestry includes; forest management activities relating to forest conservation. The majority of the forest is zoned 1 (f) (Rural (Forests) Zone, which is equivalent to the Zone RU3 Forestry. However some areas are zoned Rural 1(a). The Murray Regional Environmental Plan No 2 – Riverine land (REP) and the Local Environmental Plan removes the need for development consent in the Rural 1(a) areas.

Division 24 Water Supply Systems is also considered applicable to the project. Clause 125(1) permits development for the purposes of water reticulation systems to proceed without the necessity to gain development consent. The water reticulation system definition includes canals and therefore this clause is considered to cover the proposed diversion channel required as part of the proposal to deliver floodwaters to the forest.

3.1.2 Murray Regional Environmental Plan Number 2

The Koondrook-Perricoota Forest falls under the Murray Regional Environmental Plan No 2 – Riverine land (REP) which identifies the planning approval process for works in the area. The objectives and principles of the REP will be considered as part of the environmental assessment process.

3.1.3 Local Environmental Plans

The forest is located in both the Murray Shire Council and the Wakool Shire Council. The upstream area of the forest occurs in Murray Shire, while the downstream area is located in Wakool Shire. The respective Local Environmental Plans are the Murray Local Environmental Plan 1989 and the Wakool Local Environmental Plan 1992. Both LEPs have a clause that states that development may be carried out within a State Forest within the meaning of the *Forestry Act 1916* without development consent. Therefore the LEP does not prohibit the works.

3.2 State Legislation

3.2.1 Environmental Planning and Assessment Act 1979

It has been determined that the project does not require development consent. Consideration was given to whether the assessment process falls under Part 3A (Major Projects) or Part 5 (Environmental Assessment) of the *Environmental Planning and Assessment Act* 1979 (EP&A Act).

A Ministerial Order was made in the NSW Government Gazette on 29 July 2005 that states that in accordance with Section 75B(1) of the EP&A Act 1979 that "Development that is an activity for which the proponent (that is not a local council or county council) is also the determining authority and that, in the opinion of the proponent, will (but for this order) require an environment impact statement to be obtained under Part 5" is a development to which Part 3A applies.

Although the Koondrook-Perricoota Flood Enhancement Works are predicted to achieve a net environmental benefit, a number of construction impacts including vegetation clearing and spoil management issues are predicted. Given the sensitivity of the site, DPI and DWE (both the proponents and determining authorities) are of the opinion that an Environmental Impact Statement will be required under Part 5. Therefore in accordance with Section 75B(1) of the EP&A Act 1979 an application is being made to the Minister for Planning to proceed under Part 3A of the Act.

3.2.2 Fisheries Management Act 1994

Sections under the *Fisheries Management Act 1994* applicable to the project include:

- Section 218 - Minister (Department of Primary Industries (NSW Fisheries)) to be notified in regards to the construction of regulator structure and to enable consideration of the need for fish passage
- Section 199 - Notification of Dredging and reclamation in "waterland

It is noted that approval under Section 219 to block fish passage is not required for projects assessed under Part 3A of the EP&A Act. Potential to block fish passage would be considered in the environmental assessment.

The environmental assessment would consider threatened species, ecological communities and populations and key threatening processes listed under the *Fisheries Management Act 1994*.

3.2.3 Protection of the Environment Operations Act 1997

Protection of the Environment Operations Act 1997 (PEO Act) regulates noise, air, land and water pollution. The construction works will be managed to meet the requirements of the Act.

Dredging works as defined by Schedule 1 of the PEO Act, require licensing where they obtain more than 30,000 m^3 per year of bed, bank and foreshore material. Extractive industries that obtain, process or store for sale or re-use an intended quantity of more than 30, 000 m^3 of extractive material are required to be licensed by The Department of Environment and Climate Change (DECC).

DECC would need to be consulted regarding the application of the Act and whether the works are considered to fall within the above definitions as the main characterisation of the project is not for dredging or extractive industries.

3.2.4 Threatened Species Conservation Act 1995

Impacts on threatened species, populations or ecological communities and their habitats listed in the *Threatened Species Conservation Act 1995* (TSC Act) would be required to be assessed using a seven part test under section 5A of the EP&A Act.

It is noted that no Species Impact Statement (SIS) would be required under Part 3A of the EP&A Act.

3.2.5 National Parks and Wildlife Act 1974

Permits under Section 87 to move or excavate an archaeological site and under Section 90 consent to destroy or damage a site under the *National Parks and Wildlife Act 1974* are not required for a project approved under Part 3A.

However the impacts on any Aboriginal archaeological sites will need to be investigated as part of the environmental assessment process. An archaeological survey will be undertaken for the environmental assessment. The Aboriginal community will be consulted and the DECC consultation procedures followed.

3.2.6 Water Management Act 2000

The Water Management Act includes approvals for:

- Section 89 - water use approval,
- Section 90 - water management work approval,
- Section 91 – controlled activity approval,

Under Part 3A, these approvals are not required. However DWE requirements will need to be considered in the environmental assessment process.

3.2.7 Heritage Act 1977

No heritage listed on the State Heritage register have been identified in the vicinity of the proposed works. No approval is required under the Heritage Act for projects assessed under Part 3A of the EP&A Act.

3.2.8 Forestry Act 1916

Section 11 of the *Forestry Act* 1916 outlines the powers and duties of the Forests NSW (DPI). The proposal is consistent with the *Forestry Act* 1916 to maintain forest health.

