Australian Government

MURRAY–DARLING BASIN AUTHORITY

MURRAY-DARLING BASIN AUTHORITY

The Living Murray Program

OPERATING PLAN

Hattah Lakes
Environmental Works and Measures Program

Note to authors and reviewers

The Hattah Lakes Operating Plan should be viewed as a living document, which will evolve in response to changing site conditions and ongoing knowledge development. The plan forms part of the Icon Site Environmental Management plan but also includes sufficient detail to be a stand-alone document.

This plan does not prescribe particular watering events or if a watering event is to occur; the principal purpose of this document is to provide assistance in planning watering events. It should also provide a record of previous events and any considerations to improve subsequent operations in supporting the ecological objectives and in response to any impacts of operations to third parties.

This document will be updated as required in light of new information, changing site conditions and/or the performance of water management infrastructure.

Version control

Version	Date	Prepared	Reviewed	Approved
1.0	11 July 2012	Heather Peachey, MDBA	Considered at Hattah Lakes Operating Plan workshop in Mildura on 18 July 2012	
1.1	26 July 2012	Updated by Andrea Joyce, MDBA		
10.0	25 September 2012	Updated by Nicholas Sheahan MCMA	Distributed to State Construction Committee	
11.0	14 November 2012	Feedback incorporated by Nicholas Sheahan	Distributed for State Construction Committee	
11.1	19 November 2012	Nicholas Sheahan	Amendments requested by SCC incorporated	Victorian State Construction Committee
Post commissioning update. Version 1	March 2015	Emma Healy Nicholas Sheahan	Distributed to Hattah Operations Group	
Post commissioning update V2	May 2015	Emma Healy	Amended as per feedback. Submitted to Vic Construction and Steering committees.	
Update	March 2016	Emma Healy		

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1. Background

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

The Living Murray (TLM) Initiative was established in response to concerns about the environmental health of the River Murray. The initiative has recovered 500 GL of environmental water and has constructed water management structures to enable the efficient and effective use of environmental water. Following on from construction, the TLM program has begun to implement environmental watering activities, which are subject to monitoring and review, to ensure the greatest ecological outcomes are achieved for the prevailing environmental and river system conditions.

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

The Hattah Lakes is one of these icon sites. They are situated within the semi-arid Mallee landscape, with an extensive wetland complex covering approximately 13,000 ha within the 48,000 ha Hattah-Kulkyne National Park (Figure 1-1). The lake system supports a mosaic of Red Gum, Black Box and Lignum communities.

The Lakes are recognised for their role as a refuge and breeding habitat for waterbirds and for its sites of Indigenous cultural significance. Twelve of the lakes are listed as wetlands of international significance (under the Ramsar Convention).

Without water management operations, changes to the flow regime in the River Murray can have significant impacts on the ecological health of the Hattah Lakes system. This is primarily due to a reduction in the frequency and magnitude of flooding as a consequence of the long-term effects of river regulation; further compounded by the recent 10 year drought.

