Amendment date: 28 June 2017

	Title of measure	**Nyah Floodplain Management Project**
	Proponent undertaking the measure	**Victoria**
	Type of measure	**Supply**
1.	**Confirmation**	
	Date by which the measure entered into or will enter into operation *Must be before 30 June 2024*	This environmental works project will be operational by 30 June 2024.
	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.
	Confirmation that the proponent state(s) undertaking the measure agree(s) with the notification ***Basin Plan 7.12(3)(c)***	Yes.
2.	**Details of the measure**	
	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*	Yes.
3.	**Description of the works or measure**	
	The works will water almost 500 hectares of floodplain within Nyah Forest, replicating River Murray flows of up to 25,000 ML/day. The works will influence over 53% of the total forest area and almost all of the flood dependent communities. The works consist of four regulators, three on the downstream end of Parnee Malloo Creek and one on the upstream end. Additional works to contain water within the forest include 1,648 metres of low level track raising, forming a levee at the downstream end of the forest. A detailed description of the proposed works package is included in Chapters 3.2 and 12 of the business case **(Attachment B)**.	
4.	**Geographical location of the measure**	
	The Nyah Floodplain Management Project is located in the Nyah Vinifera Regional Park on the western bank of the River Murray, 30 km north of Swan Hill. This floodplain includes 913 hectares of wetland, forest and woodland areas.	
5.	**Representation of the project in the MDBA modelling framework**	
	The MDBA will represent the proposed infrastructure, operating strategies and water use in the MSM-BigMod model. A schematic of the model representation is shown at **Attachment A**. Spatial data provided by the proponent (derived using a hydro-dynamic model) describes the areas inundated through the operating of the works. The areas inundated are combined with the timing of modelled operation by the Environmental Outcomes Scoring Tool to quantify the change in environmental outcomes, relative to the Benchmark environmental outcomes. This site has been modelled as a weir pool storage with flow dependant travel times so backwater impact can be captured depending on operation of the proposed regulator. There is some information available from the report on hydraulic model used. Based on this, MDBA has driven further relationships as below.	

Water pooled by raising the regulator downstream		
Level (mAHD)	Volume (ML)	Area (ha)
61.4	0	0
62.5	858	203
62.7	1350	313
62.9	1710	385
63.2	3390	558
63.3	3420	582

Water pooled without raising the regulator downstream		
inflow (ML/d)	Area (ha)	Travel time (day)
163	525.0	3.0
191	630.0	4.5
294	964.8	2.0
1445	2806.4	1.2
2450	3911.9	1.0
3456	4767.0	0.7
5387	5635.9	0.2
6507	6307.9	1.0
7000	6800.9	1.0

Interaction between river flows and site inflows

There is no existing representation of this project site in MSM-Bigmod. Therefore there is one new branch relationship developed to describe natural hydrologic characterises to the site depending on river flows downstream of Swan Hill. Details shown in table below.

DS Swan Hill (ML/d)	Flow to Site (ML/d)
10000	0
12500	1
15000	163
17500	191
20000	294
22500	1445
25000	2450
27500	3456
30000	5387
32500	6507
35000	7000

Return flow from site to the river

Once inflows to the site are calculated, the model applies hydrologic routing to calculate level, volume and inundation for the floodplain storage area within the site. For a weir storage, given inflow from a branch (Table 2), flow behaviours are calculated by flow-level relationship at downstream of the weir. Using this information, the model calculates storage volume or water level so that downstream level is lower than or equal to the weir pool level. For this, the following relationships have been drawn, by the MDBA, from the hydrodynamic model (as developed by Jacobs for the MCMA).

Flow (ML/d)	Level (mAHD)
163	62.4
191	62.7
294	62.9
1445	63.3
2450	63.4
3456	63.5
5387	63.6
6507	63.7
7000	63.75

Surface water loss relationships

As part of developing the site based hydraulic model, no seepage loss rate has been applied for the site. However, a constant rate of 2 mm/day has been applied by MSM-Bigmod for consistency with other sites. Evaporation and rainfall are calculated using daily data from Lake Hume climate stations.

6. Representation of each operating strategy in the MDBA modelling framework.

In the case of measures involving floodplain environmental work, Criteria 6 of the Notification requires the proponent to outline information on the rate/volume, timing and volume of inflows required to support the proposed operating regimes. Chapter 9 of the Business Case (which is included as an attachment to the Notification) outlines a series of proposed operating regimes. From this information, Table 5 has been developed for model representation of the works operation.

Operating strategy	Flow to start operation (ML/d)	Regulator status	Duration	Optimal frequency	Resilience period (yr)	Natural equivalent flow (ML/d)
Fresh[1]	15,000	Fully open	-	-	-	15,000
Intermediate[2]	17,500	Maintain at 63.2 mAHD	4 months	8 in 10	3	20,000
Maximum[2]	20,000	Maintain at 63.2 mAHD	2 months	1 in 3	4	25,000

[1] Not included in the model as there is no additional benefit from current regimes.

[2] These operations are always piggybacking on natural overbank events and close regulators at their recession to manage inundation duration. Therefore only one operational mode (advantageous watering) has been modelled so that the works are operated always at the back of overbank flow events. Their frequencies are modelled to operate at every opportunity for the intermediate strategy and every second opportunity for the maximum strategy.

7. 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)
Nyah Fresh	28
Nyah Intermediate (NYI)	366
Nyah Maximum (NYM)	487

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 the tables below the areas represent the inundation area that is additional to the area already inundated by a nested work. If NYM is operated, the inundation areas associated with the operation of NYI are also inundated. Figures in the NYM table below show the additional area the NYM operation would inundate.

Inundation area (ha) for NYF	SFI Flow Bands				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	3.0	1.0	0.0	28.0
Bitterns, crakes and rails	0.0	3.1	0.8	0.2	26.3
Breeding – Colonial-nesting waterbirds	0.0	3.0	1.0	0.0	28.0
Breeding – other waterbirds	0.0	3.1	0.8	0.2	26.3
Redgum Forest	0.0	3.2	0.5	0.2	27.5
Redgum Woodlands	0.0	0.0	0.1	0.0	0.1
Forests and Woodlands: Black Box	0.0	0.0	0.2	0.0	0.4
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	3.1	0.8	0.2	26.3
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	3.1	0.8	0.2	26.3
Long lived fish	0.0	3.0	1.0	0.0	28.0

Inundation area (ha) for NYI	SFI Flow Bands				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	3.0	1.0	0.0	330.0
Bitterns, crakes and rails	0.0	0.3	0.0	0.0	13.2
Breeding – Colonial-nesting waterbirds	0.0	3.0	1.0	0.0	330.0
Breeding – other waterbirds	0.0	0.3	0.0	0.0	13.2
Redgum Forest	0.0	3.4	0.7	0.3	316.7
Redgum Woodlands	0.0	0.0	0.0	0.0	3.3
Forests and Woodlands: Black Box	0.0	0.0	0.0	0.0	8.5
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	0.3	0.0	0.0	13.2
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	0.3	0.0	0.0	13.2
Long lived fish	0.0	3.0	1.0	0.0	330.0

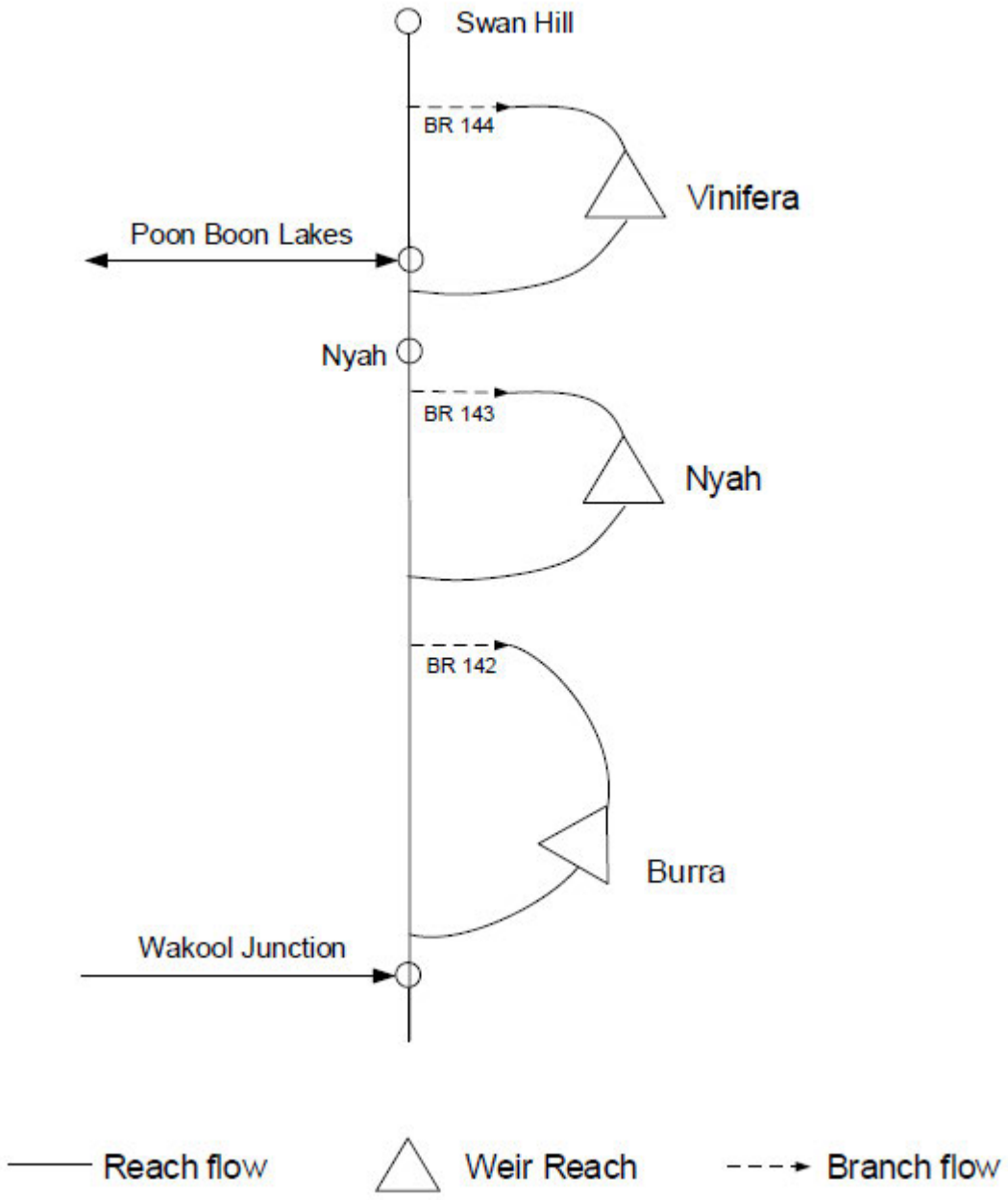
Inundation area (ha) for NYM	SFI Flow Bands				
Ecological Element	**16,000**	**20,000**	**30,000**	**40,000**	**>40,000**
General health and abundance – all Waterbirds	0.0	0.0	0.0	0.0	121.0
Bitterns, crakes and rails	0.0	0.0	0.0	0.0	11.4
Breeding – Colonial-nesting waterbirds	0.0	0.0	0.0	0.0	121.0
Breeding – other waterbirds	0.0	0.0	0.0	0.0	11.4
Redgum Forest	0.1	0.2	0.1	0.0	105.5
Redgum Woodlands	0.0	0.0	0.0	0.0	2.1
Forests and Woodlands: Black Box	0.0	0.0	0.0	0.0	12.8
Lignum (Shrublands)	0.0	0.0	0.0	0.0	0.0
Tall Grasslands, Sedgelands and Rushlands	0.0	0.0	0.0	0.0	11.4
Benthic Herblands	0.0	0.0	0.0	0.0	0.0
Short lived fish	0.0	0.0	0.0	0.0	11.4
Long lived fish	0.0	0.0	0.0	0.0	121.0

8.	**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 supplying measures. The identification of affected units does not constitute an agreement between juristictions on apportioning the supply contribution, which will be required in coming months.
9.	**Details of relevant constraint measures**
	Not directly linked to any specific constraint measures but implementing a confirmed package of constraint measures may have implications for the proposed operating strategy.

Attachments:

A	MDBA	Nyah floodplain management project representation in Murray model
B	Mallee CMA, December 2014	Phase 2 Assessment Supply Measure Business Case: Nyah Floodplain Management Project

Attachment A: Nyah floodplain management project representation in Murray model (based on Bigmod Rev. 266)



Sustainable Diversion Limit Adjustment

Phase 2 Assessment

Supply Measure Business Case:

Nyah Floodplain Management Project

Executive Summary

The *Nyah Floodplain Management Project* is a proposed supply measure that is designed to off-set water recovery under the Murray-Darling Basin Plan by achieving equivalent or better environmental outcomes on the ground. The Victorian Government's long standing position is that efficient environmental watering is critical to the long-term success of the Basin Plan.

This view is based on the understanding that engineering works like flow control regulators, pipes and pumps can achieve similar environmental benefits to a natural flood, using a smaller volume of water to replenish greater areas. Works also allow for environmental watering in areas where system constraints prevent overbank flows and, due to the smaller volumes required, can be used to maintain critical refuge habitat during droughts.

This project is one of several proposed by the Victorian Government as having the potential to meet the Basin Plan's environmental objectives through smarter and more efficient use of water.

The *Nyah Floodplain Management Project* (the Project*)* is located in the Nyah Vinifera Regional Park on the western bank of the River Murray, 30 km north of Swan Hill in northwest Victoria. This floodplain includes 913 ha of wetland, forest and woodland areas and encompasses an elongated basin that is drained by Parnee Malloo Creek, a seasonal anabranch of the River Murray.

The Park is dominated by an imposing river red gum forest interspersed with broad wetland depressions, fringed by black box communities on the higher, terrestrial part of the floodplain. Floods promote the growth of river red gum and wetland communities which provide the physical habitat and food sources for native fauna. Flood waters draining from the forest support the river channel ecosystem with organic matter and mineral nutrients.

Nyah is a low-lying floodplain area that was reliably inundated in spring under natural (without regulation) flow conditions. River Murray flows of 25,000 ML/d occurred on an annual basis, inundating most of the forest. Changed river operations has resulted in a decline in the condition and productivity of the floodplain due to the reduced flood frequency and durations.

The Project will provide infrastructure to better control the frequency and duration of inundation to reinstate a watering regime matched to the ecological requirements of the significant vegetation and fauna at Nyah Park. The proposed works involve regulators to be constructed at both ends of Parnee Malloo Creek and track raising to enable control of both flood and pumped flows into and out of the creek. This project provides the opportunity to reverse condition decline across the floodplain and deliver significant benefits to improve habitat for the diversity of species.

The proposed works will provide inundation of almost 500 hectares of inundation-dependant habitat with a water level of 63.2 m AHD. Analysis of the inundation flow equivalences (Jacobs, 2014) shows that the proposed works will replicate the flood extent of River Murray flows of up to 25,000 ML/day, which is the interface of the floodplain and terrestrial environments. The proposed works allow for this inundation area to be achieved at much lower River Murray flows (GHD 2014, Alluvium 2013a).

This project will build upon the benefits of Basin Plan flows by improving the frequency and duration of inundation to achieve the environmental water requirements of Nyah Park. The works can be operated flexibly to meet the different water regimes of the various vegetation communities found within the part. As an example, the inundation frequency of the Red Gum Swamp Forest community will increase from 7 to 9 events in 10 years and the duration of inundation from 93 to 120 days, compared to Basin Plan.

Under a restored water regime, the wetland and flooded forest areas will provide dependable refuge and breeding habitat for aquatic fauna and waterbirds. The site's environmental values have been used to inform

the development of ecological objectives and targets, allowing the project to measure progress toward its expected outcomes.

A broad level of community support exists for this project, which is the result of working directly with key stakeholders and community members to ensure the integration of local knowledge and advice into the project. Stakeholders materially affected by the *Nyah Floodplain Management Project* such as Parks Victoria, have provided in-principle support for the progression of the project. Support has also been gained from a number of individuals, groups and organisations central to the project's success, including adjacent landholders, Aboriginal stakeholders and community groups.

Further confidence in the success of this project can be taken from the extensive knowledge, skills, experience and adaptive management expertise of the agencies involved in the development of this project. This is evidenced by more than a decade of environmental water delivery and successful construction and operation of environmental infrastructure projects that have delivered measurable ecological benefits across the region.

The *Nyah Floodplain Management Project* has been developed by the Mallee Catchment Management Authority (CMA), on behalf of the Victorian Government, and in partnership with the Department of Environment and Primary Industries, Parks Victoria and Goulburn-Murray Water, through funding from the Commonwealth Government.

Project risks have been comprehensively analysed and are well known. They can be mitigated through established management controls that have been successfully applied to previous watering projects by the Mallee CMA and partner agencies, as well as the Murray-Darling Basin Authority (MDBA), Commonwealth and Victorian Environmental Water Holders. The adoption of these standard mitigation measures minimise the risks associated with the implementation of this project.

Project costs that will be subject to a request for Commonwealth Funding total $10,942,589 in 2014 present value terms. Victoria is seeking 100 per cent of these costs from the Commonwealth. In terms of project benefits, the value of water savings is not estimated within this business case.

This business case presents the cost to fully deliver the project (i.e. until all infrastructure is constructed, commissioned and operational), including contingencies. Cost estimates for all components in this proposal are based on current costs, with no calculation undertaken of future cost escalations. To ensure sufficient funding will be available to deliver the project in the event that it is approved by the Murray-Darling Basin (MDB) Ministerial Council for inclusion in its approved Sustainable Diversion Limit (SDL) Adjustment Package to be submitted to the MDBA by 30 June 2016, cost escalations will be determined in an agreed manner between the proponent and the investor as part of negotiating an investment agreement for this project.

Contents

Acronyms

AEM	Airborne Electromagnetic datasets
AH Act 2006	*Aboriginal Heritage Act 2006* (Vic)
ANCOLD	Australian National Committee on Large Dams
ARG	Aboriginal Reference Group
AS/NZS ISO 31000:2009	Australia and New Zealand Risk Management Standard 2009
BSMS	Basin Salinity Management Strategy
CEMP	Construction Environmental Management Plan
CEWH	Commonwealth Environment Water Holder
CFA	Country Fire Authority
CHMP	Cultural Heritage Management Plan
CMA	Catchment Management Authority
CPI	Consumer Price Index
CRG	The Living Murray Community Reference Group
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CWA	Country Women's Association
DEPI	Department of Environment and Primary Industries
DO	Dissolved Oxygen
DTF	Department of Treasury and Finance
EE Act 1978	*Environmental Effects Act 1978* (Vic)
EMP	Environmental Management Plan
EPBC Act 1999	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EVC	Ecological Vegetation Class
EWMP	Environmental Works and Measures Program
FERC	Federal Energy Regulatory Commission
FFG Act 1988	*Flora and Fauna Guarantee Act 1988* (Vic)
G-MW	Goulburn-Murray Water
GST	Goods and Services Tax
IGA	Intergovernmental Agreement on Murray-Darling Basin Water Reform 2014
ISO	International Organisation for Standardisation
LWAC	Land and Water Advisory Committee
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MER	Monitoring, Evaluation and Reporting
MERI	Monitoring, Evaluation, Reporting and Improvement
MLDRIN	Murray Lower Darling Rivers Indigenous Nations
MNES	Matters of National Environmental Significance
NP Act 1975	*National Parks Act 1975* (Vic)
NSW	New South Wales
OPBR	Office of Best Practice Regulation
OH&S	Occupational Health and Safety
O&M	Operations and Maintenance
PCB	Project Control Board
PE Act 1987	*Planning and Environment Act 1987* (Vic)
PMBOK	Project Management Body of Knowledge
PPE	Personal Protective Equipment
RiMFIM	River Murray Floodplain Inundation Model
RGG	Regulatory Governance Group
SA	South Australia
SDL	Sustainable Diversion Limit

TEV	Total Economic Value
TLM	The Living Murray
TSMP	Threatened Species Management Plan
USBR	United States Bureau of Reclamation
VEAC	Victorian Environmental Assessment Council
VEWH	Victorian Environment Water Holder
VMIA	Victorian Managed Insurance Authority
WRP	Water Resource Plan
WTP	Willingness to Pay

Abbreviations

Basin	Murray-Darling Basin
Basin Plan	The Murray-Darling Basin Plan adopted by the Commonwealth Minister under section 44 of the Water Act 2007 (Cth) on 22nd November 2012
Guidelines	Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases
H	Horizontal
mnths	Months
No.	Number
N/A	Not applicable
temp	Temperature
V	Vertical
VIC	Victoria
4WD	Four wheel drive

Units

cm/day	Centimetres per day
EC	Electrical conductivity
GL	Gigalitres
ha	Hectares
km	Kilometres
m AHD	Elevation in metres with respect to the Height Datum
m/s	Metres per second
ML	Megalitres
ML/d	Megalitres per day
m	Metres
mm	Millimetres
mS/cm	Millisiemens per centimetre
µS/cm	Microsiemens per centimetre
$M	Million dollars

1. Introduction

1.1. Context

The *Nyah Floodplain Management Project* is a low risk proposal that will deliver a high magnitude of environmental benefits, meeting the outcomes and stated objectives of the Basin Plan.

This Business Case for the *Nyah Floodplain Management Project* has been developed in accordance with the Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases. This project is one of nine proposed works-based supply measures within Victoria, and one of seven within the Mallee Catchment Management Authority (CMA) region including:

- Lindsay Island
- Wallpolla Island
- Hattah Lakes North
- Belsar-Yungera Floodplain Complex
- Burra Creek
- Nyah Park and
- Vinifera Park.

These measures will work in conjunction with proposed altered river operations and existing environmental infrastructure to deliver the environmental outcomes of the Basin Plan, using much lower volumes of water. Figure 1-1 provides a conceptual overview of the distribution of sites across the Mallee CMA region and the longitudinal connection to the lower Murray region.

1.2. Forest overview

The *Nyah Floodplain Management Project* is located in the Nyah-Vinifera Park on the western bank of the River Murray 30 km north of Swan Hill, between Nyah and Wood Wood (Figure 1-2).

The Nyah floodplain forms an elongate basin aligned parallel to the River Murray. The basin is bounded by the terrestrial landscape to the west and the natural levee of the River Murray to the east. The basin is drained by a central watercourse, Parnee Malloo Creek, into which back water enters the downstream end at moderate River Murray river flows. At higher river flows (12,500 ML/d) the upstream connection of the creek becomes active and through-flow commences. The floodplain has an area of 907 ha.

Lying near the western limit of the Murray Fans bioregion, the floodplain is one of the most downstream areas of the central river red gum forests which include Barmah-Millewa, Gunbower-Koondrook-Perricoota, Werai, Campbells Island, Guttrum and Benwell. These communities provide complex physical habitats and are highly productive. Several fauna species common in this bioregion are at the downstream limit of their range at Nyah including the sugar glider and black wallaby. The forests support breeding by colonial nesting waterbirds and provide habitat for woodland fauna that require dense and productive understorey (Ecological Associates 2014a).

The floodplain includes wetlands in floodplain depressions adjacent to Parnee Malloo Creek. Under a natural flow regime, these wetlands would have been flooded almost annually and frequently remained flooded throughout the year. Persistent annual flooding would have excluded trees and supported a community of marshland plants including spiny mudgrass (*Pseudoraphis spinescens*). Growling grass frog (*Litoria raniformis*), Murray-darling rainbow fish (*Melanotaenia fluviatilis*) and other aquatic species that depend on permanent aquatic habitat would have expanded from these refuges into the forest understorey during spring floods.

Growling grass frog (Clare Mason)

1.3. Land tenure

The *Nyah Floodplain Management Project* is located entirely within Crown Land. The former Nyah State Forest became part of the Nyah Vinifera (Regional) Park in 2010 in recognition of its conservation values and its outstanding range and concentration of Aboriginal cultural heritage sites (VEAC 2008).

The Park is currently managed by Parks Victoria. It is expected that in future, there will be co-management between the Wadi Wadi community, Parks Victoria and Department of Environment and Primary Industries (DEPI).

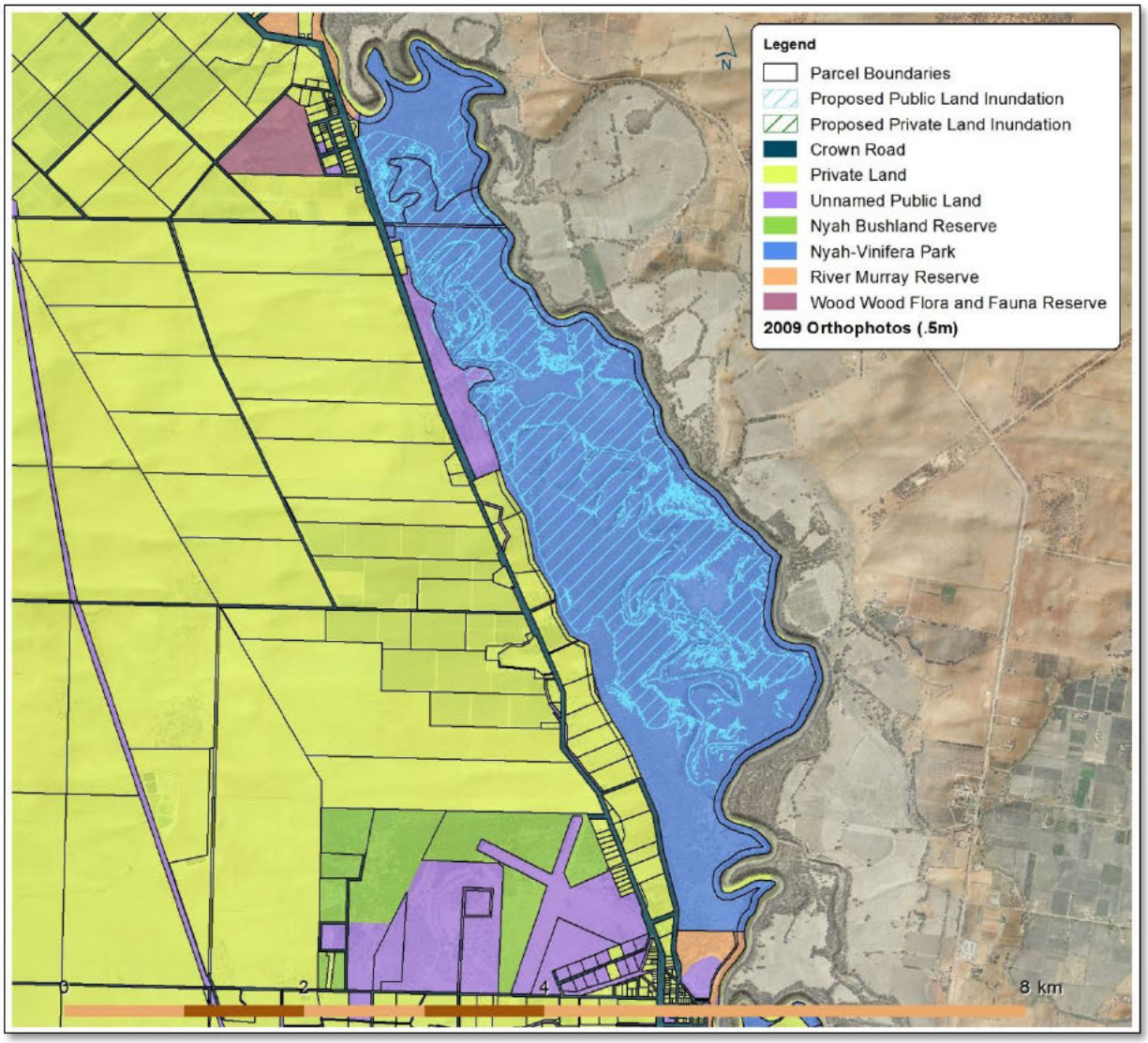


Figure 1-1: Land tenure in Nyah Park

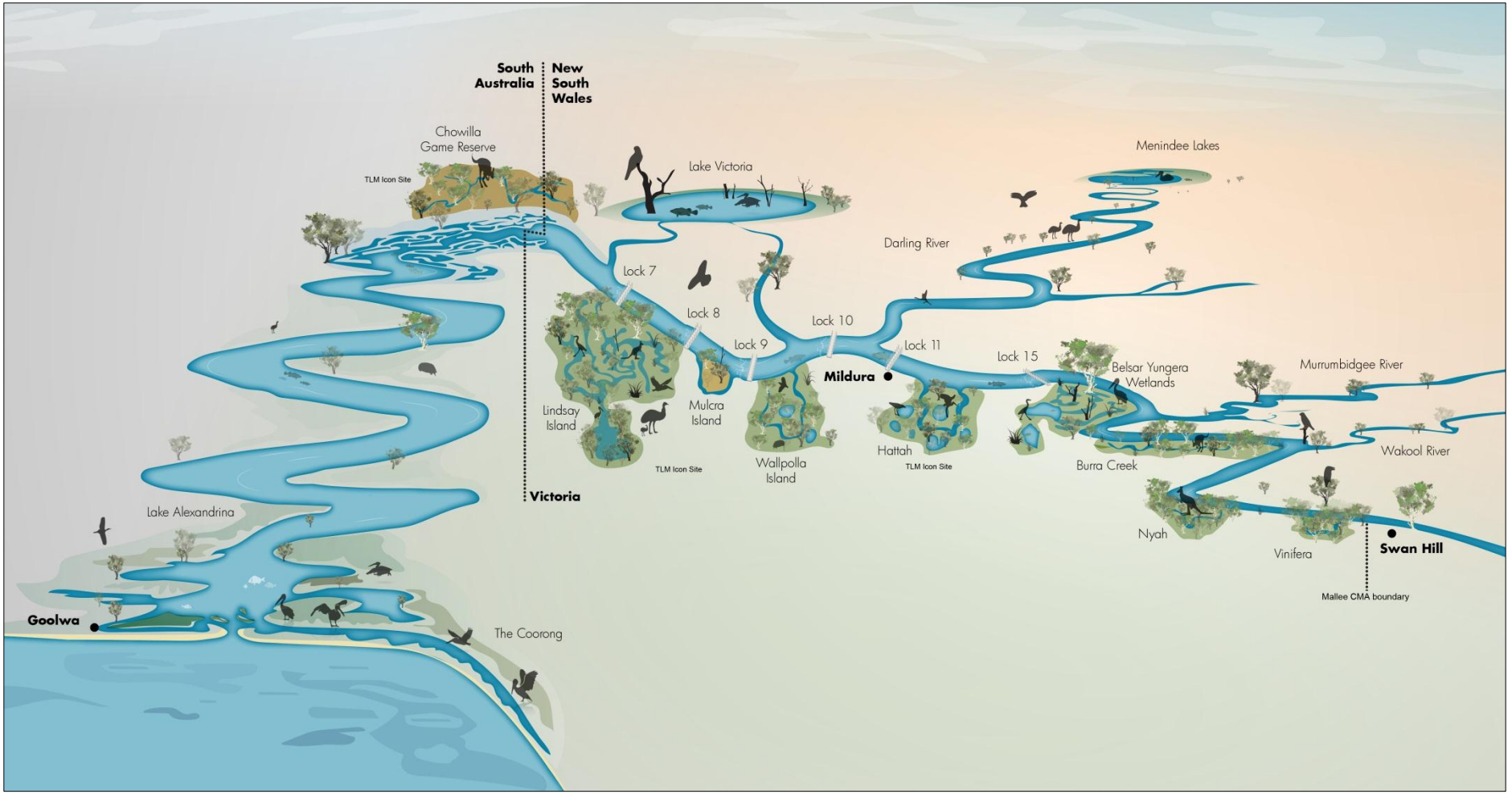


Figure 1-2: Distribution of proposed supply measure sites across the Mallee CMA region (Vinifera, Nyah, Burra Creek, Belsar-Yungera, Hattah (North), Wallpolla, Lindsay Island) and TLM EWMP sites (Hattah Lakes, Mulcra Island, Chowilla Game Reserve and parts of Lindsay Island); diagram is not to scale

1.4. The proposal

A range of options have been investigated to address the changes to hydrology to achieve defined ecological objectives. Feasibility, cost-effectiveness and ability to meet objectives have been considered in the analysis of all options. This has resulted in the development of environmental works and measures that optimises costs, achieves the ecological objectives for Nyah and provides a hydrological regime that meets the requirements of the indigenous fauna and flora.

The Nyah works consist of four regulators, three on the downstream end of Parnee Malloo Creek and one on the upstream end. Additional works to contain water within the forest include 1,648 m of low level track raising, forming a levee at the downstream end of the forest. A detailed description of the proposed works package is included in Sections 3.2 and 12 of this business case.

The works will reinstate an appropriate water regime to 488 hectares of inundation dependent habitat. This represents 53% of the total forest area and almost all of the flood dependent communities found within the forest.

