Burra Environmental Watering Plan - DRAFT

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VICTORIAN MURRAY FLOODPLAIN RESTORATION PROJECT

HEALTHY LANDSCAPES, STRONG COMMUNITIES

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List of abbreviations	
Abbreviation	**Full description**
AHD	Above Height Datum
ARI	Arthur Rylah institute
AWOC	After SDL works operation commencement
BSMS	Basin Salinity Management Strategy
BWS	Basin-wide Environmental Watering Strategy
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary industry
DTF	Department of Treasury and Finance
EMF	Environmental Management Framework
EPBC	Environmental Protection and Biodiversity Conservation
EWMP	Environmental Water Management Plans
FFG	Flora and Fauna guarantee
GHD	Guttridge Haskins & Davey
GL	Gigalitre
GMW	Goulburn Murray Water
JAMBA	Japan-Australian Migratory Bird Agreement
LMW	Lower Murray Water
LTWP	Long-Term Watering Plans
MCMA	Mallee Catchment Management Authority
MDBA	Murray Darling Basin Authority
MDFRC	Murray-Darling Freshwater Research Centre
MER	Monitoring, evaluation and reporting
ML	Megalitre
PEA	Priority Environmental Assets
PEF	Priority Ecosystem Functions
PWOC	Prior to SDL works operation commencement
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SDL	Sustainable Diversion Limit
SKM	Sinclair Knight Merz [consultant]
SWP	Seasonal Watering Proposal
TLM	The Living Murray
VEAC	Victorian Environmental Assessment Council
VEWH	Victorian Environmental Water Holder
VMFRP	The Victorian Murray Floodplain Restoration project
WRP	Water Resource Plan

1. Introduction

1.1 Victorian Murray Floodplain Restoration Project

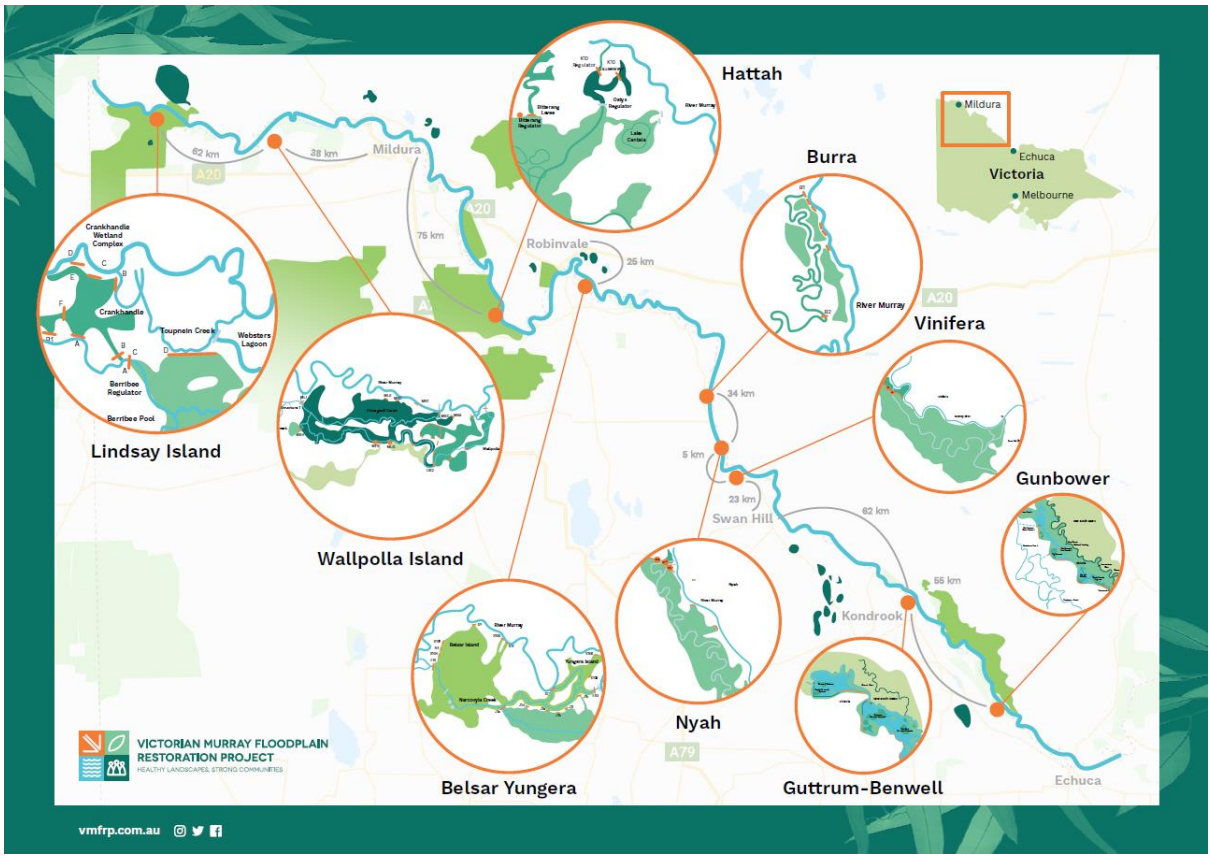
The Victorian Murray Floodplain Restoration project (VMFRP) consists of nine discrete environmental works projects that aim to return a more natural inundation regime across more than 14,000 ha of high ecological value.

Murray River floodplain in Victoria through the construction of new infrastructure and in coordination with existing infrastructure operation regimes (Refer to Figure 1).

The inundation events will mimic the impact of natural flood events and improve the condition of vegetation communities and provide habitat for native fish, birds, frogs and reptiles.

The VMFRP is being implemented as part of meeting Victoria's obligations under the Murray Darling Basin Plan (Commonwealth of Australia, 2012) in partnership with Lower Murray Water, Goulburn Murray Water, Mallee CMA, North Central CMA, Parks Victoria and the Department of Environment, Land, Water and Planning (DELWP).

Figure 1: VMFRP project locations



1.2 Burra Creek Project

Burra Creek is located north of Nyah between the rural localities of Piangil and Kenley. Burra Creek is an anabranch of the River Murray, extending 54 km just upstream of the junction of the Wakool River.

The land between the creek and the River Murray forms Macreadie Island, which consists of floodplain with areas of cropping and grazing land and floodplain vegetation.

For approximately 17 km of its northern length, Burra Creek flows through River Murray Reserve. A narrow strip of River Red Gum lines the bank of the Creek. Floodplain vegetation further afield, generally consist of Black Box and Lignum communities.

The area in the north of Macreadie Island, Burra North, is largely unmodified and comprises wetland, forest and woodland. The southern part of the island is mainly freehold land and has been developed for agriculture. Burra North is the target for the managed floodplain inundation of the VMFRP project.

Figure 2 shows the proposed VMFRP structures and inundation extent.

The Burra Creek site provides significant habitat for a suite of plant and animal species of conservation significance, both at a Victorian and national level.

The Burra Creek works aim to complement Basin flows in returning a more natural inundation regime to 404 ha of the Burra Creek floodplain. In the absence of sufficient flows in the River Murray to provide sufficient inflows to the site, the works will also enable watering of the floodplain through the use of temporary pumping (MCMA, 2014).

1.3 Content of Addendum

Environmental Water Management Plans (EWMPs) provide detailed management information at the waterway scale. They set out the environmental watering goals, ecological objectives, and the water-regime required to meet the ecological objectives.