3.2.9 Crowns Land Act 1989

The project will involve work within the bed of creeks which may be Crown Land. Where the bed of creeks is Crown land then the Department of Lands approval will be required.

3.3 Commonwealth Legislation

3.3.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for Commonwealth involvement in development assessment and approval in circumstances where 'matters of national environmental significance' (such as nationally listed threatened species and ecological communities, migratory species and World Heritage properties) are involved and where there is potential for a significant impact.

The Koondrook Perricoota Forest forms part of the NSW Central Murray State Forest Ramsar site and provides habitat for migratory birds and nationally listed threatened fauna species. The project will be referred to the Commonwealth Department of Environment, Water, Heritage and the Arts to identify if the works are a controlled action.

4 Preliminary Environmental Assessment

A preliminary environmental assessment of the potential key construction and operational impacts, based on studies undertaken to date, are provided below.

4.1 Risk Identification

Managing any risk associated with the proposed scheme of works requires first identifying and assessing all potential risks. This is difficult given the varying levels of uncertainty in both input assumptions and proposed directions associated with the Koondrook-Perricoota Forest Flood Enhancement Works proposal.

The reference to risk relates to the potential adverse impact of events, actions and assessments at all phases of the project. As part of the Investment Proposal an independent ecological risk assessment project is to be undertaken which will be coordinated from the MDBC office. Formal risk management will fall out of the environmental assessment required as part of the project approval under Part 3A of the EP&A Act.

Potential risks identified to date include:

Social

- Impacts to adjoining properties
- Impacts to cultural heritage sites
- Impacts to downstream users
- Impacts on downstream water quality
- Temporary loss of access to some areas for forestry and recreation.

Environmental

- Oxygen depleted waters may retard biofilm development and have harmful (allelopathic) effect on macrophytes
- Depth of flooding at lower end of forest may kill some young seedlings
- Length of flooding may have a negative effect on mature Black box and recruitment if flooded too frequently
- Depth of flooding may increase the lag time before breeding commences in fisheating waterbirds in some areas
- Abandonment of young if floodwaters recede too quickly
- Fish death from blackwater event
- Fish stranding on floodplain
- Breeding of carp and other non-native fish
- Injury caused by regulators and fishways
- Blackwater event from first and subsequent floods re-entering Murray
- Development of blue-green algal bloom event
- Impacts on other environmental values such as soil degradation

- Unforeseen salinity impacts
- Inability or reluctance to modify land management practices in line with changing climate.

Economic and Operational

- Potential for increase in cost of Detailed Design [$2.35M (Aug 2007) to $2.44M (Aug 2008)]
- Potential for increase in cost of project [$47.50M (Aug 2007) to $50.77M (Aug 2008)]
- Potential damage to structures caused by woody debris mobilised in the effluents
- Failure of structures to operate as designed
- Risks associated with system not delivering on environmental objectives

4.2 Land Use and Social Issues

The main land use within the Koondrook-Perricoota Forest is commercial timber production. The Forest provides a perpetual and sustainable source of timber that is used for a range of products. The timber harvesting process is sustainably managed to ensure a patchwork of tree sizes and ages throughout the forest are maintained to ensure a diversity of habitat. Harvesting is carried out in accordance with a harvesting plan. The plan ensures that across the harvest area that a portion of trees are marked and retained for animal habitat. The plan ensures that flora, fauna and archaeological values are protected (NSW DPI Website).

Koondrook-Perricoota Forest also supports a mixture of additional land uses, which include recreation, biodiversity conservation, education, livestock grazing, apiculture, water supply and flood mitigation.

The forest attracts a high level of recreational use, including four-wheel driving, motorcycling, horse riding, picnicking, camping, swimming, boating, skiing, fishing, orienteering, canoeing, and nature study (MBDC, 2007b).

The forest is Crown Land, which is dedicated as State Forest under the New South Wales *Forestry Act 1916* for the purposes of timber production and other matters in the public interest. The site is managed by the Department of Primary Industries (Forests).

The surrounding area is predominantly freehold title and is dominated by irrigated and dryland cereal cropping and pastures. Other adjacent land uses include horticulture, private native forestry and residential development.

Construction Impacts

Some disruption to recreational land use may occur due to construction traffic, noise, dust, acess restriction and general amenity disturbances. Community consultation and notification of the works will assist in reducing the impacts associated with the construction works.

Operational Impacts

Public access to the forest will be restricted during a flooding event. However given the relatively low frequency of flooding events, this has not been identified as a significant issue and can be managed through adequate consultation and notification.

The levee has been designed to provide minimal obstruction to natural flooding in accordance with DWE floodplain management requirements. There is a series of private levee systems, including the road that acts as a levee downstream of the forest. The levee design is consistent with the existing levees in the downstream area. The proposed downstream structures have a waterway capacity to handle the flood of record. The downstream structures are high capacity flood structures to ensure that there are minimal changes to flood

distribution and flooding outside of the forest. Therefore the effect on a natural flood is anticipated to be minimal on areas outside the forest.

Land uses within the Koondrook-Perricoota Forest will be enhanced post construction through the improved ecological condition of the Forest.

4.3 Soils and Erosion

Geotechnical investigations to be undertaken as part of the detailed design, will confirm existing soil conditions at the site.