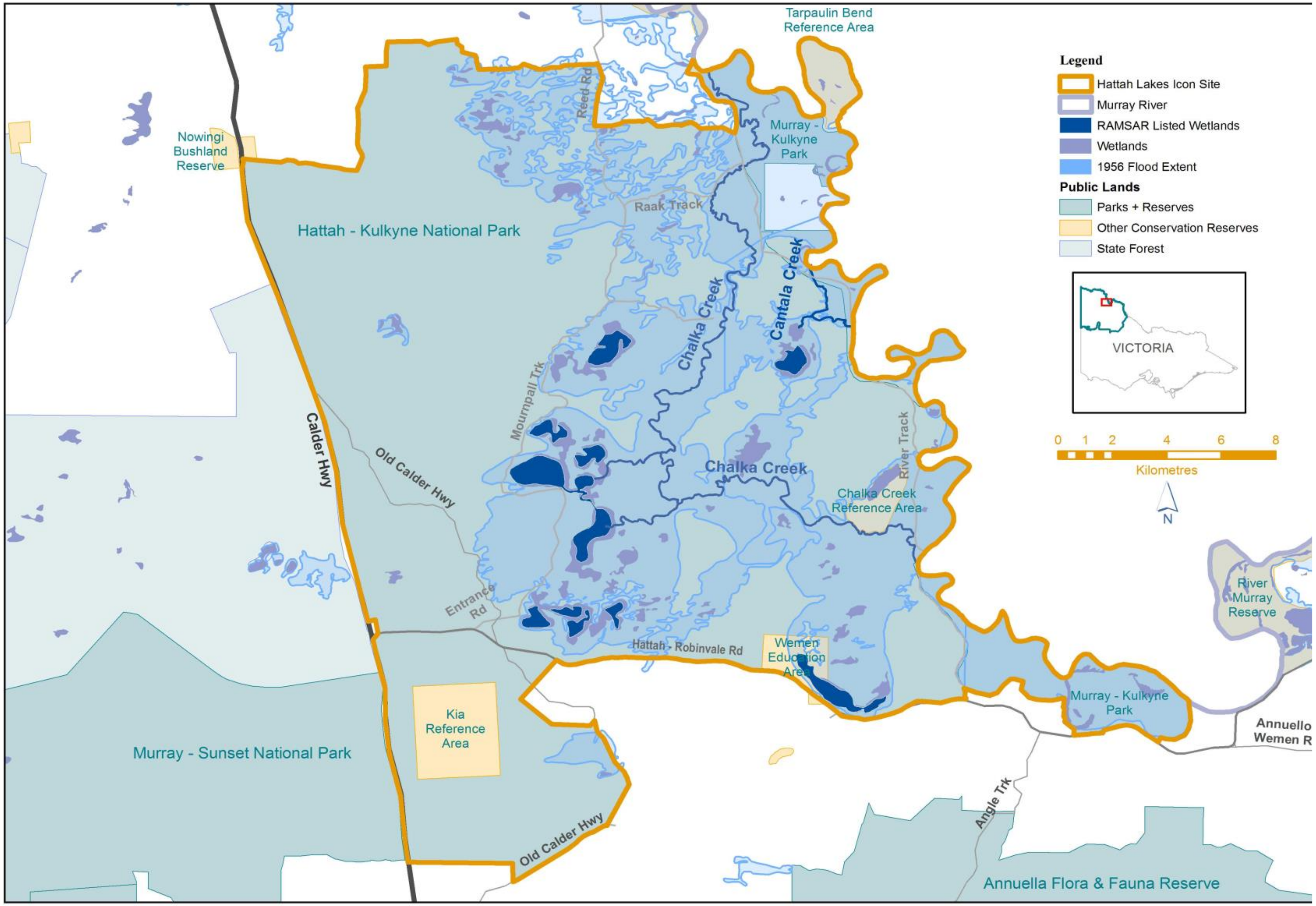

Figure 1-1: Icon Site boundaries and 1956 flood extent (1 in 100 year flood) at Hattah Lakes Icon Site

As part of The Living Murray program, ecological objectives were created at each Icon Site. Nine TLM ecological objectives were created for Hattah Lakes Icon Site.

Two of those objectives[1] are to; restore a mosaic of hydrological regimes, which represent pre-regulation conditions; and maintain, and where practical, restore the ecological character of the Ramsar site with respect to the Strategic Management Plan (DSE 2003). The other ecological objectives are dependent upon the hydrology and refer to increases in bird, fish and macrophyte numbers, and providing refuge habitat for local and international birds. These ecological objectives will also provide a mechanism for evaluation and monitoring to help determine the success of this restoration project.

To achieve these objectives a package of water management structrues has been constructed to flexibly manage the delivery of environmental water to the lakes via natural inflows from the River Murray or pumping. These works include:

- lowering of sills in Chalka Creek to 41.75 m AHD enabling flows to enter the site at a passing flow of 26,000 ML/day rather than the pre works flow of 36,700 ML/day, increasing the frequency of natural inflows
- construction of four regulators (Oatey's, Cantala, Messengers and Kramen) to retain water on the floodplain;
- construction of three earthen stop banks (Bitterang, Breakout and Cantala) to retain water on the floodplain;
- refurbishment of the Little Hattah regulator; and
- construction of a permanent pumping station to top up natural flooding events and fill the lakes during dry spells.

The works enable the lakes to be filled in the absence of high river flows and water to be retained on the floodplain. This can inundate over 6,000 ha of floodplain, including wetland habitat for native fish, waterbirds, frogs and turtles. The works can also contribute to an improvement in the condition of fringing Red Gum communities, as well as Black Box communities higher up on the floodplain.

[1] Refer to the Hattah Lakes Environmental Water Management Plan (MDBA, 2012) for further details

2. Purpose of the Operating Plan

This Operating Plan provides the framework for the operation of the Hattah Lakes water management structures to meet key ecological objectives within the broader context of TLM, legislative requirements and governance. The purpose of the operating plan is to:

- Summarise the governance arrangements for environmental watering activities at the site;
- Summarise the roles and responsibilities of partner agencies;
- Aid in decision making and planning prior to and during watering events;
- Summarise operational risks and mitigation strategies;
- Outline water measurement arrangements;
- Outline communication and consultation requirements; and
- Provide links to documents containing further detail.

The operating plan also defines the obligation of the various parties to manage and operate the structures as required under the Murray-Darling Basin Agreement (S 52 – 54).

The Operating Plan is not intended to prescribe particular watering events. The audience for the Operating Plan is summarised in Table 2-1.

It is important to note that this document is a 'living document' that will be further refined and developed regularly over time and with each watering event, by the Mallee CMA. It is expected that knowledge and information in relation to adjusting and optimising structure operations will improve with each event. Revision of the document enables future operational decisions to be based upon the best available knowledge.

Table 2-1: Intended Audience for the Operating Plan

Audience	Key Requirements	Primary Interest		
		Ecological	Operation	Risk
Event Managers (Mallee CMA, RM Operations)	Adaptive management	✓	✓	✓
Land Manager (Parks Vic)	Adaptive management	✓		✓
Other Environmental Managers (DELWP)	Adaptive management	✓		✓
Operators (Goulburn-Murray Water & RM Operations)	Operation of structures Accounting		✓	✓
Water holder/funder (TLM-MDBA, CEWH, VEWH)	Accountability	✓	✓	✓
MDBA (BSMS)	Meet legal requirements			✓
Asset Manager (MDBA Assets)	Meet legal requirements		✓	✓

Additional Documents

This document is one of four schedules to the Hattah Lakes Environmental Water Management Plan (EWMP) (MDBA, 2012). Each schedule focuses on a specific area of management for the Hattah Lakes (Table 2-2). This document will refer to the EWMP and other schedules, as well as additonal documents where necessary, to provide the audience with additional information (Table 2-3).

Table 2-2: Documents supporting water management at the Hattah Lakes Icon Site

Document	Purpose
Hattah Lakes Environmental Water Management Plan	Long term strategic plan that outlines the site's overall management arrangements, objectives, environmental water requirements, and scope of environmental works to manage the water. Supported by detailed schedules.
Schedule 1 Operating Plan for the Hattah Lakes Icon Site (this document)	Describes the environmental works, how the works relate to the ecological objectives, and defines the governance, risk management and water measurement principals for operation of the structures to deliver environmental water.
Schedule 2 TLM Projects Risk Assessments Report (Newell et al, 2016)	Identifies operational, environmental, cultural and socio-economic risks and mitigation measures
Schedule 3 Condition Monitoring Plan for the Hattah Lakes Icon Site (MDFRC, 2011)	Describes the condition monitoring activities at the site. Currently under review
Schedule 4 Communication Plan (Mallee CMA 2010)	Overview of communications roles and responsibilities.