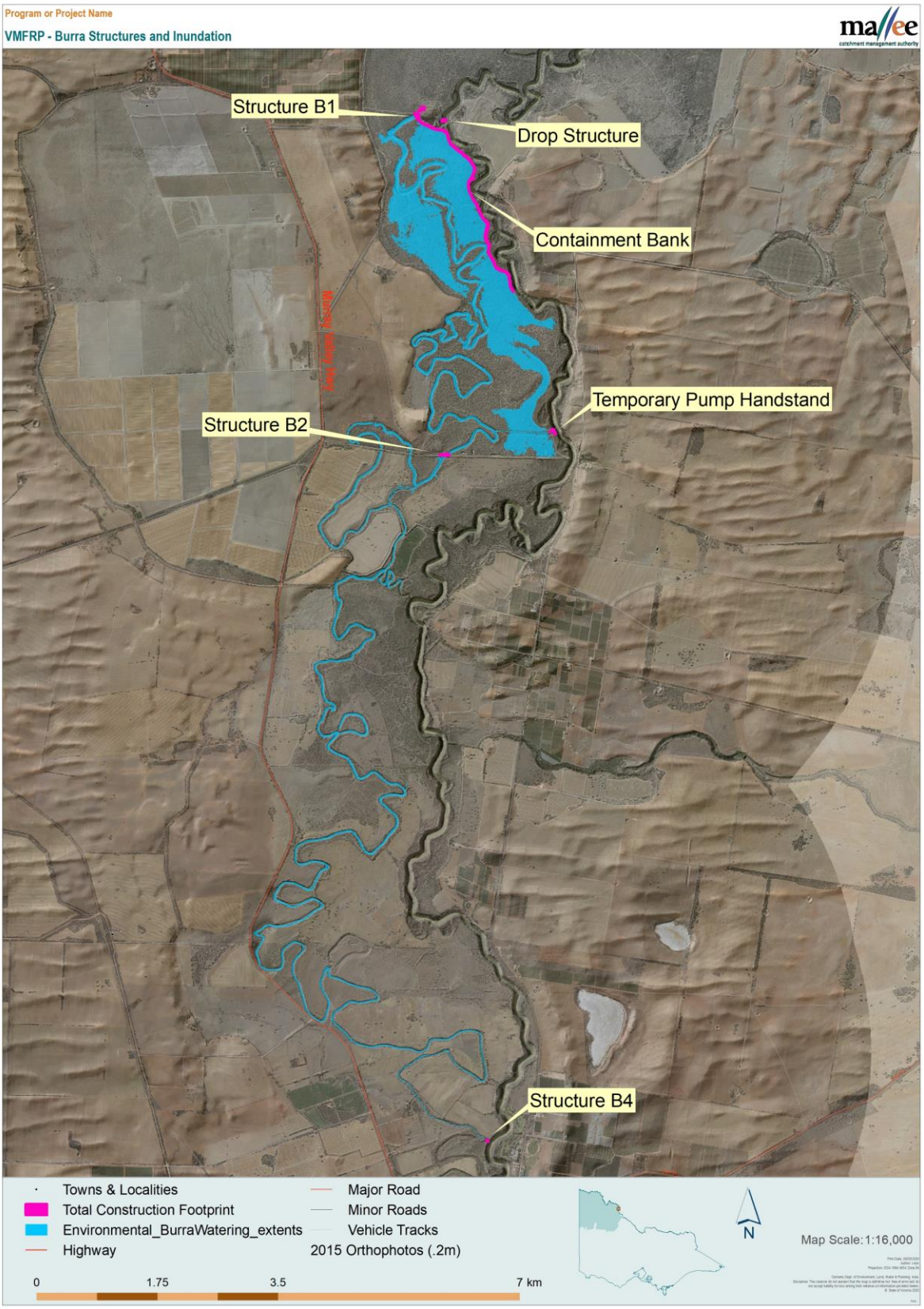
They are characterised by a long-term focus (i.e. more than 10 years) for rivers or wetlands identified by a catchment management authority in their regional Waterway Strategy as priorities for environmental watering.

In northern Victoria, EWMPs are a key reference for the long-term watering plans prepared for Basin Plan. The existing Burra Creek EWMP (Sunraysia Environmental, 2015) provides context for the Burra North water planning, monitoring and consultation process.

This addendum provides an update of the Burra Creek EWMP and should be read in conjunction with the 2015 EWMP (Sunraysia Environmental, 2015) and the Burra Creek Operating Plan prepared for the VMFRP works (VMFRP Project Team, 2020).

It identifies environmental objectives and targets (where appropriate), water delivery options and regimes for the Burra Creek project.

Figure 2: VMFRP Structures and Inundation Extent



2. Planning context and legislative framework

Basin Plan Environmental Management Framework

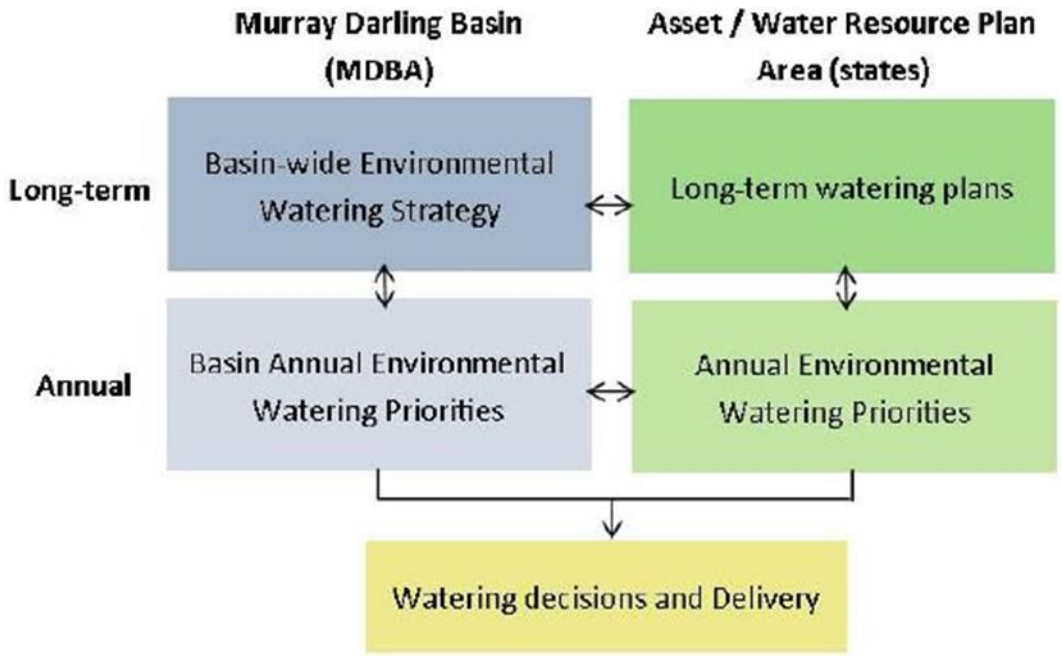
The Basin Plan establishes the legal and policy framework for the use of environmental water in the Murray-Darling Basin (Commonwealth of Australia, 2012).

The primary environmental goal of the Basin Plan is the protection and restoration of water dependent ecosystems and ecosystem functions in the Murray-Darling Basin, with strengthened resilience to a changing climate.