Construction Impacts

Total excavation for both upstream and downstream structures is predicted to be approximately 400,000 m^3. Excavated spoil (subject to its suitability) will be used for the construction of the downstream levee. The levee will require excavation and placement of approximately 766 000m^3 of locally sourced material (including approximately 60 000 m^3 of topsoil). The spoil balance will be imported to the site.

Operational Impacts

There is potential for some erosion along the channel during initial flood cycles until stabilised. Continuing erosion during flood is anticipated to reflect what will occur under natural conditions. The Koondrook-Perricoota Forest occurs on a depositional floodplain. However there will be transport of sediment to the Murray River with return flows.

4.4 Hydrology

River Regulation

The Murray River is a regulated river system. Three major storages (Hume andDartmouth Dams in the upper catchment and Lake Victoria in South Australia) capture winter and spring rain for use later in the season. A series of weirs spaced along the length of the River provide additional control over the movement of tributary inflows, and elevated water levels for diversion.

The River is operated according to three distinct modes: storing mode generally in winter and spring, supplying mode during the irrigation season (November until May), and spilling mode when inflows exceed the capacity to store and transfer. It is the storing mode that has the greatest impact on the floodplain communities.

The impact of the storages and the operation of the River vary along the length of the River. Broadly the impact is characterised as a reduction in the frequency and magnitude of late winter/spring floods that would naturally be generated from rainfall above the storages. Along the mid-River section, reduction in spring floods has resulted in a general decline in health and a contraction in the extent of floodplain ecologies. Fish passage along the length of the River has been compromised by the presence of the various dams and weirs.

Gunbower-Koondrook-Perricoota Forest

The Gunbower-Koondrook-Perricoota Forest is located downstream of the Hume and Dartmouth Dams and the Barmah Choke. Since river regulation, flows to the forest depend on upstream diversions from the Murray River, regulation of the Goulburn River and other effects of the management of flow using water management infrastructure (MDBC 2005).

Torrumbarry Weir is located near the southeastern end of the Gunbower-Koondrook-Perricoota Forest. The weir is used to raise the level of the Murray River by approximately 6 m. The flow downstream of Torrumbarry Weir depends largely on flows in the Murray River at Barmah and the flow from the Goulburn River that joins the Murray near Echuca. The

magnitude of flooding in the Gunbower Koondrook-Perricoota Forest is strongly dependent on whether flows in the Murray River and Goulburn River coincide.

Construction Impacts

No impacts anticipated as construction would occur in the dry.

Operational Impacts

DHI has undertaken extensive flood modelling to be able to predict the flow of water during a flood event. This predicts the movement of water through the forest. Figure 4.1 shows the predicted maximum flood coverage.