Table 2-3: Additional documents supporting water management at the Hattah Lakes Icon Site

Document	Purpose
Hattah Lakes Watering Guide (Mallee CMA, 2016)	Provides detail on ecological objectives, water requirements and tolerances, preferred watering regime, and role of each structure in delivering water to meet the objectives. This document also encompasses the adaptive management process for achieving the site ecological objectives.
Annual Intervention Monitoring Proposal (including risk monitoring)	Describes the intervention, risk and compliance monitoring undertaken at the site. Prepared by the Mallee CMA annually.
Hattah Lakes Operations, Maintenance and Safety Manual	Produced by Goulburn Murray Water as a standalone document for agency staff.

3. Interactions with other systems or structures

This section looks at the interaction of other water management structures, river systems and sites, with the Hattah Lakes system.

The Hattah Lakes system is situated between the Euston (Lock 15) and Mildura (Lock 11) lock and weir structures. The Chalka Creek South confluence is located 70 river km downstream of the Euston Weir and sits upstream of the Mildura Weir pool.

The volume of water flowing past Hattah is influenced by three major river systems and the operations of major structures on these rivers:

- the River Murray and the Edward-Wakool system including operation of the Hume Dam and Yarrawonga and Euston Weirs;
- the Goulburn River and the operation of Eildon Dam; and
- the Murrumbidgee River

A combination of high river levels and the operations of each of the major structures on these rivers will determine the volume of water flowing past Hattah and the Chalka Creek South and North confluences.

River Murray flows greater than 26,000 ML/day at Euston lead to flows reaching Messengers Regulator Chalka Creek South.

Euston Weir Operations and Travel Times

Historically the volume of water entering the site has been solely dependent on the magnitude and duration of passing flows. The Euston Weir is the long term measuring site which has been used as a reference for passing flows in the River Murray adjacent to the Hattah Lakes

Euston Weir normally operates[2] between 2,500 ML/day and 10,000 ML/day during regulated flow conditions. During high unregulated flows Euston Weir will pass all flows downstream and the Euston Weir structure may only be dismantled between 40,000 and 50,000 ML/day.

Travel time from the Euston Weir to the Chalka Creek South confluence is approximately 1-1.5 days (Figure 3-1).

[2] The Euston Lock and Weir structure is operated by Water NSW (previously State Water Corporation) on behalf of MDBA (River Management Division). Water is released when an instruction has been given to Water NSW from the MDBA River Operators.

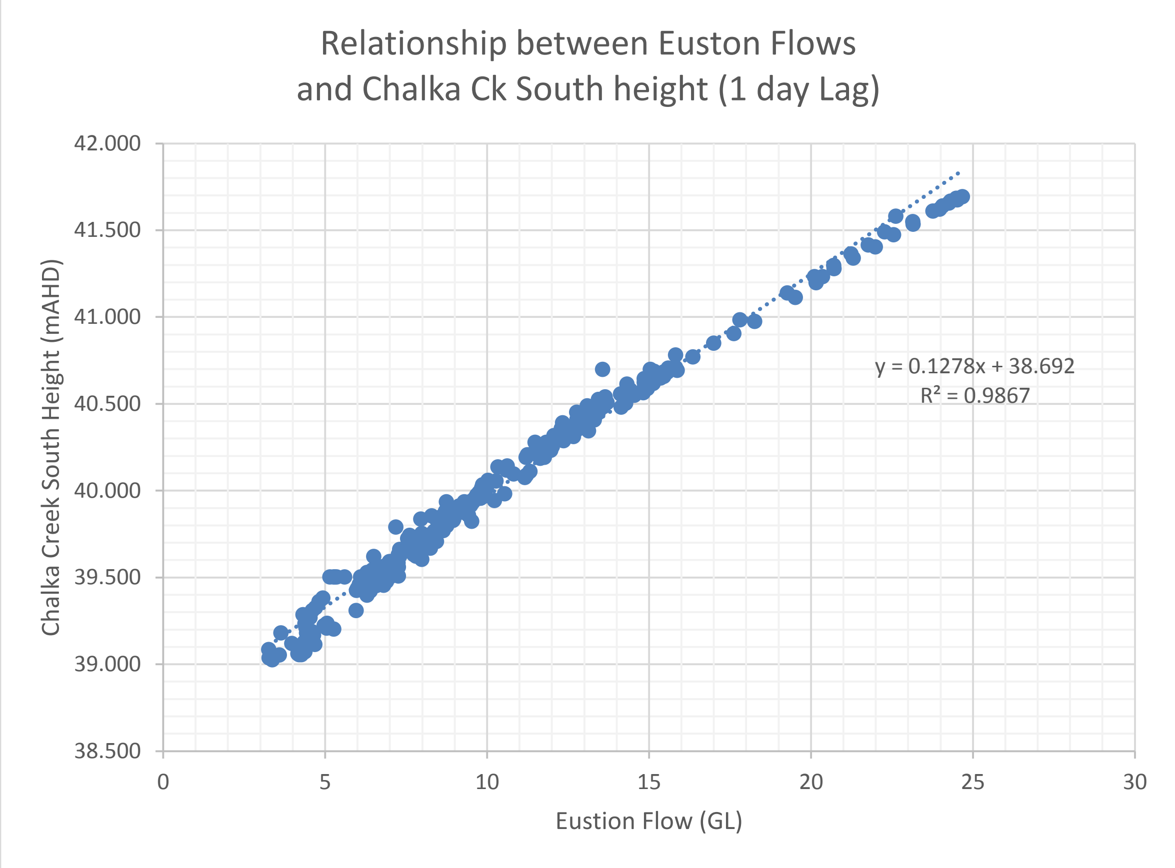

Figure 3-1: Relationship between Euston flows and water height at the Chalka Creek south confluence.