The Environmental Watering Plan of the Basin Plan (Chapter 8) sets out the overall environmental objectives for the water dependent ecosystems of the Murray-Darling Basin, the targets (schedule 7) by which to measure progress towards achieving those objectives and an Environmental Management Framework (EMF) for planned environmental water and held environmental water (Commonwealth of Australia, 2012).

This planning provides for both long-term and annual environmental water objectives, at both the Basin and a more localised scale, as shown in Figure 3.

Figure 3: The long-term and annual planning documents required under Basin Plan Chapter 8 'Environmental Watering Plan' (DELWP, 2015)



The EMF is intended to:

- Coordinate the planning, prioritisation and use of environmental water on both a long-term and an annual basis; and
- Enable adaptive management to be applied to the planning, prioritisation and use of environmental water; and
- Facilitate consultation, coordination and cooperative arrangements between the Authority, the Commonwealth Environmental Water Holder and Basin States (Commonwealth of Australia, 2012).

The long-term watering plan (LTWP) has been prepared by the Victorian Government in accordance with its obligations under the Basin Plan. LTWPs will assist planning for environmental water outcomes, in order to meet the Basin Plan objectives and targets, and the overall environmental objectives for water dependent ecosystems outlines in Part 2 of Chapter 8 of the Basin Plan.

As part of the development of the LTWPs for Water Resource Plan Areas, Basin states are required to identify priority environmental assets (PEAs) and priority ecosystem functions (PEFs) that can be supported with environmental water.

Burra supports populations of grey-crowned babbler (*Pomatostomus temporalis*), brown treecreeper (*Climacteris picumnus*) and red-capped robin (*Petroica goodenovii*) (MCMA, 2014). These three species are listed as threatened under the Flora and Fauna Guarantee (Victorian Government, Flora and Fauna Guarantee Act, 1988; Victorian Government, Flora and Fauna Guarantee Amendment Act, 2019).

The site therefore meets the criteria for identifying an Environmental Asset in accordance with Schedule 8 of the Basin Plan (Commonwealth of Australia, 2012), and can be managed with environmental water, rendering it a PEA.

Objectives and targets relating to the criteria for which the PEAs and PEFs were identifies are to be documented in the LTWP for assets and to have regard to the Basin-wide Environmental Watering Strategy (BWS) environmental outcomes.

The objectives and targets set in this Addendum are consistent with Basin Plan objectives and have been aligned to the criteria for identifying PEAs and PEFs, the BWS outcomes and Schedule 7 targets.

3. Water management

The purpose of the Burra Creek VMFRP project is to restore the integrity and productivity of the ecosystem by increasing the frequency and duration of floodplain inundation.

This will require the removal of blockages to allow the flow of Burra Creek, and the construction of regulating structures and temporary pumping to retain and regulate water over the floodplain.

The infrastructure has been designed to be operated in several possible flow regimes:

- Natural flood
- Flood capture
- Managed inundation – gravity released
- Managed inundation – pumped release

Constructed elements of the water management infrastructure include gated regulators, a drop structure, containment banks and overflow sills, as well a hardstand on which to place temporary pumps.

For more detail on the operating scenarios, refer to the *Burra Creek Operating Plan* (VMFRP Project Team, 2020).

4. Ecological objectives and targets with associated inundation regimes and requirements

Ecological objectives, as summarised in the 2014 Business Case (MCMA, 2014), were developed for the Burra Creek site, drawing on a range of approaches and recommended lines of enquiry, including:

- The overarching objectives in Schedule 7 of the Murray Darling Basin Plan (Commonwealth of Australia, 2012)
- The Basin-wide Environmental Watering Strategy (MDBA, Basin-wide environmental watering strategy, 2014)
- A review of relevant literature including monitoring data from the TLM initiative (Henderson, et al., 2012; Henderson, et al., 2013; Henderson, et al., 2014)
- Desktop and field-based flora and fauna surveys (Australian Ecosystems, 2016)
- Ecological objectives identified in the report prepared by Ecological Associates (Ecological Associates, SDL Rationale and Outcomes. Ecological Associates report AL040-1D. Report for the Mallee CMA, 2014)
- Site visits
- An ecological objectives workshop with an expert panel comprised of aquatic wildlife and restoration ecologists and key project stakeholders from DELWP and the Mallee CMA.

With the ecological component, being a significant part of the overall VMFRP (MER) program, Mallee CMA in collaboration with the Arthur Rylah Institute for the Environmental Research (ARI) is developing long-term monitoring strategies for the ecological component of the VMFRP.

As part of this undertaking, refinement of the ecological objectives and targets produced updates that were incorporated into the VMFRP specific ecological objectives and targets through an ecological objectives workshop with ARI and key project stakeholders from DELWP, Parks Victoria, North Central CMA, and Mallee CMA.

The VMFRP specific ecological objectives and targets for each water regime class are outlined in Table 5.

The ecological objectives for Burra Creek 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 works, and guide monitoring and evaluation.

4.1 Ecosystem type and biodiversity

The ecological significance of Burra Creek is underpinned by its unique location, providing longitudinal connection to the River Murray and its floodplains. It provides 54 kilometres of complex and diverse creek habitat as well as connection to the semi-arid Mallee environment (MCMA, 2014).

Burra Creek north, designated as River Murray Reserve, is largely unmodified and comprises wetlands, forest and woodland. It is one of the best-preserved floodplain woodland and shrubland communities in the western part of the Murray Fans bioregion.

The system has intact vegetation strata with an overstory of black box, a mid-storey of lignum, and a complex ground layer with high levels of logs and understorey grasses and shrubs.

The area supports a diverse bird community with over 140 bird species reported from the site and local vicinity, including Environmental Protection and Biodiversity Conservation (EPBC) Act- (Commonwealth of Australia, 2012) listed regent parrot (*Polytelis anthopeplus monarchoides*) (Brown, Bryant, & Horrocks, 2013).

The bird fauna is dominated by species that depend on woodland and shrubland vegetation such as grey-crowned babbler (*Pomatostomus temporalis*), brown treecreeper (*Climacteris picumnus*) and red-capped robin (*Petroica goodenovii*) (MCMA, 2014). These three species are listed as threatened under the Flora and Fauna Guarantee (Victorian Government, Flora and Fauna Guarantee Act, 1988; Victorian Government, Flora and Fauna Guarantee Amendment Act, 2019).

The bat fauna is also diverse with twelve species reported from the site. Bats are largely insectivorous and depend on high levels of floodplain productivity to provide prey (Ecological Associates, 2014).

Burra creek supports nineteen reptile species including the lace monitor (*Varanus varius*) and curl snake (*Suta suta*) ((Brown, Bryant, & Horrocks, 2013). The presence of these species indicates the availability of vertebrate prey species such as frogs, birds and small reptiles and that sheltering habitat is available in the form of logs, litter and tree hollows (Ecological Associates, 2014).

In 2007, six frog species were recorded representing two families, the Tree Frogs (Hylidae) were represented by a single species, Peron's Tree Frog, and the Southern Frogs (Myobatrachidae) five specie: Plain Froglet[1], Common Froglet, Southern Bullfrog, Barking Marsh Frog and Spotted Marsh Frog[2].

One species not recorded during the survey, that may occur in the area is the nationally threatened Growling Grass Frog (*Litoria raniformis*) (Lumsden, Brown, Cheers, & Palmer, 2007). The species is listed as vulnerable in Victoria and nationally, vulnerable in the EPBC Act, and threatened under the FFG Act.