The overall objective of water management at Nyah Park is:

"*to restore the key species, habitat components and functions of the Nyah Park ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities*".

This will be achieved by:

- restoring the vegetation structure of wetland plant communities
- re-establishing resident populations of frogs and small fish
- providing seasonal feeding and reproductive opportunities for riverine fish species
- providing reliable breeding habitat for waterbirds, including colonial nesting species
- restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler and
- contributing to the carbon requirements of the River Murray channel ecosystem.

A representation of the planned works and inundation at Nyah is shown in Figure 3-3. For ease of reference, a fold-out map of the proposed project is also included as Appendix A to provide a spatial representation of the planned works discussed in this document.

1.5. Project development

The feasibility study and business case for the *Nyah Floodplain Management Project* have been developed by the Mallee CMA, on behalf of the Victorian Government, and in partnership with DEPI, Parks Victoria and Goulburn-Murray Water, through funding from the Commonwealth Government.

This proposal draws on a decade of collective experience from all project partners in the construction of large-scale environmental works and measures programs and environmental water delivery in the Mallee region. A recent example of collaborative work successfully delivered by this team includes the $32 million Living Murray environmental infrastructure project at Hattah Lakes. A project that delivered environmental water to more than 6000 hectares of Ramsar lakes and floodplain.

1.6. Project stakeholders

The Mallee CMA has worked with key stakeholders and interested community groups to develop the concept for the Nyah project over an extended period of time from 2012 to 2014. Consultation has been undertaken with Aboriginal stakeholder groups, land managers, key partner agencies, and targeted community groups. The project has high visibility among adjacent landholders/managers, along with Aboriginal stakeholders and

other interested parties to ensure the advice and concerns of those involved have been considered and responded to accordingly a detailed Communication and Engagement Strategy has been developed and implemented for this project. This strong commitment to working directly with project partners and the community will be ongoing throughout the construction and implementation phases of the project, further cementing community support for the Nyah Floodplain project and ensuring it will continue to be a successful project.

Carpet python

2. Eligibility (Section 3.4)

Victoria considers that this supply measure meets the relevant eligibility criteria for Commonwealth supply measure funding.

In accordance with the requirements of the Murray-Darling Basin Plan, Victoria confirms this is a new supply measure, additional to those already included in the benchmark assumptions under the Plan.

Pending formal confirmation of off-set potential, the operation of this measure is expected to:

- increase the quantity of water available for consumptive use
- provide equivalent environmental outcomes with a lower volume of held environmental water than would otherwise be required under the Basin Plan and
- be designed, implemented and operational by 30 June 2024.

This business case demonstrates in detail how each of the above criteria is met.

Other than the provision of financial support to develop this business case, this proposal is not a 'pre-existing' Commonwealth funded project, and it has not already been approved for funding by another organisation, either in full or in part.

Nyah Park during high River Murray flows (2011)

3. Project Details (Section 4.1)

3.1. Description of proposed measure, including locality map

The *Nyah Floodplain Management Project* is a proposed supply measure project located on the River Murray floodplain, 30 km north-west of Swan Hill, in northwest Victoria (Figure 3-1).

In accordance with the Phase 2 Assessment Guidelines, this project falls within the category of environmental works and measures at point locations.

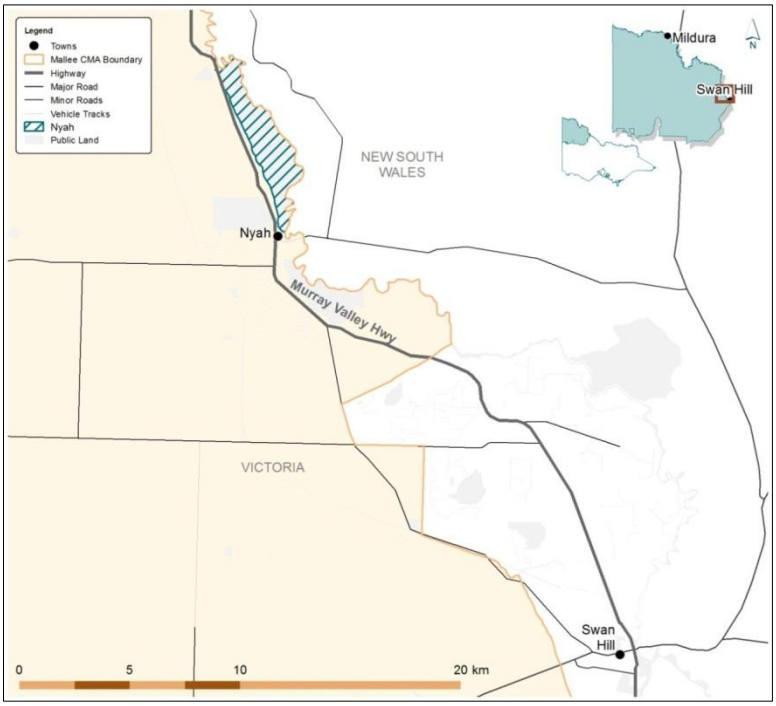
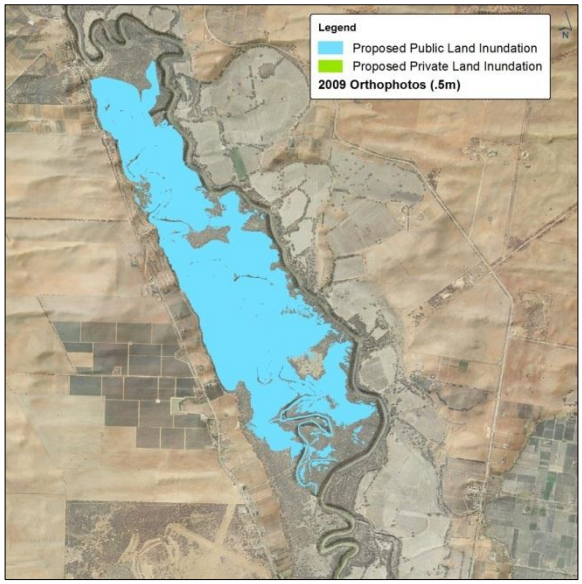


Figure 3-1: Location on of the Nyah Floodplain Management Project

The purpose of this project is to increase the frequency and duration of inundation to reinstate a watering regime matched to the ecological requirements of river red gum and other significant vegetation and fauna at Nyah Park. This will require regulating structures and temporary pumping (in the absence of suitable River Murray flows) to provide a more natural inundation regime.

The project can flood over half of the forest to a water level of 63.2 m AHD, requiring a volume of 2,797 ML. Analysis of the inundation flow equivalences (Jacobs, 2014) shows that the proposed works will replicate inundation flows up to 25,000 ML/d at the site (Figure 3-2).

(a)



(b)

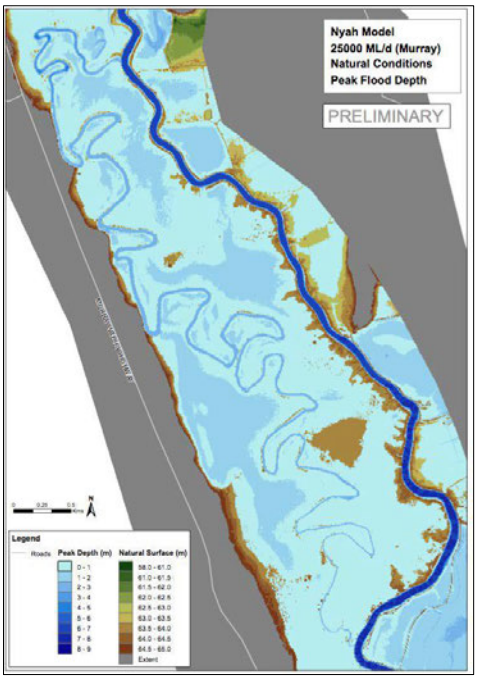


Figure 3-2: Comparison of (a) project flooding footprint against (b) the corresponding River Murray flow of 25,000 ML/d (from Ecological Associates 2014a)

3.2 Environmental Works and Measures at Point Locations

The proposed package of works for Nyah Park have been designed to:

- allow water movement in and out of Nyah Park on a natural flow, as well as
- meet targets for flood duration and frequency using flow detention and regulating structures.

Water will be detained in the floodplain basin by a combination of regulating outflows and levees to the north as summarised below.

The primary component of the works is three box regulators (N1a, N1b and N2) and a stop bank (levee) with overflow sills near the downstream river connection of Parnee Malloo Creek. The bank will be created by raising an existing track to retain water at a level of up to 63.2 m AHD. The regulators will be installed in the bank to allow through-flow in the creek and to manage water levels.

A fourth piped regulator (N5) is required at the upstream entrance of Parnee Malloo Creek to maintain the ponded area.

Minor works are also required at effluents along the river levee to prevent the escape of water. The works include constructing a short length of levee (340 metres) and overflow sills using the existing river track.

The works also include decommissioning of former irrigation infrastructure (site N4) including two blockages and an overflow bypass on Parnee Mallee Creek.

These structures will enable inundation of the floodplain to be extended following inflows from natural floods or pumping, and will maintain access during watering events.

The location of these works within the Park are shown in Figure 3-3 below.

An overview of the key elements of the proposed works package is provided in Table 3-1 below. A more detailed description of the works is provided in section 12.

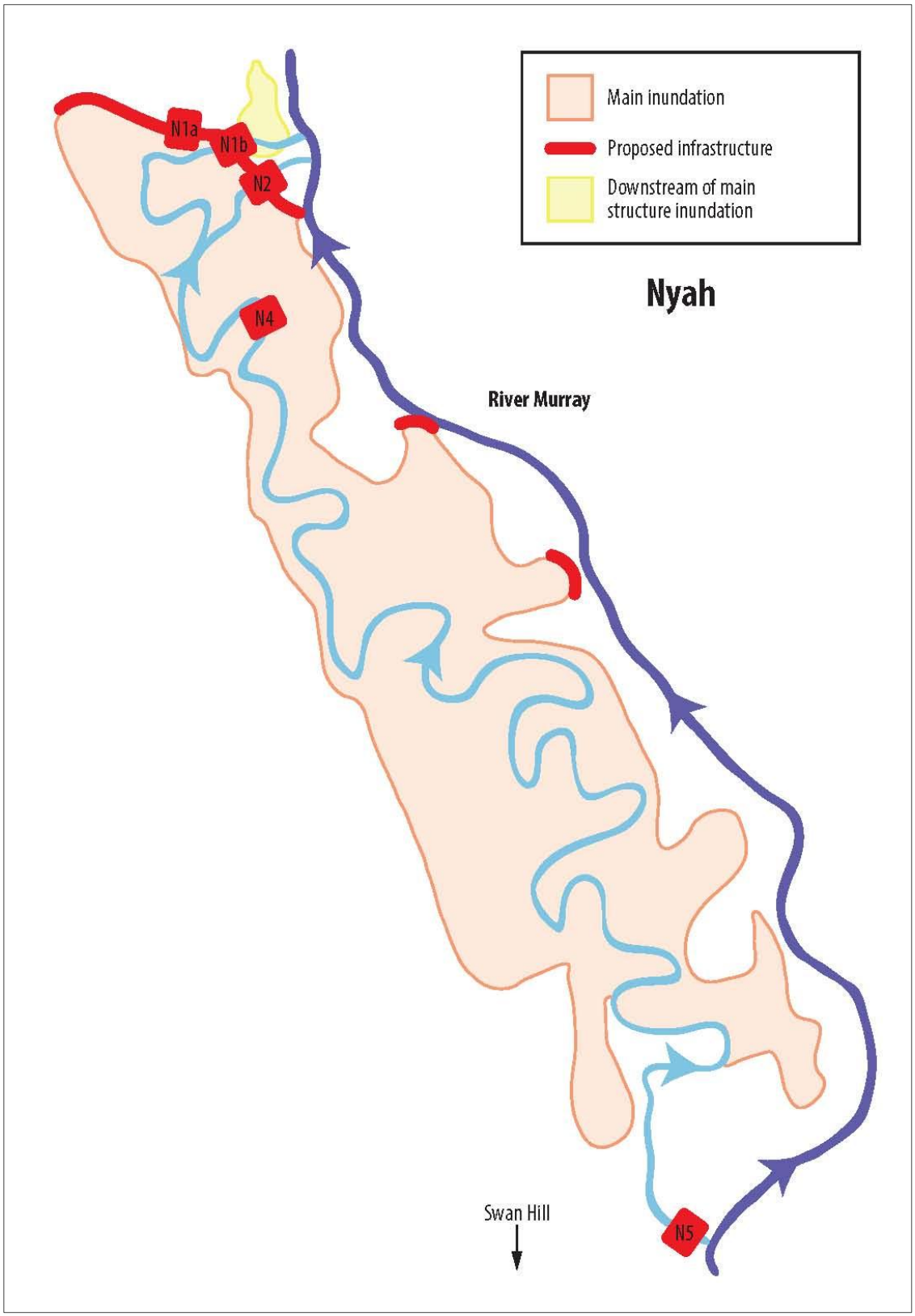


Figure 3-3: Representation of planned works and inundation at the Nyah site. Diagram is not to scale

Table 3-1: Elements of the Nyah works (Jacobs, 2014a)

Structure	Description
Main track raising and overflow sills	A section of the main track at the northern end of the floodplain will be raised in order to retain water to 63.2 m AHD. The track raising will incorporate regulators N1a, N1b, N2 and 3 overflow sills. Existing track alignment to be raised over a length of 1,308 m and will include 300 mm freeboard and 150 mm crest allowance. Overflow sills 1 and 3 will each be 100 m long; overflow sill 2 will be 65 m long.
N1a & N1b	Enables water to be held up to 63.2 m AHD and released as required. Two regulators, each consisting of 3 box culverts, each with single sluice gates and access provision.
N2	The main regulator and outlet point for the floodplain, N2 will be used to hold water to 63.2 m AHD and control return flows. Regulator consists of 8 box culverts, all with split leaf gates and access provision.
Drop structure	Situated downstream of N2, the drop structure is necessary to protect banks against erosion upon release of impounded water. The structure will establish a tailwater at the regulator sufficient to prevent sweep out of the hydraulic jump and provide a plunge pool for downstream fish passage. Consists of sheet piles and rock beaching.
N5	Replacement structure for an existing pipe culvert of correct size but unreliable quality, at the southern end of the Parnee Malloo Creek. This structure will prevent impounded water draining back to the River Murray. 1,200 mm diameter reinforced concrete pipe with manually actuated penstock gate and access provision.
Raised track sections and overflow sills (4, 5, 6, 7, 8)	Small sections of additional track raising and overflow sill works, to contain water on the floodplain and provide inflow and outflow path for natural flood events. Approximately 340 m of track raising is proposed at 5 locations, incorporating overflow sills at each.
N4	Decommissioning of redundant irrigation infrastructure including blockages in the creek and a bypass pipeline.

3.3 Name of proponent and proposed implementing entity

As the project owner, DEPI will have oversight responsibility for project implementation, pending confirmation of construction funding. Further information regarding the proposed governance and project management arrangements for implementation is provided in Section 17.

3.4 Summary of estimated costs and proposed schedule

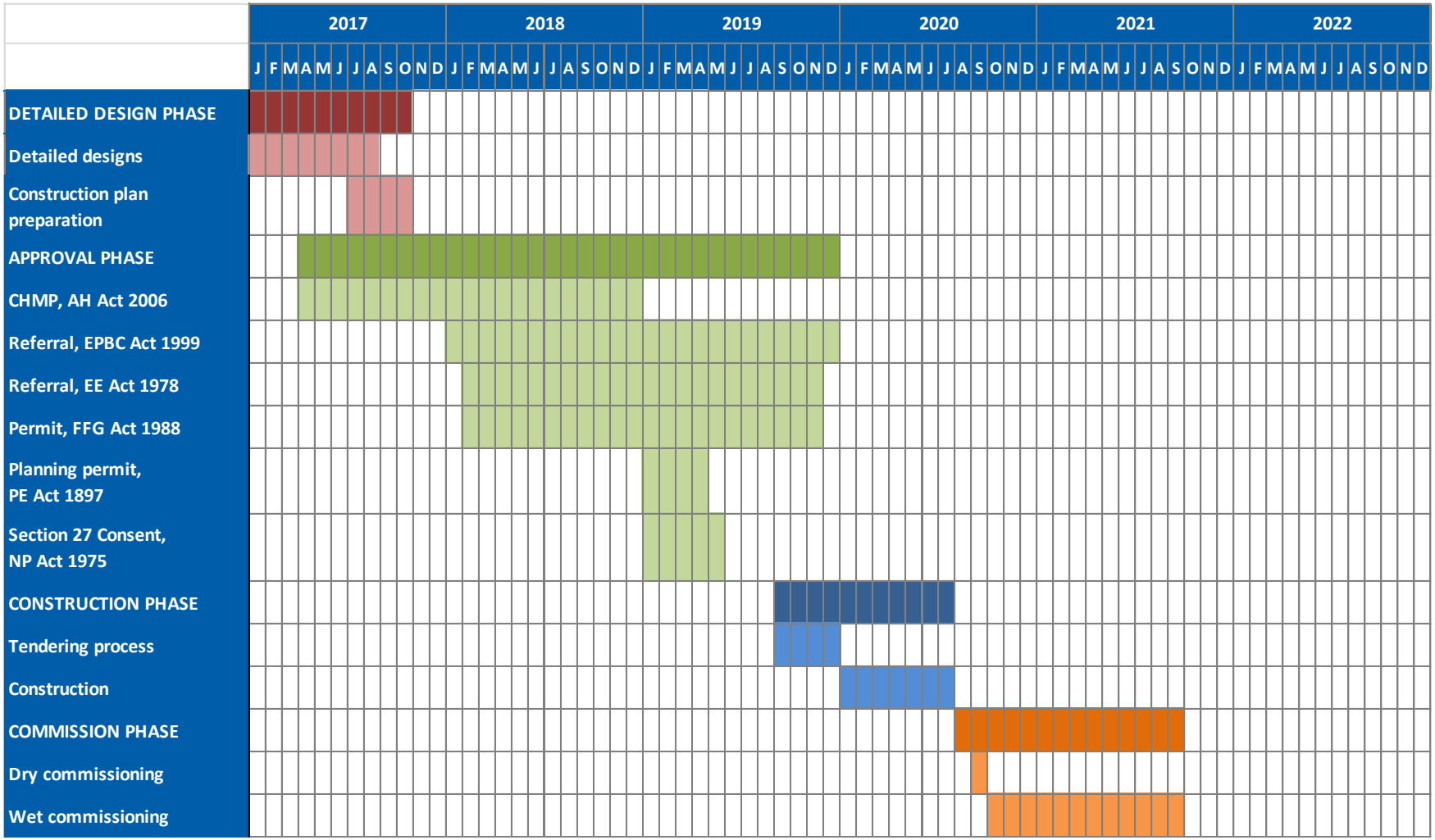
The total cost of the *Nyah Floodplain Management Project* is $10,942,589. Further details on costs are provided in Section 14.

This business case presents the cost to fully deliver the project (i.e. until all infrastructure is constructed, commissioned and operational), including contingencies. Cost estimates for all components in this proposal are

based on current costs, with no calculation undertaken of future cost escalations. To ensure sufficient funding will be available to deliver the project in the event that it is approved by the MDB Ministerial Council for inclusion in its approved SDL Adjustment Package to be submitted to the MDBA by 30 June 2016, cost escalations will be determined in an agreed manner between the proponent and the investor as part of negotiating an investment agreement for this project.

Table 3-2 outlines a high-level program schedule for the project. The program does not include durations for hold points at project gateways, as these are yet to be confirmed. The works are planned to be fully operational prior to 2024.

Table 3-2: Proposed project delivery schedule. Timelines are indicative only and will depend on finalisation of funding agreements



4. Ecological values of the site (Section 4.2)

4.1 Ecological values

Nyah Park is one of the most downstream areas of the central river red gum forests, lying near the western limit of the Murray Fans bioregion. It provides a unique ecological community where the semi-arid Mallee landscape and River Murray and its floodplain connect, providing an essential biodiversity corridor for fauna to move between environments vital to their life-cycles.

Recent flora and fauna surveys conducted in the Nyah-Vinifera Park indicate that the Nyah site is important for conserving biodiversity (Brown et al, 2013; Cook 2012; Davies et al, 2008; DSE, 2005; Ecological Associates, 2014a; GHD, 2013), as summarised below.

The park contains, or is expected to contain, the following numbers of animal species of conservation significance:

- thirty species listed on the DEPI advisory list of rare or threatened fauna in Victoria
- sixteen species listed under the FFG Act including fish, bushbirds, waterbirds, bats and reptiles
- of the 16 species listed directly above, the regent parrot (*Polytelis anthopeplus monarchoides*) and
- Murray cod (*Maccullochella peelii peelii*) are considered vulnerable under the *Environment Protection Biodiversity Conservation Act* (EPBC Act).

Significant and listed species recorded during recent and past surveys are listed in full in Appendix B.

Regent parrots feed in nearby Mallee woodlands, but depend on the large, healthy river red gum trees near the river to provide nesting hollows. The forest, creek and wetlands also provide essential resources for a vast array of flora and fauna, including waterbirds, woodland birds, mammals and reptiles as well as small and large-bodied fish. The sugar-glider and black wallaby are common in the park and use the highly productive and complex habitat available, even though they are at the downstream limit of their range.

Black fronted dotterel

The bird fauna at Nyah-Vinifera Park is diverse, with over 140 species recorded at the site and local vicinity (Brown, Byant and Horrocks, 3013, in Ecological Associates, 2014a). Of these, 20 species are of conservation significance in Victoria, including the regent parrot, also listed under the EPBC Act. The state listed eastern great egret (*Ardea modesta*) and white-bellied sea eagle (*Haliaeetus leucogaster*) are also subject to international migratory bird agreements with China and Japan. The wetlands provide habitat for dabbling, diving and filter feeding ducks, piscivorous waterbirds and wading birds (Ecological Associates, 2014a). A significant population of grey-crowned babbler (*Pomatostomus temporalis*) inhabit the floodplain, with their favoured habitat being black box and red gum woodland where they forage both on the ground and on the trunks and branches of trees and shrubs (Ecological Associates 2014a).

The woodlands and understory of Nyah Park also support a range of mammals. A recent survey recorded 13 species, including the black wallaby, water rat and state listed yellow-bellied sheathtailed bat (Brown, Bryant and Horrocks, 2013 in Ecological Associates, 2014a). A further ten species are recorded as occurring at the site in the Victorian database (Ecological Associates, 2014a).

Nyah Park also provides habitat for reptiles and frogs, including the threatened carpet python and lace monitor. A recent survey recorded the presence of nine reptile and five amphibian species, with a further ten reptiles and one amphibian recorded as occurring in the Victorian database (Brown, Bryant and Horrocks, 2013 in Ecological Associates, 2014a). High levels of forest productivity are required to provide the refuge habitat and vertebrate and invertebrate prey on which reptiles and amphibians depend (Ecological Associates, 2014a).

Bearded dragons (2013)

The site provides seasonal wetlands and flowing creek habitat expected to be suitable for ten River Murray fish species (Davies, et al. 2008 in Ecological Associates, 2014a). The Parnee Malloo Creek provides seasonal fast flowing habitat suitable for large-bodied fish species, including the EPBC-listed Murray cod and state listed

freshwater catfish (*Tandanus tandanus*), silver perch (*Bidyanus bidyanus*) and golden perch (*Maquaria ambigua*) (Ecological Associates, 2014a). The freshwater catfish is also expected to inhabit wetland habitats with submerged aquatic vegetation, woody debris and plant and invertebrate food sources. The resources provided by wetlands on the Nyah floodplain would potentially support up to six small-bodied fish species, including the state listed Murray-Darling rainbowfish (*Melanotaenia fluviatilis*) (Ecological Associates, 2014a).

4.2 Vegetation values

Nyah Park has a diverse flora assemblage and supports numerous species of conservation significance. More than 270 indigenous plant species were observed in the Nyah-Vinifera Park during a flora survey in 2012 (Cook, 2012) and 15 rare or threatened flora species have been recorded within or close to the forest complex (Cook, 2012; GHD, 2013; Ecological Associates, 2014a).

Recent flora and fauna surveys conducted in the Nyah-Vinifera Park indicate that the Nyah site is important for conserving biodiversity (Brown et al, 2013; Cook 2012; Davies et al, 2008; DSE, 2005; Ecological Associates, 2014a; GHD, 2013), as summarised below.

The park contains, or is expected to contain, the following numbers of plant species of conservation significance:

- thirty one species listed on the DEPI advisory list of rare or threatened plants in Victoria and
- one species listed under the *Flora and Fauna Guarantee Act 1988* - wavy marshwort (*Nymphoides crenata*).

Significant and listed species recorded during recent and past surveys are listed in full in Appendix B.

The vegetation of Nyah Park is dominated by river red gum forest, with areas of shrubby understory that includes pale-fruit ballart (*Exocarpus strictus*), as well as areas with only a sparse ground layer. The wetland areas of the floodplain, where the canopy is more open, supports aquatic macrophytes including *Ludwigia peploides, Eleocharis acuta* and *Marsilea drummondii*. The high terrace along the western edge of the park supports terrestrial species, including a greater proportion of grasses and chenopods (Ecological Associates, 2014a).

Ecological Vegetation Classes

The vegetation communities of the Nyah Park are distributed across the floodplain according to hydrological conditions, soil types and groundwater quality. In Victoria vegetation mapping units known as Ecological Vegetation Classes (EVCs) are the standard unit for classifying vegetation types. EVCs are described through a combination of floristics, lifeforms and ecological characteristics, and preferred environmental attributes (DEPI, 2014). The EVC classifications provide a suitable basis to inform water management planning at the site.

A total of ten EVCs have been mapped at Nyah Park of which all are flood dependent (Figure 4-1). The EVCs are:

- Grassy Riverine Forest
- Floodway Pond Herbland
- Grassy Riverine Forest / Floodway Pond Herbland Complex
- Grassy Riverine Forest / Riverine Swamp Forest Complex
- Riverine Swamp Forest
- Sedgy Riverine Forest
- Sedgy Riverine Forest / Riverine Swamp Forest Complex
- Spike-sedge Wetlands
- Riverine Chenopod Woodland and
- Riverine Grassy Woodland.

One EVC (Riverine Chenopod Woodland) is endangered in the Murray Fans bioregion, two are vulnerable (Spike-sedge Wetlands and Riverine Grassy Woodland) and the remaining seven EVCs are regionally depleted.

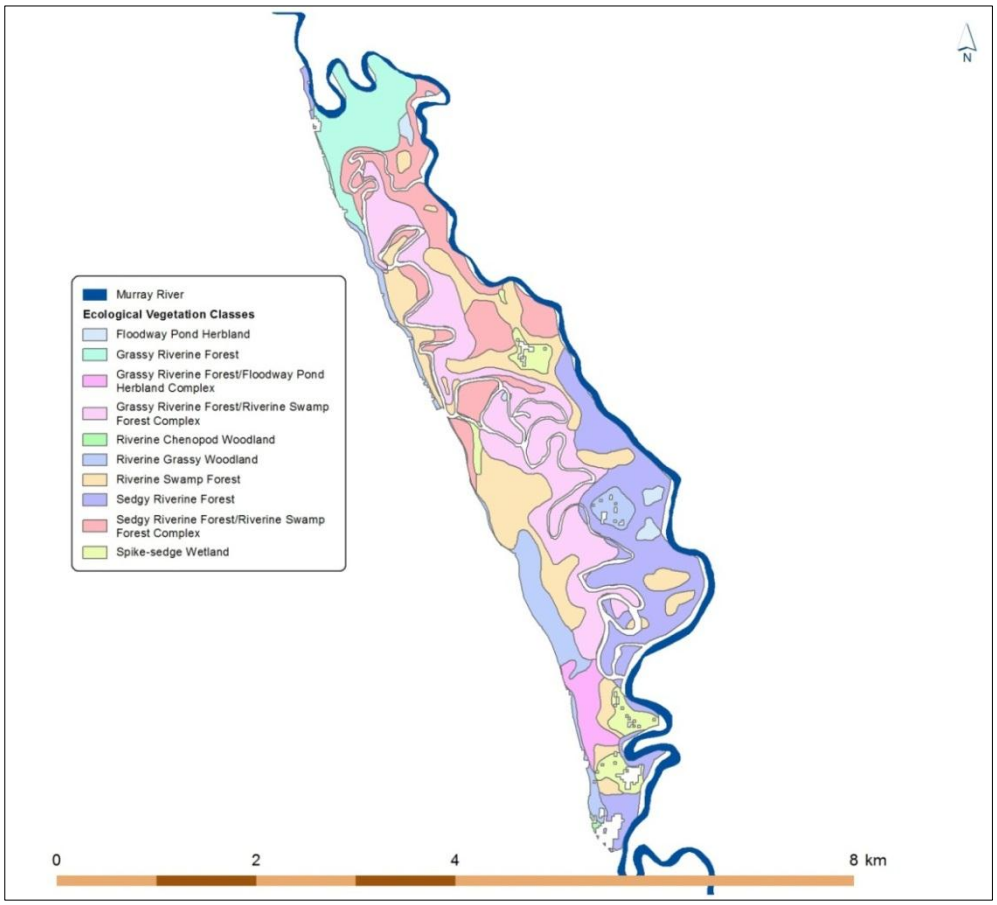


Figure 4-1: Ecological Vegetation Classes present at Nyah Park

Water regime classes

Floodplain ecology is influenced by the duration, depth, frequency and timing of inundation events. Therefore, it is useful to define water regime classes to establish objectives for the location, extent and condition of components of the floodplain ecosystem.

Plant communities present at Nyah Park have been described and mapped in detail as EVCs. Possible relationships between EVCs and water regimes were assessed. Using topographic data and information on the known spread of water on a rising hydrograph, EVCs were arranged in the order in which they are likely to be flooded and likely frequency and relative durations of flooding. This environmental gradient was refined by reviewing the EVC descriptions, which set out the species present during flooded and dry phases, their relative abundance and their habitat. Species with known relationships to flooding could be used to rank EVCs from most-likely to least-likely to be flooded (Ecological Associates 2007).

EVCs were amalgamated into five water regime classes (Figure 4-2). Table 4-1 provides a brief description of the water regime classes at Nyah Park. A more detailed description of the characteristics of these water regime classes is provided in Appendix B.