Hattah Lakes Pumping

The pump station enables the Hattah Lakes to be watered independently of river level. It provides the flexibility to pump water from the river into the Hattah Lakes system when river levels are higher than 38.3 m AHD. This level represents a flow at Euston of approximately 2,500 ML/day. Flows lower than this are considered unlikely in all but the most extreme drought conditions.

Multi-site Watering

Potential exists for the operation of this site in conjunction with other icon sites and environmental watering activities, to achieve multiple benefits from a single release of environmental water from storage. Flows released from environmental watering upstream can be re-used at Hattah. Additionally, as part of large watering events significant volumes of water will be returned to the River Murray. An important consideration when re-using water in this manner is the quality of the water being returned to the system, particularly with regards to dissolved oxygen and nutrient load, as well as algal loads, as poor quality water poses risks to the water quality in the River Murray and downstream sites (Section 11).

Interactions within the Park

There are four privately owned properties within the National Park. None of these will be inundated by operation of the works; however two may be affected during operations:

Messengers

This property is located approximately 300 m downstream of the pump station. A study to determine the impact of noise from the pump station concluded that the predicted noise impact would be compliant with the 32 dB(A) criteria (GHD - Memorandum Noise Assessment for Hattah Lakes Pump Station, 30 November 2011).

Sextons

This property may have reduced access during operations to release water from Oateys Regulator, as a low level crossing on Chalka Creek North becomes inundated. Access will remain open from the southern end of the park during managed events. The existing communication arrangements between the landholder and Parks Victoria to manage access issues during natural events will be utilised during managed events.

4. GOVERNANCE

This section describes the high level program governance as well as the roles and responsibilities for stakeholder groups, for operation of the Hattah Lakes works.

For more detail on Victorian legislative frameworks and agreements, as well as planning and policy frameworks, please refer to the *Regional Context Document for Environmental Water Management Plans: Mallee CMA Region* (MCMA, 2014). Additional details on the Living Murray governance structure as well as relevant Commonwealth and New South Wales legislation can be found in the *Hattah Lakes Environmental Water Management Plan* (MDBA, 2012).

4.1 Overview of TLM governance

TLM is a joint initiative between the Australian, South Australian, New South Wales, Victorian and Australian Capital Territory governments. It is governed by:

a) *Intergovernmental Agreement (2004) on addressing water over allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2004);*

b) *Supplementary Intergovernmental Agreement (2006) on addressing water over allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2006);*

c) *Further agreement (2009) on addressing water over allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2009).*

The TLM Business Plan 2007 also complements the IGA (2004) and provides operational policies to guide the implementation of TLM.

The groups with a direct role in TLM governance are Ministerial Council, the Authority, the Basin's Officials Committee (BOC), TLM Committee (TLMC) and the Southern Connected Basin Environmental Watering Committee (SCBEWC). Detailed Governance and Planning arrangements for use of TLM water is contained within the Hattah Lakes Icon Site Environmental Water Management Plan.

While the MDBA is responsible for implementation of TLM (under Section 18H of the Water Act 2007), the management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located. The Chief Executive Officer of the Mallee CMA is the coordinator for the Hattah Lakes Icon Site and is responsible for delivering the TLM program at the site. In addition, Parks Victoria, the MDBA, Goulburn-Murray Water, DELWP, Victorian Environmental Water Holder (VEWH) and Commonwealth Environmental Water (CEW) also play key roles.

4.2 Governance arrangement for operating the Hattah structures

The MDBA manages the assets in accordance with: the Water Act (2007); the Murray-Darling Basin Agreement (Schedule 1 to the Water Act); the MDBA's annual Corporate Plan; the Asset Agreement; and the Asset Management Plan for River Murray Operations Assets. Operation and maintenance of the assets is conducted by the MDBA River Management Division in conjunction with the relevant State Constructing Authority (in this case, Goulburn-Murray Water). MDBA river operations staff coordinate the delivery of water (both irrigation and environmental) and manage unregulated flows throughout the River Murray System.

Management arrangements for an event are as follows:

- Following approval of environmental allocations, the Hattah Operations Group (Hattah OG) is convened by the Icon Site managers (MCMA).

- This group will oversee the event, and make recommendations regarding environmental water delivery.

Requests for water delivery management:

- Once a recommendation that requires changes to regulator operations is made by the Hattah OG, the Mallee CMA will complete the environmental water order template Appendix A) consistent with the Hattah OG recommendation
- The Mallee CMA will provide the request in the form of the environmental water order template to GMW and MDBA. This is done via email and goes to GMW Mildura for action, to GMW Water Resources for accounting and information and to the MDBA River Murray Operations Duty Officer for information. GMW will then order water from MDBA
- Once actions have been undertaken, GMW confirms via email to the Mallee CMA and MDBA River Operations
- In extenuating circumstances, such as emergencies, if actions undertaken do not comply with MDBA procedures MDBA River Management may request GMW to make a change. This information is to be sent to the Mallee CMA for information, however at all other times the above process is to be followed.

4.3 Hattah Operations Group

The MCMA convenes the Hattah Operations Group to provide advice to the MDBA regarding event management and the day-to-day management of the structures during an event. The group is convened via teleconference weekly (or as required) during event planning and operation, or otherwise as required, to plan ahead for operations and to provide feedback on current operations. The key responsibilities are to ensure the necessary planning, monitoring, communication and reporting arrangements are established prior to and during events as well as to identify and monitor any event risks or issues.