The northern floodplain of Burra Creek provides a strongly contrasting habitat to the surrounding floodplain woodland. Under natural unregulated conditions the creek flowed almost every year for about four months. When flowing, the creek would have supported large channel specialist fish such as the EPBC Act-listed Murray Cod (*Maccullochella peelii peelii*).

Deep permanent pools would have supported resident populations of small fish such as gudgeon species and Murray-Darling rainbowfish (*Melanotaenia fluviatilis*) (Ecological Associates, 2014).

Flooded lignum and woodland provide habitat for a range of small fish that benefit from submerged aquatic vegetation, woody debris and plan, biofilm and invertebrate food sources.

The restoration of floodplain habitat would provide feeding and breeding opportunities for Murray-Darling rainbow fish, carp gudgeon, flathead gudgeon and Australian smelt.

Between flood events, lignum is an important habitat for terrestrial vertebrate fauna including snakes and lizards (Ecological Associates, 2014)

Burra Creek has a diverse flora assemblage and supports numerous species of conservation significance. Australian Ecosystems recorded 95 indigenous species in 2016, including seven species listed as rare, vulnerable or poorly known on the Department of Primary Industry Advisory List of Rare or Threatened Plants in Victoria (DEPI, 2014).

[1] Also observed during survey by Australian Ecosystems in 2016 (Australian Ecosystems, 2016)
[2] *Ibid*

Table 1: Plants identified by Australian Ecosystems 2016 in the Burra project area with Advisory list status

Scientific name	Common Name	Advisory list status (DEPI, 2014)	FFG
Alternanthera sp. 1 (Plains)	Plains Joyweed	Poorly known	Not listed
Dianella sp. aff. longifolia (Riverina)	Pale Flax-lily	Vulnerable	Not listed
Haloragis glauca f. glauca	Bluish Raspwort	Poorly known	Not listed
Picris squarrosa	Squar Picris	Rare	Not listed
Sida intricate	Twiggy Sida	Vulnerable	Not listed
Tetragonia moorei	Annual Spinach	Poorly known	Not listed
Senecio cunninghamii var. cunninhamii	Branching Groundsel	Rare	Not listed

For a full list of the flora and fauna sound within the Burra Creek area, refer to the Burra EWMP (Sunraysia Environmental, 2015).

4.2 Current conditions

As of 2014, the current condition of the Burra Creek has declined due to altered flow regimes, altered inundation patterns and low flow conditions of the early 2000s. The alteration in water regime is adversely affecting riparian, floodplain and aquatic vegetation, as well as impacting on native fish populations and other fauna (MCMA, 2014).

Index of Stream Condition (ISC) assessments conducted in 2010 (DEPI, 2010) demonstrate Burra Creek to be in poor condition.

The condition of water-dependent vegetation along the creek is generally poor with large red gum and block box trees in poor health from an inadequate water regime.

Riparian and aquatic macrophytes are largely absent and aquatic fauna such as fish, frogs and tortoise are rarely present (Ecological Associates, 2014). Even so, Burra Creek remains one of the best-preserved floodplain woodland and shrubland communities in the western Murray Fans bioregion (Ecological Associates, 2014).

Conditions have been conserved in discrete pockets of Burra Creek where environmental water requirements have been partially achieved with temporary works. Environmental water delivery using temporary infrastructure at Burra commenced in 2004 as an emergency response to prevent the total loss of River Red Gum woodland and forest.

The water for these events was from various sources as outlined in Table 2. All management zones previously received environmental water, except Burra North Wetland located 2 km north east of Burra Creek North Floodplain (Sunraysia Environmental, 2015).

Table 2: A summary of recent environmental watering events in Burra (Sunraysia Environmental, 2015)

Water year	Time of inflow	Inflow source	Inundation zone	Source volume (ML)	Total volume (ML)
2003-04	7 May – 30 Jun	EWA	North	223	223
			South	609	609
2004-05	1 Feb – 30 Jun	Donation	North	228	228
2005-06	Mar – 30 Jun	Donation	North	200	200
			South	600	800
2013-15	28 May – 30 Sep	VEWH CEWH	South	1150	1034.895
2013-15	28 May – 24 Aug	VEWH CEWH	South proper	50	50
2014-15	7 Apr – 30 May	VEWH	North	400	317
2015-16	6 May – 17 Jun	VEWH	North	350	277
2016-17	30 Jul – 4 Dec	Natural inundation	North South	N/A	N/A

The initial purpose of the emergency watering program was to alleviate the impact of prolonged dry conditions that had resulted in drastic decline in River Red Gum health among the trees lining the creek. Anecdotal evidence indicated a positive response by the River Red Gums to the watering through increased foliage vigour (Sunraysia Environmental, 2015).

Once the trees began to respond positively to the environmental watering and dry condition abated, the purpose of the environmental watering changed from emergency response to long term sustainability of the system.

Objectives included providing habitat, feeding and breeding opportunities to increase the abundance, distribution and diversity of native wetland species at Burra (Sunraysia Environmental, 2015).

Environmental watering has assisted in preserving pockets of river red gum and black box stands in better condition than the majority of Burra Creek.

The proposed VMFRP works would facilitate significantly larger inundation events and would reach areas that have not been inundated during past watering activities. This would therefore deliver extended ecological benefits beyond those currently achievable (MCMA, 2014).

4.3 Overarching ecological objectives

The overarching objective of water management at Burra Creek is:

"to protect and restore the key species, habitat components and functions of the Burra North ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities." (MCMA, 2014)

The ecological objectives for Burra Creek 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 works and guide monitoring and evaluation (MCMA, 2014).

This will be achieved by using infrastructure to better meet the water requirements of Burra Creek and its northern floodplain.

The proposed works will enable widespread inundation of Burra Creek and adjoining floodplain. The works have been designed to operate in conjunction with Basin Plan flows but will also allow use of temporary pumps under low River Murray flows and will therefore protect this wetland system through droughts (MCMA, 2014).

4.4 Predicted ecological benefits of inundation

Inundation maintains the integrity and productivity of waterway and floodplain habitats. It promotes germination of aquatic plants, which provide habitat for a range of aquatic fauna species including fish, invertebrates and frogs (Ecological Associates, 2014).

Inundation also helps maintain the health of woodlands that provide important habitat like nesting sites and hollows for regent parrot and carpet python (*Morelia spilota metcalfei*) and promotes the growth of trees and triggers flowering.

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.

This inflow contributes to the energy requirements of the broader river system (Ecological Associates, 2014). Flowering attracts nectar-eating insects and birds and provides abundant insect prey for bats and insectivorous birds.

Drawing upon ecological response monitoring outcomes associated with large-scale watering of the Hattah Lakes through The Living Murray (TLM) works, it is expected that the observed trend of improved ecological condition would also occur at Burra once permanent works can facilitate an appropriate water regime.

Previous delivery of environmental water to Burra Creek has enabled reaches of the Creek and floodplain to be conserved until permanent works can deliver the required water regime to the complex (refer to

Figure 4 &

Figure 5).

Figure 4: Burra North Photo Point No.07 Showing creek and floodplain conservation via previous environmental watering events (Above left:2015; Above right: 2017)

Figure 5: Burra South Photo Point No.10 Showing river red gum tree condition improvement as a result of environmental watering (Above left:2014; Above right:2018)

Figures 4 and 5 depict floodplain conservation and the development of understorey plant communities after water has receded.

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.