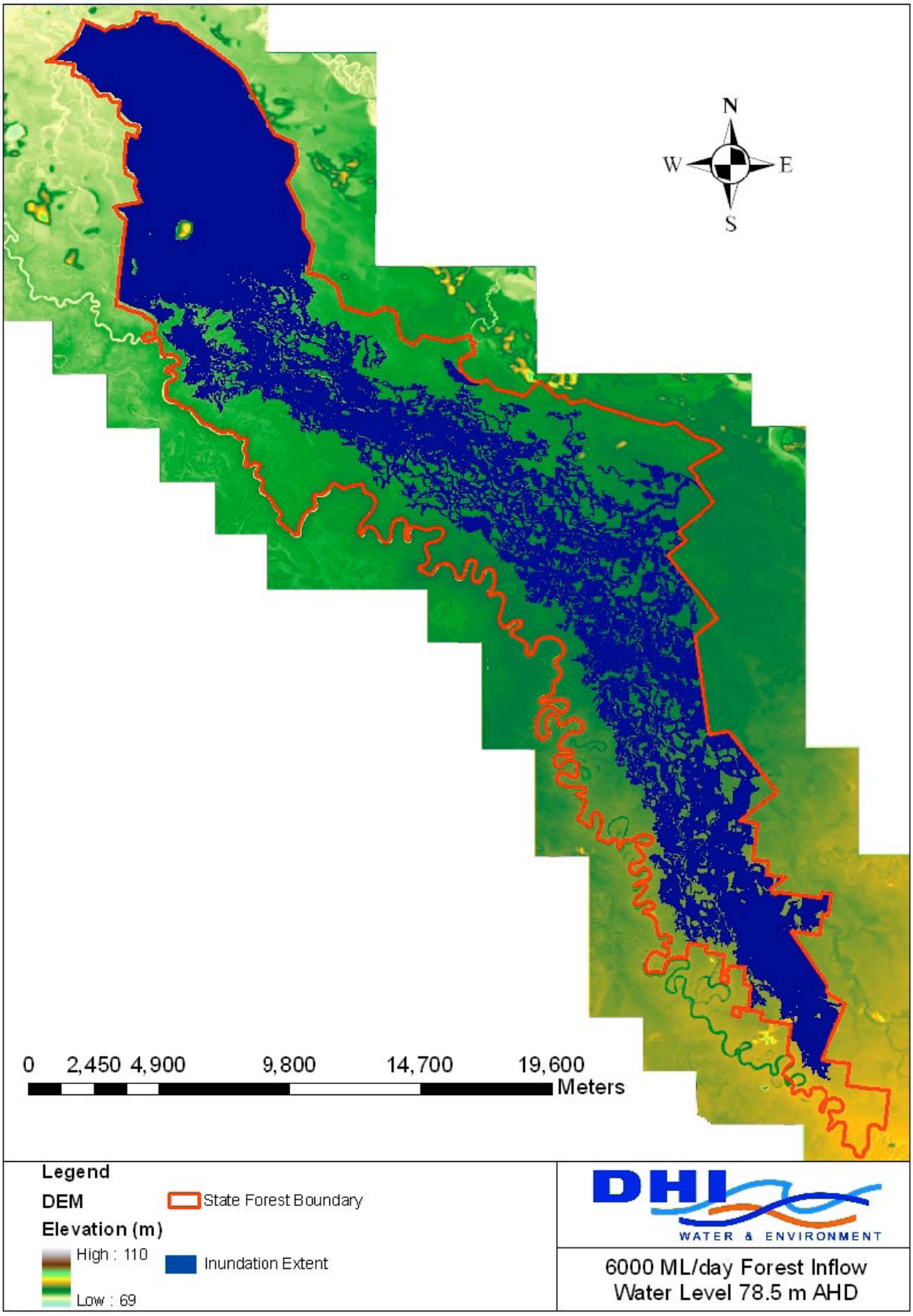


Figure 4-1: Predicted Maximum Flood Coverage (6 000 ML)

A levee will be constructed using spoil generated from the cutting to prevent flooding of neighbouring properties during a flooding event.

The project offers water savings with excess flood waters allowed to drain back to the Murray. From a total of 466 GL diverted into the forest an estimated 222 GL will be returned to the Murray River.

There will be minimal impacts to Murray River hydrology when flooding is not occurring. Regulators at the channel inlet will remain closed during non-flood periods. The structures have been designed to enable flows from the flood of record to pass.

4.5 Water Quality

The Koondrook-Perricoota Forest plays an important role in the healthy functioning of the Murray River, particularly in terms of water quality through sediment deposition and river health through carbon flux and invertebrate distribution.

Construction Impacts

There is the potential for sediment to wash into the Murray River or other waterways due to the large quantity of earthworks such as excavation, transport and stockpiling of spoil, required as part of the construction works. Sediment and control measures will be implemented to prevent sediment from leaving the construction sites.

Some revegetation will occur following construction activities.

Operational Impacts

There is an increased potential for blackwater to occur during a flood event due to the greater extent and duration of flooding at the downstream end of the Forest. Blackwater is a natural and inevitable component of floodplain watering which results from increased dissolved organic carbon and decreased dissolved oxygen (MDFRC, 2006).

A blackwater event can be minimised by allowing water to continually flow through the Forest during the flooding cycle via the return channel to the Murray River and to a lesser degree by allowing small flows through the downstream regulators. There will be a degree of dilution of any blackwater with the Murray River water, when water exits the forest.

Forest flooding has the potential to result in elevated nutrient levels that may increase the risk of a blue-green algal bloom event. There will be areas in the Forest where water will pond. However with water circulation and timing of the flooding it is considered that the risk of blue green algae is low.

Water quality issues will be investigated in detail as part of the environmental assessment process.

4.6 Salinity and Groundwater

Salient Solutions (2007) has undertaken investigation into ground water levels in the Forest. Based on a review of standing water levels and the watertable contours, Koondrook-Perricoota Forest lies in a groundwater depression with the watertable being at higher elevations in all directions outwards of the forest. This is attributed to irrigation accession in the areas surrounding the Forest. In the central part of the forest the watertable is deeper than 12 m below ground level and thus below the level of the Murray River. The depth of the watertable then reduces to levels less than 4 m around the periphery outside of the forest in the irrigation areas.

Data shows that the watertable salinity is highly variable with no discernible spatial pattern. Groundwater salinity within the forest was found to vary between 1 550 mg/L (2 384 EC) to a high of 24 200 mg/L (37 230 EC).

It has been determined that the forest water balance is dominated by overbank river flows. Drilling has confirmed that there does not appear to be any groundwater discharge directly to the Murray River. If there is connection between the river and groundwater, then it will be the river that is recharging the watertable.

Construction Impacts

Given the low watertable level under the Forest, groundwater is not expected to be encountered during the construction works.

Operational Impacts

An investigation into the potential for salinity impacts associated with the flooding was undertaken by Salient Solutions (2008). The salt wash-off process is considered to be responsible for the highest salt loads returning to the surface water system after forest watering as the data collected during the investigation indicates that there is no sub-surface pathway out of the forest.

The salt wash off from the Forest is estimate at 0.46 tonnes per day for a 100-day period every 3 years. This is not considered to be an accountable action under the Basin Salinity Management Strategy (BSMS). The study concluded that salinity impacts would not constrain the project.

4.7 Ecological

The Gunbower-Koondrook-Perricoota Forest is the second-largest River Red Gum Forest in Australia. River Red Gum forests and associated wetlands are recognised for their distinctive habitat that provides breeding, resting and feeding grounds for colonial waterbirds. The NSW component of the Gunbower-Koondrook-Perricoota Forest contains the second largest River Red gum (*Eucalyptus camaldulensis*) forest in Australia.

The Koondrook-Perricoota Forest is listed as a wetland of international importance under the Ramsar wetland convention (NSW Central Murray State Forests Ramsar Site listing).

Koondrook-Perricoota Forest forms part of the vegetated corridor along the Murray River providing important connectivity in southeastern Australia. The land around the forest has been largely cleared for agriculture, the Forest is therefore very important in supporting viable populations of flora and fauna that are no longer present within the wider landscape (Webster, 2008).