The group is chaired by the MCMA and membership includes agency representatives with delegated responsibilities, including those involved in day-to-day management of the structures. Representatives with delegated responsibilities include GMW, Parks Victoria, MCMA and MDBA River Murray Operations (Table 4-1). Other agencies, including DELWP, LMW, VEWH, CEWO, NSW DPI Water and SA DEWNR may attend as members, guests or observers.

The purpose of the group is to allow jurisdictional representatives to have input into decision making and ensure that recommendations made to MDBA and G-MW are sensible and practical. The operating scenario is forwarded to the MDBA River Murray Operations for consideration in light of broader river operations, delivery and issues. When the MDBA Operators are okay with the strategy then they will request GMW Lock 11 staff implement the operating scenario.

Table 4-1: Roles and responsibilities supporting Hattah Lakes environmental watering

Organisation	Main Roles	Tasks/Responsibilities		
		Event Planning	**Event Management**	**Event Reporting**
Icon Site Manager - Mallee CMA	Event Coordination Communications Monitoring	-Convene Hattah Operations Group (Hattah OG) -Ensure planning process is to annual schedule -Review and Revise Operating Plan and Risk Management Plan with other HOG input -Prepare Annual Watering Plan with Hattah OG input	-Convene Hattah OG and coordinate weekly (or as required) meetings/teleconferences. -Coordinate event monitoring (ecology/environment/water use) -Coordinate Community Communications and Consultation	-Prepare Annual Watering Report with other stakeholder input -Compile/Collate Monitoring Results -Update event record and incorporate lessons learnt into operating plan
MDBA - River Operations Modellers	Instruct Operations Water Delivery Modelling	-Provide advice on basin wide river operations and any implications for Hattah -Provide advice to assist in planning	- Issue Operating Instructions and requests Provide advice on basin wide river operations and any implications -Re-calibrate the water use model during the event	-Assist GMW with water accounting -Provide advice on any water delivery implications encountered and future considerations -Report on water use and model calibration confidence
GMW	Structure Operation & Maintenance Water accounting	-Provide advice on structural or maintenance issues and any implications -Conduct maintenance -Provide advice on water accounting planning and preparedness and any implications for an event	-Operate Structures to meet requests -Provide advice on structural or maintenance issues and any implications -Data collection and provision of data to MDBA during events including flow, level and water quality monitoring -Watering accounting – calculate weekly diversion volumes	-Provide details on performance of structures and any issues or future considerations -Provide details of issues associated with operational costs -Watering accounting against Victorian entitlements – provide the VEWH with volumes used and inform Hattah OG
Parks Victoria	Land Manager	-Provide advice on expected ecological response to proposed watering -Advise the group regarding site ecological values or threats and any implications - Approve watering on public land	-Manage public access during and after event -Advise of any threats to site ecological values	-Provide details of site ecological responses and any future implications
VEWH	Water Availability (If VEWH water used) Approvals	-Approve Victorian state wide watering priorities -Approve Annual Watering Plan – Victorian priorities -Co-ordinates water use with other environmental water holders, including advising on water availability for the site from all environmental water holders.	- Authorises all watering activities through Seasonal Watering Statements - Provides indication on water availability for watering activities - Seek further water if required - Water accounting verification of volumes, use and coordinate return flows	-Assist with report compilation and review -Review volumes of environmental water used
MDBA TLM Planning and Delivery	Water Availability (If TLM water used)	-Advise on TLM watering objectives -Advise on TLM water availability -Coordinating activities across TLM Icon Sites	OBSERVER ROLE ONLY if contributing environmental water	-Assist with Water Accounting -Assist with report compilation and review
CEWH	Water Availability (If Commonwealth water used)	-Advise on Commonwealth watering objectives -Advise on Commonwealth water availability -Coordinating other CEWH activities	OBSERVER ROLE ONLY if participating	-Assist with report compilation and review
DEWLP	Environmental Water Policy	- Provide advice on state wide environmental water policy - Ensure integration of TLM activities with the Basin Plan and related state initiatives	OBSERVER ROLE ONLY	OBSERVER ROLE ONLY

Scientific consultants	Event Monitoring	-Provide advice on achieving ecological objectives	-Undertake monitoring activities as directed by the Mallee CMA or other contracting agency	-Report monitoring results
Scientific Advisors	Specialist Advice	-Assist setting ecological objectives	-Provide specialist advice when required	NO ROLE EXPECTED
SCBEWC (includes TLM partner governments)	Allocation of TLM entitlements Coordination of environmental water in the Southern Connected Murray-Darling Basin	- Decision making on the use of TLM portfolio, River Murray unregulated flows and River Murray increased flows - Input into the development of large scale multi-site environmental watering events	NO ROLE –unless site or in river conditions lead to substantial change from planned event	-Reporting included in annual SCBEWC report to the Basin Officials Committee and reporting on annual TLM watering activities

4.4 Stakeholder Roles and Responsibilities

Mallee Catchment Management Authority (CMA) – Icon Site Manager

The icon site manager for the Hattah Lakes is the Chief Executive Officer of the Mallee CMA. Catchment Management Authorities are the caretakers of river health and responsible for the management of environmental water in Victoria, as specified in the *Water Act 1989*. The Mallee CMA is the coordinator of the delivery of the TLM program at the icon site level, where it works closely with its partner agencies, Goulburn-Murray Water, Parks Victoria and DELWP and is supported by a number of site-specific committees.