The proposed Burra VMFRP inundation works will restore flooding frequency and duration and improve productivity to areas of creek, lignum and black box and red gum woodland (Ecological Associates, 2014; MCMA, 2014).

The anticipated ecological benefits that are expected for each water regime class as a result of the project are outlined in Table 3.

Table 3: Water regime class, strategy and ecological benefits (Ecological Associates, SDL Rationale and Outcomes. Ecological Associates report AL040-1D. Report for the Mallee CMA, 2014; MCMA, 2014)

Water regime class	Strategy	Ecological benefit
Seasonal anabranch and billabongs	Remove blockages in the Burra North section of Burra Creek. Regulate the channel to capture flood peaks in flow or to store pumped water.	Restoration of inundation will promote the growth of in-stream and riparian aquatic macrophytes. If deep pools are present, a resident population of small-bodied native fish will establish, migrating between pools and the River Murray when water levels are high in spring.
Lignum shrubland 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.	Lignum grows quickly and forms dense, continuous thickets. Provides an extension of habitat for aquatic floodplain fauna e.g. Fish, reptiles and frogs. Provides a productive substrate for epiphytes that support high macroinvertebrate productivity and shelter from predators. Inundated lignum is also used as a platform by nesting waterbirds including ibis and spoonbill. Floodwater draining from lignum will carry dissolved and particulate carbon as well as algae and invertebrates, which will contribute to the food web of the river channel.
Black box and red gum 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	Tree recruitment and the productivity of the vegetation are enhanced. Inundation maintains a diverse tree age structure and a complex understorey plant community that is required by carpet python and other vertebrate fauna. The diversity of birds is increased because black box woodland habitat improves. Black box woodland supports ground foragers and hollow-nesting species and canopy feeding bush birds such as superb fairy wren, little friarbird and blue-faced honeyeater benefit. Seasonal migrants such as grey fantail and white-bellied cuckoo-shrike benefit. Habitat improves for insectivorous bats. Floodwater draining from woodland carries dissolved and particulate carbon, algae and invertebrates contributing to the food web of the river channel.

4.5 Specific objectives and targets

Specific VMFRP ecological objectives have been developed to provide some quantification on the degree of environmental benefit expected from the Burra project based on the key water-dependent values of the Burra area (refer to Table 5). The objectives are consistent with those of the Burra Creek EWMP (Sunraysia Environmental, 2015) (refer to Table 4) and will contribute to achieving the environmental objectives set out by the Basin Plan (Commonwealth of Australia, 2012). The Basin Plan objectives are attached as Appendix 1 Basin Plan Objectives.

Table 2 shows the association and progression of the ecological objectives from the Business Case 2014 to the current ecological objectives set by Arthur Rylah Institute to be delivered by the VMFRP.

Table 4: Specific objectives established for Burra. This table shows the progression of ecological objectives from 2014 to 2020 (Ecological Associates, 2014; MCMA, 2014; Arthur Rylah Institute, 2020; Sunraysia Environmental, 2015).

Ecological Associates Rational & Outcomes 2014 (Ecological Associates, SDL Rationale and Outcomes. Ecological Associates report AL040-1D. Report for the Mallee CMA, 2014), Burra Business Case (Mallee CMA, 2014)	Burra Environmental Watering Plan (Environmental, 2015)	VMFRP Specific Objectives 2020 (Institute, 2020)
Restore seasonal aquatic habitat to Burra Creek	Improve vegetation health and structure in the fringing Lignum, Black Box and Red Gum	1. Reduce high threat exotic plant cover 2. Maintain plant cover and diversity of target native vegetation groups 3. Maintain threatened native flora presence 4. Maintain the health of native trees.
Restore floodplain productivity to maintain resident populations of vertebrate fauna including bats, sugar glider and lace monitor	Promotion of seasonal emergent and semi-emergent macrophytes	1. Increase abundance of native woodland birds 2. Develop seasonal populations of small-bodied native fish 3. Increase the abundance of bats as an indicator species of increased resources resulting from increased floodplain productivity 4. Sugar Glider was also identified as a target species for monitoring at Burra Floodplain sites. However,

		examination of the records held on the Victorian Biodiversity Atlas and the Atlas of Living Australia revealed this species does not occur in these areas (Institute, 2020). Sugar Gliders are a common species that is readily detected using standard fauna surveys techniques, so its absence is most likely due to the habitat being unsuitable for viable populations. This species is therefore considered to be a very low priority for monitoring at these sites and will not be considered further. 5. Develop seasonal populations of native frogs. 6. Increase the abundance of reptiles as an indicator species of increased resources resulting from increased floodplain productivity.
NA	Reinstate seasonal connectivity along Burra Creek, wetlands, and the floodplain in the target area	NA
Contribute to the carbon requirements of the River Murray channel ecosystem	NA	Contribute to the carbon requirements of the River Murray channel ecosystem to support system productivity.

Table 5: Specific objectives and targets established for Burra and the relevant water regime classes. This table also shows the contribution of each specific objective to Basin Plan objectives (Arthur Rylah Institute, 2020; Commonwealth of Australia, 2012; Ecological Associates, 2014; MCMA, 2014; Sunraysia Environmental, 2015)

SDL Burra Business Case Specific objectives 2014	**VMFRP MER Area** (Institute, 2020)	**VMFRP Specific Objectives 2020** (Institute, 2020)	**VMFRP Ecological Targets 2020** (Institute, 2020)	**Expected Functional Outcomes from intermediate inundation** (MCMA, 2014)	**Water Regime Class** (MCMA, 2014)	**Associated Basin Plan Objective**
Restore seasonal aquatic habitat to Burra Creek	Vegetation	Reduce high threat exotic plant cover	High threat+ exotic plants make up <5% of total extant vegetation cover in all sampled locations in all years AWOC.	**Seasonal Anabranch and Billabongs** At least two frog species and two vegetation-dependent fish species are present in Burra Creek in spring annually between 2025 and 2035. **Lignum shrubland and woodland / Black box and red gum woodland** All red gum and black box 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. The total abundance of bats in Burra North increases by 25% from 2015 levels by 2030 The average annual carbon load (dissolved	Seasonal Anabranch and Billabongs	8.05(2), 8.05(3), 8.06(3), 8.06(5), 8.06(7), 8.06(6), 8.06(7), 8.07(2), 8.07(3), 8.07(6).
		Maintain plant cover and diversity of target native vegetation groups	Plant cover and diversity within each previously recorded Plant Functional Group does not decline by more than 25% from PWOC levels in any flood year within the first ten years AWOC.			
		Maintain threatened native flora presence	>90% of threatened flora species previously recorded continue to occur within the site in all flood years AWOC.			
		Maintain the health of native trees.	At least 75% of surveyed trees with 'healthy' canopy condition within ten years AWOC.			
Restore floodplain productivity to maintain resident populations of vertebrate fauna including bats, sugar	Birds	Increase abundance of native woodland birds	Native woodland bird abundance increases by 10%2 from PWOC levels within 10 years AWOC.		Lignum shrubland and woodland Black Box and Red Gum Woodland	8.05(2), 8.05(3), 8.06(3), 8.06(5), 8.06(7), 8.06(6), 8.06(7), 8.07(2), 8.07(3), 8.07(6).