River Red Gum is the predominant overstorey species, which occupies over 80% of the Forest. It usually forms a pure stand and only occurs with other eucalypt species on less frequently flooded sites. Tree height and diameter are related to moisture availability. The better quality forest occurs on the more frequently flooded areas or on sites with shallow water tables (MDBC 2007a).

Black Box (*E. largiflorens*) also occurs on areas prone to floods of lower frequency and duration. Other overstorey species, such as Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*) and White Cypress Pine (*Callitris glaucophylla*), occur above the level of the floodplain on lighter textured soils and sand hills. Few woody species exist as an understorey (MDBC 2007a).

Vegetation mapping of Koondrook-Perricoota Forest undertaken by Forests NSW shows the distribution of vegetation communities in the Koondrook-Perricoota Forest. Webster (2008) quantifies the communities as:

- River Red Gum SQ1: exceeds 34m in height, located in frequently flooded areas Approximate area 2 013ha
- River Red Gum SQ2: stands between 21-34m tall and located on intermediate levels of the floodplain. Approximate area 17 477ha

- River Red Gum SQ3: woodland stands of trees <21m tall on the higher areas of the floodplain. Approximate area 5 780ha
- River Red Gum / Box: Approximate area 1 193ha
- Box (includes Black Box and Inland Grey Box): Approximate area 3 990ha
- Open Plain or Swamp

Koondrook-Perricoota Forest contains up to 150 small wetlands, including Pollack Swamp that offers important bird and fish breeding habitat.

Gunbower Koondrook-Perricoota Forest is provides habitat for more than 210 flora and 143 fauna species. Many of these are listed as threatened under NSW, Victorian and Commonwealth legislation.

The Interim Icon EMP (2007b) identifies the following natural flooding regime which would have occurred in the marsh and forest communities:

Shallow Freshwater Marshes: Shallow freshwater marshes are generally shallow depressions of various forms throughout the forest that retain water as flood levels fall. These wetlands would have naturally been flooded about 6 to 9 years in ten for between 2 - 8 months of the year. These wetting periods would have mostly occurred from winter to early summer when the wetlands would have dried out until the next wet winter rains. A variety of wetland species would have emerged along the edges of the wetlands as waters receded (e.g. *Myriophyllum* spp., Moira grass, Potamogeton etc.). A variety of herbs would be found when these wetlands are dry.

Note: Shallow freshwater marshes have previously been referred to as Semipermanentwetlands at this Icon Site.

River Red Gum Forest: River Red gum forest communities will have received water in around 7-9 years in 10 for 1 to 8 months. They will have been flooded from winter to spring. The main vegetation type in these communities is the River Red Gum with understorey (such as Troglochin, *Elepcharis acuta* and Warrego Summer Grass) which needs flood to survive.

River Red Gum Woodland: These communities receive less frequent flooding than River Red Gum Forest Communities. They are higher up on the floodplain. Naturally, River Red Gum Woodland communities will have received floods around every 4-5 years in 10 and will have been flooded for around 1-2 months when flooding did occur. River Red Gum is the main overstorey vegetation in these communities, with Black Box occurring in the drier end (or higher elevation) of the zone. This community contains an understorey of flood-tolerant species (e.g. Wallaby grass, chenopods, *Carex tereticaulis, Whalenbergia fluminalis, Senecio spp., Helichrysum*)

Black Box: Black Box communities will have only been flooded during larger floods occurring around one in ten years and will have remained flooded for up to one month during these events. These communities will contain an overstorey of Black Box and some flood tolerant woodland trees and an understorey that includes chenopods and terrestrial grasses.

Grey Box: Grey Box communities will have only been flooded during larger floods occurring around 1 in 20 years and will have remained flooded for up to one month during these events. These communities contain both Grey Box and Black Box overstorey with an understorey of chenopods and terrestrial grasses. It is noted that the Grey Box community of the Riverina is listed as an endangered ecological community under NSW Threatened Species Conservation Act.

Current Ecological Condition

The Gunbower-Koondrook-Perricoota River Red Gum forests have evolved around the natural flooding of the Murray River. However, since the early 1900s, the Murray River has been increasingly regulated to provide secure supplies of water for consumptive use and many other uses. This modification to the natural flooding regime has led to a decline in the forest health and productivity (MDBC 2007a).

A survey conducted across the Koondrook-Perricoota Site in 2006 indicated that there had been decline in River Red Gum Health since the previous survey in 2005. Results from the 2006 forest health survey (Turner and Kathuria 2007) indicated that of the River Red Gums:

- 19% were healthy
- 59% were unhealthy
- 22% were severely stressed/dead.

The Black Box and Grey Box stands were generally much healthier than River Red gum stands.

Signs of severe stress have been evident in a large proportion of River Red Gums for several years, including dead and dying limbs, loss of leaf cover, and epicormic growth. There is evidence of tree death across large areas of the Koondrook- Perricoota Forest. This includes large dominant trees, as well as areas of dense regrowth. Only isolated areas were reported to be in a relatively healthy condition (MDBC 2007a). The areas in the poorest condition were primarily in the Koondrook Forest at higher elevations.

Construction Impacts

The main construction impacts to flora and fauna would be through vegetation clearing to construct the structures and earthworks. It is predicted that approximately 90ha of native vegetation will be cleared as part of the upstream channel. Much of the area is sparsely vegetated and seed trees will remain.