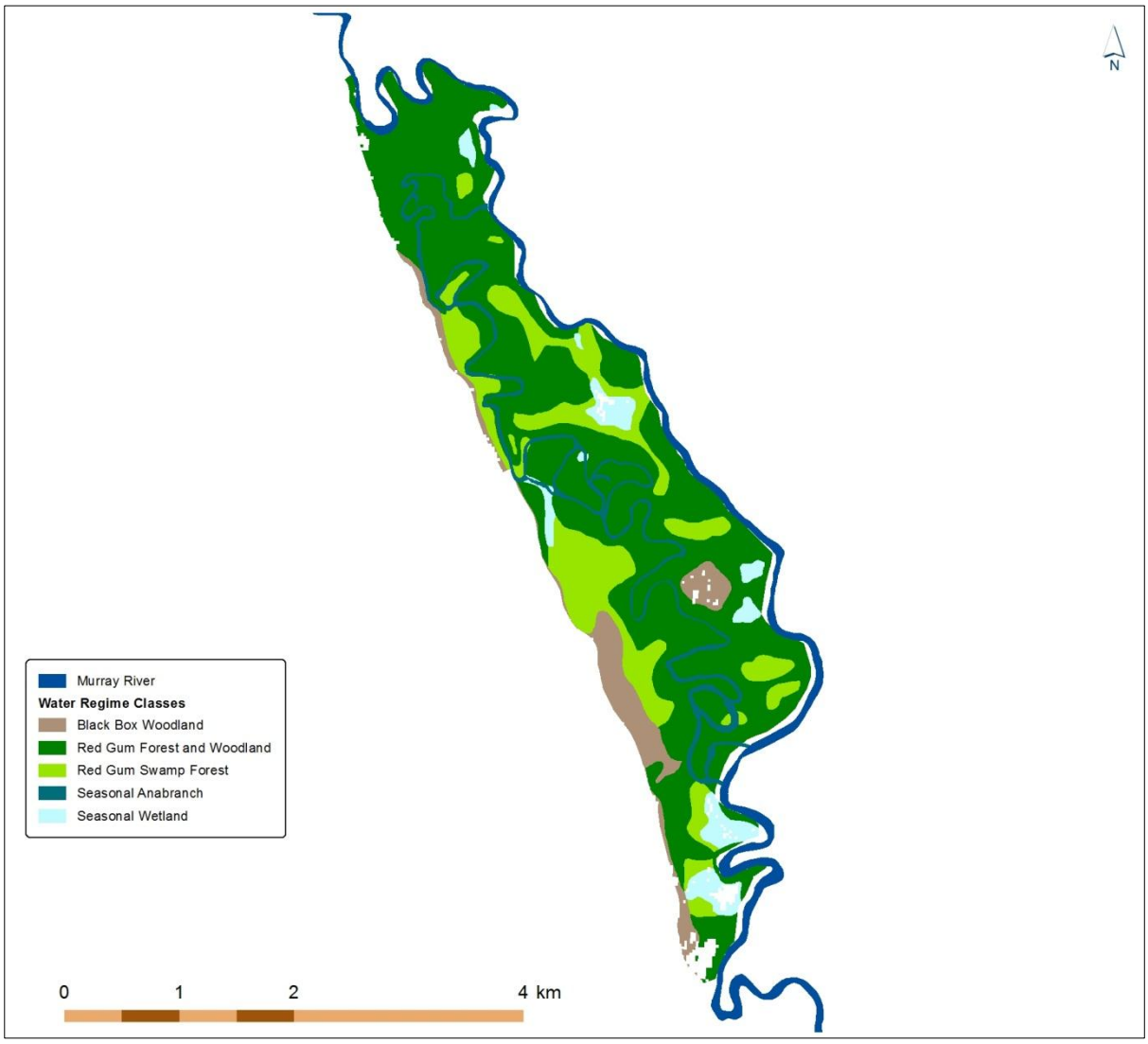


Figure 4-2: Nyah Park Water Regime Classes

Table 4-1: Nyah Park Water Regime Classes (Ecological Associates 2014a)

Water regime class	Area at Nyah Park	Area to be watered within this project	Ecological vegetation classes
Seasonal Anabranch[1]	58 ha	37 ha	n/a
Seasonal Wetland	45 ha	23 ha	819 Spike-sedge Wetlands 810 Floodway Pond Herbland
Red Gum Swamp Forest	168 ha	128 ha	814 Riverine Swamp Forest
Red Gum Forest and Woodland	576 ha	293 ha	106 Grassy Riverine Forest 811 Grassy Riverine Forest / Floodway Pond Herbland Complex 812 Grassy Riverine Forest / Riverine Swamp Forest Complex 816 Sedgy Riverine Forest 817 Sedgy Riverine Forest / Riverine Swamp Forest Complex
Black Box Woodland	64 ha	4 ha	103 Riverine Chenopod Woodland 295 Riverine Grassy Woodland
No EVC mapping[2]	3 ha	3 ha	n/a
TOTAL	913 ha	488 ha	

[1] Parnee Malloo Creek as mapped by Murray Wetlands Working Group "Wetlands54"

[2]There is a small area at Nyah where EVCs have not been mapped due to gaps in spatial data

Table 4-1 shows that:

- The project predominantly manages inundation in four of the water regime classes identified targeting the vegetation communities that are most reliant on flooding.
- The fifth water regime class - Black Box Woodland - is outside the scope of the proposed works as it typically occurs at high elevations at the perimeter of the floodplain.

4.3 Current condition

The forests and woodlands of the River Murray floodplain have been declining rapidly in condition over the past two decades. The decline is associated with increasing regulation of the River Murray and extended periods of drought (Cunningham et al, 2011).

Reductions in flooding duration of Nyah Park have caused a decrease in tree density and canopy cover, resulting in a decline in forest productivity (Ecological Associates 2014a). Nyah Park has a sparse understory and reduced diversity and habitat value due to the alteration in the site's water regime (Ecological Associates 2014a). Structural habitat and food resource availability for species such as carpet python, swamp wallaby, grey-crowned babbler and other woodland species has also reduced (Ecological Associates 2014a).

The Nyah floodplain features broad wetland depressions that retain water to a depth of one metre or more following flood recession. These areas require frequent and persistent inundation to sustain their rich ecological values (Ecological Associates 2014a).

Seasonal wetland habitat has been lost from Nyah Park through a reduction in the duration of spring flow peaks. High river levels now inundate wetlands only briefly, and have promoted the establishment of river red gum on former wetland beds (Ecological Associates 2014a). Flood duration is too short to support aquatic marshland vegetation and the understorey is now dominated by grasses and seasonal floodplain herbs (Ecological Associates 2014a). The decline in wetland habitat means the floodplain now only provides opportunistic habitat for aquatic fauna that recolonise the system when water is available. The encroachment by trees now excludes many waterbirds that rely on open water (Ecological Associates 2014a).

Flood duration in the Parnee Malloo Creek is also too brief to meet the habitat requirements of channel specialist fish species and Murray crayfish (Ecological Associates, 2014a).

One method for assessing the current condition of a wetland is the Index of Wetland Condition (IWC) developed by DSE (now DEPI). The IWC defines wetland condition as the state of the biological, physical and chemical components of the wetland ecosystem and their interactions. The 2009 IWC assessment on the Nyah floodplain rated the health of wetlands at the site as moderate. Within this assessment, the hydrology sub-index was rated as very poor due to an inadequate watering regime. The wetlands assessed also received a poor biota score indicating a lack of diversity and abundance of species compared to the expected biota. The assessment concluded that the altered water regime is considered a major threat to the ecology of the Nyah floodplain (DSE, 2011).

4.4 Past Management Activities and Actions

Historically the Nyah floodplain area was managed under pastoral leases and then as a timber reserve. The area has been managed as state forest since the 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989), primarily with a focus on timber harvesting and cattle grazing. These activities ceased in 1990 and 1998 respectively (P. Kelly, 2014, pers. comm.).

Since the Victorian Environmental Assessment Council (VEAC) recommendations in 2008, Nyah-Vinifera forest has been proclaimed as a regional park. Land management is now focused on the protection of conservation and aboriginal heritage values, while still permitting recreational use. The management activities for regional parks include, but are not limited to, management of pest species, managing fire, preserving natural values and providing recreational opportunities.

To prevent ecosystem collapse on the Nyah floodplain, an emergency environmental watering program was initiated in 2004-05 as an immediate response to the poor condition of the floodplain. Over four years, environmental water was delivered to the Parnee Malloo Creek, two wetlands and low lying riparian zones via portable pumps and ponded on the floodplain using temporary earthen levees.

Where temporary works were able to partially facilitate the necessary inundation depth, duration and extent, condition of red gum stands improved. This is illustrated in the photographs below, which show that the floodplain has the capacity to respond to an improved watering regime.

An Environmental Water Management Plan (Mallee CMA, 2012) was developed for Nyah-Vinifera Park in 2012. The plan identified ecological objectives and hydrological targets for the Park and recognised the requirement for infrastructure to better manage the inundation regime. The same ecological objectives and targets have been adopted for the *Nyah Floodplain Management Project.*

Nyah Park before (left) (2010) and after environmental watering (right) (2011)

4.5 Other values

In addition to its environmental values, Nyah Park is recognised for its many social and cultural values.

Cultural and Historical values

The Nyah floodplain occurs within the broader Nyah-Vinifera Park and contains a large number of culturally significant sites. More than a dozen archaeological investigations on the Nyah floodplain have been conducted since 1977, all recording significant Aboriginal archaeological sites (Grinter et al, 2014). Nyah is an important cultural site for the Wadi Wadi Aboriginal people and there are numerous burial sites, scarred trees and middens listed under the Register of the National Estate (VEAC 2008). Under the *Aboriginal Heritage Act 2006* the Nyah-Vinifera area is specified as an area of cultural heritage sensitivity in accordance with several categories.

Since European settlement, Nyah Park has had many uses including grazing, forestry and local firewood collection. A European Heritage due diligence assessment has been undertaken and there are no sites that will have a material impact on this project.

Social and Recreational Values

Since the 2008 VEAC recommendations, management of the area is more focused on protecting conservation and aboriginal heritage values, at the same time permitting recreational use.

The Nyah-Vinifera Park is managed for multi-use values, including conservation, recreation, apiary and indigenous values. Recreational uses include dispersed camping (including camp fires and associated firewood collection), fishing, boating, four wheel driving, horse riding, trail bike riding and walking. The Parnee Malloo Creek and wetlands provide high value low impact 'beside water activities' including sightseeing, walking, hiking and cycling (Mallee CMA, 2012).

There are also active community groups, including Friends, Field Naturalists, residents and the indigenous community advocating to protect and restore the ecology of the Parnee Malloo Creek system (Mallee CMA, 2012).

Aboriginal earthern mound at Nyah Park

5. Ecological objectives and targets (Section 4.3)

Ecological objectives have been developed for the Nyah Park site, drawing on a range of approaches and recommended lines of enquiry including, but not limited to:

- the overarching objectives in Schedule 7 of the Murray-Darling Basin Plan (MDBA, 2014)
- the Basin-wide Environmental Watering Strategy (MDBA, 2014)
- a review of relevant literature including monitoring data from the TLM initiative (2010; Henderson et al, 2012; Henderson et al, 2013; Henderson et al, 2014)
- desktop and field based flora and fauna surveys (GHD, 2013; Brown, Byant and Horrocks, 2013)
- site visits
- an ecological objectives workshop with an expert panel comprised of aquatic, wildlife and restoration ecologists and key project stakeholders from DEPI and the Mallee CMA (Ecological Associates, 2014a) and
- site Environmental Water Management Plan (Mallee CMA, 2012).

The ecological objectives for the Nyah Park project were developed with a view to enhance the conservation values of the site with the proposed works inform the detailed design and operation of the work and guide monitoring and evaluation.

5.1 Overarching ecological objective

The overarching objective of water management in the Nyah Park site is:

*"to **protect and restore** the key species, habitat components and functions of the Nyah Park ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities"* (Ecological Associates, 2014a).

This will be achieved by using infrastructure to better meet the water requirements of Nyah Park. The proposed works will enable wide spread inundation of Parnee Malloo Creek and adjoining wetlands and floodplain. The works have been designed to operate under low River Murray flows (5,000 ML/d) and can be operate to protect this system through droughts.

5.2 Specific objectives and targets

Specific ecological objectives and targets have been developed for the proposed supply measure based on the key water-dependent values of Nyah Park. The objectives are consistent with those of the Nyah Vinifera Environmental Water Management Plan (Mallee CMA, 2012) and will contribute toward achieving the environmental objectives set by the Basin Plan.

The Basin Plan objectives have been summarised as follows:

1. to protect and restore a subset of all water-dependent ecosystems in the Murray-Darling Basin ensuring that:
   (a) declared Ramsar wetlands that depend on Basin water resources maintain their ecological character: and
   (b) water-dependent ecosystems that depend on Basin water resources and support the lifecycles of species listed under the Bonn Convention, CAMBA, JAMBA or ROKAMBA continue to support those species: and
   (c) water-dependent ecosystems are able to support episodically high ecological productivity and its ecological dispersal.
2. to protect and restore biodiversity that is dependent on Basin water resources, by ensuring that:
   (a) water-dependent ecosystems that support the lifecycles of a listed threatened species or listed threatened ecological community, or species treated as threatened or endangered in State law, are protected and, if necessary, restored so that they continue to support those life cycles:
   (b) representative populations and communities of native biota are protected and if necessary restored.
3. that the water quality of Basin water resources does not adversely affect water-dependent ecosystems and is consistent with the water quality and salinity management plan.
4. to protect and restore connectivity within and between water-dependent ecosystems including by ensuring that:
   (a) the diversity and dynamics of geomorphic structures, habitats, species and genes are protected and restored; and
   (b) ecological processes depend on hydrologic connectivity longitudinally along rivers, and laterally, between rivers and their floodplains (and associated wetlands) are protected and restored: and
   (c) the Murray Mouth remains open at frequencies, for durations and with passing flows, sufficient to enable the conveyance of salt, nutrients and sediment from the Murray-Darling Basin to the ocean: and
   (d) the Murray Mouth remains open at frequencies, and for durations, sufficient to ensure that the tidal exchanges maintain the Coorong's water quality within the tolerance of the Coorong ecosystems' resilience and
   (e) barriers to the passage of biological resources (including biota, carbon and nutrients) through the Murray Darling Basin are overcome or minimised.
5. that natural processes that shape landforms (for example, the formation and maintenance of soils) are protected and restored.
6. to provide habitat diversity for biota at a range of scales
7. to protect and restore food webs that sustain water-dependent ecosystems, including by ensuring that energy, carbon and nutrient dynamics (including primary production and respiration) are protected and restored.
8. to protect and restore ecosystem functions of water-dependent ecosystems that maintain populations (for example recruitment, regeneration, dispersal, immigration and emigration) including by ensuring that;
   (a) flow sequences, and inundation and recession events, meet ecological requirements (for example, cues for migration, germination and breeding); and
   (b) habitat diversity that supports the life cycles of biota of water dependent ecosystems (for example habitats that protect juveniles from predation) is maintained.
9. to protect and restore ecological community structure and species interactions.
10. that water-dependent ecosystems are resilient to climate change, climate variability and disturbances (for example, drought and fire)
11. to protect refugia in order to support the long-term survival and resilience of water-dependent populations of native flora and fauna, including during drought to allow for subsequent re-colonisation beyond the refugia.
12. to provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible changes.
13. to mitigate human-induced threats (for example, the impact of alien species, water management activities and degraded water quality).
14. to minimise habitat fragmentation.

The contribution of the proposed project's specific objectives to the Basin Plan objectives is demonstrated in Table 5-1 over page.

Table 5-1: Relationship between the site based objectives and targets and the Basin Plan objectives

Specific Objective	Ecological Target	Water Regime Classes	Associated Basin Plan Objectives
Restore the vegetation structure of wetland plant communities	The projected red gum canopy cover in seasonal wetlands decreases by 50% from 2015 levels by 2030. The projected aquatic macrophyte plant cover in December in seasonal wetlands exceeds 50% by 2030.	Seasonal Anabranch Seasonal Wetlands	1,2,4,6,7,8,9,10, 11,12,13,14
Re-establish resident populations of frogs and small fish	At least four native fish species are present in seasonal wetlands every spring between 2025 and 2035. At least three frog species are present in seasonal wetlands every spring between 2025 and 2035.	Seasonal Wetlands	1,2,4,6,7,8,9,10, 11,12,13,14
Provide seasonal feeding and reproductive opportunities for riverine fish species	Juveniles of Murray cod are present in Parnee Malloo Creek every spring between 2025 and 2035. Adults of Murray cod are present in Parnee Malloo Creek in spring in six years between 2025 and 2035.	Seasonal Anabranch Seasonal Wetlands	1,2,4,6,7,8,9,10, 11,12,13,14
Provide reliable breeding habitat for waterbirds, including colonial nesting species	Any species of waterfowl, crake, rail, waterhen or coot breeds every year between 2025 and 2035 at Nyah Park. Cormorants and / or nankeen night heron breed at Nyah Park on at least six occasions between 2025 and 2035.	Seasonal Wetlands Red Gum Swamp Forest Red Gum Forest and Woodland	1,2,4,6,7,8,9,10, 11,12,13,14
Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler	All red gum stands within the project area achieve a health score of moderate or better under Cunningham (2011) tree health monitoring for all years between 2025 and 2035. Total bat abundance increases by 25% from 2015 levels by 2030.	Red Gum Swamp Forest Red Gum Forest and Woodland	1,2,4,6,7,8,9,10, 11,12,13,14
Contribute to the carbon requirements of the River Murray channel ecosystem	The average annual carbon load (dissolved and particulate) to the River Murray from Nyah Park for the period 2025 to 2035 is double 2015 to 2020 levels.	Red Gum Swamp Forest Red Gum Forest and Woodland	1,2,4,6,7,8,9,10, 11,12,13,14

Ecological targets have also been developed to measure progress towards the specific ecological objectives. It is anticipated that these targets will be tested and refined once the proposed supply measure is operational. The targets describe an ecological outcome or process and are:

- quantitative and measurable
- time-bound and
- justified by existing site data or scientific knowledge.

The ecological targets compare the current state of the ecosystem (i.e. using 2015 as a baseline) with a future state after the recommended water regimes have been applied, assuming that the proposed works are commissioned in 2020. It will take some time to realise ecological outcomes due to the time required for vegetation to adapt to the new inundation conditions, for floodplain productivity to increase (e.g. for additional energy and nutrients to be distributed through the food web) and for fauna populations to respond. Targets based on relatively stable variables are evaluated in 2030. Targets based on the frequency of an event

occurring are evaluated over the period from 2025 to 2035.

Photo point monitoring shows river red gum tree condition improvement as a result of environmental watering (Above left: 2010; Above right: 2012)

5.3 Environmental water requirements

The works will provide flexibility to deliver a wide range of environmental watering events to meet the above ecological objectives and targets.

The hydrological regime experienced by each water regime class has varied from natural due to river regulation and diversions. provides a comparison of the water regime that can be provided by the proposed measure with the following water regimes:

- natural
- baseline Condition (current condition) and
- Basin Plan (2750) without the measure.

Basin Plan flows will contribute toward achieving the environmental water requirement of Nyah Park compared to baseline conditions. The proposed measure is required to bridge the gap between Basin Plan flows and the environmental water requirements of Nyah Park.

Table 5-2: Comparison of water regimes provided by natural, baseline, Basin Plan (2750) and the Nyah measure

Threshold (ML/d)	WRC	Scenario	Frequency Mean (/100 yrs)	Interval Median (days)	Duration Median (days)	Event start date Median (day of year, 1 Jan = 1)	Prevalence years with event %
15,000	Seasonal Anabranch	With Measure[1]	100	190	150	152	100
		Natural	100.9	172	174	170	95
		Baseline	80.7	274	82	196	74
		Basin Plan without measure	86	230	133	179	82
17,500	Seasonal Wetland	With Measure[1]	90	210	120	152	90
		Natural	98.2	191	157	181	94
		Baseline	68.4	290	84	198	65
		Basin Plan without measure	85.1	344	110	185	81
20,000	Red Gum Swamp Forest	With Measure[1]	90	220	120	182	90
		Natural	100	205	143	190	92
		Baseline	61.4	307	72	201	59
		Basin Plan without measure	78.9	259	93	192	72
25,000	Red Gum Forest and Woodland	With Measure[1]	70	260	77	182	70
		Natural	71.9	286	87	210	68
		Baseline	37.7	402	70	216	36
		Basin Plan without measure	47.4	248	77	209	46

[1] Figures based on interpretation of the preliminary operations plan adapted from (Ecological Associates 2014c).

Source: Gippel (2014)

Table 5-2 shows the proposed works can be operated to meet shortfalls in the water requirements for frequency and duration across all of the water regime classes. This has been used to inform the proposed operating regime, as discussed in sections 8.3 and 9. Detailed ecological justification and the water requirements of each water regime class is provided in Appendix B.

The links between the water regime classes and the site's ecological objectives are shown in Table 5-3 and illustrate that all of the water regime classes need to be inundated in order to realise the project's ecological objectives. This has informed the selection of proposed works for the *Nyah Floodplain Management Project*.

Table 5-3: Links between water regime classes and the ecological objectives for Nyah Forest

Ecological objective	Seasonal Anabranch	Seasonal Wetland	Red gum swamp forest	Red gum forest and woodland
Restore the vegetation structure of wetland plant communities	✓	✓		
Re-establish resident populations of frogs and small fish		✓		
Provide seasonal feeding and reproductive opportunities for riverine fish species	✓	✓		
Provide reliable breeding habitat for waterbirds, including colonial nesting species		✓	✓	✓
Restoring floodplain productivity to maintain resident populations of vertebrate fauna			✓	✓
Contribute to the carbon requirements of the River Murray channel ecosystem			✓	✓

6. Anticipated ecological benefits (Section 4.4.1)

The creek, wetlands and floodplain system of Nyah Park support a variety of ecological communities, including forest, woodland and swamps (Section 4). The condition of ecological values at Nyah Park and past management activities and actions are outlined in sections 4.3 and 4.4 respectively.

A summary of the current condition of each of the water regime classes targeted by the *Nyah Floodplain Management Project* is provided in Table 6-1 below.

Table 6-1: Summary of the current condition of the main water regime classes at Nyah Park (Ecological Associates, 2014)

Water regime class	Current condition
Seasonal anabranch	Flooding within the Parnee Malloo Creek is now too brief to meet the water requirements of flow tolerant aquatic plants and channel specialist fish species. Barriers constructed within the waterway have increased the flow thresholds for through flow in the creek and resulted in a loss of flowing habitat.
Seasonal wetland	Seasonal wetland habitat has been lost from Nyah Park through a reduction in the duration of spring flow peaks. There has been encroachment of river red gums and a shift from aquatic marshland vegetation to an understorey dominated by grasses and herbs. The wetlands now only provide opportunistic habitat for aquatic fauna that colonise the system when water is available.
Red gum swamp forest	Red gum forest has been severely degraded due to a reduction in flood duration allowing higher tree density and increased shading of the understorey. Perennial aquatic plants have largely been replaced by more drought tolerant species and flooding is too brief to contribute significantly to the breeding requirements of native fish or waterbirds.
Red gum forest and woodland	While the overall health and integrity of red gum woodland at Nyah has been maintained, productivity has declined. The understorey vegetation growth has reduced, providing less physical habitat and contributing less to ecosystem carbon requirements. The food resources and structural habitat for carpet python, swamp wallaby, grey-crowned babbler and other woodland species have reduced.

6.1 Ecological benefits of inundation

The proposed Nyah Park supply measure will restore flooding frequency and duration and to improve productivity to areas of creek, wetlands, swamp and red gum forest. It will contribute significantly to the feeding and breeding requirements of colonial nesting waterbirds. Frequent flooding of wetlands will maintain wetland habitat for sedgelands and support populations of small-bodied fish. Large wetland areas, particularly Green Swamp, will provide habitat for benthic herblands which in turn contribute to the habitat requirements of small-bodied fish and a wide variety of waterbirds (Ecological Associates, 2014a).

Drawing upon the ecological response monitoring outcomes associated with previous environmental watering at Nyah Park and at other sites such as the Hattah Lakes, it is expected the observed trend of improved

ecological condition (Henderson, 2014) would continue once permanent works can facilitate an appropriate water regime. These results provide a high level of confidence that the implementation of the proposed supply measure and its associated watering regime will provide the expected benefits.

An overview of the expected benefits of reinstating more appropriate flooding patterns is summarised for each of the water regime classes at Nyah Park below.

Once the duration requirement of these vegetation communities has been met, water will be released from the floodplain back into the River Murray system. Increased rates of tree growth provide organic matter to the floodplain system, which promotes productivity and as floodwaters recede this material also enters the River Murray contributing to the energy requirements of the broader river system.

Seasonal Anabranches

The seasonal anabranch water regime class is largely represented by the Parnee Malloo Creek. The creek provides an alternative, fast-flowing habitat to the main channel of the River Murray. Improved flow regimes will provide habitat for large channel-dependent fish species such as Murray cod, silver perch and golden perch during their spawning seasons, as well as other aquatic species such as Murray crayfish and water rats (Ecological Associates, 2014a).

Re-establishing a more permanent flow regime will also restore the creeks critical role in supporting the recruitment of juvenile fish and movement of aquatic fauna, by reinstating the connections between wetland, anabranch and main channel habitats (Ecological Associates, 2014a). High water velocities and sustained inundation keep the channel largely clear of aquatic macrophytes and prevent the encroachment of river red gums into the waterway. The channel is fringed by emergent macrophytes such as *Eleocharis acuta* and *Cyperus gymnocaulos* that benefit from seasonal waterlogging and shading (Ecological Associates, 2014a).

Seasonal Wetlands

Seasonal inundation is important to wetland productivity. The plant matter that is exposed on the drying wetland bed in summer and autumn is readily mineralised when reflooded in winter. This supports a productive food web of algae and zooplankton and bacterial biofilms (Young 2001) which in turn provides prey for larger fauna including fish and waterbirds.

Soft leaved vegetation and aquatic macro-invertebrates will provide food for dabbling and grazing ducks such as grey teal, pacific black duck and Australian shelduck. The wetlands will provide reliable breeding habitat for waterfowl which build nests using reeds on scrapes in and around reedy vegetation. Reeds will provide terrestrial frogs with abundant aquatic invertebrates and flying insects, a substrate for eggs and shelter from predators. Wading birds such as royal spoonbill and intermediate egret will prey on invertebrates and small fish (Ecological Associates, 2014a).

The wetlands are a refuge habitat for frogs such as southern bullfrog and spotted marsh frog. Reliable flooding in the wetlands maintains the population, which expands to flooded red gum understorey during floods (Ecological Associates, 2014a).

Dense reedy vegetation near the wetlands provides shelter for black wallaby.

Red Gum Swamp Forest

Frequent and sustained inundation in the low-lying areas where the Red Gum Swamp Forest water regime class occurs limits tree density to an open forest structure. The understorey comprises obligate wetland plant species which require regular spring and summer flooding (Ecological Associates, 2014a). The swamp forest represents an extension of the seasonal wetland habitat with a similar understorey and similar habitat values for aquatic fauna (Ecological Associates, 2014a).

Inundation of this water regime class provides temporary habitat for aquatic fauna, particularly vegetation-

dependent fish such as gudgeon complex, rainbow fish and hardyhead. The habitat for terrestrial frogs, which is normally limited to the reeds fringing wetlands, will expand to the red gum understorey. Burrowing frogs, which aestivate in the floodplain soil, will become active. Other wetland species that will extend into the flooded woodland will include yabby, tortoises and water rat (Ecological Associates, 2014a).

Flooding events will support waterbird breeding. The trees provide nesting sites for waterbirds that breed over water such as little egret, white-necked heron, white-faced heron, great cormorant and little black cormorant. A range of other waterbird guilds will breed including waterfowl, large waders and small waders (Ecological Associates, 2014a).

These habitat values of red gum forest can be restored by increasing the duration of flooding events while maintaining a high flooding frequency. Longer events will contribute to the breeding requirements of waterbirds while shorter events will provide foraging habitat and breeding opportunities for resident aquatic fauna. A higher density of vegetation on the forest floor will contribute to the habitat requirements of terrestrial fauna. It will provide forage and shelter for swamp wallaby and a source of prey and physical habitat for carpet python. High levels of insect productivity will sustain local bat populations (Ecological Associates, 2014a).

Red Gum Forest and Woodland

Red gum woodland is present on higher ground near the terrestrial boundary of the floodplain and on local rises within the forest. Red gum trees forms an open woodland canopy while the understorey is dominated by tussock grasses that respond to winter and spring rain but do not depend on flooding (Ecological Associates, 2014a). The ground layer is grassy with a sparse scattering of low shrubs (Ecological Associates, 2014a).

Red gum trees and their understorey have an important role in providing structural habitat for floodplain fauna, particularly hollows for nesting wood duck, carpet python, bats and brush-tailed possum. Red gum growing close to water provide nesting habitat for some birds which feed in adjacent Mallee including regent parrot and Major Mitchell cockatoo. Dense understorey vegetation provides habitat for grey-crowned babbler, swamp wallaby and carpet python (Ecological Associates, 2014a).

The grassy understorey provides seeds and forage for granivores such as finches, cockatoos, galah, lorikeet and budgerigar, the frugivorous emu and large herbivores including western grey kangaroo and swamp wallaby (Ecological Associates, 2014a). The trees directly support insectivorous and omnivorous birds such as honeyeaters and wattlebird. Both overstorey and understorey vegetation support insect production on which a wide range of insectivorous birds and bats depend (Ecological Associates, 2014a).

The ecological values of woodland can be restored by increasing the frequency of floods to support tree and the growth of trees and understorey grasses and shrubs over late spring and summer.

6.2 Proposed ecological benefits

Eleven ecological targets have been developed to provide some quantification on the degree of environmental benefit expected by the measure (Table 5-1).

The expected ecological benefits for each water regime class, as a result of the supply measure are outlined in Table 6-2.

Table 6-2: Summary of water regime class, strategy and ecological benefits for Nyah (Ecological Associates 2014a)

Water Regime Class	Strategy	Ecological benefits
Seasonal Anabranch	Increase through-flow in Parnee Malloo Creek by increasing River Murray flow in spring and early summer.	Flowing habitat between later winter and early summer (July to December) will benefit channel specialist fish species and Murray crayfish, with the highest priority period from October to November. These flows will also promote flow-tolerant aquatic plants such as Triglochin procerum and help exclude river red gum from the channel. Providing these flows in eight out of ten years will maintain local populations and successful recruitment of juvenile fauna.
Seasonal Wetlands	Capture peaks in river flow by closing regulators on the flood recession. Pump water into wetlands if peaks in river flow are too infrequent.	Seasonal wetland habitat may be restored to Nyah Park by providing flooding of nine to 12 months duration in 90% of years, between winter and summer. This flooding regime will provide regular breeding habitat for waterbirds and will support the seasonal requirements of aquatic wetland fauna including native fish. Ensuring water levels fall over summer and autumn will promote macrophyte growth over broad areas of the wetland bed and promote mineralisation of organic matter.
Red Gum Swamp Forest	Capture peaks in river flow by closing regulators on the flood recession. Pump water into wetlands if peaks in river flow are too infrequent.	Inundation of red gum forest and woodland provides temporary habitat for aquatic fauna, particularly vegetation-dependent fish. The habitat for terrestrial frogs, which is normally limited to the reeds fringing wetlands, will expand to the red gum understory. Burrowing frogs, which aestivate in the floodplain soil, will become active. Other wetland species that will extend into the flooded woodland will include yabby, tortoises and water rat. Flooding events will support waterbird breeding. The trees provide nesting sites for waterbirds that breed over water. A range of other waterbird guilds will also breed.
Red Gum Forest and Woodland	Capture peaks in river flow by closing regulators on the flood recession. Pump water into forest if peaks in river flow are too infrequent.	Increasing the duration of flooding events while maintaining a high flooding frequency can restore the habitat values of red gum forest (flooding should commence in late winter or early spring and be sustained until summer). Longer events will contribute to the breeding requirements of waterbirds while shorter events will provide foraging habitat and breeding opportunities for resident aquatic fauna. Woodland productivity can be restored by increasing the frequency of floods exceeding 25,000 ML/d to eight in 10 years with a median event duration of four weeks Ensuring flooding in winter and spring will support tree and the growth of trees and understorey grasses and shrubs over late spring and summer.

6.3 Monitoring and Evaluation plans

The effectiveness of the proposed supply measure and its operation will primarily be monitored and reported on through the Mallee CMA's well established monitoring, evaluation and reporting (MER) strategies and protocols. These strategies and protocols will build upon experience and lessons learned though the ongoing, long-term Living Murray ecological monitoring programs, which include condition and intervention monitoring across several sites in the Mallee. The Mallee CMA has been implementing and coordinating the local Living Murray annual MER process since 2006.

The MER strategies and protocols are linked to overarching State and Victorian Environmental Water Holder frameworks to provide a routine process to:

- Establish a robust program logic to define the correlation between works and other inputs and identified outputs and ecosystem outcomes. This provides the basis for a suite of quantifiable ecological targets that are relevant to the specific site.
- Monitor progress against those targets on a regular basis.
- Evaluate the implications of the results for the operational parameters of the scheme. Amend and adjust the operational arrangements to optimise performance and outcomes.

Monitoring data is required to plan watering events, to optimise water delivery, to manage risks and to refine ecological objectives. The evaluation process involves analysing collected data and improving operations.

A detailed monitoring and evaluation plan has been prepared for the Nyah site by Ecological Associates (2014b). Monitoring and evaluation will focus on the effects of local watering actions and includes:

- evaluating water use
- measuring ecological outcomes against ecological targets
- refining conceptual models and improving knowledge and
- managing risk.

The Nyah monitoring and evaluation plan identifies the agencies responsible for commissioning, reviewing and acting on monitoring data. The linkages back to decision-making are described in the detailed plan.

Initial monitoring will provide a baseline of the existing status of the ecological objectives and outcome monitoring will measure progress towards these objectives. This information will inform the ongoing operations at the site. Over time the results of the outcome monitoring will test assumptions and monitoring data will assist with refining conceptual models and ecological objectives. Parameters for monitoring each ecological objective of the supply measure for Nyah Park are detailed in Appendix C (Ecological Associates 2014b).

The environmental risks from implementing the proposed water regime are detailed in Section 10 - Operational Risks. Monitoring data will identify emerging hazards and enable operational decisions to minimise risk.

This MER approach will be formalised once funding for the supply measure has been confirmed.

The final MER approach for this supply measure will be informed by broader intergovernmental arrangements for Basin-wide monitoring and evaluation under the Basin Plan. This measure is expected to contribute to the achievement of outcomes under two key Chapters of the Plan, namely: (i) the delivery of ecological outcomes under Chapter 8; and (ii) under Chapter 10, meeting the relevant sustainable diversion limit/s (SDLs), which must be complied with under the state's relevant water resource plan/s (WRPs) from 1 July 2019.