glider and lace monitor	Fish	Develop seasonal populations of small-bodied native fish.	Small-bodied native fish species are present every spring within the first ten years AWOC. Two species in Burra Creek	and particulate) to the River Murray from Burra North for the period 2025 to 2035 is double 2015 to 2020 levels. **Black box and red gum woodland** All red gum and black box 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. The total abundance of bats in Burra North increases by 25% from 2015 levels by 2030 The average annual carbon load (dissolved and particulate) to the River Murray from Burra North for the period 2025 to 2035 is double 2015 to 2020 levels.		
	Bats	Increase the abundance of bats as an indicator species of increased resources resulting from increased floodplain productivity	Total bat activity increases by 25 % from PWOC levels within 10 years AWOC", quantifying the target level of restoration for bat populations in the region			
	Mammals	Sugar Glider was also identified as a target species for monitoring at Burra Floodplain sites. However, examination of the records held on the Victorian Biodiversity Atlas and the Atlas of Living Australia revealed this species does not occur in these areas (Institute, 2020). Sugar Gliders are a common species that is readily detected using standard fauna surveys techniques, so its absence is most likely due to the habitat being unsuitable for viable populations. This species is therefore considered to be a very	NA			

		low priority for monitoring at these sites and will not be considered further.				
	Frogs	Develop seasonal populations of native frogs.	At least three frog species are present in all wetlands every spring in the first ten years AWOC.			
	Reptiles	Increase the abundance of reptiles as an indicator species of increased resources resulting from increased floodplain productivity.	Total carpet python abundance increases by 10% from PWOC levels within ten years AWOC.			
Contribute to the carbon requirements of the River Murray channel ecosystem	Carbon requirements	Contribute to the carbon requirements of the River Murray channel ecosystem to support system productivity.	Floodplain inundation results in a net increase in carbon (dissolved and particulate) to the River Murray, given carbon and water volumes within floodplain inflows and outflows, in all managed flow years.		Lignum Shrubland and Woodland Black Box and Red Gum Woodland	8.05(2), 8.05(3), 8.06(2), 8.06(3), 8.06(5), 8.06(7), 8.06(6), 8.06(7), 8.07(2), 8.07(3), 8.07(6).

PWOC = Prior to works operation commencement, AWOC = After works operation commencement

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 infrastructure 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

4.6 Operating Scenarios

The Burra works have been designed to replicate key components of the natural hydrology of the system. The infrastructure has been designed to operate in several possible flow regimes consistent with the requirements set out in the Business Case (MCMA, 2014). Transitioning between scenarios is possible and provides a high level of operational flexibility when delivering planned watering events or responding to natural inflows.

Water will be delivered to the Burra North floodplain area and Burra Creek South using gravity and occasional temporary pumping as required, this is further described in Table 6 and Table 7 respectively.

The works will provide for the inundation of up to 404 ha of floodplain.

Table 6: Burra North operating scenario (Ecological Associates, 2015; Jacobs, 2016; Sunraysia Environmental, 2015)

Scenario	Pre-conditions (Murray Flow required ML/d) (Jacobs, 2017)	Structure Operation	Maximum design inundation level (m AHD) (Jacobs, 2017)	Preferred Frequency (Sunraysia Environmental, 2015)	Threshold (depth, level or discharge) (Jacobs, 2017)	Holding Duration (Sunraysia Environmental, 2015)	Preferred Timing (Ecological Associates, 2014)	Maximum Interval Between Events (Sunraysia Environmental, 2015)	Water Regime Class Targeted
Capture Low Flood Peaks in Burra Creek (Scenario 1)	Capture can occur when discharge at Swan Hill exceeds 20,000 ML/d. Peaks up to 22,500 ML/d represent a low flood peak.	Regulator is closed when the flood peak starts to recede Regulator is opened when the flood duration target is met.	57.7	9 years in 10	Levels equivalent to 22,500 ML/d	3 months	June to November	3 years	Seasonal Anabranch
Capture Large Flood Peaks in Burra Creek	Capture can occur when discharge at Swan Hill exceeds 20,000 ML/d.	Regulator is closed when the flood peak starts to recede.	58.2	3 years in 10	Levels equivalent to 25,000 ML/d	3 months	June to November	7 years	Seasonal Anabranch Lignum Shrubland and Woodland

(Scenario 2)	Peaks up to 25,000 ML/d represent a very large flood peak.	Regulator is opened to release water when the flood duration target is met.							
Capture Very Large Flood Peaks in Burra Creek (Scenario 3)	Capture can occur when discharge at Swan Hill exceeds 20,000 ML/d. Peaks up to 30,000 ML/d represent a very large flood peak.	Regulator is closed when the flood peak starts to recede. Regulator is opened to release water when the flood duration target is met.	58.70	0.9 years in 10 (Jacobs, 2016)	Levels equivalent to 30,000 ML/d	15 days	June to November	10 years	Seasonal Anabranch Lignum Shrubland and Woodland Black Box and Red Gum Woodland
Pump to High Floodplain Areas (Jacobs, 2016) (Scenario 4)	Pumping can commence when discharge at Swan Hill equals or exceeds 20,000 ML/d.	Upstream and downstream regulators are closed. Water is pumped into storage area. Regulator is opened to release water when the flood duration target is met.	58.70	0.9 years in 10 (Jacobs, 2016)	Levels equivalent to 30,000 ML/d	1 month	June to November	10 years	Seasonal Anabranch Lignum Shrubland and Woodland Black Box and Red Gum Woodland

Table 7: Burra South operating scenario ((Sunraysia Environmental, 2015; Ecological Associates, 2015)

Scenario	Pre-conditions (Murray Flow required ML/d)	Structure Operation	Maximum inundation level (m AHD)	Preferred Frequency (Sunraysia Environmental, 2015)	Threshold (depth, level or discharge) (Sunraysia Environmental , 2015)	Holding Duration (Sunraysia Environmental, 2015)	Preferred Timing (Ecological Associates, 2015)	Maximum Interval Between Events (Sunraysia Environmental, 2015)	Water Regime Class Targeted (Ecological Associates, 2015)
Capture Large Flood Peaks in Burra Creek (Scenario 2)	Capture can occur when discharge at Swan Hill exceeds 22,500 ML/d. (Jacobs, 2017) Peaks up to 25,000 ML/d represent a large flood peak. (Jacobs, 2017)	Regulator is closed when the flood peak starts to recede. Regulator is opened to release water when the flood duration target is met.	Water to be maintained within creek line. Maximum water level to be below creek top bank level.	9 years in 10	Levels equivalent to 25,000 ML/d	3 months	June to November	3 years	Seasonal Anabranch
Pump to Large Flood level in Burra Creek (Authority, 2019) (Scenario 4)	Pumping can commence when discharge at Swan Hill equals or exceeds 6,000 ML/d. (Authority, 2019) (MDBA, 2019)	Upstream and downstream regulators are closed. Water is pumped into storage area. Regulator is opened to release water when the	Water to be maintained within creek line. Maximum water level to be below creek top	9 years in 10	Levels equivalent to 25,000 ML/d	3 months	June to November	3 years	Seasonal Anabranch

		flood duration target is met.	bank level.						

5. Environmental Monitoring

The effectiveness of the proposed managed inundation will primarily be monitored and reported through the monitoring, evaluation and reporting (MER) strategies and protocols set by the Mallee CMA.

During the development of the Business Case a monitoring and evaluation plan for Belsar-Yungera was prepared for by Ecological Associates (Ecological Associates, 2014).