It is estimated that the downstream structures, including the levee and floodway, may require the clearing of approximately 110ha of native vegetation. Opportunity exists for the regeneration of trees in some of the areas that are cleared.

The clearing requirements need to be balanced against the overall forest health improvement achieved by the flood enhancement works. As part of the environmental assessment, identification of measures to minimise the impact of the clearing will be identified.

Operational Impacts

The main ecological impacts associated with the project would be beneficial through the restoration of flooding to the forest. This would contribute to overcoming the greatest threat to the Koondrook-Perricoota Forest health, being the current altered water regime due to river regulation.

A 2008 assessment of the ecological outcomes of the proposed works considers the use of a variable flow regime. The assessment was primarily focused on 6 000ML/day inundation,as this will have the greatest influence on the forest.

It is anticipated that the availability of water for environmental flows, in particular the volume required for a large flood event, will only occur in those (wet) years where flooding under natural (unregulated) conditions would have been likely. The timing of a large flood using environmental water is then more likely to trigger breeding in those species that are reliant on seasonal or flooding cues. Initially it is expected that the resultant flood regime will be directed at maintaining and restoring the vegetation communities currently present in the Koondrook-Perricoota Forest and basic wetland processes, which will in turn improve the habitat value and foraging opportunities for a range of wetland-dependant and other regionally important species. This complements the 'high priority' water management options for deep and shallow freshwater marshes in Gunbower Forest that will improve the breeding opportunities for large populations of water birds that traditionally have used the Koondrook-Perricoota Forest to feed.

Ecological benefits of the project are summarised as;

- Delivery of water across a significant area of the Koondrook-Perricoota Forest including communities of River Red Gum, Black Box and shallow freshwater marshes.

- Ability to provide a variety of flows to the forest using existing waterways and swamps, effectively targeting the natural distribution of vegetation communities within the Forest.

- Delivery of water to key habitats that in turn supports recruitment and long-term survival of a variety of species of wetland dependant flora and fauna across the whole forest, as well as those species from adjacent lands that use the forest as a refuge.

- Ability to significantly contribute to breeding and foraging opportunities for waterbirds, fish and other forest dependant fauna.

- Ability to ameliorate other identified threats by improving water and fish passage between the river and floodplain and potential to reduce habitability for introduced species.

- Ability to manage smaller flows that can be used to maintain core wetland areas, or medium flows of variable volume and duration that can be manipulated to either provide a quick fresh across the forest or be drawn out to ensure successful recruitment of wetland species.

- Provision of operational flexibility to manage flows through the downstream regulators so as to provide ecological benefits to the downstream environments of the Barbers Creek and Wakool River system.

There is the risk that by enhancing the ability to flood the forest, that carp and other non-native fish may move from the forest onto the floodplain and breed. The risk associated with carp and potential management measures, require further detailed investigation as part of the environmental assessment process.

There is the potential that water quality issues, such as blackwater events, may impact on aquatic species. The longer the frequency between flooding, the greater the risk of a blackwater event. The management of water quality issues would be investigated as part of the environmental assessment process.

There is risk of fish not being able to exit the floodplain. Therefore the proposed suite of works facilitates fish passage. Fishways will be designed in consultation with the Fish Passage Taskforce to optimise fish passage based on fish biology. Long-term and deep flooding could impact on areas of the Black Box community with extended flooding, however it is considered that this impact is a small risk and of much less risk than not undertaking any action (Gary Rodda, pers comm, 2008).

Summary of Environmental Risks and Benefits

Table 4-1 Summary of environmental benefits and risks of proposed scheme of works and operating strategy.

Ecological Component	Benefits	Risks
Shallow freshwater marshes	o Key breeding areas are inundated for at least 7 months. Others for at least 3 months. o Re-establish wet dry cycle. o Improve habitat quality and structure. o Increase species diversity. o Support successful recruitment of wetland species (flora and fauna). o Connection with river will maintain genetic diversity.	Oxygen depleted waters may retard biofilm development and have harmful (allelopathic) effect on macrophytes.
River red gum forest (Flood dependent understorey (FDU] and flood-tolerant understorey [FTU])	o (FDU) Maximum of 63% watered with at least 50% inundated for 3 months. o (FTU) Maximum of 43% watered, with around 36% inundated for 3 months. o Inundation long enough for positive growth response in established trees. o Create conditions suitable for regeneration and improve chance of seedling survival. o Reduce rates of herbivory in healthy crowns. o Suppress weeds and non-flood tolerant eucalypts with more frequent flooding. o Restrict feral species such as rabbits. o Shallow floodwaters and recharging of soil moisture create conditions suitable for FDU to re-establish, recruit and persist in forest. o Improve habitat quality for other forest dependant fauna, such as woodland birds, mammals, reptiles and amphibians. o Improve foraging opportunities for large numbers of waterbirds that breed across the Icon site. o Maintain sources of water in forest between flood events. o Improved nutrient cycling decomposition of leaf litter.	Depth of flooding at lower end of forest may kill some young seedlings.
Black box woodland	o Maximum of 40% watered with 30% inundated for 3 months. o Create conditions suitable for regeneration. o Improve habitat quality for other forest dependant fauna, such as woodland birds.	Length of flooding may have a negative effect on mature Black box and recruitment if flooded too frequently.
Waterbirds	o Known breeding areas are inundated for at least 7 months (likely to be longer). o Improve habitat quality, including nesting sites and foraging opportunities for invertebrate, fish and herbivorous feeders.	Depth of flooding may increase the lag time before breeding commences in fisheating waterbirds in some areas. Abandonment of young if floodwaters recede too quickly.