Both Chapter 8 and Chapter 10 of the Basin Plan are captured under the MDBA's own monitoring and evaluation framework. Once specific Basin Plan Chapters commence within a state, the state must report to

the MDBA on relevant matters. This will include five yearly reporting on the achievement of environmental outcomes at an asset scale in relation to Chapter 8, and annually reporting on WRP compliance in relation to Chapter 10.

The proponent is satisfied that its participation in the MDBA's reporting and evaluation framework will effectively allow for progress in relation to this supply measure to be monitored, and for success in meeting associated ecological objectives and targets to be assessed.

This approach closely aligns with agreed arrangements under the Basin Plan *Implementation Agreement*, where implementation tasks are to be as streamlined and cost-efficient as possible.

Photo point monitoring undertaken at Nyah Forest during high River Murray flows (2013)

7. Potential adverse ecological impacts (Section 4.4.2)

This business case has taken into consideration potential adverse ecological impacts of this proposal. It is acknowledged that works that alter floodplain hydraulics and hydrology may threaten the ecological values of the Nyah Floodplain, and potentially those of surrounding areas. In order to identify and assess these risks during project development, a comprehensive and rigorous risk assessment was completed (Lloyd Environmental, 2014). This involved identifying potential undesirable outcomes, determining their root causes, assessing likely consequences and significance; and developing relevant mitigation measures to reduce any residual risk to an acceptable level (very low to moderate). Experience gained from previous works and measures, and environmental watering projects of similar scale and complexity, including TLM, informed this process.

The methodology described in Section 7.2 was applied to assess the threats to successful project development, delivery and operation, and the potential adverse ecological impacts of the proposed supply measure. It is therefore also relevant to Sections 11 and 17.

The comprehensive approach undertaken to assess potential adverse ecological impacts of the Nyah Floodplain project ensures risk management strategies can be implemented to ensure management and mitigation of:

- Adverse salinity impacts or water quality outcomes at the site;
- The potential to increase pest species;
- The potential to favour certain species to the detriment of others or to adversely affect certain species; and
- Adverse impacts on ecological function and connectivity.

The nature of any downstream salinity and/or water quality impacts, and any potential cumulative impacts with other measures, cannot be formally ascertained at this time. This is because such impacts will be influenced by other measures that may be operating upstream of this site, including other supply/efficiency/constraints measures under the SDL adjustment mechanism, and the associated total volume of water that is recovered for the environment.

It is expected that likely or potential downstream/cumulative impacts will become better understood as the full package of adjustment measures is modelled by the MDBA and a final package is agreed to by Basin governments.

7.1 Risk assessment methodology

A risk assessment was completed in line with the requirements of AS/NZS ISO 31000:2009 (Lloyd Environmental 2014). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and prioritised mitigation strategies and measures. Table 7-1 and Table 7-2 show, respectively, the definitions used for assigning levels of the consequences of threats, and definitions used for assigning levels of the likelihood of threats. Tables 7-3 and 7-4 show, respectively, the risk matrix and definitions used in this risk assessment.

A thorough review of existing literature and a cross-disciplinary expert workshop with the Mallee CMA and key stakeholders was undertaken to complete the risk assessment for the project site (Lloyd Environmental, 2014). In summary, the process included:

- Identification of values, threats to those values and the significance of these threats
- Assessment of the likelihood and consequences of potential impacts for each threat
- Identification of mitigation options

- Assessment of the residual risk after mitigation options were identified.

Further work to consolidate the risk assessment was undertaken as the project developed and incorporated into Table 7-5.

Table 7-1. Definitions used for assigning levels of the consequences of threats

	Level	Description
Consequence	Minor (1)	The effects are limited in extent or duration and do not significantly impact on the site values
	Moderate (2)	The effects are moderate in extent or duration and are in conflict with site values or will have minor impacts on offsite values
	Severe (3)	The event significantly undermines site values or moderately impacts on offsite values
	Catastrophic (4)	The event is in significant conflict with the site values or severely impacts offsite values and will result in a serious deterioration of the system

Table 7-2. Definitions used for assigning levels of the likelihood of threats

	Level	Description
Likelihood	Remote (1)	An event which is not expected to occur but may occur under rare, exceptional circumstances
	Unlikely (2)	An event which is not expected to occur as a result of normal activities but may occur
	Possible (3)	An event which is possible and will occasionally occur as a result of normal activities
	Likely (4)	An event which is expected to occur as part of normal activities
	Certain (5)	An event which is expected to occur as a result of the action

Table 7-3. ISO Risk Matrix

Likelihood	Consequence			
	Minor	Moderate	Severe	Catastrophic
Remote	1	2	3	4
Unlikely	2	4	6	8
Possible	3	6	9	12
Likely	4	8	12	16
Certain	5	10	15	20

Table 7-4. Definitions of the levels of risk

Risk	Scores	Risk	Definitions
	1-2	Very Low	There is no reasonable prospect the project objectives will be affected by the event
	3-4	Low	The event is a low priority for management but risk management measures should be considered
	5-8	Moderate	The risk is a moderate priority for management. Risk management measures should be undertaken.
	9-12	High	The risk is a high priority for management. There is a reasonable likelihood it will occur and will have harmful consequences. Risk management is essential.
	15-20	Very High	The risk is a very high priority for management. It is likely to occur and will have very harmful consequences. Risk management is essential.

7.2 Risk assessment outcomes

A summary of the risk assessment and subsequent work undertaken are presented in Table 7-5, including the mitigation measures developed and an assessment of the residual risk after these are applied. Where a residual risk is given a range of ratings, the highest risk category is listed. It is important to note that the majority of the risks identified in this table exist in both an "existing conditions" or "Basin Plan without works" scenario, but are included because the proposed works provide mitigation opportunities.

Table 7-5. Risk of potential adverse ecological impacts with and without mitigation. Adapted from Lloyd Environmental (2014

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
Adverse salinity impacts or water quality outcomes						
Low dissolved oxygen (DO) levels	Low dissolved oxygen (DO) concentrations can occur through a variety of processes, including blackwater events, algal and cyanobacterial blooms, high organic matter loadings and stratification. Low DO can cause the death of aquatic fauna and have negative impacts on the health of wetland communities in general. More frequent inundation (i.e. through managed watering events) will reduce the accumulation of organic matter on the floodplain between inundation events.	Likely	Severe	High	Planning phase: • Monitor antecedent floodplain conditions (i.e. organic matter loads) to assess risk of a hypoxic event occurring. • Consider seasonal conditions (e.g. temperature, algae) prior to watering Operations phase: • Commence watering as early as possible to move organic matter off the floodplain while temperatures are low • Maintain through-flow where possible in other areas to maximise exchange rates and movement of organic material. • Monitor DO and water temperature to identify hypoxic areas to inform consequence management (see below). Managing consequences: • Ensure dilution of low DO water by managing outflow rates and river flows • Delay outflows if river flows are too low. • Dispose of hypoxic water by pumping to higher wetlands where possible. • Agitate water using infrastructure to increase	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
					aeration.	
Poor water quality	Water manipulations may lead to suspension of sediments and/or organic matter causing elevated nutrients, high turbidity and/or low dissolved oxygen (DO) levels. This may impact reduce food sources and possibly toxic algal blooms upon wetland community health, threatened species, fish and other aquatic fauna communities, and waterbird communities (via impacts). The risk assessment for low DO water is presented above.	Possible	Moderate	Moderate	As above.	Low
Inability to discharge poor quality water	Inability to discharge water of poor water quality during a managed flow event, due to downstream impacts (e.g. increases in instream salinity), could result in impacts on floodplain vegetation (due to extended inundation) or formation of blackwater/algal blooms.	Likely	Severe	High	Schedule watering events to make use of dilution flows where possible. Maintain good relationships with other water managers. Integrate water management with other sites in seasonal water planning process. Where possible and useful, water can be disposed within the site (pump to higher wetlands). Continue to undertake water quality monitoring before, during and after watering events to inform adaptive management strategies and real-time operational decision making.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual risk
Development of saline mounds under wetlands and displacement of saline groundwater	An increase in groundwater levels may occur in response to project inundation events. Shallow saline groundwater can impact on the health of floodplain vegetation and wetland communities, both at Nyah and downstream. Further details on the salinity impact assessment and mitigation strategies for this proposed supply measure is provided in Section 11.4.	Likely	Severe	Moderate	Avoid watering salinity hot spots identified through the use of AEM datasets (Munday et al. 2008), instream nanoTEM (Telfer et al. 2005a and 2005b, 2007) and other salinity investigations. Monitor the salinity of ground and surface water salinity before, during and after watering events to inform management and ensure sufficient volumes are available for mitigation such as: • Diluting saline groundwater discharge with sufficient river flows. • Diluting saline water on the floodplain by delivering more fresh water to these areas. Reduce the frequency and/or extent of planned watering events if sufficient volumes not available.	Low

The potential to increase pest species						
Increased carp populations	Carp will breed in response to both natural and managed floods. High numbers of carp can threaten the health and diversity of wetland vegetation, affecting native fish and other aquatic fauna. This has potential impacts both within the project site and at the reach scale.	Certain	Severe	Very High	Tailor watering regimes to provide a competitive advantage for native fish over carp. Dry wetlands that contain large numbers of carp. Manage the drawdown phase to provide triggers for native fish to move off the floodplain and, where possible, strand carp.	Moderate
Proliferation of pest plants	Pest plants may be promoted under certain water regimes, potentially impacting the health of all wetland and floodplain vegetation communities. This, in turn, will impact on dependent fauna, including threatened species.	Certain	Severe	Very High	Time water manipulations to drown seedlings, minimise growth, germination and seed set. Time water manipulations to promote native species. Control current populations and eradicate/control new infestations via existing management strategies (e.g. Parks Victoria pest management action plans/strategies). Support partner agencies to seek further funding for targeted weed control programs if necessary.	Low
Increase in pest animals	The reinstatement of more frequent flooding regimes is likely to provide and maintain more favourable conditions for many terrestrial animal pests. In particular, pigs are swamp dwellers and their impacts on watered areas may be more severe than other species.	Likely	Severe	High	Control pest animal populations via existing management strategies (e.g. Parks Victoria pest management action plans/strategies). Support partner agencies to seek further funding for targeted control programs if necessary.	Moderate

Transport or proliferation of invasive weeds due to construction activity	Proliferation of weeds will have impacts on the health of all wetland and floodplain vegetation communities. This, in turn, will impact on dependent fauna, including threatened species.	Likely	Moderate	Moderate	Develop and adhere to an Environmental Management Plan (EMP) that includes hygiene protocols, enforcement and contractor management.	Low
The potential to favour certain species to the detriment of others or to adversely affect certain species						
Permanent habitat removal or disturbance during construction	Construction of the proposed works will cause disturbance to the floodplain and require the permanent removal of some vegetation/habitat.	Certain	Moderate to Severe	High to Very High	Utilise existing access tracks wherever possible. Design and locate infrastructure/works to avoid and minimise the extent of clearing and disturbance. Ensure clear on-site delineation of construction zones and adequate supervision during works to avoid unauthorized clearance/disturbance.	Moderate
Temporary habitat removal or disturbance during construction	Construction of the proposed works will cause disturbance to the floodplain and require the temporary removal of some vegetation/habitat.	Certain	Moderate	Moderate to Very High	As above. Remediate/revegetate the site once construction activities are complete.	Moderate
Invasion of river red gum in watercourses and open wetlands	Germination of dense thickets of river red gum within watercourses and wetlands, and at the edge of the Berribee Regulator pool may block flow through the system. Obstruction of flows can diminish the effectiveness of future watering events. Prolific germination of seedlings within wetlands will change the habitat structure and the	Certain	Moderate	High	Use of operational strategies to control unwanted germination and establishment, including: • Drowning seedlings. • Timing the recession to avoid optimal conditions for germination in targeted areas (if feasible).	Low

	suite of dependent biota.				Targeted removal of seedling/saplings to remove flow obstructions, if necessary.	
Adverse impacts on ecological function and connectivity						
Increase in fire frequency, extent and intensity	The reinstatement of more frequent flooding regimes threat will increase the biomass of floodplain vegetation, increasing the fuel load for bushfires. An increase in the frequency, extent and duration of bushfire could have impacts on ecosystem form and function.	Possible	Moderate	Moderate	No specific mitigating actions have been identified. If a bushfire occurs on Nyah Floodplain, Parks Victoria and DEPI will respond as usual in such situations.	Moderate
Managed inundation regimes do not match flow requirements for key species	The delivery of an inappropriate water regime may occur through inadequate knowledge of biotic requirements or conflicting requirements of particular species with broader ecological communities. This may lead to adverse ecological outcomes, e.g. failure of waterbird breeding events, lack of spawning response in fish, spawning response but no recruitment.	Possible	Moderate	Moderate	Consider the various requirements of key species/communities when developing operating strategies and planning for watering events. Assess the response of species of concern during and after managed watering events and adjust operational arrangements if required. Update operating strategies to capture new information on the water requirements/ response of key species/communities. Target different taxa at different times (e.g. target vegetation one year and fish the next).	Low
Prolonged inundation of	Vegetation in the deepest parts of the regulator	Possible	Moderate	Moderate	Ensure through-flow when operating structures to	Low

vegetation	pool may receive excessive inundation (duration and depth) if the water requirements of vegetation at the perimeter of the pool are met. This is likely to cause localized impacts on vegetation health, possibly death of some less tolerant species.				more closely replicate a more natural hydraulic gradient. Incorporate information on operations, potential impacts and tolerance of inundation regimes and the role of natural floods in ecosystem function into operational plans to minimise the impact.	
Inadequate water regime delivered	An inadequate water regime could be delivered through: • Design and construction issues; • Invalid modelling assumptions and/or flow measurement; • Inadequate or incorrect information regarding water requirements and/or system condition; • Errors in planning and calculation of the volumes required; or • An inadequate volume allocated to the event. This could result in adverse ecological impacts such as drought-stress of vegetation, loss of habitat and limited breeding opportunities for fauna.	Unlikely	Severe	Moderate	Confirm the validity of modelling assumptions during operations to inform future planning and refine the operating arrangements. Design structures for maximum operational flexibility. Ensure adequate measures are in place to measure inflows/outflows. Assess ecosystem response during and after managed watering events and adjust operational arrangements if required. Maintain strong working relationships with river operators, partner agencies and water holders to facilitate timely issue resolution (e.g. allocation of additional water if required).	Low
Stranding and isolation of fish on floodplains	Stranding can occur through sudden changes in water levels and/or new barriers preventing native fish from escaping drying areas during flood recessions. This may result in the death of a	Possible	Moderate	Moderate	Develop a 'Fish Exit Strategy' to inform regulator operation during the drawdown phase to maintain fish passage for as long as possible and to provide cues for fish to move off the floodplain.	Low

	portion of the native fish population.				Monitor fish movement and adapt operations as required. Continue to build on knowledge and understanding through current studies relating to fish movement in response to environmental watering and cues.	
Barriers to fish and other aquatic fauna movement	Installation of regulators in waterways and wetlands creates barriers to the movement of fish and other aquatic fauna. This can reduce access to feeding and breeding habitat, and limit migration or spawning opportunities.	Possible	Moderate	Moderate	Determine fish passage requirements and incorporate into regulator design (as in Hames, 2014). Continue to build on knowledge and understanding through current studies relating to fish movement in response to environmental watering and cues.	Low

7.3 Consideration of significant, threatened or listed species

Throughout project development, significant consideration has been given to the potential impact on significant, threatened or listed species that occur at Nyah Floodplain (see Section 4). Overall, the project is expected to benefit these species by increasing the frequency, duration and extent of floods of various sizes (see Section 6). However, construction activities will involve physical disturbance to the floodplain and some vegetation clearance is unavoidable. This will result in temporary and permanent vegetation removal and habitat disturbance (see Table 7-5).

In order to minimise the potential impacts on threatened species, detailed vegetation assessments and further assessment of the impacts on all threatened species will be carried out during the detailed design process, to inform final construction footprints and the development of mitigation measures, where necessary. To date, preliminary locations for infrastructure and works have been chosen to minimise vegetation loss. New access tracks and upgrades of existing tracks will be designed to minimise clearance of large trees and understorey vegetation.

Any losses of native vegetation will be offset in line with current state policy. A program-level approach to offsetting is currently being developed, where the primary offsetting mechanism will be the gains in vegetation condition within the areas watered by the various Victorian works-based supply measures. An assessment of vegetation offset requirements based on preliminary construction footprints indicates that the offsets for this proposed supply measure can be met using this approach.

If funded for construction, this proposed supply measure will be referred under the EPBC Act and Victorian EE Act. Measures to avoid and minimise impacts to threatened species will be a key component of the referrals. Such measures will be consolidated in relevant management plans such as a Construction Environment Management Plan (CEMP) and a Threatened Species Management Plan (TSMP).

Monitoring the response of threatened species to operation (e.g. population abundance, structure and distribution) and the effectiveness of mitigating actions will be critical to inform the planning and management of watering events.

7.4 Risk mitigation and controls

The risk assessment confirms that all identified risks are reduced to acceptable levels (very low to moderate) once well-established risk mitigation controls are implemented. While there are several potential threats could generate high risks to ecological functionality (Table 7-3), these are considered manageable because they:

- Are well known and are unlikely to involve new or unknown challenges
- Can be mitigated through well-established management controls
- Have been successfully managed by the Mallee CMA and project partners (including construction authorities) in previous projects
- Result in very low or moderate residual risks after standard mitigation measures are implemented.

As noted in Lloyd Environmental (2014), characterisation of the residual risk must be read within the context of the works creating a substantial improvement in the ecological condition of the site. The improvement will have a very significant role in mitigating many of the impacts. However, these improvements will take time to be realised and therefore the impacts may seem more significant in the short term.

Six threats retained a residual risk of moderate after implementation of the recommended mitigation strategies (Table 7-6). Further consideration of these threats may assist in further understanding the potential

impacts and, in some cases, identifying additional mitigation measures to reduce the residual risk.

7.5 Risk management strategy

A comprehensive risk management strategy will be developed for the proposed supply measure, building on the work completed for this business case. The strategy will cover ecological and socio-economic aspects to provide a structured and coherent approach to risk management for the life of this project (i.e. construction and operation). The strategy will include review processes and timetables for risk assessments, based on new developments or actions taken, and will assign responsible owner/s to individual risks. This will be an important input into the development of operating arrangements for the site.

The risk management strategy will include mitigating measures to address the following potential ecological impacts, as described in Table 7-5:

- Adverse salinity impacts or water quality outcomes either at the site or downstream
- The potential to increase pest species
- The potential to favour certain species to the detriment of others or to adversely affect certain species
- Adverse impacts on ecological function and connectivity.

Risk assessment and management is not a static process. Regular monitoring and review of the risk management process is essential to ensure that:

- Mitigation measures are effective and efficient in both design and operation
- Further information is obtained to improve the risk assessment
- Lessons are learnt from events (including near-misses), changes, trends, successes and failures
- Risk treatments and priorities are revised in light of changes in the external and internal context, including changes to risk criteria and the risk itself, and
- Emerging risks are identified.

The risk assessment process will continue throughout the development and implementation of this project. It is anticipated that additional threats will be identified and evaluated as the project progresses, and any new risks incorporated into the risk management strategy.

Table 7-6. High priority risks, mitigation and residual risk

Threat	Risk without mitigation	Residual Risk Rating	Additional considerations (Lloyd Environmental, 2014)	Guiding documents[1]
Enhancing carp recruitment conditions	Very High	Moderate	Additional targeted carp fishdowns, water level manipulations to disrupt the survival of juveniles and the installation of carp cages may all help reduce carp numbers. In addition, future research on carp control may identify new control measures.	Nyah Floodplain Management Project Operating Plan (Preliminary) *Fish exit strategy*
Permanent habitat removal or disturbance during construction	High to Very High	Moderate	The risk assessment for these threats will be revised once construction footprints are finalised and detailed vegetation assessments are carried out. If significant species or EVCs are found to be at or close to the site and could be impacted, further actions to reduce the residual risk would include targeted management actions and/or vegetation offsets for the relevant biota.	Basin Plan Environmental Works Program: Regulatory Approvals Strategy (GHD, 2014a) Statutory Approval Requirements (Golsworthy, 2014). *Environmental Management Framework* *Construction Environmental Management Plan* *Offset Strategy* *Threatened Species Management Plan*
Temporary habitat removal or disturbance during construction	Moderate to Very High	Moderate		
Low DO levels	High	Moderate	The risk assessment has assumed that more frequent inundation will result in more frequent blackwater events than occur currently, and that these events will be of similar magnitude. It is, however, possible that more frequent events may be less intense as tannins and organic material are thought to reduce in subsequent watering events. This is a knowledge gap that could be addressed through ongoing studies.	Assessing the Risk of Hypoxic Blackwater Generation at Proposed SDL Offset Project Sites on the Lower River Murray Floodplain (Ning et al, 2014) Nyah Floodplain Floodplain Management Project Operating Plan (Preliminary)
Increase in pest animals	High	Moderate	More intensive culling programs may be needed. Further research into alternative control measures may provide additional control options.	Nyah Floodplain Management Project Operating Plan (Preliminary)
Increase in fire frequency, extent and intensity	Moderate	Moderate	Unavoidable risk that accompanies a project designed to promote growth of native vegetation in the region.	Mallee Loddon Fire Operations Plan 2014/15–2016/17 (DEPI, 2014)

[1] Documents in italics are yet to be developed

8. Current hydrology and proposed changes (Section 4.5.1)

8.1 Pre-regulation river hydrology

River Murray flow at Nyah is influenced by the Murray and Goulburn Rivers and all upstream River Murray tributaries. The Nyah floodplain experiences its largest floods when the Murray and its upstream tributaries are in flood, generally occurring from late winter to early summer.

The natural hydrology of the River Murray at Nyah is characterised by frequent inundation events of between 12,500 and 22,500 ML/d. Flooding persisted for four to eight months in most years and frequently lasted throughout the year. Most floodplain depressions at Nyah are shallow and retain little water, but under pre-regulation river hydrology they would have frequently remained flooded throughout the year.

The Nyah floodplain is a shallow basin aligned parallel to the River Murray. It is formed between the high ground of natural levee along the river bank in the east and the terrestrial landscape to the west. Parnee Malloo Creek is an intermittently flowing anabranch that meanders through the floodplain over a distance of 16 km. The creek departs from the River Murray near Nyah at 1353 river km and rejoins the river near Wood Wood at 1346 river km. Shallow wetland depressions adjacent to the creek are filled by water spilling from the creek and by minor effluents in the river levee (Ecological Associates 2006).

Water first enters Nyah Park at the downstream end of Parnee Malloo Creek. The upstream connection of the channel is connected soon after with through-flow occurring at river discharges approaching 12,500 ML/d.

As river levels continue to rise above 17,500 ML/d, water spills from Parnee Malloo Creek to adjacent wetlands. Effluents along the river bank also introduce water to wetlands, the most important of which is Green Swamp which is flooded at river levels over 20,000 ML/d.

Water spreads through the forest understorey as river levels rise and at river discharges exceeding 25,000 ML/d approaches the higher ground along the river levee and terrestrial boundary of the floodplain.

On the falling hydrograph, water remains pooled Green Swamp and other wetland areas (Ecological Associates 2006). A deep billabong just north of the Parnee Malloo Creek confluence is filled by water spilling from the creek at river discharges exceeding 20,000 ML/d. This wetland retains water to a depth of more than 2 m.

As shown in Table 5-2, the natural hydrology of the river at Nyah Park is characterised by very frequent and sustained floodplain inundation events. Events between 12,500 ML/d and 22,500 ML/d, which inundate wetland and forest areas, occurred with a frequency of more than 10 events every 10 years. The duration of these events was substantial. Events that would inundate wetlands and activate through-flow in Parnee Malloo Creek (12,500 ML/d) had a median duration of more than five months while the median duration of forest flooding events (20,000 to 25,000 ML/d) was than two to three months. Flows 25,000 ML/d inundate red gum woodland at the edges of the floodplain. Under natural conditions these flows occurred approximately 100 years in 100 and lasted approximately six weeks.

8.2 Current floodplain hydrology and infrastructure

Floodplain modifications

The spread of water in the Parnee Malloo Creek is currently impeded by levees from redundant irrigation infrastructure and now provides access to the forest during inundation. Two earthen banks form a storage in the creek that is filled by water pumped from the River Murray. A former water supply for the now defunct Nyah Golf Club, the storage is now used as a fire water supply by two landholders. Addressing the barriers to though-flow in Parnee Malloo Creek is important to achieving the ecological objectives for fish set by the *Nyah*

Floodplain Management Project. Accordingly, the removal of these levees has been included as part of the proposed works package (section 12).

Changed hydrology

Regulation of the River Murray has patterns of flooding at Nyah Park. The hydrology of the River Murray at Swan Hill was analysed under natural and current conditions (Ecological Associates, 2006), as summarised below.

Key changes to the hydrology of Nyah Park under current (regulated) conditions:

- Median monthly flow peaks have declined under current conditions, with the greatest impacts being in the high flow months from June to January (Figure 8-1).
- The impacts on median flows in autumn are relatively minor (Figure 8-1).
- The frequency of flow peaks greater than 10,000 ML/d has declined somewhat but the median duration of these events has declined even more (Figure 8-2.)
- Flows of 10,000 to 15,000 ML/d, which would have occurred almost 15 times every 10 years under natural conditions, last only 5 weeks rather than the 5 month median duration under natural conditions and (Figure 8-2).
- The duration of events which reach the upper extent of red gum forest communities (25,000 ML/d) has almost halved from 75 days to 30. The frequency of these events has also declined significantly from 10 events every 10 years to only 6 (Figure 8-2).

Very high flows of 30,000 ML/d rarely occur in this reach and remain relatively unimpacted by regulation.

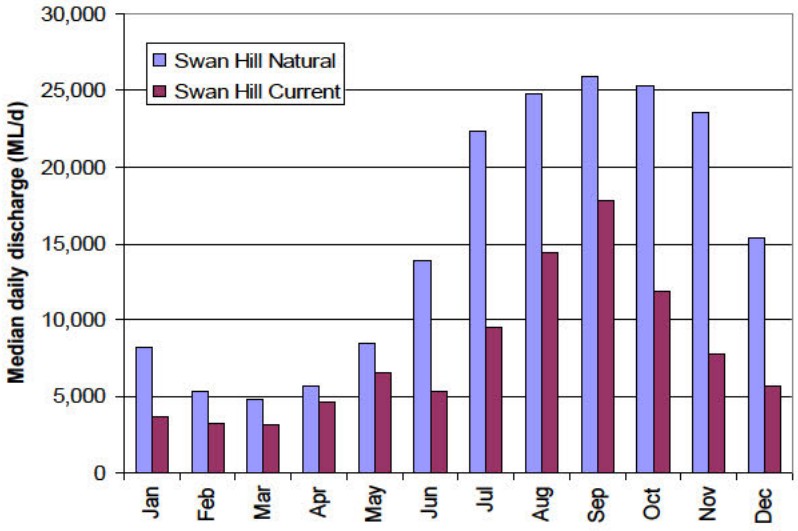


Figure 8-1: Distribution of median flows for each month in the River Murray for natural and current conditions. Derived from MDBC MSM-Bigmod 109 year data (Ecological Associates, 2006)

The river is now managed in a low-flow state for a greater proportion of time in order to deliver water efficiently to downstream consumers. The low-flow component of the hydrology is characterised by a high frequency of brief flow peaks less than 10,000 ML/d (Figure 8-2).

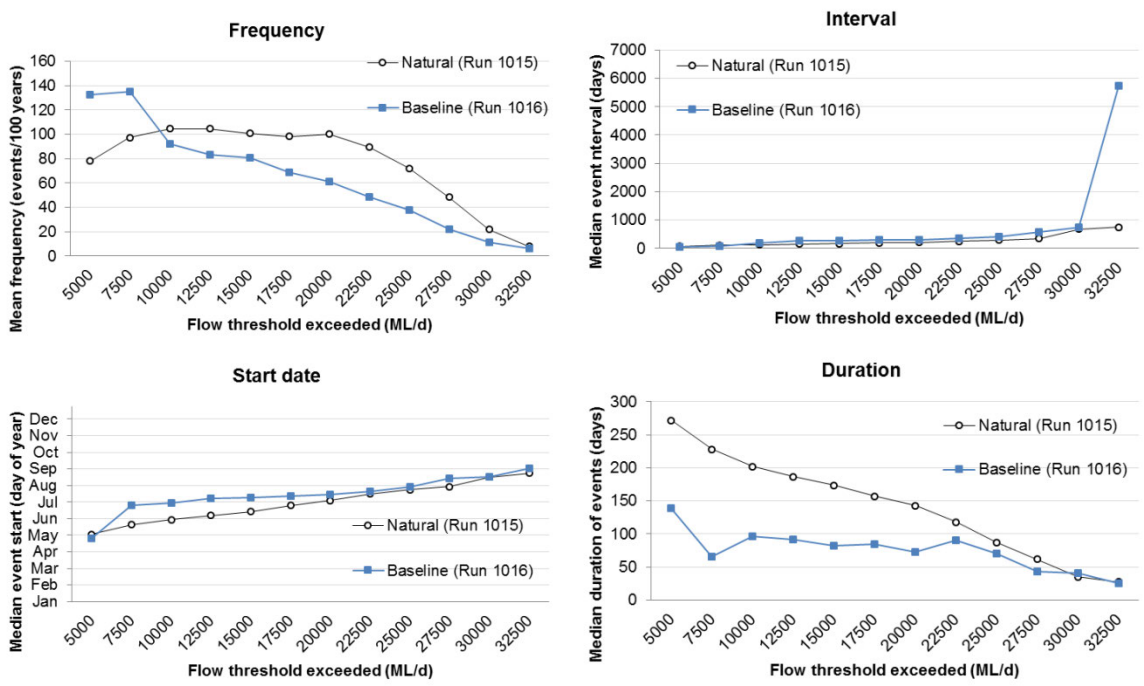


Figure 8-2: Comparison of statistical properties of events at Swan Hill under Natural and Baseline modelled flow scenarios, over a 114 year modelled period (Gippel, 2014)

Hydraulic modelling of Nyah under baseline condition shows that there is connection of the waterways at 12,500 ML/d, with the floodplain engaging at 17,500 ML/d and with more widespread floodplain inundation at 20,000 ML/d (Figure 8-3).

These hydraulic modelling outputs were derived from steady state conditions, which may not reflect operational River Murray hydrographs and, as such, may result, in lower inundation areas in practise than expressed in the modelling outputs.

For example, the modelled extent shown of 20,000 ML/d in Figure 8-3, represents the absolute maximum extent achieved after a steady state flow of 20,000 ML/d over a period of many months.

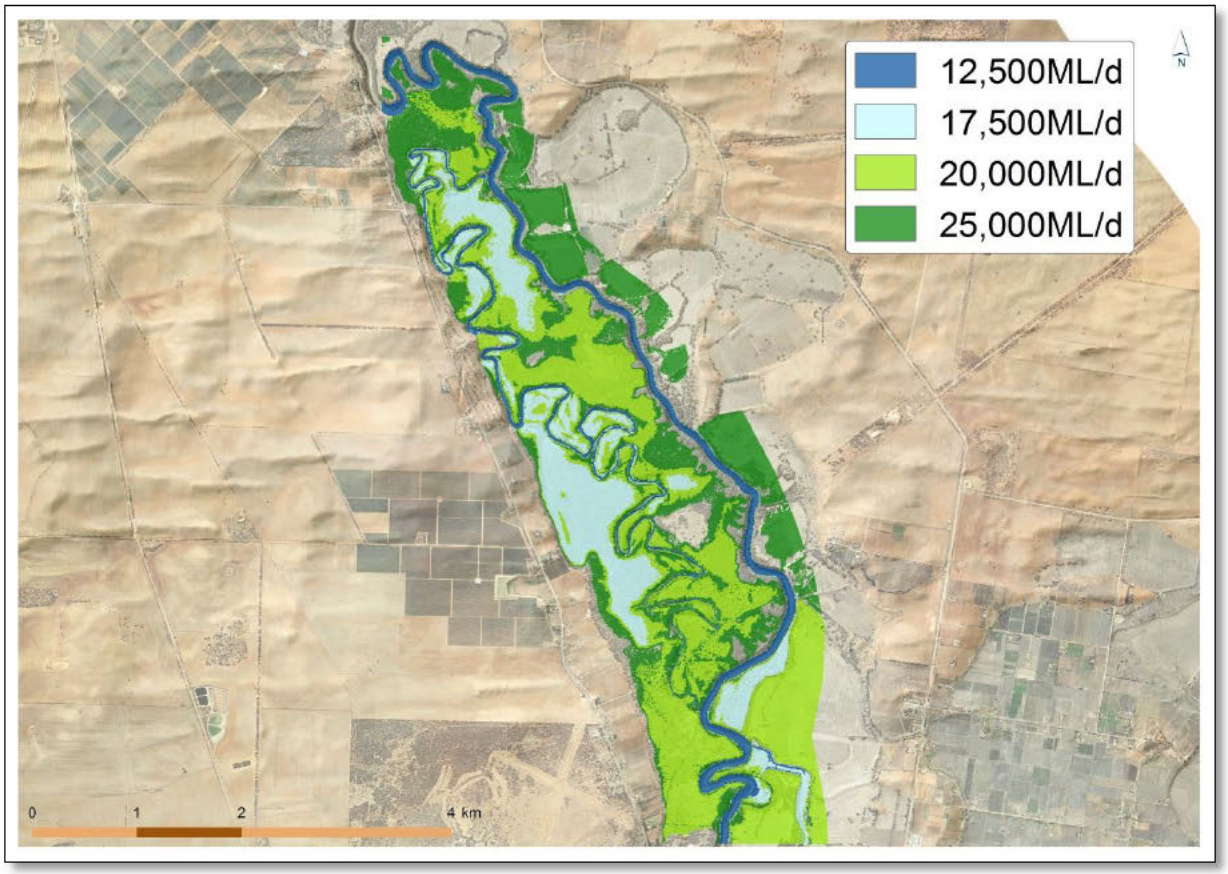


Figure 8-3: Nyah floodplain inundation at flows of 12,500, 17,500, 20,000 ML/d (Jacobs, 2014)

8.3 Proposed Changes

Basin Plan flow will contribute toward bridging the gap between natural and baseline conditions as shown in the spells analysis (Figure 8-4) and Table 8-1. Note: Basin Plan 2750 model run number 983 has been used as the basis of this analysis.