Parks Victoria – Public Land Manager

Parks Victoria is the public land manager responsible for management of the Hattah-Kulkyne National Park. Under the *Parks Victoria Act 1998*, Parks Victoria is responsible for providing services to the state and its agencies for the management of parks, reserves and other public land and is responsible for all areas reserved under the *National Parks Act 1975*.

Murray-Darling Basin Authority – River Management (Operations, Modelling and Data Management)

The water delivery structures (assets) within the Icon Site are part of a suite of River Murray Operations assets, which are managed by the MDBA on behalf of the "asset controlling governments" (New South Wales, Victoria, South Australia and the Commonwealth). Strictly, the assets are owned by the body that owns the land on which the asset sits, however ownership is not outright for the relevant body but beneficial on behalf of the four asset controlling governments.

In determining how structures should be operated, MDBA River Operations attends and contributes to the Hattah Operations Group meetings. The group then issues a request for an operation to the MDBA. MDBA requests G-M Water to operate the structures as required.

Operational data is collected at structures throughout watering events. The data is stored on the MDBA data system and is available for all to use upon request. Modellers provide advice to Mallee CMA during events – from the water bid proposal to the end of the event. The modellers also re-calibrate the model as the event takes place.

Murray-Darling Basin Authority – TLM Planning and Delivery

The MDBA – TLM Planning and Delivery coordinates the planning and delivery of TLM environmental water to TLM Icon Sites. This is achieved in close consultation with the Southern Connected Basin Environmental Watering Committee (SCBEWC), which is chaired by the MDBA Members include the TLM government partners and the Commonwealth Environmental Water Office.

Goulburn-Murray Water (GMW) – Asset operations and maintenance

Goulburn-Murray Water (GMW) is responsible for day to day river operations.

GMW is also responsible for the operation and maintenance of all TLM water delivery structures within Hattah, as well as the weir operations that support environmental watering. This is undertaken as part of an asset agreement between the MDBA and GMW. Under this agreement, GMW is responsible for "accounting for the assets, recording, reporting and auditing as well as specific high level requirements in relation to construction, maintenance and operation of assets" (MDB Agreement, Clause 55). It is anticipated that GMW may engage local contractors to undertake some operation and maintenance activities if required. As is consistent with the operation of any

River Murray asset by GMW, all directions for the operation of the water management infrastructure at LMW will be issued by MDBA River Murray Operations. The structures will NOT be operated outside of these requests unless there is an issue of public safety or the integrity of the structure is at risk.

GMW is also responsible for collecting data during the event and providing it to MDBA River Management to assist with real-time management and modelling.

Goulburn-Murray Water (GMW) – Water accounting

GMW is the delegated Resource Manager for the Victorian River Murray system under the Water Act 1989 (Victoria) and coordinates the accounting of resources associated with operations in this reach. In this role, GMW liaises closely with the River Murray Operations team of the MDBA to ensure bulk and retail water accounts are correctly credited and debited.

Victorian Department of Environment, Land, Water and Planning (DELWP)

In Victoria, the overall TLM program is delivered by DELWP, which provides high level policy input and coordinates the delivery of TLM across all Victorian Icon Sites. One of the key roles for DELWP is to provide statutory and strategic guidance to the planning of Victoria. DELWP is also the site owner for most Crown land in Victoria and may delegate the management of Crown land to others on its behalf, as is the case with Parks Victoria.

Victorian Environmental Water Holder (VEWH)

The VEWH is responsible for holding and managing Victoria's environmental water entitlements and allocations and coordinating the delivery of Victorian environmental water allocations with other environmental entitlement holders to maximise benefits to the environment. The VEWH works closely with catchment management authorities and Melbourne Water to ensure that environmental water entitlements are used to maximise ecological outcomes for the water available. In terms of Hattah, the VEWH will consider environmental watering proposals along with all others in the state to determine environmental watering priorities from a state perspective.

If Hattah is determined to be an environmental priority for the year and water is made available to the site, the VEWH then authorises the use of water by the Mallee CMA through a Seasonal Watering Statement.

Commonwealth Environmental Water Office (CEWO)

As a component of Murray-Darling Basin reforms, the Australian Government has acquired a number of water entitlements with the objective to return more water to the environment. These entitlements have become a part of the Commonwealth environmental water holdings and are managed by CEWO. The volume of environmental water held by CEWO is significant and may constitute an important source of environmental water for the Hattah Lakes and other significant sites.

Southern Connected Basin Environmental Watering Committee (SCBWEC)

The SCBEWC is responsible for the planning and delivery of the TLM annual portfolio.

The Southern Connected Basin Environmental Watering Committee (SCBEWC) was established in 2014 and replaces the former Environmental Watering Group (EWG). The committee has dual functions:

- making decisions on The Living Murray portfolio, River Murray Unregulated Flows and River Murray Increased Flows water
- coordination of the delivery of environmental water to maximise environmental outcomes in the Southern Connected Basin

The committee consists of jurisdictional representatives working in environmental and river operational management and is chaired by MDBA.

4.5 Sourcing environmental water for a watering event

Environmental water for the Hattah Lakes Icon Site may be sourced from a number of environmental water holders. These sources include The Living Murray (TLM) Program, Victorian Environmental Water Holder (VEWH) and Commonwealth Environmental Water Holder (CEWH). There is also an unregulated flow component that is attached to some Victorian TLM entitlements.

Before a watering action can commence, a Seasonal Watering Proposal must be prepared by the Icon Site Manager and approved by the VEWH (Figure 4-1). Submissions for environmental water allocations are presented by the VEWH to the relevant water holders who subsequently prioritise the watering proposals against all other watering proposals.

Once a watering action is approved, the VEWH ensures sufficient water is in the appropriate allocation bank account (ABA). This may require a transfer of water from one ABA to another. The VEWH will then issue a Seasonal Watering Statement to the Mallee CMA allowing access to an allocation of water in the ABA. Once the Seasonal Watering Statement is approved, a water order can be placed by MCMA with GMW, enabling a diversion to commence.