Fish	o Reconnect floodplain to river for native fish. o Duration suitable to support fish breeding and spawning on floodplain. o Increased abundance of zooplankton and macro-invertebrates.	Fish death from blackwater event. Fish stranding on floodplain. Breeding of carp and other non-nativefish. Injury caused by regulators and fishways.
Water quality	o Deposition of sediments and nutrients on floodplain, filter incoming water. o Carbon and nutrient exchange with river. o Flexibility of regulators to optimise water quality.	Blackwater event from first and subsequent floods re-entering Murray. Development of blue-green algal bloom event.
Groundwater	Recharge watertable. Lateral movement of water through soil profile to benefit greater area of forest.	Wash some solutes into the river.

4.8 Cultural Heritage

The Koondrook-Perricoota Forest is recognised as having cultural significance for the local Indigenous community (MDBC 2006). The Forest contains numerous Aboriginal sites, providing evidence of a past occupation. Forests NSW maintains a database detailing the location of Aboriginal sites identified within the Forest, however no comprehensive survey of the forest has been undertaken.

A few items of early European settlement are also located throughout the forest, including remains of irrigation schemes, barges and early timber operations (MDBC, 2006).

The Environmental Assessment process will include a detailed cultural heritage study which will cover both indigenous and non-indigenous heritage. Initial consultation has been undertaken with Aboriginal representatives, which has included some on-site inspections.

Construction Impacts

The main aim of the cultural heritage assessment will be to assist in the siting of engineering structures and channels so as to avoid impacting on Aboriginal sites, where possible. The objective will be to avoid cultural heritage sites, however if this is not possible, management of any identified sites will be undertaken in consultation with the local community.

Operational Impacts

Flooding under the proposed operational regime will aim to mimic natural flooding. Therefore the impact to Aboriginal sites (such as scarred trees) would be similar to a natural event. The appropriate management of Aboriginal sites will be recommended by a qualified archaeologist in consultation with the local Aboriginal community.

4.9 Economic

Gunbower-Koondrook-Perricoota Forest represents an important economic resource to the local area. The Forest provides a perpetual and sustainable source of timber that is used for a range of products. Timber production and other forest-based enterprises are a significant source of employment for the towns of Barham and Koondrook. The operation of the Forest is in accordance with ecologically sustainable forest management principles and supports a

range of local industries such as harvesting, hauling, apiary, tourism and processing industries.

Another direct economic outcome provided by the Koondrook-Perricoota Forest is grazing. Grazing of domestic stock is an historical use of the area that acts as an effective bushfire and weed management tool while still providing economic returns for local and regional economies. Stock numbers and the periods of grazing are managed based on the biomass and condition of the desired vegetation.

River Red Gums provide a valuable source of nectar for honey production (apiculture). Honey produced in the region is considered to be of a good quality and quite valuable.

Gunbower-Koondrook-Perricoota Forest provides additional economic benefits through recreation and tourism. These support local industries such as accommodation, local shops, restaurants and tourist based businesses.

At present, local full time equivalent employment numbers 100.5, directly related to local timber production harvesting, local haulage, sawmilling and firewood operations. This figure does not include long distance haulage of product to markets.

Construction Impacts

It is estimated that 80 full-time-equivalent jobs over a year for construction. There is the potential that the project will generate direct employment for nearby towns as a result of the construction activities. Indirect economic benefits may also result due to the demand for local services during the construction period.

Operational Impacts

It is estimated that 2-3 full-time-equivalent jobs over a year for ongoing operation of the Works. The economic value of Koondrook-Perricoota Forest is dependent on its ecological health and therefore improving the forest health will increase the productivity and economic value of the forest, including significant indirect employment benefits to businesses related to timber production, and the recreation and tourism industry.

5 Monitoring and Governance

5.1 Monitoring

As identified in the Interim Icon Site EMP, the responsibility for monitoring of the scheme will be shared by governments, scientists and communities with their involvement determined by the type of monitoring required and the skills and knowledge different groups can provide. The ecological outcomes from the proposed works will be monitored to assess effectiveness in achieving the ecological objectives.

Monitoring will be conducted in an adaptive management context to alter and improve management actions as new data and information becomes available. The monitoring arrangements for The Living Murray have been developed and agreed to ensure consistency in monitoring across all The Living Murray Icon Sites, and where appropriate draw on existing monitoring programs. The focus of The Living Murray monitoring is on fish, birds and vegetation, as these ecological indicators provide an adequate representation of the overall health of the Icon Site. The monitoring data will be used to assess progress against the objectives for the Gunbower-Koondrook- Perricoota Forest (MDBC 2007b).

The types of monitoring relevant to Gunbower-Koondrook-Perricoota Forest Icon Site are:

- Icon Site Condition Monitoring - To determine the change in the environmental condition of the Icon Site resulting from water application and implementation of works programs under The Living Murray Program;
- Intervention Monitoring - To determine the effectiveness of interventions (management actions/watering) in improving environmental condition;
- Compliance Monitoring - To determine if works and water regime have been undertaken as agreed;
- Knowledge generation – To identify and address knowledge gaps and inform the management of risks posed. (MDBC 2007b).