The Basin Plan will primarily affect flows less than that required for floodplain watering at Nyah (Table 5-2). For example a seasonal fresh scenario for Parnee Malloo Creek requires flows of 15,000 ML/day, this will occur 8 times in 10 years under baseline, 8.6 times under Basin Plan and 10 naturally. By comparison, inundation of Red Gum Swamp Forest requires flows of 20,000 ML/day, this will occur 6 times in 10 years under baseline, 7.8 times under Basin Plan and 10 naturally.

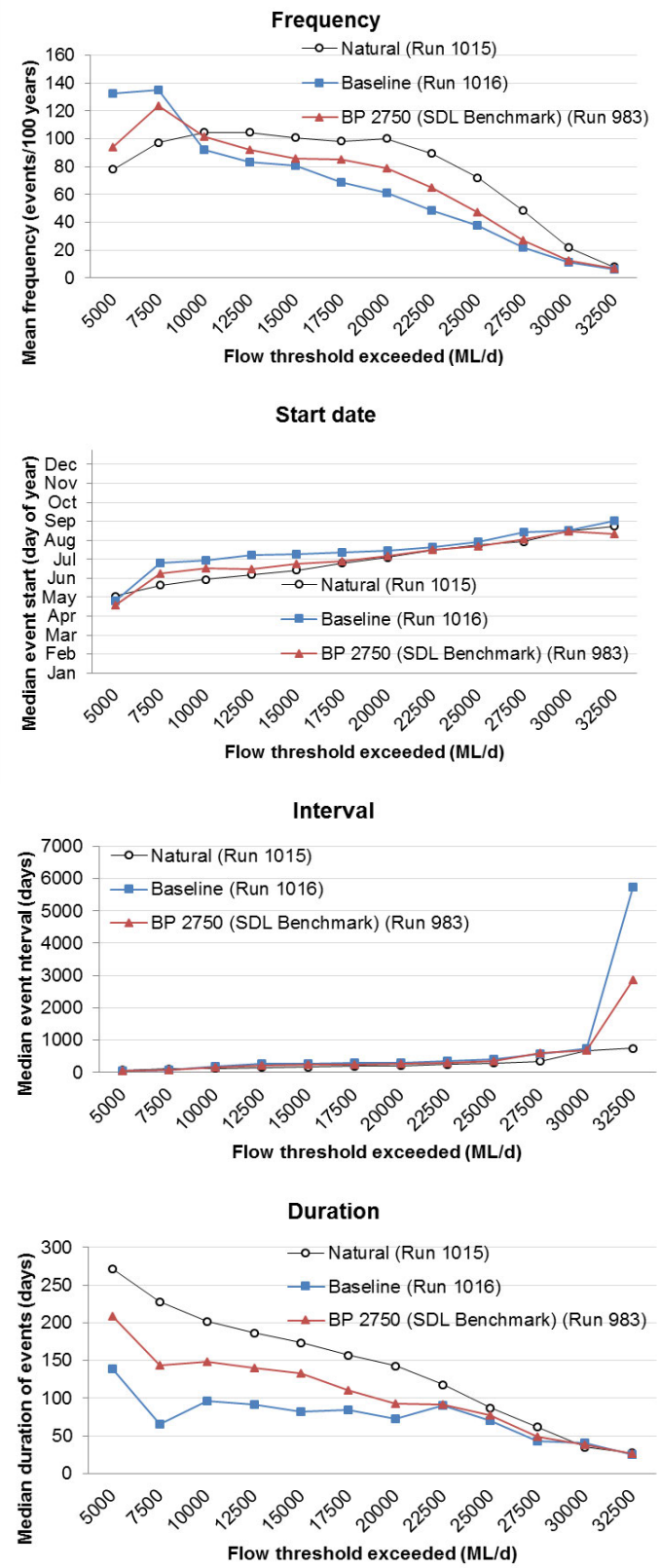


Figure 8-4: Comparison of statistical properties of events at Swan Hill under the Natural, Baseline and Basin Plan 2750 modelled flow scenarios, over a 114 year modelled period

Table 8-1: Proposed operating plan to meet the gap in the shortfall in flood frequency and duration for Nyah Forest under the Basin Plan (2750) without measures scenario

Threshold (ML/d)	WRC	Conditions	Prevalence yrs with event %	Duration Median (days)	Timing	Proposed operations to meet gap	
						Frequency (year in 10)	Approx. Duration
15,000	Seasonal Anabranch	With Measure[1]	100	150	Late autumn – early winter	2	5 months
		Basin Plan without measure	82	133	Late autumn – early winter	8	1 month
17,500	Seasonal Wetland	With Measure[1]	90	120	Late autumn – early winter	1	4 months
		Basin Plan without measure	81	110	Early winter	-	-
20,000	Red Gum Swamp Forest	With Measure[1]	90	120	Early winter	2	4 months
		Basin Plan without measure	72	93	Early winter	7	1 month
25,000	Red Gum Forest and Woodland	With Measure[1]	70	77	Early to mid-winter	3	2.5 months
		Basin Plan without measure	46	77	Early to mid-winter	-	-

Source: Gippel (2014).

[1] With Measures figures based upon interpretation of the preliminary operations plan adapted from (Ecological Associates 2014c)

Table 8-1 shows the expected shortfall in frequency and duration between Basin Plan and target flows will be:

- 2 years in 10 to meet the frequency requirements for seasonal anabranches.
- 1 year in 10 to meet the frequency requirements for seasonal wetlands.
- 2 years in 10 to address the gap in the frequency requirements for Red Gum Swamp Forest.

Table 8-1 also shows the Basin Plan flows will:

- Meet the frequency and duration requirement of Red Gum Forest and Woodland 4 to 5 years in 10 and no additional operations are required to meet the duration requirements in those years. and
- Be extended with managed releases to meet the duration requirements of different water regime classes e.g. additional releases into the Red Gum Swamp Forest 7 years in 1- for 1 month.

Flows which result in flooding across broader expanses of the Nyah floodplain e.g. Red Gum Swamp Forest watering events, will also result in flooding of the lower lying areas where the seasonal wetlands and anabranches occur. This may meet the frequency requirements of the lower lying areas however not meet the duration requirements, as discussed in section 9. This will be taken into account in seasonal water planning.

In order to further demonstrate the differences in the scenarios described in Table 8-1, hydrographs of the flow regimes are illustrated in Figure 8-5. The flow regimes represent a wetter than average sequence of years (1990s) and an extremely dry sequence of years (2000s).

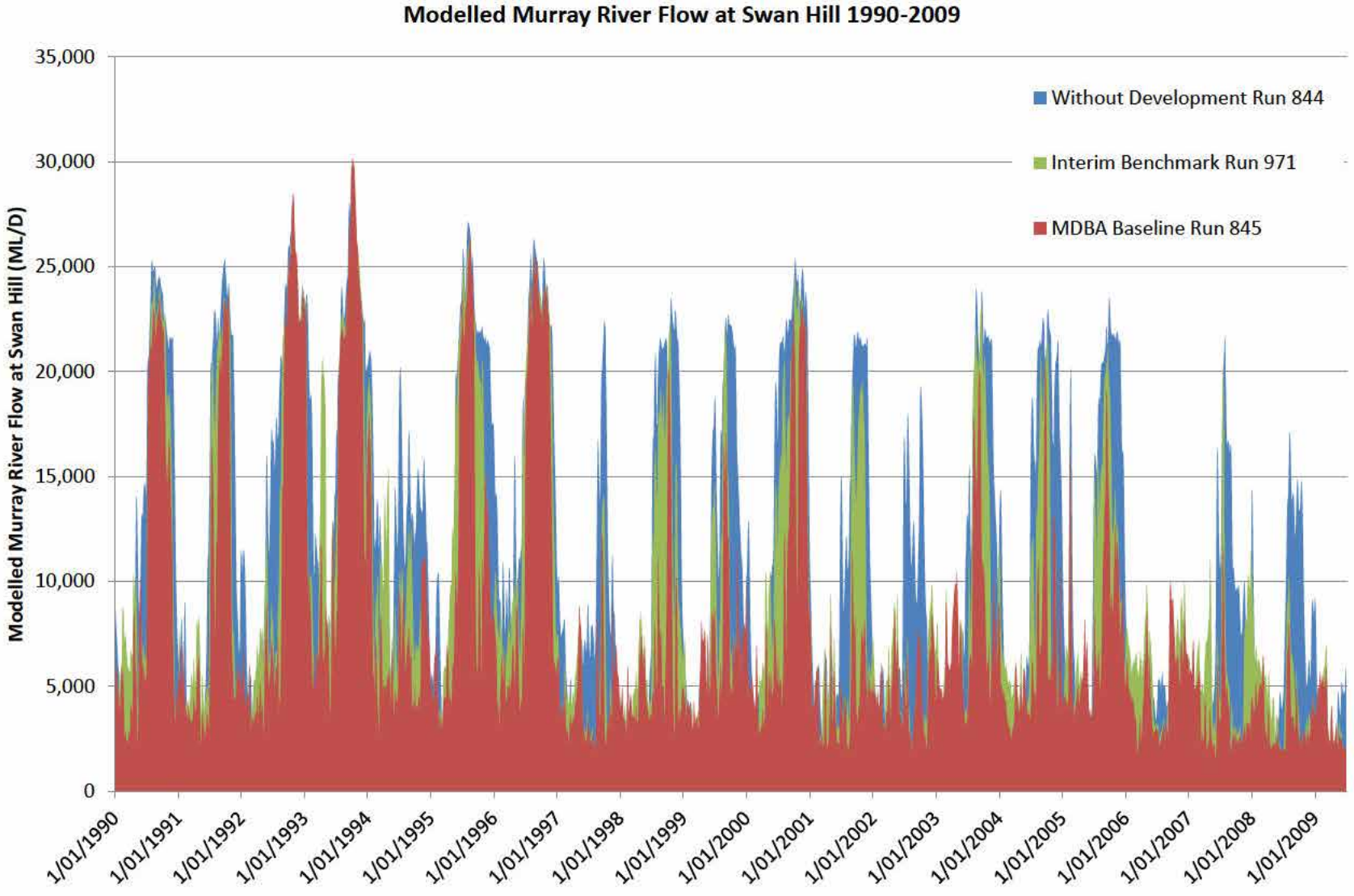


Figure 8-5: Daily Peak Flow by year for different flow regimes at Swan Hill (Data supplied Mallee CMA, 2014)

9. Environmental water requirements (Section 4.5.2)

The environmental water requirements of the *Nyah Floodplain Management Project* have been identified (Table 5-2, Table 8-1) and contribute to the achievement of ecological objectives and targets for this site (Ecological Associates, 2014a).

The process for identifying the environmental water requirements for this site built on the work undertaken in establishing ecological objectives. Detailed hydrographic information, spatial data and scientific literature relating to the site was analysed and compared against ecological objectives, which was then combined to generate site-specific environmental water requirements (Ecological Associates, 2014a).

This project considers the environmental water requirements across the following water regime classes:

- seasonal anabranch
- seasonal wetland
- Red gum swamp forest and
- Red gum forest and woodland.

The Nyah measure will support a diversity of water depths in accordance with landscape formations and topography. The Parnee Malloo Creek is deeply incised supporting an approximate water depth of two to three meters during operation of the works.

Ecological objectives and targets, and their corresponding environmental water requirements, are outlined in Table 9-1. Importantly this table illustrates the flexibility that will be incorporated into the future operation of the proposed works to mimic the variability that would have occurred under natural flow patterns.

Mechanisms to deliver these environmental water requirements are detailed in Section 10.

Table 9-1: Ecological objectives, targets and environmental water requirements (Ecological Associates, 2014a)

Water Regime Class	Flow threshold	Strategy	Frequency	Duration	Timing
Seasonal Anabranch	15,000 ML/d	Increase through-flow in Parnee Malloo Creek by increasing River Murray flow in spring and early summer.	Seasonal flow in Parnee Malloo Creek.	Four to six months annually.	Late autumn – early winter
Seasonal Wetland	17,500 ML/d	Capture peaks in river flow by closing regulators on the flood recession. Pump water into wetlands if peaks in river flow are too infrequent.	Wetland depth to exceed retention level of wetland nine years in ten. Wetlands completely dry one year in ten.	Six of these events to last more than nine months. Three of these events to last more than 12 months. Wetland depth to be less than 50% of retention level in May five years in ten.	Late autumn – early winter
Red Gum Swamp Forest	20,000 ML/d	Capture peaks in river flow by closing regulators on the flood recession. Pump water into wetlands if peaks in river flow are too infrequent.	Flooding to be provided nine times in ten years.	Five of these events to be five months long. Four of these events to be seven months long.	Early winter
Red Gum Forest and Woodland	25,000 ML/d	Capture peaks in river flow by closing regulators on the flood recession. Pump water into forest if peaks in river flow are too infrequent.	Provide flooding eight times in ten years.	Four of these events to be six weeks long. Four of these events to be 12 weeks long.	Early winter – mid-winter

10.Operating regime (Section 4.6)

10.1 Role of structures and operating scenarios

The proposed works consist of environmental regulators and a range of supporting structures.

The N1a, N1b, N2 and N5, in conjunction with Basin Plan flows, will be the primary means of delivering water to Nyah Park and achieving the ecological objectives for the site.

The proposed works and the existing infrastructure are described in Table 10-1. The volumes in Table 10-1 were derived from scenario modelling to determine the extent of flooding, and depth/area relationships with stage height for each of the regulators. The volumes therefore refer to void space and assumes no losses or return flows. This information, together with the proposed operating regime, will enable the MDBA to model return flows for the full range of operational scenarios during the assessment process.

The sources of water for managed inundation are:

- gravity inflow from the River Murray via backflow through structure N2 (once flow exceeds 13,000 ML/day)
- pumped inflow from the River Murray (using temporary pumps)[2]
- gravity inflow from the River Murray via structure N5 (once flow exceeds 17,500 ML/day) and
- overland flow (once flow exceeds 20,000 ML/day).

Table 10-1: Summary of existing and proposed environmental watering infrastructure at Nyah and its role in the project

Infrastructure[3]	Role	Associated area	Maximum inundation area	Volume to fill
N1a and N1b	Downstream flow control, enables water to be held at inundations up to 63.2 m AHD and released as required.	Whole of project	487.79 ha	2.797 GL
N2	The main regulator and outlet point, enables water to be held at inundations up to 63.2 m AHD (when closed) and released as required. Remains open during through flow conditions in Parnee Malloo Creek.			
Drop structure	Provides a plunge pool for downstream fish passage			
Raised tracks and overflow sills	Main mechanism to pond water on the floodplain. Water to be retained at inundations up to 63.2 m AHD.			
N5	Enable water to be retained at inundations up to 63.2 m AHD (when closed). This structure will prevent the pool draining back to the River Murray.			

[2] Pump infrastructure is not part of the concept design package
[3] There is no existing infrastructure at Nyah Park. All infrastructure listed is part of the proposed works package.

10.2 Operating scenarios

The Nyah water management works have been designed to provide maximum operational flexibility and can be used to complement Basin Plan flows or to deliver environmental benefits. Five scenarios have been developed to illustrate how these works can be used to achieve environmental outcomes. Scenarios include:

- default
- seasonal Fresh
- Nyah Intermediate
- Nyah Maximum and
- natural Flooding.

Each of the scenarios align with the water regime classes for Nyah Park, as illustrated in Table 10-2 below.

Table 10-2: Links between the operating scenarios and water regime classes at Nyah Park

Scenario	> 13,000 ML/d	Up to 17,500 ML/day	Up to 20,000 ML/day	> 20,000 ML/day
Seasonal anabranch	Seasonal Fresh	Nyah Intermediate	Nyah Maximum	Natural flows All structures open
Seasonal wetland				
Red gum swamp forest				
Red gum forest and woodland				

Table 10-2 shows that a seasonal fresh meets the water requirements of seasonal anabranches (Parnee Malloo Creek). Similarly, a Nyah maximum operation will meet the requirements of the Red Gum Swamp Forest, as well as the seasonal wetlands and anabranches.

An overview of each of the operational scenarios is provided below.

Default

This scenario is the default configuration for Nyah water management structures, in normal regulated river conditions when environmental watering is not required.

In this scenario all environmental structures are to be open.

Seasonal Fresh

The seasonal fresh scenario would provide flow within Parnee Malloo Creek and is achieved through suitable River Murray flow.

During this scenario all environmental regulators would remain in their default position of open.

Nyah Intermediate

Intermediate operation of the Nyah regulators and their associated support structures will enable watering of Parnee Malloo Creek, low level floodplain wetlands and the lower floodplain more frequently without inundating upper floodplain areas. This scenario requires the opening of N1a, N1b, N2 and N5. Once passing flows reach their peak or begin to recede, N1a, N1b, N2 and N5 are closed to manage inundation at the desired target level for an appropriate duration to meet required objectives. Natural inflows maybe augmented by temporary pumps.

Nyah Maximum

Maximum operation of the Nyah regulators and their associated support structures will enable watering of Parnee Malloo Creek, floodplain wetlands and up to the upper floodplain areas. This scenario requires the opening of N1a, N1b, N2 and N5. Once passing flows reach their peak or begin to recede, N1a, N1b, N2 and N5 are closed to manage inundation to the maximum operating level for an appropriate duration. Natural inflows maybe augmented by temporary pumps.

Natural Flooding

In order to minimise the impact of the infrastructure on natural flooding patterns, all regulating structures will be open during natural events, to allow full connectivity between the River Murray, the Parnee Malloo Creek and the floodplain.

Transition between operating scenarios

For a range of reasons it may be necessary to change between operation scenario during the course of a watering event.

Factors that may influence a decision to transition between scenarios may include;

- inflows causing increase in environmental water allocations
- inflows generating natural flooding
- response to ecological opportunities or to mitigate risks
- response to operational opportunities or to mitigate risks and
- response to water quality risk mitigation requirements.

An operation matrix (Table 10-3) has been developed which summarises how each structure would be operated to change from one scenario to another. For example, to move from Default conditions to Nyah Maximum, N5 would be opened to allow river flows to enter Parnee Malloo Creek, other regulators would be progressively closed to raise water levels in Nyah Park while maintaining appropriate passing flows.

The 'Condition during scenario' sections of the matrix show the status of the structures once each scenario has been established and is in operation.

During transition to all structure open under flood conditions, regulators are progressively opened until tailwater and headwater levels are matched. The structure may then be completely opened to allow unimpeded passage of natural flows.

Table 10-3: Operational matrix

Scenario	To Default	To Seasonal Fresh	To Nyah Intermediate	To Nyah Maximum	To Natural Flows
From Default	Condition During Scenario: All structures open	No change	N1a, N1b,N2, N5 – set to height required to achieve operation objectives (between open and 63.2 m AHD), with through flow maintained	N1a, N1b,N2, N5 – set to maximum level 63.2 m AHD, with through flow maintained	No Change
From Seasonal Fresh	No change	Condition During Scenario: All structures open	N1a, N1b,N2, N5 – set to height required to achieve operation objectives (between open and 63.2 m AHD), with through flow maintained	N1a, N1b,N2, N5 – set to maximum level 63.2 m AHD, with through flow maintained	No Change
From Nyah Intermediate	All structures open	All structures open	Condition During Scenario: N1a, N1b,N2, N5 – set to height required to achieve operation objectives (between open and 63.2 m AHD), with through flow maintained	N1a, N1b,N2, N5 – set to maximum level 63.2 m AHD, with through flow maintained	All structures open
From Nyah Maximum	All structures open	All structures open	N1a, N1b,N2, N5 – set to height required to achieve operation objectives (between open and 63.2 m AHD), with through flow maintained	Condition During Scenario: N1a, N1b,N2, N5 – set to maximum level 63.2 m AHD, with through flow maintained	All structures open
From Natural Flows	No change	No change	N1a, N1b,N2, N5 – set to height required to achieve operation objectives (between open and 63.2 m AHD), with through flow maintained	N1a, N1b,N2, N5 – set to maximum level 63.2 m AHD, with through flow maintained	Condition During Scenario All structures open

10.3 Timing of Operations and Risk Management

The proposed works provide a high degree of operational flexibility. Ecological Associates (2014c) provides a selection of possible operating scenarios. The decision to initiate an environmental watering event will be based on:

- water availability
- the floodplain water requirements consistent with the watering regime, ecological objectives and targets
- operational risks and
- the regional context (i.e. survival watering, recruitment watering, maintenance watering) and other river operations that may occur within the river reach.

Mimicking natural variability will provide a diverse range of inundation events, which will restore a mosaic of vegetation consistent with pre-regulation conditions, as presented in Table 9-1.

With this in mind, the Mallee CMA will seek to collaborate with the MDBA and other stakeholders to help develop new “real time” river information tools that will better inform operations.

The structures will be operated to manage adverse impacts as per the risk mitigation covered in Section 11.

11. Assessment of risks and impacts of the operation of the measure (Section 4.7)

A comprehensive risk assessment of the potential operational impacts of the proposed supply measure has been carried out during development of this business case. It is acknowledged that operation may have a range of impacts, including adverse impacts on cultural heritage, socio-economic values and impacts from operation of structures. This risk assessment process was informed by experience with operating environmental watering projects of similar scale and complexity, including TLM.

11.1 Risk assessment methodology

The risk assessment for the Nyah Floodplain project was completed in line with the requirements of AS/NZS ISO 31000:2009 (Lloyd Environmental, 2014). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and prioritised mitigation strategies and measures.

Refer to Section 7, Tables 7-1 to 7-4 to view the risk matrix and definitions used in this risk assessment, and further details on the methodology.

The risk assessment was consolidated as the project developed and additional information incorporated into Table 11-1.

11.2 Risk assessment outcomes

Table 11-1 presents a summary of the assessment and subsequent work undertaken, including mitigation measures developed and an assessment of residual risks after these are applied. It should be noted that where a residual risk is given a range of ratings, the highest risk category is listed.

Table 11-1. Risk assessment – threats and impacts of operation of the measure without mitigation and residual risk rating after mitigation

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Adverse impacts on cultural heritage						
Loss of artefacts via erosion; loss of artefacts via inundation	The Nyah Floodplain is considered an area of high cultural heritage sensitivity. Fluvial processes during watering events could damage cultural sites and places, resulting in the loss of artefacts in-situ on the floodplain. This may damage relationships with Indigenous stakeholders and subsequently affect future operation of the works.	Possible	Moderate	Moderate	Preliminary cultural heritage assessment work has been undertaken through the Nyah Floodplain Due Diligence Assessment (Bell, 2013). A Cultural Heritage Management Plan will be required prior to construction activities and will be developed in partnership with Indigenous stakeholders. This will provide for any further remedial works during/after operations. Implement measures during operations to minimise damage to cultural sites. Proactive engagement with Indigenous stakeholders during operation, which may involve inspection of cultural sites pre and post watering events to monitor and undertake protection works, relocation of artefacts as required, and rehabilitation works.	Low
Damage to relationships with Indigenous stakeholders	This threat could occur through unforeseen impacts on cultural sites during operation, which may damage relationships with Indigenous stakeholders. This could affect the future operation of works and subsequently impact on the site's water-dependent ecological values.	Possible	Moderate	Moderate	As above.	Low
Adverse impacts on socio-economic values						
Restricted access to public land during watering events	Watering events may inundate roads and bridges, limiting or prohibiting public access. This may reduce opportunities for active and passive recreation, and possibly tourism.	Certain	Minor	Moderate	Improved planning and modelling to predict access limitations during operation. Issue public notifications of access changes/limitations prior to watering events. Close consultation with tourism industry to ensure timely communication around planned events. Upgrade roads to improve access where practical. Provide boat access as an alternative, where relevant.	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Disturbance of beekeeping and other commercial operations (kayaking, camping, tours etc.)	In addition to restricting access, watering events could inundate vegetation with pollination potential and beehive sites. Watering events could also restrict other commercial operations such as camping and kayaking tours.	Possible	Moderate	Moderate	Engage with the relevant stakeholders (apiarists, licensed tourism operators etc.) to ensure they are aware of the extent of upcoming watering events and can plan accordingly. This will be incorporated into the project stakeholder management strategy.	Low
Rise in river salinity	A key driver to salinity is discharge of saline groundwater along gaining reaches during a flow recession. Increases in salinity (measured as EC units at Morgan) may breach Basin Salinity Management Strategy requirements and also exceed Basin Plan salinity targets. This may result in poor water quality for downstream users.	Likely	Moderate	Moderate	Provision of dilution flows in the Murray River during and following drawdown. Not operating during high-risk periods. Use regulators to: • Control the level and area of floodplain inundated and rate of recession to manage the volume of saline water returned to the river. • Enable hold periods to be shortened or lengthened to mitigate impact of release of stored water. • Restrict release from impounded areas to allow evaporation and seepage. Ongoing monitoring of groundwater and surface water levels and salinity to inform adaptive management and update of Operational Plans.	Low
Increased mosquito populations	Ponding water on the floodplain has the potential to localised increases in mosquito populations. This could lead to human discomfort, disease exposure and eventually to negative perceptions about the project.	Possible	Moderate	Moderate	Active community engagement to improve awareness and encourage people to take precautions. This would be carried out as part of wider communication and engagement activities.	Low
Adverse impacts resulting from operating structures						
Structural failure of new works during operation	Structures can be vulnerable to inundation flows during operation via processes and attributes such as: inadequate elevation; insufficient protection from scour; insufficient rock armour; flood preparation including strip boards and handrails.	Possible	Severe	High	Provide adequate protection from erosion during and after operation. Ongoing inspection and maintenance of structures for early identification of potential problems during operation. Flood preparation actions written into O&M documents including removing structural parts	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					likely to be barriers to flow or large debris.	
Poor design of structures	This could occur through inadequate technical rigour during design or maintenance, causing maintenance issues or reduced effectiveness in operations.	Possible	Moderate	Moderate	Peer review of structure designs. Develop and implement appropriate maintenance programs.	Low
Unsafe operation of built infrastructure	Unsafe operation, such as breaches of OH&S procedures, could threaten human safety.	Unlikely	Catastrophic	Moderate	Ensure appropriate design that incorporates best-practice OH&S provisions. Operate infrastructure in compliance with OH&S requirements. Develop and implement a suitable maintenance program, in conjunction with Operation and Maintenance Plans. Provide safe access provisions and public safety provisions. Provide appropriate induction and training for staff operating infrastructure and equipment. Provide appropriate personal protective equipment (PPE) and equipment for operations.	Low
Adverse impacts on operation, maintenance and management. *Please note: These threats impact operations, but are not caused by the operating regime.*						
Lack of clear understanding of roles and responsibilities of ownership and operation	Lack of clear understanding of roles and responsibilities of ownership and operation could prevent the effective operation of the infrastructure.	Possible	Moderate	Moderate	Establish a MoU between all relevant agencies outlining roles and responsibilities during operation. Facilitate shared knowledge of project objectives among asset owners and operators. Develop all documentation with relevant agencies prior to construction, including production of Operation and Maintenance manuals. Ensure emergency response arrangements are in place. Ensure ongoing maintenance of structures and insurance arrangements. Maintain strong working relationships with river operators, partner agencies (including agencies in NSW, SA and Victoria), and Commonwealth and	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					Victorian water holders through regular operations group meetings. Maintain clear lines of communication during operation and reporting of water accounts/flows (i.e. reporting and accounting arrangements).	
Lack of funding for ongoing operation, maintenance and management	Insufficient funding for maintenance activities result in deterioration of structures, increasing the risk of failure. Inability to coordinate/direct operations due to insufficient agency resources.	Possible	Severe	High	Maintain strong relationships with investors/funding bodies to secure long term operational funding. Suspend operations if insufficient resources available to support relevant agencies.	Low
Operational outcomes do not reflect hydrological modelling outputs	On-ground outcomes during operation do not meet expectations due to incorrect assumptions, input data, interpretation or inaccurate models.	Possible	Severe	Moderate	Models developed using best available information. Undertake sensitivity modelling to confirm minor discrepancies in model accuracy do not result in dramatic changes to operational outcomes. Models independently peer-reviewed and determined to be fit for purpose.	Moderate
Community/ stakeholder resistance, backlash or poor perception	Poor communication with project stakeholders and the community can result in misunderstanding of the project's works and ongoing operations. This may limit on the capacity to operate the site as required.	Possible	Moderate	Moderate	Ongoing stakeholder liaison (early and often) guided by a stakeholder engagement plan. Targeted engagement to address identified concerns of key stakeholders.	Low

11.3 Risk mitigation and controls

The risk assessment confirms that all the risks identified in the risk assessment are reduced to acceptable levels (very low to moderate) once well-established risk mitigation controls are implemented.

While the risk assessment identifies several potential threats that could generate high risks to the operation of the structures (Table 11-1), these risks are considered manageable because they:

- Are well known and are unlikely to involve new or unknown challenges
- Can be mitigated through well-established management controls
- Have been successfully managed by the Mallee CMA and project partners (including construction authorities) in previous projects
- Result in very low or moderate residual risks after standard mitigation measures are implemented

Two risks retained a residual risk of moderate after implementation of the recommended mitigation strategies (Table 11-2). Further consideration of these threats may assist in further understanding the potential impacts and, in some cases, identifying additional mitigation measures to reduce the residual risk.

While downstream and cumulative salinity impacts cannot be formally ascertained at this time (see Section 7), particular consideration has been given to the potential salinity impacts of the project, as described in Section 11.5.

Table 11-2. High priority risks, mitigation and residual risk

Threat	Risk without mitigation	Residual risk rating	Additional considerations (Lloyd Environmental, 2014)
Restricted access to public land during watering events	Moderate	Moderate	Alternative recreational sites could be promoted as a form of 'offset' during watering events. New infrastructure could be provided to enhance the most common recreational pursuits (e.g. walking tracks and bird hides, campgrounds for campers)
Operational outcomes do not reflect hydrological modelling outputs	Moderate	Moderate	Opportunities for improvement of models identified for action as more information becomes available. Further refinement of models undertaken as project develops and contextual information is provided regarding Basin Plan flows, detailed designs and initial operations

11.4 Salinity Impact Assessment and Mitigation Strategies

A preliminary salinity impact assessment of the Nyah Floodplain Management Project has been completed which includes analysis of both BSMS considerations and real time salinity impacts. The parameters applied in this assessment are based on historically observed surface and groundwater responses. While the salt mobilisation responses can be identified and estimated, the operating regime of the River Murray under the Basin Plan is largely unknown at this point in time and may affect the observed salinity response. The preliminary salinity impact assessment must be considered in this context.

The Victorian Salt Disposal Working Group provides advice to DEPI about Victoria's compliance and implementation of the BSMS, including the assessment of salinity impacts. The Group comprises representatives from DEPI, Goulburn Broken, Mallee and North Central CMAs, G-MW and Lower Murray Water. The Group has reviewed the preliminary salinity impact assessment for the NyahFloodplain project and

considered the findings of the expert peer review (see Appendix L). The Group endorses the assessment methodology as consistent with the BSMS and fit for purpose to support this business case.

Preliminary Salinity Assessment Approach

The study estimated salt loads to the river system using a combination of approaches (semi-quantitative and qualitative) based on an initial desktop assessment of hydrogeological and salinity information and methods including mass balance, flow nets and groundwater mound calculations. Associated salinity impacts at Morgan were derived using the Ready Reckoner developed specifically for environmental watering projects (Fuller and Telfer 2007).