Prepare Seasonal Watering Proposal
(March-May)
Prepared by the Icon Site Manager in consultation with the Land Manager and other regional partners. The proposals are prepared with input from ecological experts and the local indigenous and non-Indigenous communities.

Submit Seasonal Watering Proposal
(April-May)
Watering proposals are submitted to VEWH for approval from the Victorian environmental water perspective.

Depending on which environmental water holder is to provide the water, the proposal is then submitted to the SCBEWC for consideration if requesting TLM water and/or to CEWO if requesting Commonwealth water.

Operational Planning
(May-June)
SCBEWC and/or CEWO plans for environmental water use in a manner that coordinates watering proposals to contribute to environmental outcomes appropriate for seasonal conditions.

Transfer Water Allocation
(Timing will depend on delivery requirements and seasonal conditions)
The water holder transfers water allocation from their portfolio to the appropriate Allocation Bank Account (ABA) and issues a Seasonal Watering Statement.

Place the Water Order
(Timing will depend on delivery requirements)
Icon Site Manager prepares a water order for submission to Goulburn Murray Water, enabling a diversion to commence.

Figure 4-1: Sourcing environmental water for a watering event at Hattah

5. Site Characteristics Guiding Environmental Watering

The Hattah Lakes floodplain is an extensive complex of lakes and creeks set within a wider Mallee landscape floodplain. The system includes 20 perennial and intermittent freshwater lakes, ranging in size from less than 10 ha to approximately 200 ha. The surrounding vegetation communities include those that require frequent flooding, such as river red gum (*Eucalyptus camaldulensis*) woodland, to those that require only periodic inundation, such as black box (*E. largiflorens*) woodland and lignum (*Muehlenbeckia florulenta*) shrubland. The system has adapted to utilise regular inundation events created by peaks in River Murray of varying magnitude and durations.

5.1 Waterflow

Central Lakes

During unmanaged conditions, Chalka Creek South commences to flow when river flows exceed 26,000 ML/day at Euston Weir (Figure 5-1). Chalka Creek South runs for 19km before it reaches Lake Lockie, the first connected wetland. Once Lake Lockie is filled, water flows toward Lake Hattah and Lake little Hattah and provides inflows to subsequent southern lakes (Lake Bulla, Lake Arawak, Lake Marramook, Lake Brockie, Lake Boich, Lake Tullamook, and Lake Nip Nip, in order). Once water levels in Lake Lockie are high enough to flood the southern lakes, water starts to divert to the northern arm of Chalka Creek (Chalka Creek north). Water moves from the flooded Lake Lockie to Lake Yarang first, which contributes water supplies to Lake Mournpall and Lake Konardin. Water then travels to Lake Yelwell, from which water flows along Chalka Creek north and eventually feeds Lake Bitterang.

As River Murray flows rise, widespread flooding occurs. The lakes with higher commence-to-flow thresholds are filled, the lakes with lower commence to flow thresholds spill water into surrounding floodplain and water spreads progressively into river red gum woodland first, then black box and lignum communities higher on the floodplain.

When river flows fall, water levels on the floodplain and in the lakes drop until the levels reach the lakes' drainage sills. At this stage, lake height decline is influenced by climatic conditions. Lakes Hattah and Mournpall, which are the deepest lakes in the system, are known to hold water for up to 3 and 7 years, respectively (SKM, 2004).

During managed watering conditions, Messengers and Oateys regulators are closed and the pumped inflows fill the system in the same manner. The main point of difference is that Chalka Creek north and south don't receive water until releases are operated via Messengers and Oateys regulators.

Lake Cantala

Lake Cantala is isolated from the central lakes and fills naturally via Cantala Creek, an independent flow path joining the lake to the River Murray. During unmanaged conditions, Lake Cantala fills when River Murray levels exceed 45,000 ML/day at Euston (SKM, 2004). The overland connection between the lake and Chalka Creek north requires much higher passing flows to connect naturally, but this flow path is the means of delivery for water delivered using the works package.

Lake Kramen

Kramen Creek diverges from Chalka Creek approximately 300m downstream of Messenger's Regulator and flows overland in a south-westerly direction until it reaches Lake Kramen. Naturally, Kramen Creek's commence to flow level is 152,000 ML/day at Euston weir.

To water Kramen Creek and Lake using the works, a dedicated pipeline from the pump station to the Kramen regulator is used. Water can be provided to Lake Kramen when Euston flows are as low at 7000 ML/d.

Dry Lakes

Flows above 180,000 ML/day at Euston inundate the Lake Boolca and Dry Lakes area to the north. The Living Murray works project at Hattah doesn't include scope to water the Lake Boolca/Dry Lakes area, due to the greatly increased works and associated costs necessary. As such, this operating plan does not include the watering of the Dry Lakes area.

5.2 Rating Curves

The hydraulic interaction between the lakes and the River Murray is complex. Flow direction and rate is dependent on the hydraulic gradient (head difference between the Lakes and the River Murray) and is further complicated by the installation of Oateys and Messengers regulators. As a result of this complexity, it is not possible to define a standard rating table for flow in Chalka Creek. To overcome this, Acoustic Doppler gauging stations have been installed which measure velocity and area to define the flow at Messengers and Oateys regulators.