This data, to be gathered from the monitoring, will form part of an adaptive management program for the Koondrook-Perricoota Forest.

Condition Monitoring

Condition Monitoring will be undertaken in accordance with the approved Gunbower-Koondrook-Perricoota Forest Condition Monitoring Plan, currently in preparation. A comprehensive set of surveys will be undertaken including continuation of the crown health assessments and bush bird assessments. Additional surveys will include understorey monitoring and event-based waterbird monitoring.

5.2 Project Governance

The Department of Water and Energy NSW (DWE) is the delivery agency in NSW for the Living Murray Environmental Works and Measures Program (EWMP). Along with having responsibility for the delivery of the EWMP program it is DWE's role to ensure that the water being used by the works is done so consistent with NSW legislation and policy.

Forests NSW – a government trading enterprise of the NSW Department of Primary Industries - is the land custodian/owner of the Koondrook-Perricoota Forest. Forests NSW's role is to refine the objectives that will maximise the benefit of the delivery of the water to the forest.

The Department of Environment and Climate Change (DECC) is the NSW environmental water manager.

State Water Corporation – is the agency responsible for the bulk delivery of water and the construction authority for the proposed works in NSW. The operational activities associated with day-to-day operations may be sub-contracted to other organisations.

The Living Murray Initiative: The Murray-Darling Basin Committee coordinates the allocation of regulated Living Murray water to states in the Murray-Darling Basin. The Department of Water and Energy control water distribution within NSW and is primarily responsible for the licensing and operation of water regulatory structures in NSW. The Environmental Watering Group prioritise the allocation of Living Murray Water. The Icon Site watering is currently managed as per the Living Murray Environmental Management Plan for the Gunbower-Koondrook-Perricoota Forest.

Integrated Coordinating Committee

An Integrated Coordinating Committee has been established, to which a Technical Advisory Committee and Community Reference Group reports. An Indigenous Reference Group is also being established and will report to the Integrated Coordinating Committee.

Operation and Maintenance

State Water is NSW's rural bulk water delivery corporation. State Water will be responsible for the physical operation of the works and the management and maintenance of the structures.

Environmental Water Management

The Department of Water and Energy, as a controller of water distribution within NSW, will be responsible for project direction, water accounting and determining the allocation of water available for the works.

Delivery of environmental water to the Icon Site will be coordinated through the Living Murray Environmental Watering Plan. On-site water management will be directed through the operational plans, which will be included in the Icon Site Plan for the site.

Monitoring and Adaptive Management

DPI (Forests NSW) will be responsible for monitoring during operation of the proposed works. A detailed monitoring and evaluation plan is being developed by DPI (Forests NSW) in conjunction with MDBC. This will measure long-term site condition and changes in environmental condition of individual Icon Sites resulting from the Living Murray water application and works programs. The monitoring program will ensure that the response to the artificial flooding can be distinguished from seasonal or climate influences.

6 Conclusion / Project Justification

6.1 Project Justification

The Koondrook-Perricoota Forest is acknowledged as a significant ecological asset. It has been identified as an Icon site as part of the Living Murray program. A large portion of the River Red Gums within Koondrook-Perricoota Forest are showing signs of severe stress. Only 19% of the River Red Gum population within the forest are considered healthy. The proposed Koondrook-Perricoota Flood Enhancement Works have been designed to reinstate the critical process of flooding for forest health. The scheme will be operated to mimic as best as possible and feasible a natural flood regime and will attempt to overcome the adverse ecological impacts which have resulted from river regulation.

The proposed scheme is capable of achieving inundation of up to 52% of the forest and maintaining inundation across 41% of the forest, with this quickly reducing during a flood recession. This meets the Environmental Management Plan's (EMP's) interim objective of maintaining 30% of River Red Gum forest in healthy condition.

Watering the forest will enhance the ecological processes on which the forest depends. Flooding will fill semi-permanent wetlands and allow the passage of native fish into the forest and wetland areas to breed. This will provide the necessary breeding trigger for colonial waterbirds with the forest able to provide essential habitat and food requirements.

The key aim of this project is to provide an adequate water regime to a representative area of the Koondrook-Perricoota Forest that has, or historically supported, a water dependant understorey. The design of the scheme provides the flexibility to operate within a range of flows. This ensures that it can deliver effective and measurable environmental outcomes across a broad range of available water.

The restoration of a natural flooding regime is required to meet the interim ecological objectives established for the Koondrook-Perricoota Forest. Unless action is taken to restore extensive flooding to the Koondrook-Perricoota Forest, the ecological condition of the NSW component of the Gunbower-Koondrook-Perricoota Forest Icon Site will continue to decline. Without the proposed works, low to medium floods are predicted to occur, however these will not be able to provide the necessary frequency, volume or duration of flows to provide for the water requirements of significant areas of the forest. The proposed works are the most effective means of achieving inundation and forest health to meet the objectives for the site, while optimising water use efficiency and also maximising return of flows to the Murray River.

Maintaining the ecological health of the forest is essential for retaining the cultural, social and economic values for which Gunbower-Koondrook-Perricoota Forest is recognised.

6.2 Conclusion

This preliminary assessment has been prepared to support the Major Projects Application for the Koondrook-Perricoota Flood Enhancement Works under Part 3A of the EP&A Act. The document presents a preliminary outline of the proposal and an overview of the potential environment impacts in order to assist the Director General of the Department of Planning in determining the level and scope of the environmental assessment requirements.

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