The is some uncertainty related to assumptions made in the analysis. Where uncertainty was identified for a given parameter, a conservative value was assumed or upper bound used. This approach is likely to overestimate the salt load magnitude.

The information provided by these assessments can be used to inform analysis of cumulative impacts of the final suite of Supply, Demand and Constraint Management Measures implemented under the Basin Plan. For detailed information please refer to the Preliminary Impact Assessment for Mallee Environmental Watering Projects – Other Sites (SKM, 2014; Appendix D).

Preliminary salt estimate

The preliminary salinity impact estimate is ~0.041 EC at Morgan for the nominated frequencies of inundation. This initial estimate does not account for implementation of mitigation strategies.

It is expected that successive watering events coupled with natural flood events could return groundwater conditions and salt store to that seen in the 1990's. This 1990s condition can be viewed as being representative of the 'cumulative impact' of a large scale sequence of watering event that represents the maximum salt impact condition (SKM 2014).

The real-time salinity impact immediately downstream of Nyah floodplain was modelled (over the 25 year benchmark period) and did not result in an exceedance of the salinity targets at Lock 6 or Morgan.

Mitigating measures and their feasibility

While the level of salinity impact is 'not significant' under the BSMS definition (i.e. less than 0.1 EC at Morgan), mitigating strategies can still be used to ensure any salinity impacts are minimised. The availability of dilution flows and their relative volume, duration and timing of release will be important considerations however, without further detail on the whole-of–river operations, it is not feasible to undertake the myriad of possible modelling scenarios required to determine the most appropriate mitigation strategy (SKM 2014).

Mitigation strategies are therefore described below in general terms. More detailed analysis of the potential salinity impacts and risk mitigation strategies is recommended upon approval of this business case, potentially using a daily river operations model. This will most useful when there is greater certainty about the structure specifications and proposed operating regimes of the River Murray. A range of management responses are available and may be appropriate to consider in minimising each salinity process triggered. These include:

- Creation of an operations protocol that explicitly connects projected salinity impacts, salinity thresholds for operation and contingency planning; and
- Implementing a monitoring regime that informs both the operation of the structures within the nominated thresholds as well as the overall estimation of salinity impacts downstream.

Should larger impacts occur with time, these could be offset by the less frequent operation and shorter duration of watering events as required.

Significant opportunities exist to manage the way that salt is generated and to mitigate the overall impacts including:

- Optimising the timing of diversion. Generally the rising limb of the flow hydrography in the lower Murray is associated with increasing salinity. Smaller wetlands could be watered earlier, before any significant increase in river salinity caused by flooding upstream. Bringing fresher water into the wetlands will minimise the impact of the salt on release.
- Optimising the timing of releases. Release of water into a falling river will have a more significant impact when flows are low. Releasing into higher flows will minimise local impacts but not necessarily affect the overall salt loads from a BSMS perspective. .
- Optimising the rate of release. If water must be released into a very low river, local effects can be mitigated by slowing the rate of release. In some cases, this may be used in conjunction with the above measures.

Monitoring requirements and further analysis

Surface water and groundwater data for the Nyah floodplain is limited both temporally and spatially. This, in turn, limits the ability to refine the quantum of salinity impact. SKM (2014) has recommended the implementation of comprehensive monitoring during early operations and the use of information obtained to assess maximum groundwater levels and infer direction of flow. This local scale investigation should form part of a larger scale investigation covering river operations and environmental watering activities taking place along the River Murray System.

Priority monitoring relies on measurements of salinity, water level from observation wells and fixed surface water monitoring sites. These include:

- Three new bore sites to be drilled close to the inundation areas
- Four data logger sites to capture continuous salinity and water level data – additional sites may be required where inundation activities present access issues
- Five bores sites monitored for water level and salinity before, during and immediately after watering events, and every three months between events; and
- Additional surface water data (flow, level and salinity) collected at existing sites at Parnee Malloo Creek and new gauging sites established adjacent to the new groundwater bore sites and the inlet and outlet stations.

11.5 Risk management strategy

As noted in Section 7.3, a comprehensive risk management strategy will be developed for the proposed supply measure, building on the work completed for this business case. The strategy will cover ecological and socio-economic aspects to provide a structured and coherent approach to risk management for the life of this project (i.e. construction and operation).

With regard to potential operational impacts, the risk management strategy will focus on the following issues, as described in Table 11-1:

- Potential impacts on socio-economic values, including salinity impacts;
- Operation of structures; and
- Maintenance and ongoing management.

Risk assessment and management is not a static process. Regular monitoring and review of the risk management process is essential to ensure that:

- Mitigation measures are effective and efficient in both design and operation
- Further information is obtained to improve the risk assessment
- Lessons are learnt from events (including near-misses), changes, trends, successes and failures
- Risk treatments and priorities are revised in light of changes in the external and internal context, including changes to risk criteria and the risk itself, and
- Emerging risks are identified.

The risk assessment process will continue throughout the development and implementation of this project. It is anticipated that additional threats will be identified and evaluated as the project progresses, and any new risks incorporated into the risk management strategy.

12. Technical feasibility and fitness for purpose (Section 4.8)

12.1 Development of designs

The options selected for the *Nyah Floodplain Management Project* have been developed to complement the delivery of basin plan flows. They offer opportunities to provide environmental water to sites during times of water shortage and by allowing delivery of water to higher parts of the floodplain beyond the reach of regulated releases to meet target inundation frequency, extent and duration parameters. In developing options for the project consultants were asked to consider the following:

A. Maximising environmental benefit from operation of the proposed works by:

- targeting areas that are difficult to reach with run of River Murray flows
- considering lifting water from areas flooded by works to higher elevations with temporary pumps
- providing the ability to deliver water to high value target areas without requiring large storage releases to generate overbank flow and without relying on removal of system constraints.
- ensuring that works can be used to magnify the effects of natural flows or regulated releases with minimal additional water use and
- designing infrastructure which will be flexible in its use to allow implementation of operational strategies developed through adaptive management of the site.

B. Maximising cost effectiveness, environmental benefits and water efficiency returns for investors through:

- Analysis of existing environmental works in the region and incorporating lessons learned from the construction and operation of these projects.
- Pragmatic analysis of available infrastructure options.
- Striking a balance between capital investment and ongoing operating costs to deliver a cost effective solution.

C. Ensuring practical and economic constructability of the project by:

- Siting structures on existing access tracks and provision of construction access plans.
- Utilisation of locally obtainable construction materials where practical.
- Use of advantageous geological features within the landscape where possible.
- Incorporating information and experience obtained during the construction and operation of nearby works regarding seepage, structure settlement and stability, construction dewatering and downstream erosion control.

D. Ensuring compatibility with nearby existing infrastructure and operational practice by:

- Use of common design features with nearby infrastructure.
- Taking into account operational capabilities of existing infrastructure which is integral to the operation of the proposed works.
- Development of operational access plans.
- Working with G-MW during options selection and development of concept designs.

E. Minimising negative impacts on the environment, cultural heritage and other river users by:

- Striving to maintain natural flow paths and capacities on the floodplain to minimise impact on natural floods.
- Using existing disturbed footprints where possible.

- Minimising site disturbance and the size of the footprint of any new infrastructure that is required.
- Considering the use of multiple cascading structures to mimic hydraulic gradient and avoiding extensive networks of tall levees.

12.2 Design criteria used

In addition to the broad considerations above, specific design criteria have been developed to inform the development of concept designs. These criteria have been developed through reference to current literature and best practice guidelines and through targeted workshops. Detailed descriptions of design rational and criteria are provided in the Appendix E concept design report. A summary of key design criteria is provided below.

Capacity and Flow Conveyance

The structures (including levees) were designed to meet a range of hydraulic criteria. Generally there was no single design flow. Criteria that influenced the structure size and geometry were:

- erosion control (head differential) of the combined system
- capacity to fill the forest
- fish passage and
- erosion control (defined spillways) at the structures.

The arrangement of structures, levees and overflow sills has been designed to minimise the potential for erosion over the whole range of flow conditions. This is consistent with the intent of making the system reasonably transparent to natural overbank flows. This required a tiered approach to hydraulic design for through flow, as follows:

i. Pass low and medium flows through hard structures (regulators) until a tailwater develops.
ii. Pass higher flows through purpose designed overflow sills, with rock protection, located on natural flow paths.
iii. Overtop the earthen levee only after the tail water is fully developed and the levee/track is near submerged by the tail water.

The head differential that is acceptable for a given structure type ranges from high at concrete regulators to low at earthen levees (Jacobs, 2014a).

Fish Passage

A fish passage workshop was held on 16 July 2014 involving key fish ecologists, representatives from design consultancies and constructing authorities. All seven of the proposed supply measures within the Mallee CMA region were considered.

Specific outcomes from the workshop relevant to design of the Nyah works included the following:

i. Engineering designs will incorporate appropriate and practical mechanisms to ensure fish passage to and from the river through regulating structures can occur.
ii. The operation of regulator N2 will allow for passive fish passage. Structure N2 has been designed to allow fish passage when fully opened and also during regulating events.

Gate Design

A gate assessment workshop was held in Tatura on 26 August 2014 and included representatives from G-MW operations and major projects as well as from Jacobs and Mallee CMA. The object of this workshop was to determine appropriate design criteria for each of the regulating structures within the project.

During this workshop the adoption of the dual leaf gate system in use on the existing TLM Hattah Lakes Environmental Regulators was confirmed.

Design of smaller regulators at the site was standardised to use mechanically actuated penstock gates installed on the upstream face of box culvert structures.

Freeboard

The design crest level for each of the structures has been set based upon the maximum design water level (DWL) and a freeboard allowance of up to 0.5m.

Minimum freeboard of 0.3m above DWL has been adopted for levees and allows for a clay core to extend to 0.15m minimum above the DWL plus protective cover.

Defined spillways have been incorporated into levees to direct flow to appropriately protected areas during overtopping events.

Design Life of works

The design life of the concrete and embankment structures within the project is 100 years when appropriately maintained. Mechanical components will have a design life of 25 to 30 years (Jacobs, 2014a).

12.3 Concept design drawings

A description of the proposed works package has been provided in section 3.2.

Concept designs have been prepared for both the proposed works summarised below in Table 12-1.

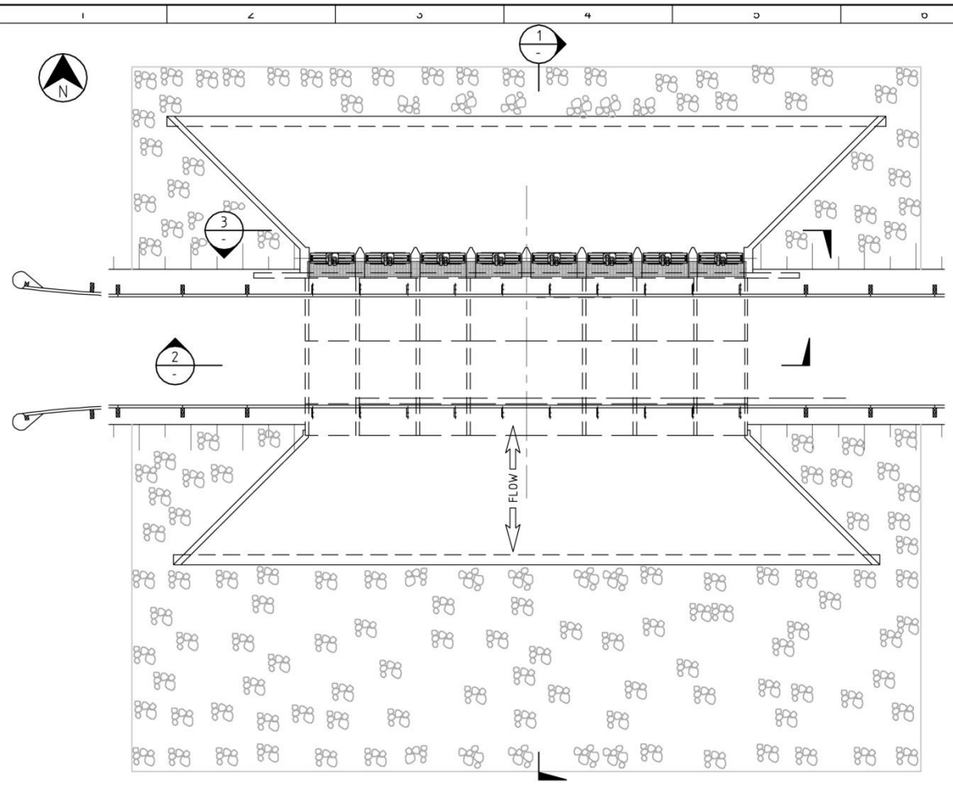
Table 12-1: Elements of the Nyah works (Jacobs, 2014a)

Structure	Description
Main levee and overflow sills	A section of the main track at the northern end of the floodplain will be raised in order to retain water to 63.2 m AHD. The track raising will incorporate regulators N1a, N1b, N2 and 3 overflow sills. Existing track alignment to be raised over a length of 1,308 m and will include 300 mm freeboard and 150 mm crest allowance. Overflow sills 1 and 3 will each be 100 m long; overflow sill 2 will be 65 m long. 340 m of additional track raising and 5 overflow sill works to contain water on the floodplain and provide inflow and outflow path for natural flood events.
N1a & N1b	Enables water to be held up to 63.2 m AHD and released as required. Two regulators, each consisting of 3 box culverts, each with single sluice gates and access provision.
N2	The main regulator and outlet point for the floodplain, N2 will be used to hold water to 63.2 m AHD and control return flows. Regulator consists of 8 box culverts, all with split leaf gates and access provision.
Drop structure	Situated downstream of N2, the drop structure is necessary to protect banks against erosion upon release of impounded water. The structure will establish a tailwater at the regulator sufficient to prevent sweep out of the hydraulic jump and provide a plunge pool for downstream fish passage. Consists of sheet piles and rock beaching.

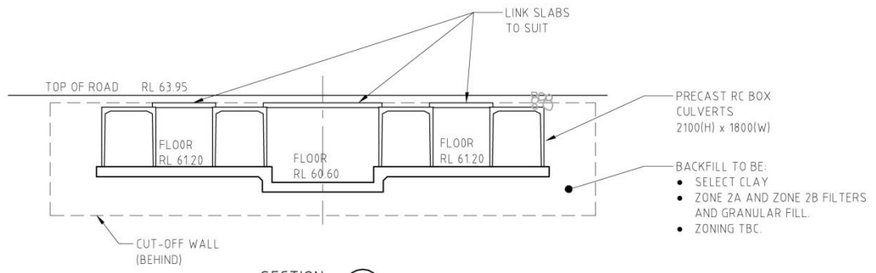
Structure	Description
N5	Replacement structure for an existing pipe culvert of correct size but unreliable quality, at the southern end of the Parnee Malloo Creek. This structure will prevent impounded water draining back to the River Murray. 1,200 mm diameter reinforced concrete pipe with manually actuated penstock gate and access provision.
Additional levee and overflow sills (4, 5, 6, 7, 8)	Small sections of additional track raising and overflow sill works, to contain water on the floodplain and provide inflow and outflow path for natural flood events Approximately 340 m of track raising at 5 locations, incorporating overflow sills at each.
N4	Works at the N4 location involve the decommissioning of redundant irrigation infrastructure including blocking but not removing an asbestos pipeline which passes through a culturally sensitive area.

As part of the design process, concept design drawings for each of the above structures have been developed and are provided within the design report attached as Appendix E.

Figure 12-1 shows the plan and section view of the proposed N2 Regulator incorporating toad crossing and provision of an area protected from traffic for operators to manipulate the gates.



SITE N2 – PLAN
SCALE 1:200



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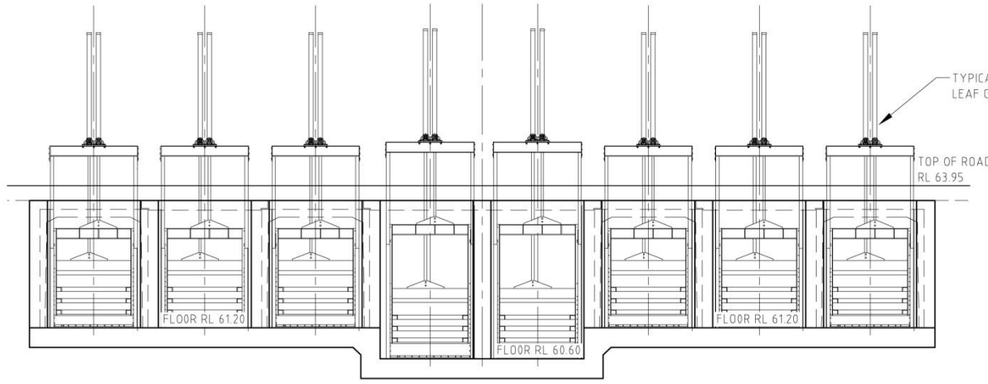

SECTION
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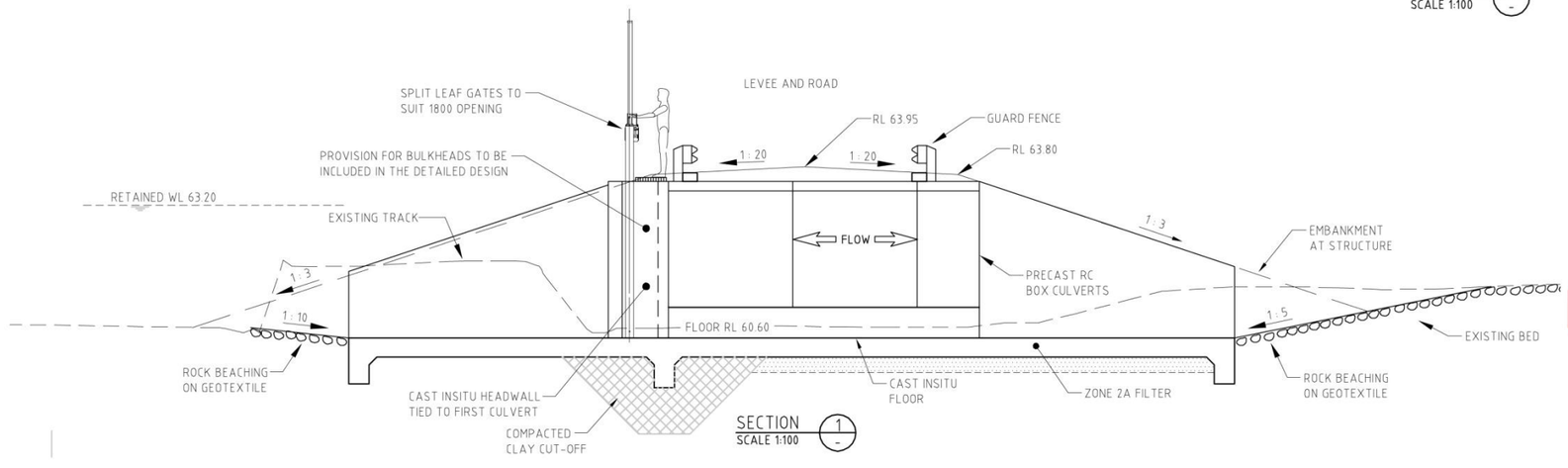

SECTION
SCALE 1:100 (1)

NOT FOR CONSTRUCTION

1:100 0 1 2 3 4 5m — 1 A3

1:200 0 2 4 6 8 10m — 2 A3

PRELIMINARY ISSUE

REV	DATE	DRAWN	REVD	APPD	REVISION
A	10/10/14			KM	PRELIMINARY ISSUE

DRAWING NUMBER | REFERENCE DRAWING TITLE

mallee catchment management authority

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CLIENT: Mallee Catchment Management Authority
PROJECT: CONCEPT DESIGN OF SDL PROJECTS

DRAWN	DRAWING CHECK	REVIEWED	APPROVED
SGO			
DESIGNED	DESIGN REVIEW	DATE	DATE
NP			

TITLE: NYAH - SITE N2
REGULATOR - PLAN AND SECTION

SCALE	DRAWING No	REV
AS SHOWN	VW07645-0000-ECC-DG-D3-0026	A

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Figure 12-1: Concept Design Drawing of N2 Regulator

mallee catchment management authority

12.4 Location of activities to be undertaken, access routes, footprint area

The location of each structure has been selected to maximise the efficiency of the works whilst minimising impacts on cultural heritage, native vegetation and the visual or recreational amenity of the park and adjacent landholders. In addition, access requirements for future operation and maintenance have also been taken into consideration.

Figure 12-2 shows the location of the works. Where possible structures have been located:

i. to maximize access from the Murray Valley Highway
ii. on existing tracks, or
iii. other areas of disturbance.

This approach minimizes the loss of vegetation, damage to cultural heritage values and improves future ease of access.

Specific set down areas, passing bays and construction footprints will be defined during the development of detailed designs and approvals. Experience from previous environmental works has shown that the selection of these smaller set down areas and construction footprints is best done as a collaborative exercise between cultural heritage advisors, ecologists and construction engineers.

For the purposes of preparing an estimate of vegetation impacts a nominal footprint at each of the proposed regulator sites was used along with nominal widths for access tracks and levees. These estimates were conservative and provide a correspondingly conservative (high) estimate of vegetation impacts.

Comprehensive mapping of these access arrangements and construction footprint is provided in Jacobs 2014a (Appendix E).

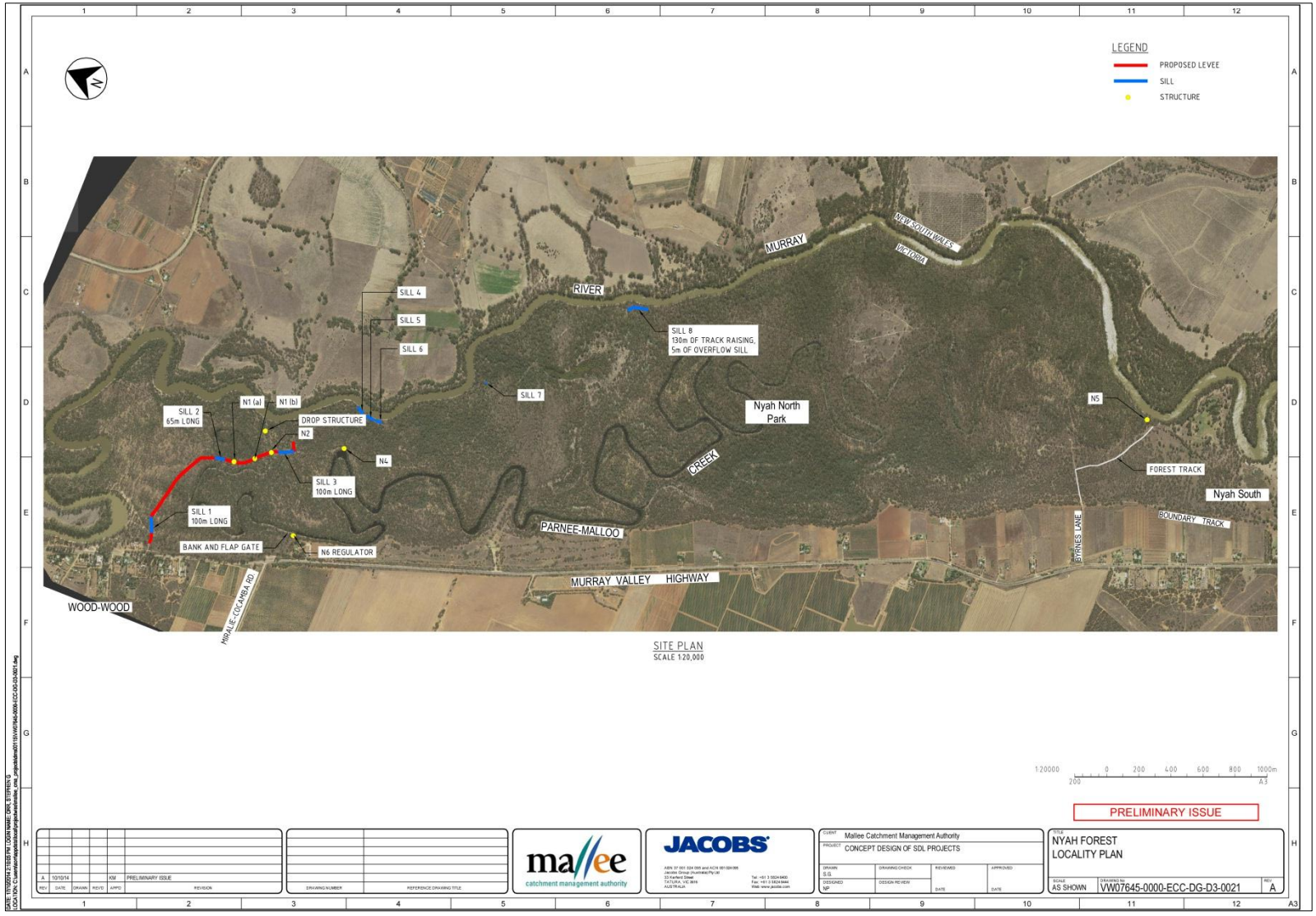


Figure 12-2: Location of proposed works and access tracks (Jacobs 2014a)

12.5 Geotechnical investigation results

At the time of preparation of this business case, geotechnical investigations had recently been completed and laboratory testing and reporting were underway. The foundation conditions at each site will need to be reviewed based on the outcomes from the geotechnical investigation and the designs modified as required.

Based on the initial observations from the investigation program it is not envisaged that substantial design changes will be required (Jacobs, 2014a).

12.6 Alternative designs and specifications

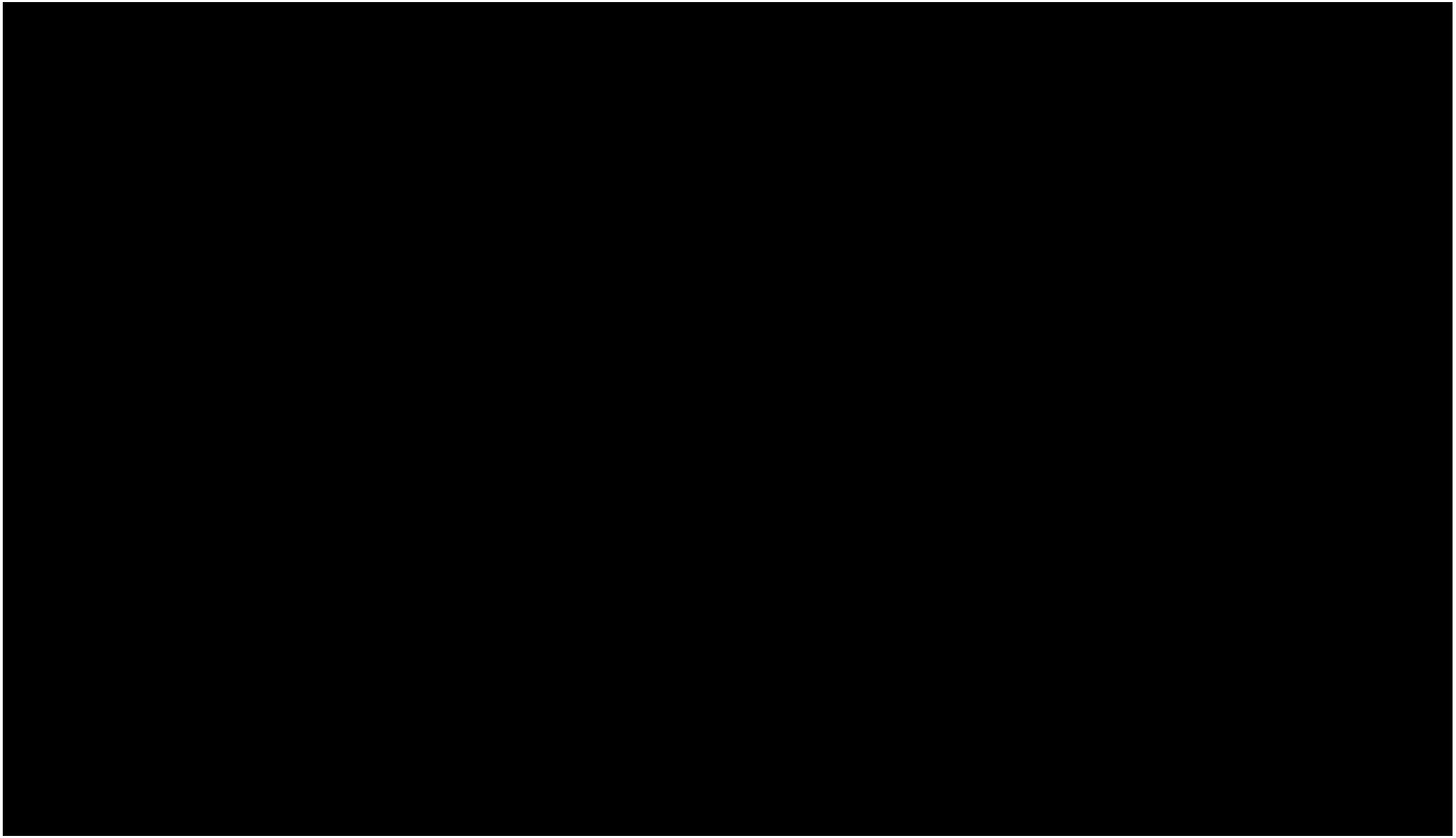
There have been numerous studies undertaken over the past decade to investigate the most effective design for watering the Nyah Park. This previous work is taken into account in describing the preferred options proposed in this business case.

As the preferred options became clearer more detailed analysis (GHD, 2014) was carried out on the six options summarised in Table 12-2. These were described as three options for each of Nyah North and Nyah South.

Each of the six options was assessed against a range of design considerations (section 12.1) which resulted in:

- All of the Nyah South options have been omitted from the preferred works package as they increased the project's construction footprint and achieved a limited additional area of inundation (17 to 80ha). In addition, Nyah South option 4 and 5 failed to meet the criteria for cost effectiveness as the costs exceeded $19,000/ha.
- Option 1 was considered preferable to option 3 due to the significant clearing required to construct the raised track and regulator midway along the Parnee Malloo creek which did not coincide with any existing tracks or other clearing.

The preferred option (Nyah North Option 1) was chosen after due consideration of the cost effectiveness and risks associated with each alternative, according to factors including capital and expected operating costs, ecological benefit, ease of construction and community support.



12.7 Ongoing operational monitoring and record keeping arrangements

The operational monitoring regime will form a key component of the operating plan developed for the site and will assign roles and responsibilities for agencies tasked with undertaking this monitoring. Critical areas of operational monitoring include those associated with water accounting and water quality which will be assigned to the constructing authority.

The project team has many years of experience in river and asset management and maintenance on the River Murray floodplain including the construction and operation of TLM Works at Hattah Lakes and Gunbower Island. Along with this experience comes the necessary organisational capacity including data management and asset management systems required to maintain and operate large works. They also have systems in place to manage data generated by operations including water accounting and water quality monitoring data. Operating and maintenance considerations will be documented in an operations manual.

Maintenance and operating costs will be similar to other environmental works projects delivered through TLM (Table 14-3). The designs incorporate simple, easy to operate structures without automation, specialist equipment or telemetry.

Pumping will be needed approximately one year in 10 years for Nyah using portable pumps. This will require approximately 2.797 ML to be pumped per event (Table 14-3).

The concept design report (Jacobs, 2014a) details considerations given to construction and operation of each of the proposed structures. This will be further refined during the detailed design stage, with additional Workplace Health and Safety considerations prepared.

Surface water flow and water quality monitoring will be implemented to ensure the water volume used and the water quality impacts of the project are recorded to appropriate standards and that this informs management and operations.

Groundwater monitoring will also be implemented to ensure salinity risks are appropriately managed.

An Operations Plan will describe how the infrastructure is to be operated for maximum environmental benefit while carefully managing risks. It will describe procedures for the Nyah works and interactions with River Murray Operations and floods.

12.8 Peer review of concept designs

Prior to the commencement of the Advanced Concept Designs a workshop was held including representatives from GHD, SA Water, G-MW and an independent expert reviewer engaged by DEPI to provide advice regarding specific areas to be addressed during further design work. The outcomes of this review were provided to Jacobs as input into the Advanced Concept Design.

Jacobs have undertaken their own internal reviews of material during development of designs as well as incorporating feedback provided by G-MW and the Mallee CMA on draft reports.

During the development of concept designs, draft material including geotechnical investigation specifications and design documentation have also been provided to independent experts engaged by DEPI. The expert peer reviewers engaged were:

- Phillip Cummins (engineering) and
- Shane McGrath (engineering).

13. Complementary actions and interdependencies (Section 4.9)

The proposed *Nyah Floodplain Management Project* supply measure will affect the Victorian Murray (SS2) surface water SDL water resource unit. This SDL resource unit is anticipated to be affected by this supply measure through an adjustment to the SDL, pending confirmation of a final off-set amount by the MDBA.