Mallee CMA, with the Arthur Rylah Institute for Environmental Research (ARI), is in the processing of updating the 2014 Ecological Associates MER and developing long-term monitoring strategies for the ecological component of the VMFRP. These strategies and protocols will build upon experience and lessons learned through the ongoing Hattah Lakes TLM MER program.

These 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 Burra
- 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 accordingly.

Monitoring and evaluation will focus on the effects of local watering actions and include:

- Evaluating water use
- Measuring ecological outcomes
- Refining conceptual models and improving knowledge
- Managing risk

The Burra VMFRP MER plan will identify the agencies responsible for commissioning, reviewing and acting on monitoring data. The linkages back to decision-making will be described in the detailed MER plan.

Initial monitoring will provide a baseline of the existing status of the ecological objectives and outcome monitoring will measure progress towards these objectives and their targets. 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. Measures for each ecological objective of the Burra VMFRP project are detailed in Table 5 (Arthur Rylah Institute, 2020). Monitoring data will identify emerging hazards and enable operation decisions to minimise risks.

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 informs management and operations.

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

The final MER approach for this project will be informed by broader intergovernmental arrangements for Basin-wide monitoring and evaluation under the Basin plan (Commonwealth of Australia, 2012). 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 Murray-Darling Basin Authority's (MDBA) 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 participation in MDBA's reporting and evaluation framework will effectively allow for progress in relation to this project to be monitored, and for success in meeting associated ecological objectives and targets to be assessed.

6. Operational Risks and Mitigation Measures

6.1 Ecological, Cultural Heritage and Socio-Economic Threats

Ecological Assessments and a Cultural Heritage Management Plan are being undertaken as part of the project.

Shared operational risks associated with environmental watering are managed through an annual workshop with DELWP that Mallee CMA participates in. This process includes discussion of risk learnings of from the previous year, risk assessment for the coming year, and improving risk management processes.

In addition to the above measures, a monitoring, evaluation and reporting (MER) framework is being put together for the VMFRP project that includes ecological, cultural and socio-economic outcomes of managed inundation events at the VMFRP sites.

6.2 Impact on Salinity, Water Environments, and Fish Passage

The in-river salinity impacts (at Morgan, South Australia) potentially caused by the proposed actions at Burra were assessed relative to a base case scenario by SKM (SKM, 2014).

The assessment concluded that the magnitude of the salinity impacts of the proposed watering scenarios was insignificant. The largest component of the salinity impact is associated with the displacement of groundwater due to diffuse recharge following inundation, but the impact is insignificant. This calculation is considered conservative as it assumes uniformly high salinity and assumes a significant percentage of the recharged water is returned the Murray River (SKM, 2014).

SKM (SKM, 2014) expects that successive watering events would create negligible increases in salt store. They recommend that if any larger impact occur with time, these could be offset by a less frequent operation and/or reduced duration of watering events (SKM, 2014).

Based on the uncertainty of the inundation events on salinity over time, SKM have recommended a monitoring program. This would comprise of groundwater and surface water monitoring. The MCMA monitors an existing network of bores within the Burra vicinity and undertakes a long-term salinity monitoring program to assess the impact of inundation events on groundwater levels and groundwater quality.

To assist in the monitoring of salinity impacts of Burra inundation the VMFRP, with assessment and recommendations from SKM (SKM, 2014) and Jacobs (Jacobs, Groundwater salinity monitoring bore specification for SDL projects, 2019), has proposed new bores within the proposed project inundation area.

These will be integrated into the existing MCMA monitoring network and monitoring program. Monitoring and ongoing assessment of risks will occur consistent with the Basin Salinity Management Strategy (MDBA, Basin Salinity Management Strategy 2030 (BSM2030), 2015). In addition to the regular groundwater monitoring, Mallee CMA will manage the monitoring of surface water quality within the Park, during operations. These monitoring activities are critical to verify modelled salinity impacts and to provide timely advice for management of any water quality issues arising during operation of the works.

The following mitigation measures are proposed to minimise and avoid impacts on water environments, salinity, and fish passage during operation of the project:

- Continue to undertake water quality monitoring before, during and after watering events to inform adaptive management strategies and real-time operational decision making.
- Commence watering as early as possible to move organic matter off the floodplain while temperatures are low. Maintain a through-flow where possible in other areas to maximise exchange rates and movement of organic material. Monitor dissolved oxygen and water temperature to identify hypoxic areas to inform consequence management.
- Schedule watering events to make use of dilution flows where possible and optimise timing of releases of Burra Creek. Ensure dilution of low dissolved oxygen 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 aeration.
- Integrate water management with other sites in seasonal water planning process. Maintaining good relationships with other water managers.
- Tailor watering regimes to provide competitive advantages for native fish over carp. Dry wetlands that contain carp. Manage drawdown following managed events to provide triggers for native fish to move off the floodplain, and where possible, strand carp.
- Mitigation measures would be implemented to minimise risks associated with barriers to fish passage, including:
    - Design of regulating structures to satisfy fish passage requirements.
    - Continuing to build on knowledge and understanding through current studies relating to fish movement in response to environmental watering and cues to further develop and refine a fish exit strategy.
- 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.

6.3 Risks associated with structures

The owner and operator have responsibility for management of risks to the integrity of the structures themselves. These risks are managed through operation of the structures within their design capabilities, monitoring of structural integrity and through maintenance. Risk frameworks are being put together for the management and operation of the structures and will be confirmed during stage 2 works.

7. Community Consultation Communication

All VMFRP sites are covered by one Community Communication and Engagement Strategy. As part of the strategy, a Stakeholder Engagement and Communication Plan was developed to ensure awareness among all stakeholders and the wider community of the Burra Creek managed inundation operations

The VMFRP Stakeholder Engagement & Communication Plan is attached as Appendix 2 and will be updated as appropriate as part of the Stage 2 works for the Burra project.

The Site Manager, LMW and Mallee CMA are committed to establishing and maintaining strong relationships within the local community during watering operations. A vital tool in the consultation is structured engagement with the community through engagement with key stakeholders and advisory groups.

8. Indigenous Engagement

Indigenous stakeholders are consulted to ensure the Indigenous community has an opportunity to provide input into water management and a chance to raise and identify their cultural and spiritual links to Burra.

These stakeholders are representatives of each of the Aboriginal parties who have a vested interest in the Burra area.

Indigenous consultation is managed via the Mallee CMA Indigenous Facilitator and through the Mallee CMA Aboriginal Reference Group. This group provides a valuable single source for Indigenous engagement, advice, input and recommendation.

The reference group has Indigenous representatives who ensure that cultural heritage and values are considered and incorporated by the Site Manager and Mallee CMA. The representatives also distribute information about Site management into the Aboriginal communities.

The development of an Indigenous engagement framework will be developed during Stage 2 works.

9. Adaptive Management and Reporting

A comprehensive risk management strategy will be developed for the Burra project. This strategy will cover ecological and socio-economic aspects to provide a structured and coherent approach to risk management for the life of the project (i.e. construction and operation).

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 changed in the external and internal context, including changes to risk criteria and risk itself
- Emerging risks are identified.

10. References

Arthur Rylah Institute. (2020, January). *Preliminary Draft VMFRP Ecological Monitoring Evaluation & Reporting Plan.* Melbourne.

Australian Ecosystems. (2016). *Nyah & Vinifera SDl Project Flora and Fauna Assessment Detailed Design Stage: Final Report.*

Authority, M. C. (2019). *Environmental Watering Delivery Plan -Burra Creek South.* Mildura.