Any potential inter-dependencies for this supply measure and its associated SDL resource unit, in terms of other measures, cannot be formally ascertained at this time. This is because such inter-dependencies will be influenced by other factors that may be operating in connection with this site, including other supply/efficiency/constraints measures under the SDL adjustment mechanism, and the total volume of water that is recovered for the environment.

It is expected that all likely linkages and inter-dependencies for this measure and its associated SDL resource unit, particularly with any constraints measures, will become better understood as the full adjustment package is modelled by the MDBA and a final package is agreed to by Basin governments.

Similarly, a fully comprehensive assessment of the likely risks for this supply measure and its SDL resource unit cannot be completed until the full package of adjustment measures has been modelled by the MDBA, and a final package has been agreed between Basin governments.

The operation of the proposed works is not dependent on the operation of any existing works.

Under current arrangements, the operation of the existing TLM infrastructure nearby is undertaken by G-MW at the request of MDBA River operators, following advice from Hattah Operating Group, which is chaired by the Mallee CMA. This arrangement ensures local requests for the operation of the TLM works are integrated into broader river operations and provides a proven model for the operational governance of the proposed works.

Complementary actions beyond water management will include pest plant and animal control programs and other NRM activities funded by state and federal programs delivered by local agencies as per current arrangements.

13.1 Cumulative impacts of operation of existing and proposed works

The operation of the proposed works in conjunction with Basin Plan flows, constraints management measures, operating rule changes and other proposed or existing environmental works will have both positive and negative cumulative impacts on the system and river users.

The benefits of integrating the operation of works along the River Murray and the delivery of Basin Plan flows will include water efficiencies and the provision of appropriate ecological cues across multiple river reaches. Potential negative impacts may include cumulative salinity and other water quality impacts.

River scale benefits will include provision of nursery habitat for fish larvae and juvenile fish spawned upstream during elevated flows or operation of environmental works. These fish will return to the river as the water is drawn down from the floodplain contributing to the fish stocks of the River Murray.

On a local scale, the cumulative impacts of the proposed Nyah project on downstream water quality will need to be monitored. It is expected that basin plan flows will more than meet any dilution flow requirements proposed and existing works as well as delivering environmental and water quality benefits along the full length of the river. The operation of the proposed Nyah works in conjunction with the Vinifera infrastructure, and other nearby environmental watering activities such as the return of a more natural flow regime to the Little Murray near Swan Hill, will dramatically increase available floodplain habitat for valued flood-dependent fauna beyond that provided by the operation of either project, or environmental water deliveries, in isolation.

Holistic planning across the Basin will be required to mitigate potential negative impacts and maximise the social and ecological contribution of the Nyah project to the outcomes of the Basin Plan.

14. Costs, benefits and funding arrangements (Section 4.10)

14.1 Introduction

Consistent with the guidance given on page 26 of the Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases, a formal cost benefit analysis has not been undertaken as yet for this project because the main benefit of the project (in this case, the SDL adjustment) cannot be reliably estimated in time to inform this business case.

However from a qualitative perspective, Victoria considers that, on balance, the benefits of this project will significantly outweigh its costs. The rationale for this assertion is that a broad range of enduring social, economic and environmental benefits can be pre-emptively assumed to arise from this project.

These include:

- The social and economic benefits that will accrue for local and regional communities and businesses associated with its construction and operation.
- The increased social and environmental amenity at this site arising from improved environmental health, increasing its attraction for tourism and recreational activities.
- The broader regional economic benefit of taking less water out of productive use as a consequence of undertaking this project and being credited with an SDL Offset.

It must also be recognised that these immediate benefits can be assumed to have a range of positive secondary and tertiary benefits through the 'multiplier effect'. For example, the investment committed to construction of the project will benefit local businesses and families through jobs, materials purchase and normal every day expenditure.

Drawing an overall conclusion from the matters described above, it can be assumed that more than any other factor over the long term, the local and regional communities located close to this site will significantly benefit from the environmental amenity dividend generated by this project over its lifetime.

By contrast, it is difficult to envisage any significant social, economic and environmental disbenefit arising from direct operation of this asset in the manner described in this business case.

The Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases require that business cases identify benefits and costs that support a compelling case for investment, including a detailed estimate of financial cost and advice on proposed funding arrangements.

This chapter provides this information on the following:

- capital cost estimates
- operating and maintenance costs
- funding sought and co-contributions
- ownership of assets and
- project benefits.

These costs and benefits are outlined both in undiscounted terms in the year in which they occur, and in 'present value' terms, discounted to 2014 dollars by a central real discount rate of 7%. This discount rate is suggested by the Victorian Department of Treasury and Finance (DTF) for projects of this kind, and is also consistent with the Commonwealth Office of Best Practice Regulation (OPBR) advice on the choice of discount rate. A project timeframe of 30 years is used for the analysis, as per Victorian DTF guidelines for Economic Evaluation for Business Cases. Year 1 of this time period is 2016 when design costs are incurred.

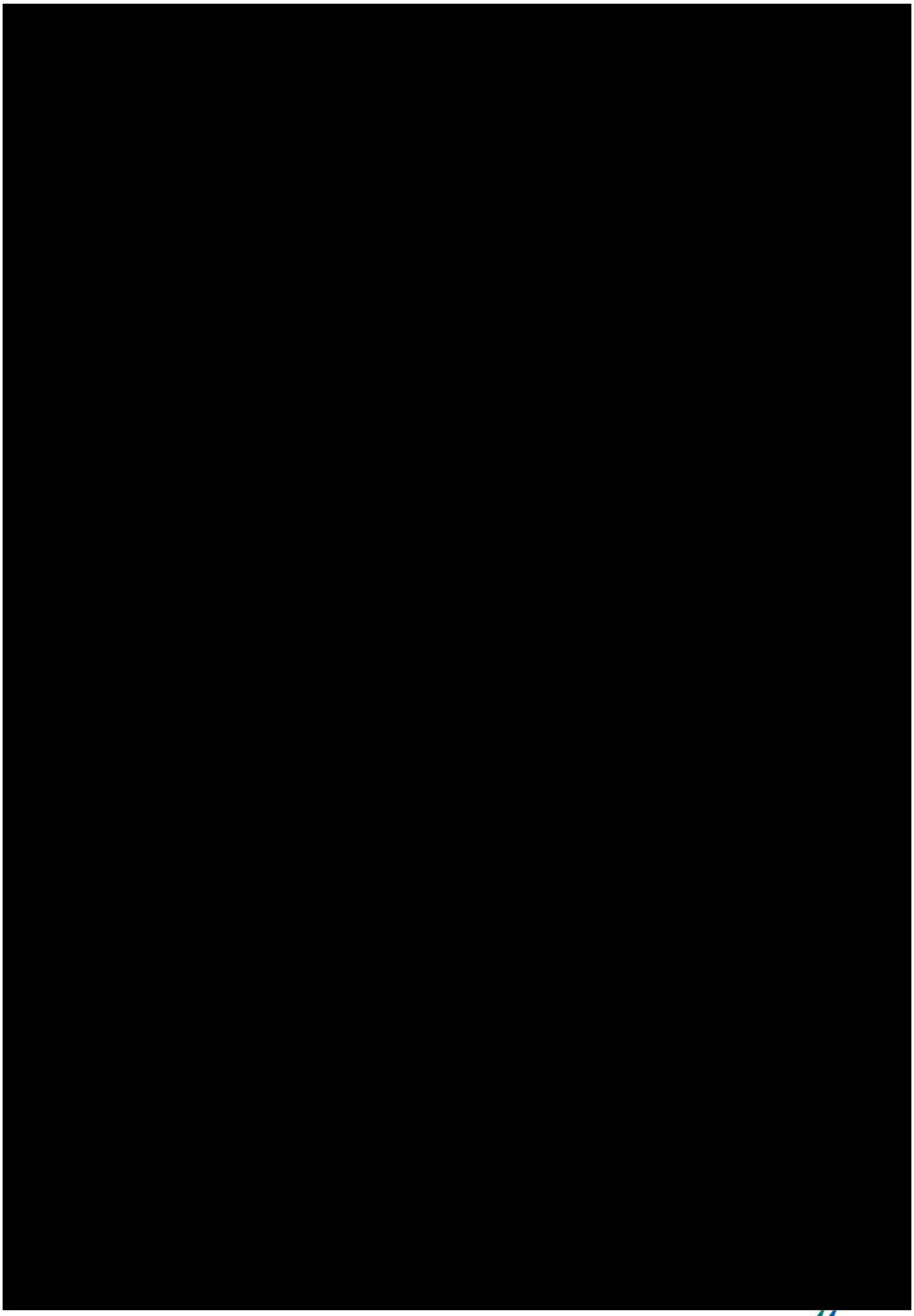
14.2 Capital cost estimates

Total project implementation costs are $10,942,589 (Present Value 2014 dollars). This business case presents the cost to fully deliver the project (i.e. until all infrastructure is constructed, commissioned and operational), including contingencies. Cost estimates for all components in this proposal are based on current costs, with no calculation undertaken of future cost escalations. To ensure sufficient funding will be available to deliver the project in the event that it is approved by the MDB Ministerial Council for inclusion in its approved SDL Adjustment Package to be submitted to the MDBA by 30 June 2016, cost escalations will be determined in an agreed manner between the proponent and the investor as part of negotiating an investment agreement for this project.

Total capital costs, including contingencies but excluding design costs, in Present Value 2014 dollars are $7,055,019. The cost of individual structures, design and contingencies is provided in Table 14-1. Capital cost estimates for this project have been developed by engineering consultancies responsible for project designs, using real-world costs from recently constructed environmental infrastructure projects in the area (e.g. Hattah Lakes and Gunbower Forest), in conjunction with agencies involved in these and other projects. These cost estimates have been peer reviewed by the Expert Review Panel, comprised of recognised experts (as described in Section 17 and see Appendix L).

Contingencies form 48% percent of the total capital costs. This reflects the current level of development of designs and incorporates, but is not limited to, contingencies associated with geotechnical uncertainty. Risks associated with wet weather, flooding and delays associated with approvals in construction are costed separately.

Table 14-1: Breakdown of capital costs, design costs and contingencies per structure (Jacobs, 2014a)



[redacted]

Project implementation costs that are in scope for Commonwealth Supply or Constraint Measure Funding are summarised by project stage in Table 14-2. Only forward looking costs have been included (that is, costs already incurred are not included in the table). Note that Table 14-2 does not include funding to coordinate the delivery of the final package of works-based supply measures; this will be determined as part of negotiating an investment agreement for this project.

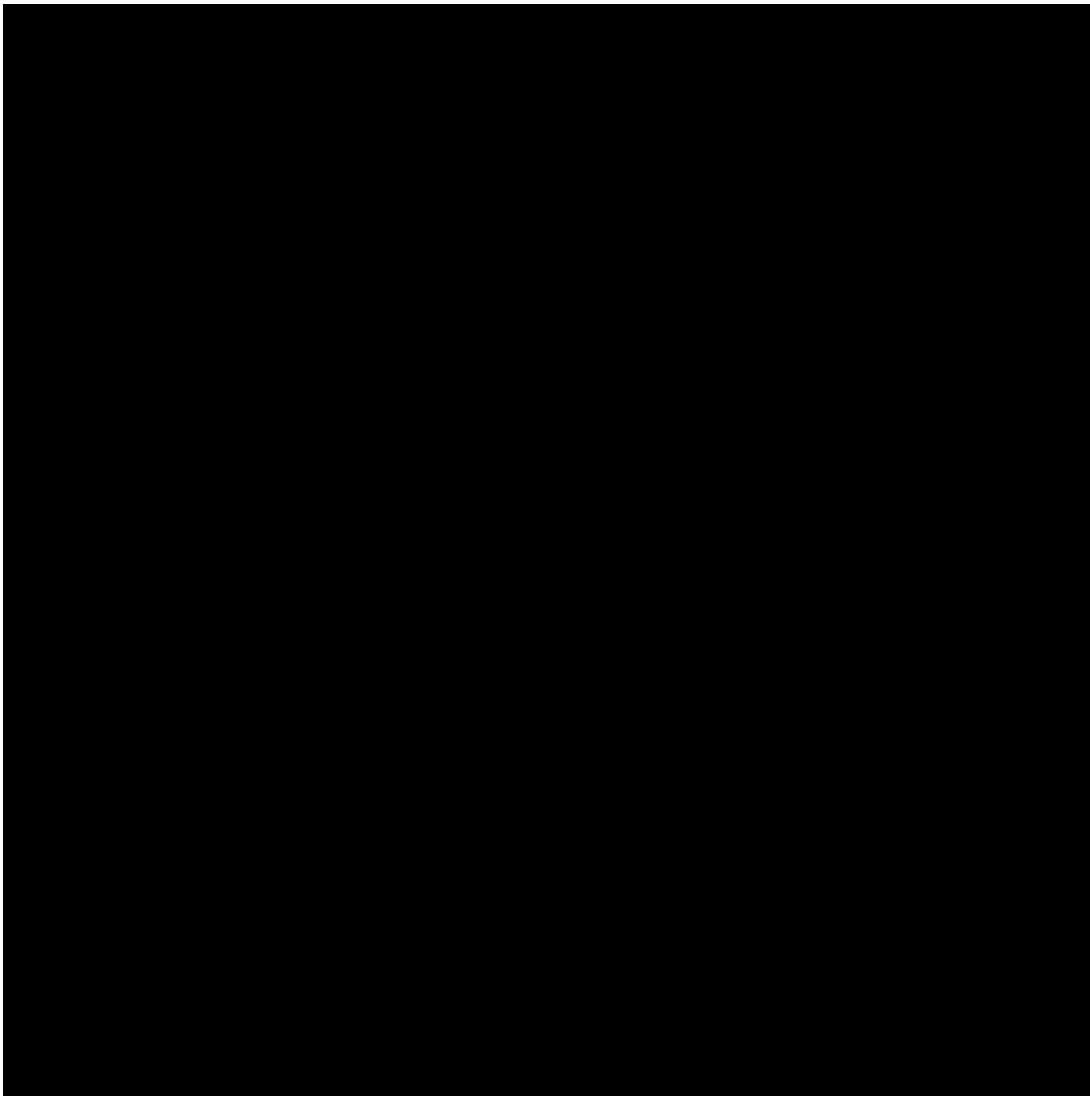
It is important to note:

- Costs incurred for monitoring related to verifying the performance and integrity of newly constructed infrastructure have been included as commissioning costs.
- Costs expressed in this document are present day values and investors will need to consider indexation and cost variations as appropriate.
- The costs presented here relate to the implementation of this project in isolation.

Only forward looking costs have been included (that is, no costs that have already been incurred have been included in the table).

Table 14-2: Nyah Park project costs for detail design, statutory approvals, construction and commissioning (GST exclusive)

[redacted]



14.3 Operating and maintenance costs

A full estimate of ongoing costs can only be developed after this proposal is built into Basin-scale modelling of post-SDL adjustment operations and the likely frequency of operation estimated

Operating and maintenance costs for the project are summarised in Table 14-3. As the precise operating procedures of the project will be detailed subsequent to this business case, Table 14-3 outlines the operating costs as an average annual cost and maximum annual cost to reflect the environmental water delivery via temporary pumping. Operation and maintenance are based on a 30 year timeframe and does not include asset renewal.

14.4 Projects seeking Commonwealth Supply or Constraint Measure Funding (funding sought and co-contributions)

Victoria will be seeking 100% of project funding for this supply measure proposal from the Commonwealth. The funding requested will ensure the proposed supply measure is construction ready, built in accordance with all regulatory approval requirements and conditions, and fully commissioned once construction is completed.

No co-contributions are provided for project capital costs.

14.5 Ownership of assets

To inform an eventual decision on proposed financial responsibility for ongoing asset ownership costs, and the preferred agency to undertake this role, DEPI convened a workshop with the key delivery partners for Victoria's proposed supply measures. Attendees at the workshop included representatives from:

- Mallee Catchment Management Authority
- North Central Catchment Management Authority
- Department of Environment and Primary Industries
- Parks Victoria and
- Goulburn-Murray Water.

The workshop was convened as a theoretical scoping exercise to draw on pre-existing expertise to evaluate the set of criteria that an agency would need to possess in order to effectively own, operate and maintain an asset like this proposed supply measure. Key criteria evaluated included:

- Access to capability to perform the required functions, either directly or under contract.
- Access to suitable resources which can be deployed in a timely, efficient manner.

- Sufficient powers conferred under legislation to enable services to be provided.
- Demonstrable benefit or linkage to primary business mission or activities.
- Ability to collaborate and co-ordinate effectively with multiple parties.
- Risks are allocated to those best placed to manage them.

Participants at the workshop were collectively of the view that while a number of Victorian agencies possessed many of the key criteria needed to perform this role, more information was needed before a conclusive decision could be made on which agency was overall the best fit. This included a more determinative sense of the full suite of adjustment measures that were likely to be agreed to across the Basin, and their spatial distribution, so that opportunities to capitalise on economies of scale could be more fully investigated.

On this basis, DEPI advises that the delegation of asset ownership and operation, including any associated proposed financial responsibility, cannot be formally ascertained at this time. Such decisions are generally whole-of-Victorian government, and sufficient information is not currently available to enable a formal position on this matter to be clarified.

In line with good financial practice, any long-term arrangements for asset ownership, operation and maintenance should maximise cost-efficiencies where they can be found. This includes options to 'package up' ongoing ownership, operation and maintenance where this is deemed the most cost-effective approach.

DEPI will be in a position to provide more formal advice on the state's preferred long-term arrangements for this supply measure once the full suite of Victorian proposals under the SDL adjustment mechanism has been more definitely scoped. This is anticipated to occur during the course of 2015, pending receipt of advice from the MDBA on likely adjustment outcomes.

14.6 Project benefits

The main benefit of this project (SDL adjustment) will be calculated after submission of this business case, and cannot be included in this document. However, the project will also produce additional significant environmental, social and economic benefits to the region, driven by the environmental improvement generated by the project. A study was commissioned into the quantifiable benefits of the project other than water savings (provided in Appendix F), which drew on a Total Economic Value (TEV) framework and involved the 'benefit transfer' method of transferring unit values from original studies in a similar context.

The quantified economic values produced by the project reflect the broader Victorian community's willingness to pay (WTP) for specific types of environmental improvement, as well as an estimate of the consumer surplus associated with increased recreation produced by this environmental improvement. Specific benefits include (Aither, 2014):

- Improved healthy native vegetation: studies have shown that the Victorian community values improvements to the health of native vegetation, specifically River Murray red gum forests[4]. Values were applied to 421 hectares of the project area.
- Improved native fish populations: the same studies reveal a community WTP for improvement in native fish populations, calculated at an estimated 0.3% increase in native fish populations in the river produced by the project[5].

[4] Bennett et al (2007) found that annual household willingness to pay for improvement to the health of 1000 hectares of river red gum forests was $3.90 for Bairnsdale households and $1.20 for Melbourne residents (local residents identified no willingness to pay for this improvement. We adjust these values with CPI from 2007 to 2014.

[5] Bennett et al (2007) found that annual household value for this change was estimated at $0.97 per Melbourne household, $1.43 per 'rest of Victoria' household, and $1.00 per 'local region' household. We adjust these values with CPI from 2007 to 2014.

- Increased frequency of colonial water bird breeding: previous analysis reveals a community WTP for an increase in the frequency of water bird breeding in the River Murray ($12 per year per household)[6]. Under the assumption that site represents 0.3% of this River Murray value, a value for increased water bird breeding to the Victorian community was developed.
- Increased recreation: Mallee CMA staff estimated that the Nyah project was estimated to increase the net annual tourist visitor days to the site from 8,500 to 10,200 (1,700 visitor days)[7]. Using previous studies that estimated the economic value of a visitor day ($134 per visitor day[8]), the economic value of an increase of 1,700 visitor days was estimated.

The economic value of these four[9] quantified economic benefits associated with the Nyah project are presented in Table 14-4. The 'present value' estimates assume benefits start accruing in the year of commissioning (2020) and continue annually for the remaining years of the analysis timeframe (30 years). They are discounted to 2014 using a 7% discount rate.

Table 14-4: Economic benefits produced by the project ($2014) (Aither, 2014)

	Annual value ($M)	Present value ($M)[10]
Healthy native vegetation	$0.81	$7.3
Native fish population	$0.37	$3.3
Frequency of colonial water-bird breeding	$0.11	$1
Recreation	$0.27	$2.5
Total	**$1.56 million**	**$14.1 million**

A number of unquantified benefits are also identified for the project, namely:

- Cultural heritage: cultural heritage sites will be impacted by the project, including scar trees that depend on seasonal high river flows and natural inundation regimes, and are currently stressed The scarred trees may benefit from improved environmental conditions, while other cultural sites (e.g. hearths) may benefit from increased protection works undertaken through the Cultural Heritage Management Plan developed for this project.
- Apiarists: the beehives that currently exist at Nyah Vinifera Park depend on seasonal flowering of river red gum forests, which will increase in regularity and reliability due to the project. This should increase the number of hives at each site, and the number of active sites. This value is not quantified.

[6] We adjust this source value for CPI from 2011 to 2014. Please note that this was not undertaken in the Aither report.
[7] Some minor negative impacts in visitor numbers were expected during inundation events, but these were expected to be offset by significant increases in visitor numbers over time.
[8] We again account for CPI from the source study in 2007 to 2014.
[9] Please note that the value for changes to healthy native vegetation, native fish population and frequency of colonial water-bird breeding may constitute a 'double-count' of environmental value, depending upon how the CSIRO SDL Adjustment Ecological Elements Method is employed. How this method will be employed is unknown at the time of this business case submission.
[10] $2014, discount rate of 7% over 30 years. Please note that the 'present value' estimates in the Aither document differ from numbers reported here, as a different discount rate was used in the Aither document (8%) to the one adopted here.

In terms of impacts on the local community of the project, Compelling Economics developed a REMPLAN input-output model of the Mildura-Wentworth region. Using this model, the impact of the proposed works at Nyah-Vinifera Park can be estimated in terms of employment, output, wages and salary, and industry value added.

During the 12 month construction phase of the proposed works, the additional expenditure will result in $9.5m of gross output and 23 jobs. The expenditure on operation and maintenance of $225,000 per year would result in $410,000 in annual gross output and one additional job.

These numbers illustrate the regional benefits of the project but are not proposed to be included in the cost-benefit analysis.

15. Stakeholder management strategy (Section 4.11.1)

The Mallee CMA and project partners worked with key stakeholders and interested community groups to develop the concept for the *Nyah Floodplain Management Project* between 2012 and 2014. Engagement via formal and informal methods has directly informed this project and helped contribute to its development. Communication and engagement approaches have included:

- More than 110 face-to-face briefing sessions, meetings, presentations and on-site visits, engaging more than 635 people, which is reflective of the wide range of project stakeholders and population density surrounding the project site.
- Fact sheets, media releases, electronic communication (website, emails, newsletters), brochures and correspondence.

This direct approach to engagement has helped ensure the views and local knowledge of key stakeholders and community members have been directly integrated into the project, resulting in broad community support for the proposed works at Nyah, as evidenced by the receipt of letters of support from:

- materially-affected land managers such as Parks Victoria
- Aboriginal stakeholders
- adjacent private landholders
- local government (Swan Hill Rural City Council)
- Regional Development Australia and Regional Development Victoria – Loddon Mallee and
- community groups and organisations.

A list of the letters of support received for this project is presented in Appendix F.

Broad community support for this proposed project is further evidenced by the sustained interest in the proposal as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.

15.1 Communication and Engagement Strategy

A detailed Communication and Engagement Strategy has been developed for this project and key stakeholders identified. This strategy has helped to ensure those who are materially affected by the project and the broader community have been consulted and their views adequately considered and responded to by the Mallee CMA (RMCG, 2014).

This strategy reflects the intent of the *Principles to be applied in environmental watering* outlined in the Basin Plan (MDBA, 2012a), aligns with the directions of the Victorian Government's Environmental Partnerships policy (Victorian Government, 2012) and is consistent with the principles of the Community Engagement and Partnerships Framework for Victoria's Catchment Management Authorities (Community Engagement and Partnership Working Group 2012) (RMCG, 2014).

The Communication and Engagement Strategy includes:

- identification of key stakeholders of the Burra Creek project
- detailed analysis of the stakeholders, which have been divided into three groups according to their level of interest in and influence on the project
- analysis of stakeholders' issues and sensitivities
- clearly articulated objectives and engagement approaches designed to meet the needs of different stakeholder groups and

- communication and engagement activities for both the Business Case and implementation phases of the project.

An overview of the Nyah Communications and Engagement Strategy and the outcomes from the Business Case phase are provided in the following sections. The full strategy is provided in Appendix H.

15.2 Identification of key stakeholders and engagement approaches

Stakeholders have been characterised into three groups relating to their interest and influence on the project outcomes. Relative to each other, Stakeholder Group 1 has the highest level of interest in and influence on the project outcomes, Stakeholder Group 2 has a moderate level of interest in and influence on the project outcomes and Stakeholder Group 3 has a lower level of interest in and influence on the project outcomes (RMCG, 2014).

Stakeholder Group 1 has been further defined into two key types; project partners and project stakeholders. Project partners are differentiated from project stakeholders for the purposes of defining appropriate communication and engagement approaches as they have a direct role in the design and development of the project (i.e. as investors, land managers, construction or operational managers) (RMCG, 2014).

The engagement approach for Stakeholder Group 1 can be described as high intensity, targeted and tailored to the needs of each individual stakeholder. On the iap2 public participation spectrum, the aim of the engagement approach for project partners is to COLLABORATE in the planning, construction and operation phases of the Lindsay Island project. For project stakeholders, the aim is to INVOLVE stakeholders in all phases of the Nyah project (RMCG, 2014).

The engagement approach for Stakeholder Group 2 is of moderate intensity, targeted and more generic in nature in comparison to Stakeholder Group 1. On the iap2 public participation spectrum, the aim of the engagement approach for Stakeholder Group 2 is to CONSULT stakeholders on the planning, construction and operation phases of the Nyah project (RMCG, 2014).

The engagement approach for Stakeholder Group 3 is of lower intensity, publicly accessible and generic in nature. On the iap2 public participation spectrum, the aim of the engagement approach for Stakeholder Group 3 is to INFORM stakeholders on the planning, construction and operation phases of the Nyah project.

Table 15-1 provides a list of stakeholders and a summary of the issues and sensitivities of each of the three Stakeholder Groups (RMCG, 2014).

Table 15-1: Stakeholders of the Nyah Floodplain Management Project and summary of issues and sensitivities

Stakeholder group	Stakeholder	Summary of issues and sensitivities
Group 1a: Project partners	DEPI Parks Victoria MDBA G-MW	Land inundation Restoring the natural ecology Consistency with Basin Plan Environmental water responsibilities Managing impacts of works on visitors and recreation Responsibility for construction/operations Impacts of water volume on river flow Appropriate infrastructure to maximise the impact of environmental watering Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture
Group 1b: Project stakeholders	Indigenous community: Wadi Wadi Elders Adjacent freehold landholders Local community: townships Nyah, Nyah West, Vinifera and Swan Hill Mallee CMA Community Committees: Land and Water Advisory Committee (LWAC), Aboriginal Reference Group (ARG), The Living Murray Community Reference Group (CRG) (Hattah Lakes and Lindsay-Wallpolla Icon Sites) Local Government: Swan Hill Rural City Council Commonwealth Environmental Water Holder (CEWH) Victorian Environmental Water Holders (VEWH)	Impact to cultural heritage and indigenous values Future environmental health of country Land inundation Restoring the natural ecology Continuity and quality of irrigation water supply Local knowledge, history and a sense of ownership of the areas involved Impact to local amenity, recreation, economy and environment Impacts of water volume on river flow Appropriate infrastructure to maximise the impact of environmental watering Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture Ensuring that proposed activities and outcomes are acceptable to the wider community Consistency with planning scheme

Stakeholder group	Stakeholder	Summary of issues and sensitivities
Group 2	Other environmental organisations: Murray-Darling Freshwater Research Centre, Murray Darling Association, Environment Victoria, Australian Conservation Foundation, Lower Murray Water Community-based environment groups: Nyah West Landcare Group, Birdlife Australia (Mildura Branch), River Watch, Sunraysia Field Naturalists Club, Sporting Shooters Association of Australia (Nhill), Murray-Darling Wetlands Working Group, Victorian National Parks Association Indigenous organisations/groups: North West Native Title Claimants, Murray Lower Darling Rivers Indigenous Nations (MLDRIN), Swan Hill and District Aboriginal Cooperative, Wadi-Wamba-Berapa Native Title Group Other community groups/businesses: Regional Development Australia and Regional Development Victoria – Loddon Mallee, 4WD clubs, angling clubs, tourism businesses, license holders (firewood, bee keeping, fishing), Rotary, Probus, Progress associations, CWA, Lions Park users/visitors: Nyah Vinifera Park	Impact to local amenity, recreation, economy and environment Ensuring projects are delivered in a way that both benefits the environment and respects Indigenous culture
Group 3	Wider community: Mallee region, Victoria, Murray Darling Basin	As above

15.3 Communication and engagement approaches and outcomes from the Business Case phase

The overall response to engagement activities undertaken to date has been positive. Engagement activities were tailored to the stakeholder's interest in the project and provided the opportunity to identify issues/sensitivities and reach agreed outcomes.

For all communication and engagement activities completed through the Business Case phase, Mallee CMA has kept a detailed record of:

- who has been consulted and the outcomes
- how consultation outcomes have been considered and responded to by the Mallee CMA and
- the extent of stakeholder and community support for the project.

The outcomes of consultation undertaken during the business case phase will directly inform the communication and engagement strategy for the implementation phase of this project.

An overview of the communication and engagement approaches and main outcomes from the consultation by stakeholder group is provided in Table 15-2.

A more detailed analysis of the approaches, including key constraints is provided in the Nyah Communication and Engagement Strategy (Appendix H: Section 3-4, pp. 9-25).

Table 15-2: Summary of consultation outcomes from the Business Case phase

Stakeholder group	Communication/engagement approach	Focus of consultation	Summary of consultation outcomes (Mallee CMA response)	Evidence of support for the project
Group 1: Project partners	Intensive engagement through: Sustainable Diversion Limits Offset Projects Steering Committee: Hattah -Vinifera meetings (monthly) Design team meetings Negotiations regarding roles and responsibilities One-on-one discussions as required.	Siting of proposed infrastructure. Design parameters of proposed infrastructure. Downstream water quality impacts. Adjustments/clarifications to technical information and/or presentation of information in business case. Monitoring and management of salinity and turbidity during operation of proposed infrastructure.	Adjusted structure location to reflect stakeholder advice. Designs developed in accordance with stakeholder preferences/ requirements. Operational scenarios for proposed infrastructure investigated to minimise water quality impacts. Business case adjusted in accordance with feedback received. Salinity investigations undertaken, monitoring and management strategies considered. Planned ongoing engagement with project partners.	Letters of support for the project from partner agencies such as Parks Victoria and Goulburn-Murray Water Sustained, consistent high-level involvement in project development throughout business case phase.
Group 1: Project stakeholders	Small group (face-to-face) briefing sessions with Mallee CMA, including on-site visits. Face-to-face engagement and on-site visits with Aboriginal stakeholders. Presentations conducted by Mallee CMA.	Minimisation of harm to sites of cultural heritage, in line with legislative requirements. Monitoring and management of salinity and turbidity during operation of proposed infrastructure.	Works proposed for existing tracks/disturbed areas where possible to minimise harm to sites of cultural heritage. Preliminary cultural heritage assessment completed to inform project development. Salinity investigations undertaken, monitoring and management strategies considered. Planned ongoing engagement with project stakeholders.	Letters of support from Aboriginal stakeholders, adjacent freehold landholders, Mallee CMA community committees and local government (Swan Hill Rural City Council). On-going discussions/preliminary approval processes completed with Swan Hill Rural City Council, resulting in a strong working relationship. Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.

Stakeholder group	Communication/engagement approach	Focus of consultation	Summary of consultation outcomes (Mallee CMA response)	Evidence of support for the project
Group 2	Teleconference briefing sessions with Mallee CMA staff. Presentations conducted by Mallee CMA staff.	Social (e.g. public access) and economic (e.g. financial investment in region) challenges/opportunities Impact on apiary operations.	Operational scenarios for proposed infrastructure investigated to minimise restrictions to public access. Clear and accessible information provided regarding proposed project. Consideration of apiary requirements in planning operation of infrastructure. Planned ongoing engagement with project stakeholders.	Letters of support from tourism operators, as well as key organisations and community groups such as Regional Development Australia and Regional Development Victoria – Loddon Mallee, Sunraysia Branch Victorian Apiarists Association and Riverwatch. Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.
Group 3	Information accessed through the Mallee CMA website.	Impacts on water quality during operation of proposed infrastructure.	Operational scenarios for proposed infrastructure investigated to minimise water quality impacts. Planned ongoing engagement with project stakeholders.	Letters of support. Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.
All stakeholders	Information package accessed on the Mallee CMA website (fact sheets, case studies, photos, contact information). Project up-dates.	As above.	As above.	Letters of support. Sustained interest in the project as illustrated by on-going requests from key stakeholders to provide briefings, presentations and updates.

15.4 Proposed consultation approaches for the implementation phase

A proposed communication and engagement strategy has also been prepared for each Stakeholder Group for the implementation phase of the Nyah project. This strategy has been directly informed by the outcomes of the consultation activities undertaken during the business case phase of the project.

An overview of the planned communication and engagement approaches is provided in Table 15-3. A more detailed analysis of the approaches is provided in the Nyah Communication and Engagement Strategy (Appendix H: Section 3-4, pp. 9-25).

A large effort has been invested in the communication and engagement activities in order to develop broad community support for the Nyah project. The project has high visibility among materially affected and adjacent landholders/managers, along with Aboriginal stakeholders and other interested parties, ensuring the advice and concerns of those involved have been considered and responded to accordingly. This strong commitment to working directly with project partners and the community will be ongoing throughout the construction and implementation phases of the project, further cementing community support for the Nyah project and ensuring it will continue to be a successful project.

Table 15-3: Communication and engagement strategy for the implementation phase

Stakeholder group	Engagement approach	iap2 level of engagement	Number / timing
Group 1: Project partners	Intensive engagement throughout project planning and development including design and construction meetings, on-site visits and other engagement methods as relevant	Collaborate	Ongoing
Group 1: Project stakeholders	Tailored events (e.g. site tours, funding announcement, commencement of construction)	Involve	Funding announcement/commencement of construction Site tours as required
Group 2	Teleconference briefing sessions with Mallee CMA staff Presentations conducted by Mallee CMA staff	Consult	Ongoing as required Throughout implementation phase
Group 3	Videos accessed through the Mallee CMA website	Inform	Accessible throughout implementation phase
	Information package accessed on the Mallee CMA website (fact sheets, case studies, photos, contact information)		As soon as possible after funding is confirmed Updated and accessible throughout implementation phase
All stakeholders	Project up-dates accessed through the Mallee CMA website and social media channels (e.g. e-newsletter, Twitter and other social media)	Inform	Regularly throughout implementation phase
	Media communication (e.g. media releases, newspaper articles, radio interviews, television interviews)	Inform	As required throughout construction and operation One media release associated with each watering event

16. Legal and regulatory requirements (Section 4.11.2)

Obtaining statutory approvals is an essential consideration for the *Nyah Floodplain Management Project*.

The process of obtaining the necessary approvals can be complex and can present risks to the timeline, budget and delivery of the project.

Early identification of statutory approvals required, background investigations required to complete the approvals, interdependencies between approvals as well as timeframes associated with both the preparation and assessment/consideration of submissions have been identified as important elements critical to the timely delivery of environmental watering projects (Golsworthy, 2014).

In order to guide the approvals process, DEPI and the Mallee CMA commissioned management strategies to guide the approvals process (GHD, 2014a, Golsworthy 2014). The strategies provide a clear understanding of the current relevant legislation as well as the approvals required, based on the type and location of planned works, the cultural heritage, flora and fauna values present within the works footprint, and the past experience of the Mallee CMA and partner agencies in completing approvals for large, infrastructure-based projects within National Parks.

16.1 Regulatory approvals

GHD (2014a, Appendix I) and Golsworthy (2014, Appendix J) have identified the approvals, permits and licences likely to be required prior to the commencement of construction. An assessment of relevant issues based on the proposed construction footprint at Nyah has indicated the need to obtain several approvals under local government, State and Commonwealth legislation.

Approvals *refers to all environmental and planning consents, endorsements and agreements required from Government agencies by legislative or other statutory obligations to conduct works (GHD, 2014a).*

The approvals required for Nyah Floodplain are listed in Table 16-1.

The following supporting documents will be required and likely to be requested through referral decisions on planning permit conditions (GHD, 2014a):

- an offset strategy for native vegetation losses
- an environmental management framework
- a threatened species management plan and
- a cultural heritage management plan.

The application process for each approval, the responsible agency, timing of submissions and timeframe for decisions are outlined in the Regulatory Approvals Strategy (GHD, 2014a). The Strategy includes an indicative program for effecting regulatory approvals that predicts a minimum 31-week period to obtain all required approvals. This timeframe assumes that an Environmental Effects Statement is not required, all applications (including supporting documentation) are already prepared and that there are no significant delays during the assessment process. The Strategy also notes that there are a number of linkages and dependencies between approvals, where for example, some approvals cannot be issued until another is approved e.g. a planning permit cannot be granted until there is an approved CHMP.

A Regulatory Governance Group (RGG) is supporting the delivery of business case requirements related to regulatory approvals by providing a mechanism for high-level engagement with responsible agencies at an early stage to streamline the regulatory approvals process. The RGG provides advice to the Project Control

Board (PCB) regarding the regulatory approvals needed for Victorian projects, the resolution of associated issues and develop a program-level strategy to obtain approvals.

Table 16-1: Regulatory approvals anticipated for Nyah (GHD, 2014a)

Approvals required	Description
Commonwealth legislation	
Environmental Protection & Biodiversity Conservation Act 1999 Referral	A number of potentially affected "matters of national environmental significance" (MNES) are present at Nyah: - upstream from NSW Central Murray State Forest, Banrock, Coorong and Riverland Ramsar sites - 13 migratory species and - 19 nationally threatened species and 4 threatened ecological communities.
Victorian legislation	
Environmental Effects Act 1978 Referral	Relevant to one of the six referral criteria for individual potential effects i.e. potential extensive or major effects on the health or biodiversity of aquatic, estuarine or marine ecosystems, over the long term.
Planning & Environment Act 1987 Planning permit Public Land Managers Consent	Applicant to request permission from public land manager to apply for a planning permit for works on public land. A planning permit application is then submitted with supporting documentation: likely to include an offset plan and threatened species management plan. Local Council refers applications and plans to appropriate authorities for advice.
Aboriginal Heritage Act 2006 Cultural Heritage Management Plan (CHMP)	A CHMP is required when a listed high impact activity will cause significant ground disturbance and is in an area of cultural heritage sensitivity as defined by the Aboriginal Heritage Regulations 2007 (Part 2, Division 5). Relevant high impact activities relates to: (xxiii) a utility installation, other than a telecommunications facility, if the works are a linear project with a length exceeding 100 metres (other than the construction of an overhead power line or a pipeline with a pipe diameter not exceeding 150 millimetres). To be prepared by an approved Cultural Heritage Advisor.
Water Act 1989 Works on waterways permit	Application for a licence to construct and operate works on a waterway.
National Parks Act 1975 Section 27 consent	Approval for a public authority to carry out its functions in a national park.
Flora & Fauna Guarantee Act 1988 Protected flora licence or permit	Application for approval to remove protected flora within public land for non-commercial purposes. Will need to include targeted surveys for threatened/protected species considered likely to be present at the site and impacted by proposed works.

16.2 Legislative and policy amendments and inter-jurisdictional agreements

At the state level, a legislative change may be needed to address the requirement to secure native vegetation offsets prior to clearing. As the primary offsetting mechanism is expected to be the gains in vegetation condition within the areas watered by the various Victorian works-based supply measures, i.e. the outcomes of the measures once operational, this requirement cannot be met. DEPI will investigate a suite of options to address this issue during the detailed design for this measure, including the potential for a planning scheme amendment. Note that the other options to be investigated do not require legislative changes.

Matters related to other regulatory approvals necessary for the implementation of this supply measure are discussed elsewhere in this business case.

No other amendments to state legislation or policy are anticipated. This includes any formal amendments to state water sharing frameworks, or river operations rules or practices.

Further to this, no changes to the *Murray-Darling Basin Agreement 2008* are required to implement this measure, nor do any new agreements need to be created either with other jurisdictions or water holders in the Basin.

16.3 Cultural heritage assessment

An Aboriginal due diligence assessment of proposed structure locations has been prepared for the site (Grinter et al, 2014) Appendix K. A desktop analysis indicated that there are two sites of Aboriginal significance within 100m of proposed structures for the Nyah site (noting that there are many more Aboriginal places within the vicinity of the site). Field inspections identified two previously unrecorded sites comprising ring trees near the main raised track structure. Under the *Aboriginal Heritage Act 2006* the Nyah-Vinifera area (including the Nyah site floodplain) is specified as an area of cultural heritage sensitivity in accordance with several categories and a Cultural Heritage Management Plan will need to be developed prior to commencement of works.

17. Governance and project management (Section 4.11.3)

Appropriate governance and project management arrangements have been put in place to minimise risks to investors and other parties from the proposed supply measure. The sections below describe the governance arrangements during business case development and proposed arrangements during project implementation.

17.1 Governance arrangements during business case development

A Project Control Board (PCB) was convened by DEPI to oversee the development of business cases for the nine Victorian works-based supply measures. The PCB is comprised of senior executives from DEPI, the Mallee and North Central CMAs, G-MW and Parks Victoria. This has ensured high level engagement of responsible agencies and has assisted in identifying and resolving program-level issues during development of business cases. The PCB's role has been to ensure that:

- All business cases meet the requirements set out in the Phase 2 Guidelines (reference).
- All business cases are of a high and consistent standard, and delivered within specified timelines.
- The technical basis of each business case is robust, credible and fit for purpose.
- That appropriate consultation with stakeholder agencies, affected persons and the community was carried out during business case development.

The PCB has been supported by an Expert Review Panel and Regulatory Governance Group, and project-specific governance arrangements set up by the North Central and Mallee CMAs (see Figure 17-1).

The *Nyah Floodplain Management Project* business case has been endorsed by the PCB as part of the final package of Victorian business cases to be submitted for assessment under Phase 2 of the SDL adjustment mechanism.

Expert Review Panel

An Expert Review Panel ('the Panel') was set up to examine the critical elements of each business case at key stages and assess quality, credibility and whether the element is fit for purpose. The Panel was chaired by David Dole and comprised of experts in engineering (including geotechnical, structural, hydraulic and water system operations), hydrology and ecology. Its members include:

- Phillip Cummins (engineering)
- Shane McGrath (engineering)
- Dr Chris Gippel (hydrology)
- Andrew Telfer (salinity) and
- Professor Terry Hillman (ecology).

The following evaluations were carried out during the development of this business case:

- Engineering: Review of concept engineering designs (hydraulics and structures), the scoping of geotechnical investigations to support water management structure design and construction costs.
- Hydrology: Review of hydrodynamic and hydrological models, data, modelled scenarios and outputs.
- Salinity: review of assessments of potential salinity impacts of works and measures projects.
- Ecology: Review of the descriptions of ecological values, the ecological objectives and targets, and environmental water requirements, and the descriptions of anticipated ecological outcomes and environmental water requirements.

The expert review process has led to the conclusion that the underlying feasibility and outcome investigations have effectively provided a soundly based proposal that is fit for purpose. See Appendix L for the Expert Review Panel reports for this project.

Regulatory Governance Group

The Regulatory Governance Group (RGG) was established to support the delivery of business case requirements related to regulatory approvals. The RGG was comprised of relevant staff from Victorian approvals agencies, including DEPI, Parks Victoria and Aboriginal Affairs Victoria. The RGG provided advice to the PCB regarding the regulatory approvals needed for Victorian projects, the resolution of associated issues and develop a program-level strategy to obtain approvals (Appendix I).

Setting up the RGG has provided a mechanism for high-level engagement with responsible agencies at an early stage to streamline the regulatory approvals process for proposed supply measures. While the RGG ceased operation when all business cases were finalised for submission (December 2014), the Group may be reconvened by the PCB as required.

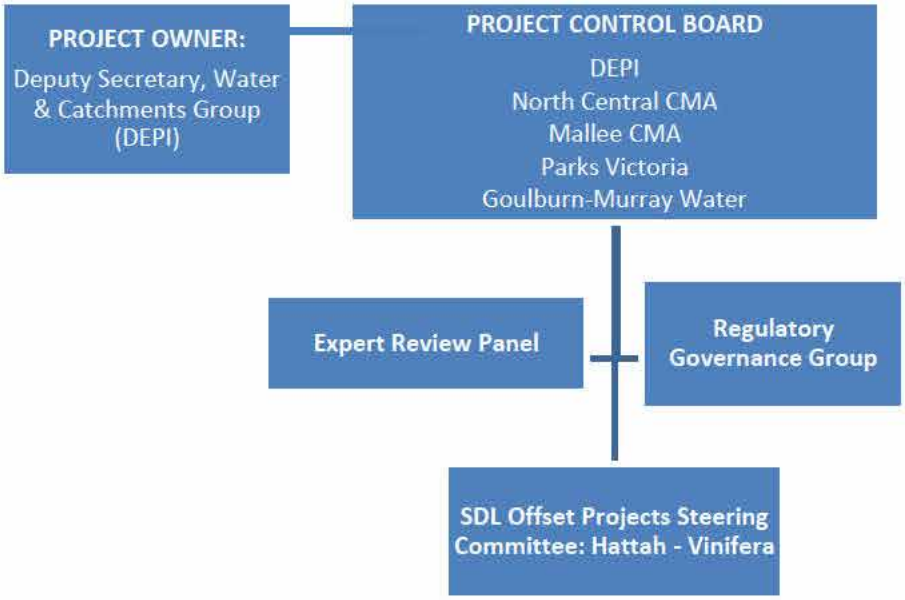


Figure 17-1: Governance arrangements during business case development.

SDL Offset Projects Steering Committee: Hattah - Vinifera

At the project level, development of the business case for the *Nyah Floodplain Management Project* was overseen by the SDL Offset Projects (Hattah- Vinifera) Steering Committee (Mallee CMA, 2014a). The committee's role was to ensure the business cases developed for these sites are of a high quality, consistent standard, and that they meet the requirements of the Commonwealth (Mallee CMA, 2014a).

Specifically the committee was responsible for the following functions in the development and delivery of the relevant SDL project business cases (Mallee CMA, 2014a):

- Provision of advice on the development and proposed delivery of SDL projects from a technical perspective.
- Ensuring projects developed and the supporting business cases produced are technically rigorous and sound.
- Providing guidance to resolve project-specific issues.
- Monitoring the development of business cases to ensure a consistent approach and that required information is provided, in accordance with the Phase 2 Guidelines for Supply and Constraint Measure Business Cases provided by the Commonwealth
- Providing advice on project procurement from a technical perspective.

The committee was comprised of the following members (Mallee CMA, 2014a):

- Chief Executive Officer, Mallee CMA
- The Living Murray Coordinator, Mallee CMA
- Manager Water, Mallee CMA
- Parks Victoria representative/s (land manager representative)
- DEPI representative/s (land manager representative and coordinator of regional environmental advice and approvals)
- G-MW representative/s
- SA Water representative/s and
- MDBA representative/s.

The Steering Committee met monthly, with extraordinary meetings scheduled as necessary. The committee ceased operation when all business cases were finalised for submission (December 2014) (Mallee CMA, 2014a).

17.2 Governance arrangements during project implementation

To ensure that this proposed supply measure is delivered on time, arrangements will be put in place that ensure appropriate senior oversight of project governance and delivery. This will allow for the successful completion and operation of the measure as part of the SDL adjustment mechanism.

These arrangements will be predominantly based around those that were used to deliver the four Living Murray Environmental Works and Measures Program (EWMP) projects within Victoria, complemented by existing state government frameworks, which together will underpin a set of robust and thorough processes for procurement and project management. Key aspects of the proposed governance and project management for this supply measure will include:

Project management structure and team

The project management structure and team will be overseen by the project owner, currently anticipated to be DEPI. In line with the governance arrangements that have underpinned the Business Case preparation for this proposed supply measure, DEPI will be supported by a PCB, comprised of senior executives from DEPI, the relevant Victorian CMAs, the relevant constructing authorities (e.g. G-MW; SA Water), Parks Victoria and the Commonwealth.

It is expected that the PCB will be comprised of appropriate senior management representation from each of the participating agencies, who will have the required decision-making authority to oversee all elements of implementation. In line with the successful governance arrangements that were utilised during the Living Murray EWMP and the outcomes of the workshop on ongoing asset management arrangements (see Section 14.5), the relevant constructing authority would be well placed to undertake the construction of the supply measure, supported by the relevant CMA.

Procurement strategy

As the primary delivery agency, the relevant constructing authority would be expected to manage procurement during the construction of the supply measure, operating under the high-level oversight of the PCB. Supporting this, the relevant CMA will play a critical role by assisting in the development of a procurement strategy, which would be approved by the PCB. More specific details of the preferred approach for procurement will be detailed in the construction proposal.

Project Steering Committees or related governance mechanisms

In line with good governance practice, and again drawing on the experience of the Living Murray, it is expected that the PCB would meet regularly throughout the construction of this proposed supply measure to ensure that milestones and timelines are met, and to resolve any potential arising issues.

As noted above, it is expected that PCB members would have the required decision-making authority to address any emerging risks, including the following:

- identifying and resolving issues, including those that might impact timelines/budget
- providing guidance to resolve project-specific issues
- ensuring appropriate consultation with key stakeholder agencies and the community
- closely monitoring implementation to ensure timelines and budgets are met and
- making recommendations to DEPI on any issues that may arise during construction.

Monitoring and reporting during implementation

It is anticipated that the PCB would be the key conduit for monitoring and reporting during the implementation of this proposed supply measure. This would include:

- The relevant constructing authority providing regular implementation updates at each PCB meeting.
- Consideration of any milestone or payment reporting that is likely to be required under all contractual funding arrangements associated with this supply measure.

Design and implementation plan with timelines

As noted, the PCB will meet regularly throughout the construction phase of this proposed supply measure to ensure milestones and timelines are met, to review designs, and to resolve any arising issues. The relevant CMA will play a critical supporting role by assisting the constructing authority with statutory approvals and the development of the construction proposal, as well as managing discrete projects to support detailed designs and the implementation/construction of the supply measure.

A detailed work plan will document the key tasks and the agency responsible, associated resources and timelines for the implementation of the supply measure.

Refer to Table 3-2 for a proposed project delivery schedule outlining timelines for the implementation of this project.

Operations Group

An Operations Group will be established to assist and advise on the commissioning and operation of this proposed supply measure. This Group will provide a forum to involve project partners in the decision-making process, to consider broader system operations (e.g. of the River Murray and other environmental watering events) during planning and operations, and to inform stakeholders of operations and progress.

For the Nyah site, the Operations Group membership will consist of partners and stakeholders, including the Murray Darling Basin Authority, the Victorian Department of Environment and Primary Industries, Goulburn Murray Water, Lower Murray Water, Parks Victoria, the Commonwealth Environmental Water Holder and the Victorian Environmental Water Holder. Other agencies and organisations may be invited to participate as guests or observers.

The key responsibilities of the Operations Group will be to ensure the necessary planning, monitoring, communication and reporting arrangements are established prior to and during events and to identify and monitor any event risks or issues. This allows for safe and effective operation of the works, real time response and adaptive management when necessary.

17.3 Governance expertise of partner agencies

Implementation of the project at Nyah will be a partnership between four agencies: Mallee CMA, DEPI, Parks Victoria and Goulburn Murray Water.

Mallee CMA

The primary responsibility of the Mallee CMA is to ensure that natural resources in the region are managed in an integrated and ecologically sustainable way. The Mallee CMA's work is based on rigorous science and delivered through meaningful partnerships with government agencies, industry, environmental organisations, private land managers, Indigenous stakeholders and the broader community. All delivery arrangements are formalised through a range of mechanisms including operating agreements, service level agreements and landholder incentive / tender management agreements, the application of comprehensive MERI frameworks; and the application and interpretation of complex spatial data.

The Mallee CMA have a proven track record in successfully delivering a vast range of environmental projects which have varied in complexity, monetary value (up to multi-million dollar projects); and in spatial extent (from concentrated focal points to landscape scale programs).

Operating within policies and controls approved and overseen by the Mallee CMA Board ensures transparent and accountable governance systems that embody performance and continuous improvement. These governance arrangements include a quality management approach to project management, with policies and procedures for project management, contractual arrangements, procurement and risk management.

Department of Environment and Primary Industries

The primary responsibility of DEPI in regard to this project is to act as its sponsor through the project assessment process established by the *Intergovernmental Agreement on Implementing Water Reform in the Murray-Darling Basin* 2014 (IGA). As part of this process, DEPI will represent the State of Victoria in negotiations with Commonwealth Government agencies to secure funding for the project, consistent with the commitments and arrangements outlined in the above mentioned IGA.

Once a funding agreement is reached for this project, DEPI will then assume an oversight role for the rollout of the project consistent with the terms of the funding agreement. As indicated previously, this oversight will be applied through the establishment of a PCB for the purposes of this project and any others that secure Commonwealth Government funding. It is envisaged that this PCB will be chaired and operated by DEPI. Its primary focus will be to ensure that milestones and timelines are met and where necessary, to resolve any emerging issues that present a material risk to the conduct and/or completion of this project.

Over the past decade, DEPI has had considerable experience in undertaking such oversight roles to a high standard for major Commonwealth funded water infrastructure projects in Victoria. Notable examples in this regard include the Living Murray Environmental Works and Measures projects at Gunbower, Hattah Lakes, Mulcra and Lindsay Islands, the G-MW Connections Program and the Lake Mokoan project.

Parks Victoria

Parks Victoria is a statutory authority, created by the *Parks Victoria Act 1998* and reporting to the Minister for Environment and Climate Change.

Parks Victoria is responsible for managing an expanding and diverse estate covering more than 4 million hectares, or about 17%, of Victoria.

Parks Victoria is committed to delivering works on the ground across Victoria's park network to protect and enhance park values. Parks Victoria's primary responsibility to ensure parks are healthy and resilient for current and future generations and manage parks in the context of their surrounding landscape and in partnership with Traditional Owners.

Parks Victoria works in partnership with other government and non-government organisations and community groups such as the DEPI, CMAs, private land owners, friends groups, volunteers, licensed tour operators, lessees, research institutes and the broader community.

Health Parks Healthy People is at the core of everything Parks Victoria does. Parks and nature are an important part of improving and maintaining health, both for individuals and the community. Parks Victoria has a clear role to play in connecting people and communities with parks

Goulburn-Murray Water

G-MW provides rural water and drainage services in northern Victoria. G-MW is Victorian Murray Resource Manager, with responsibilities for water accounting and liaison with MDBA on planned and actual Victorian diversion operations. G-MW is also the Victorian State Constructing Authority (SCA) for the MDBA. G-MW manages $4 billion of its own assets and a further $2 billion of MDBA assets to fulfil its functions. As SCA, G-MW was the delivery authority for the Hattah and Gunbower Living Murray Projects in Victoria. G-MW has the asset management and design and construction policies and controls in place to delivery against a large capital works program. These policies and controls will direct G-MW's activities for the delivery of each of the SDL Offset projects.

18. Risk assessment of project development and construction (Section 4.11.4)

A comprehensive risk assessment of the project development and construction phases has been carried out. A number of threats to successful project delivery were identified, as described in Table 18-1. The risk assessment process was informed by the past experience of the project team in the development and construction of environmental watering projects of similar scale and complexity, including TLM.

18.1 Risk assessment methodology

The risk assessment for the Nyah Floodplain project was completed in line with the requirements of AS/NZS ISO 31000:2009 (Lloyd Environmental, 2014). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and prioritised mitigation strategies and measures.

Refer to Section 7, Tables 7-1 to 7-4 to view the risk matrix and definitions used in this risk assessment, and further details on the methodology.

The risk assessment was consolidated as the project developed and additional information incorporated into Table 18-1.

18.2 Risk assessment outcomes

Table 18-1 presents a summary of the assessment and subsequent work undertaken, including mitigation measures developed and an assessment of residual risks after these are applied. It should be noted that where a residual risk is given a range of ratings, the highest risk category is listed.

Table 18-1. Risk assessment – Potential impacts to project delivery and construction without mitigation and residual risk rating with mitigation, adapted from Lloyd Environmental (2014)

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Unexpected delays in obtaining statutory approvals	The high environmental and cultural values of Nyah Floodplain may result in a lengthy regulatory approvals process, due to requests for additional information to clarify the potential impacts and proposed mitigation measures. Numerous conditions could also be placed on permits and approvals to ensure appropriate controls are in place during construction to minimise impacts.	Certain	Moderate	High	General: • CEMP developed and implemented; monitoring during construction to ensure compliance. • Site-based approvals group convened to engage with the relevant regulatory authorities • Project delivery timelines informed by Regulatory Approvals Strategy to minimise unexpected delays. Cultural heritage: • Preliminary assessment to inform structure design and location • A CHMP will be developed in consultation with Indigenous stakeholders and implemented during construction to minimise impacts on cultural values.	Low
Delays to construction planning and completion	Time and cost overruns could occur if the time required to obtain all necessary approvals is not embedded in the project planning and delivery timeframe.	Certain	Moderate	High	As above, and: Maintain strong working relationships with partner agencies (including agencies in NSW, SA and Victoria) through regular design and construction group meetings. Incorporate potential for delays into contractual arrangements.	Low
Weather related delays	Adverse weather (such as storms, heat	Certain	Moderate	High	Consider weather conditions and medium	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
	waves) may create short-term delays to works through limitations to site access due to poor track conditions, OH&S and fire safety considerations.				to long-term forecasts when sequencing site works to minimise impacts and inform program scheduling to accommodate extreme weather events. Incorporate potential for delays into contractual arrangements, including appropriate terminology and clauses to ensure the principal and client are not put at undue risk for natural events.	
Floods	Natural floods may inundate the site and restrict access during construction, leading to cost increases and delays. These issues may be compounded by local weather conditions preventing demobilisation at the site.	Possible	Severe	High	Physically managing flows, as far as practical, through river operations. Utilise long-range weather forecasts, flow forecasts and general flow data (travel time, historical/predictive flows) to provide advance warning of floods to ensure sufficient lead time for demobilisation. Maintain strong working relationships with partner agencies (including agencies in NSW, SA and Victoria) through regular design and construction group meetings to assist timely issue resolution. Incorporate potential for delays into contractual arrangements, including appropriate terminology and clauses to ensure the principal and client are not put at undue risk for natural events.	Moderate

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					Contingency planning for inundation events. Obtain insurance covering inundation events.	
Fire	Equipment that can create sparks, such as angle grinders and welding equipment, can cause fires that threaten worker safety and require site evacuation. Bushfires (other causes) can have similar outcomes. Depending on the size and severity, fires can cause project delays and increase costs.	Unlikely	Severe	Moderate	Include safety provisions for relevant equipment in the CEMP and the site safety plan. Ensure comprehensive fire management plans are in place prior to construction that include: • Training and equipment requirements for on-ground personnel. • Site access/equipment restrictions that apply on fire danger days. • Emergency response (including evacuation) if a fire does occur. Monitor bushfire danger by liaising with DEPI, CFA, BOM and other relevant authorities. Contractual arrangements that accommodate changes resulting from fire incidents. Appropriate insurance for contractors, equipment and liability.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Poor contractual arrangements	Ambiguous contractual arrangements may lead to confusion regarding the scope of work to be delivered and/or multiple contract variation requests. This can delay construction and have significant financial impacts.	Possible	Moderate	Moderate	Seek expert/legal advice on contractual arrangements. Ongoing supervision of contractors.	Very Low
Poor engineering design	Poor engineering design can create a number of issues, including: • Design not fit for purpose • Difficulties in operation • Increased maintenance costs • Reduced design life	Possible	Moderate	Moderate	Detailed designs and construction drawings peer reviewed before they are finalised. Early engagement of contractors and operators to provide feedback on design practicalities/constructability.	Very Low
Inadequate geotechnical information	Unforeseen geotechnical conditions encountered during construction may require significant alteration to existing designs or relocation of infrastructure causing project delays and additional expense.	Possible	Severe	High	Appropriate geotechnical investigations conducted carried out during the design phase to reduce uncertainty. Conservative design of structures to allow for variations to geotechnical conditions.	Moderate
Unclear roles and responsibilities	Unclear roles and responsibilities could hinder effective project development and construction.	Possible	Moderate	Moderate	Establish a MoU between all relevant agencies outlining roles and responsibilities during project development and construction. Ensure appropriate contractual arrangements are in place between the project owner and the agencies responsible for construction management,	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
					approvals preparation, etc. Maintain strong working relationships with river operators, partner agencies (including agencies in NSW, SA and Victoria), and Commonwealth and Victorian water holders through regular design and construction group meetings. Maintain clear lines of communication with all partner agencies and project stakeholders during project development and delivery.	
Insufficient resourcing	Insufficient resourcing available for agency staff and equipment. This will impact on the ability to deliver the project within agreed timelines and budget.	Possible	Moderate	Moderate	Clear identification of roles, responsibilities, associated activities and resourcing requirements; funding agreements negotiated on the basis of these requirements. Maintain strong relationships with investors/funding bodies to secure adequate resources for project development and delivery.	Low

18.3 Risk mitigation and controls

While the risk assessment identifies several potential threats that could generate high risks to construction (Table 18-1), these risks are considered manageable because they:

- Are well known and are unlikely to involve new or unknown challenges
- Can be mitigated through well-established management controls
- Have been successfully managed by the project team (including construction authorities) in previous projects
- Result in very low or moderate residual risks after standard mitigation measures are implemented.

The risk assessment confirms that all risks are reduced to acceptable levels (moderate or lower) once well-established risk mitigation controls are implemented. Two threats retained a residual risk of moderate after implementation of the recommended mitigation strategies (18-2). Additional considerations may assist in further understanding, and in some cases reducing, the residual risk rating.

Table 18-2. High priority risks, mitigation and residual risk

Threat	Risk without mitigation	Residual risk rating	Additional considerations
Inadequate geotechnical information	High	Moderate	Obtaining peer review of designs and geotechnical information prior to engagement of contractors.
Floods	High	Moderate	The risk of a flood occurring is unpredictable and mitigation options are limited. Flood risks must be adequately considered in project costs. This is reflected in the inclusion of explicit costing for flood risk in the cost estimates for this business case.

18.4 Risk management strategy

As noted in Section 7.3, a comprehensive risk management strategy will be developed for the proposed supply measure, building on the work completed for this business case. The strategy will provide a structured and coherent approach to risk management for the life of this project (i.e. construction and operation). With regard to the potential threats to project development and construction, the risk management strategy will focus on the following issues, as described in Table 18-1:

- Ability to complete construction
- Project development and delivery

Risk assessment and management is not a static process. Regular monitoring and review of the risk management process is essential to ensure that:

- Mitigation measures are effective and efficient in both design and operation
- Further information is obtained to improve the risk assessment
- Lessons are learnt from events (including near-misses), changes, trends, successes and failures
- Risk treatments and priorities are revised in light of changes in the external and internal context, including changes to risk criteria and the risk itself, and
- Emerging risks are identified.

The risk assessment process will continue throughout the development and implementation of this project. It is anticipated that additional threats will be identified and evaluated as the project progresses, and any new risks incorporated into the risk management strategy.

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20. Appendices

Appendix A: Nyah proposed works and inundation extents.

Appendix B: Ecological Associates 2014a. SDL Floodplain Watering Projects: Rationale and Outcomes, Report AL040-1-D. Report for the Mallee CMA.

Appendix C: Ecological Associates 2014b. SDL Floodplain Watering Projects: Monitoring and Evaluation. Ecological Associates report ALo45-1-B. Report for the Mallee Catchment Management Authority, Irymple, Victoria.

Appendix D: SKM 2014. Preliminary Salinity Impact Assessment for Mallee Environmental Watering Projects – other sites. Report for the Mallee CMA.

Appendix E: Jacobs 2014a. SDL Adjustment Supply Measures Advanced Concept Design Report – Nyah Park. Report for the Mallee CMA.

Appendix F: Aither 2014. Social and economic assessment- Nyah Water Management Works, Benefits for the Basin Plan Sustainable Diversion Limits offset program business case. Report for the Mallee CMA.

Appendix G: Nyah letters of support.

Appendix H: RMCG 2014. Nyah Sustainable Diversion Limits Offset Project, Final Communication and Engagement Strategy. Report for the Mallee CMA.

Appendix I: GHD 2014a. Basin Plan Environmental Works Program: Approvals Strategy. Report for the Department of Environment and Primary Industries.

Appendix J: Golsworthy Consulting 2014. SDL Offsets Projects, Statutory Approval Requirements, Belsar, Burra, Hattah, Lindsay, Nyah, Vinifera and Wallpolla. Report for the Mallee CMA.

Appendix K: Grinter, B., Edwards, A. & Bell, J 2014. Nyah-Vinifera Park, River Red Gums National Park Due Diligence Assessment. Jo Bell Heritage Services Pty. Ltd. Euroa, Victoria.

Appendix L: Expert Review Panel Reports.