Brown, G., Bryant, D., & Horrocks, G. (2013). *Terrestrial vertebrate fauna surveys of the Burra Creek and Nyah-Vinifera reserves, northern Victoria. Arthur Rylah Institute report to Mallee CMA.*

Commonwealth of Australia. (2012). Basin Plan. Canberra.

DELWP. (2015). *Long term watering plan - Wimmera Mallee.* Melbourne: DELWP.

DEPI. (2010). *Index of Stream Condition. The Third Benchmark of Victorian River Condition (ISC3).*

DEPI. (2014). *Advisory List of Rare or Threatened Plants in Victoria.* Melbourne: Victorian Department of Environment and Primary Industries.

Ecological Associates. (2014). *SDL Floodplain Watering Projects: Monitoring and Evalutaion. Report AL045-1-B.* Adelaide.

Ecological Associates. (2014). *SDL Rationale and Outcomes. Ecological Associates report AL040-1D. Report for the Mallee CMA.*

Ecological Associates. (2014). *SDL Rationale and Outcomes. Ecological Associates report AL040-1D. Report for the Mallee CMA.* Adelaide.

Ecological Associates. (2015). *SDL Floodplain Watering Projects: Operating Plan, Report AL048-1-B.* Adelaide: Ecological Associates.

Environmental, S. (2015). *Burra Environmental Water Management Plan.* Mildura: Sunraysia Environmental.

Henderson, M., Freestone, F., Vlamis, T., Cranston, G., Huntley, S., Campbell, C., & Brown, P. (2014). *The Living Murray Condition Monitoring at Hattah Lakes 2013-2014: Part A - Main Report. Final Report prepared for the Mallee Catchment Management Authority by the Murray-Darling Frehswater Research Centre (MDFRC).*

Henderson, M., Freestone, F., Wood, D., Cranston, D., Campbell, C., & Vlamis, T. a. (2013). *The Living Murray Condition Monitoring at Hattah Lakes 2012-2013: Part A - Main Report. Final Report prepared for teh Malle Catchment Management Authority by the Murray-Darling Freshwater Research Centre, MDFRC.*

Henderson, M., Wood, D., Cranston, D., Hayward, G., Campbell, C., Johns, C., & Vilizzi, L. (2012). *The Living Murray Condition Monitoring at Hattah Lakes 2011/2012: Part A - Main Report Final Report prepared for the Mallee Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC.*

Institute, A. R. (2020, January). *Preliminary Draft VMFRP Ecological Monitoring Evaluation & Reporting Plan.* Melbourne.

Jacobs. (2016). *SDL Offset Sites Hydrodynamic Modelling - Burra Report.* Melbourne.

Jacobs. (2016). *SDL Offset Sites Hydrodynamic modelling- Burra Report.* Melbourne.

Jacobs. (2017). *Hydromodelling_Natural&Existing Burra Report.* Melbourne.

Jacobs. (2019). Groundwater salinity monitoring bore specification for SDL projects.

Lumsden, L., Brown, G., Cheers, G., & Palmer, C. (2007). *Floodplain Fauna Surveys - Macredie Island and Burra Forest. Report by the Arthur Rylah Institute for Environmental Research for the Mallee Catchment Management Authority.*

Mallee CMA. (2014). *Sustainable Diversion Limit Adjustmetn Phase 2 Assessment Supply Measure Business Case: Burra Floodplain Management Project.* Irymple: Mallee CMA.

MCMA. (2014). *Sustainable DIversion Limit Adjustment Phase 2 Assessment Supply Measure Business Case: Burra Creek Floodplain Management Project.* Irymple.

MDBA. (2014). *Basin-wide environmental watering strategy.*

MDBA. (2015). *Basin Salinity Management Strategy 2030 (BSM2030).* Canberra: Murray-Darling Basin Ministerial Council.

MDBA. (2019, April 8). *Swan Hill Murray* . Retrieved from River Murray Live Data: https://livedata.mdba.gov.au/swan-hill

SKM. (2014). *Prelimiary Salinity impact Assessment for Mallee Environmental Watering Projects - Wallpolla, Hattah Lakes, Belsar-Yungera, Burray Creek, Nyah and Vinifera.*

Sunraysia Environmental. (2015). *Burra Environmental Water Management Plan.* Mildura: Sunraysia Environmental.

Victorian Government. (1988). Flora and Fauna Guarantee Act. Victorian Government: Melbourne.

Victorian Government. (2019). *Flora and Fauna Guarantee Amendment Act.* Melbourne: Victorian Government.

VMFRP Project Team. (2020). *Burra Creek Operating Plan.* Mildura.

Appendix 1 Basin Plan Objectives

Chapter 8 - Part 2: Overall environmental objectives for water-dependent ecosystems

Section:

8.05 (2). 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, China-Australia Migratory Bird Agreement (CAMBA), Japan-Australian Migratory Bird Agreement (JAMBA) or Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) continue to support those species; and

c. Water-dependent ecosystems are able to support episodically high ecological productivity and its ecological dispersal.

8.05 (3). To protect and restore biodiversity that is dependent on Basin water resources by ensuring that:

a. Water-dependent ecosystems that support the life cycles of a listed threatened species or listed threatened ecological community, or species treated as threatened or endangered (however described) in State law, are protected and, if necessary, restored so that they continue to support those life cycles; and

b. Representative populations and communities of native biota are protected and, if necessary, restored.

8.06 (2). 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.

8.06 (3). 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 dependent on hydrologic connectivity:

(i) longitudinally along watercourses; and

(ii) laterally between watercourses and their floodplains (and associated wetlands); and

(iii) vertically between the surface and subsurface;

c) The Murray Mouth remains open at frequencies, for durations and with passing flows, sufficient to enable the conveyance of salt, nutrients and sediments 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) The levels of the Lower Lakes are managed to ensure sufficient discharge to the Coorong and Murray Mouth and help prevent river bank collapse and acidification of wetlands below Lock 1, and to avoid acidification and allow connection between Lakes Alexandrina and Albert, by:

(i) maintaining levels above 0.4 metres Australian Height Datum for 95% of the time, as far as practicable; and

(ii) maintaining levels above 0.0 metres Australian Height Datum all of the time; and

f) Barriers to the passage of biological resources (including biota, carbon and nutrients) through the Murray Darling Basin are overcome or mitigated

8.06 (4). That natural processes that shape landforms (for example, the formation and maintenance of soils) are protected and restored.

8.06 (5). To support habitat diversity for biota at a range of scales (including, for example, the Murray-Darling Basin), riverine landscape, river reach and asset class).

8.06 (6). To protect and restore ecosystem functions of water-dependent ecosystems that maintain population (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.

8.06 (7). An objective is to protect and restore ecological community structure, species interactions and food webs that sustain water-dependent ecosystems, including by protecting and restoring energy, carbon and nutrient dynamics, primary production and respiration.

8.07 (2). That water-dependent ecosystems are resilient to climate change, climate variability and disturbances (for example, drought and fire).

8.07 (3). 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.

8.07 (4). To provide wetting and drying cycles and inundation intervals that do not exceed the tolerance of ecosystem resilience or the threshold of irreversible changes.

8.07 (5). To mitigate human-induced threats (for example, the impact of alien species, water management activities and degraded water quality).

8.07 (6). To minimise habitat fragmentation.

Appendix 2: VMFRP Stakeholder Engagement & Communication Plan

(attached)