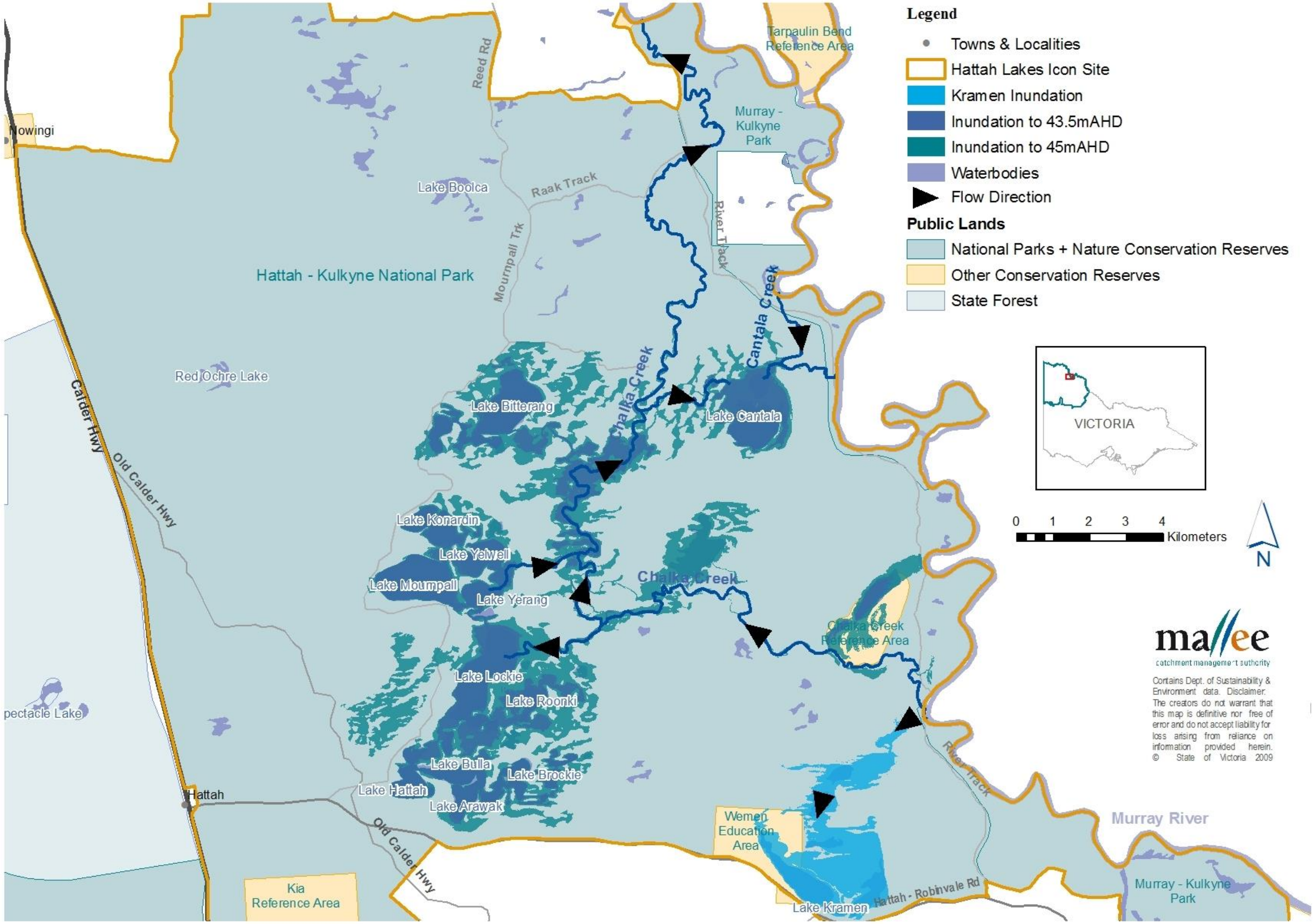

Figure 5-1: Schematic drawing of the flow paths of the Hattah Lakes system

6. Operational thresholds

This section provides guidance on the operational thresholds that inform the Hattah OG during planning and adaptive management of events.

6.1 Natural inundation events

Natural inflows into Hattah Lakes can occur at four locations:

- **Chalka Creek South** (inc. Messenger's regulator) – the main site of inflows from the River Murray.
- **Cantala Creek** (inc. Cantala regulator) – becomes engaged during large flood events.
- **Chalka Creek North** (inc. Oatey's regulator) – only carries flows into the lakes on the rising limb of a large flood event.
- **Overbank flows** (inc. any combination of regulators and banks, dependent on river height) – only occur during very large flood events.

Outflows from Chalka and Cantala Creeks to the River Murray occur via the same locations as inflows. This means that flow is bidirectional, a relatively uncommon occurrence in natural waterways.

6.2 Natural duration verses managed events

The intent of the works is to reintroduce a more natural water regime to the lakes and to enable management of the water regime to offset the impact of upstream regulation and consumption.

Analysis of modelled historic River Murray flows undertaken by the MDBA provides some context for the selection of a 1000 ML/d capacity for the pump station and will assist environmental water planning and operations, to meet the ecological objectives at the site. For example if the watering objective was to water Lake Bitterang to 44 m AHD, for a duration of 80 days, 1000 ML/day could be pumped without exceeding the natural duration.

However Figure 6-1 also shows that if the aim was to water Lake Bitterang for longer than 100 days the level of pumping affects whether the natural duration will be exceeded. It can be seen that pumping at 500 ML/day would take too long to fill Lake Bitterang and exceed the natural duration. How long the natural duration is exceeded may impact ecological values e.g. causing vegetation stress or death by exceeding ecological thresholds.

Pumping times will also depend on the ecological watering objective i.e. the target elevation, and whether or not the natural duration is exceeded. Figure 6-2 shows that pumping at 1000 ML/day may at times exceed the natural duration for a minimal amount of time.

Real time modelling of natural River Murray flows can be undertaken by MDBA during watering events, to provide information on natural duration and the appropriateness of extending duration of pumping to different levels.

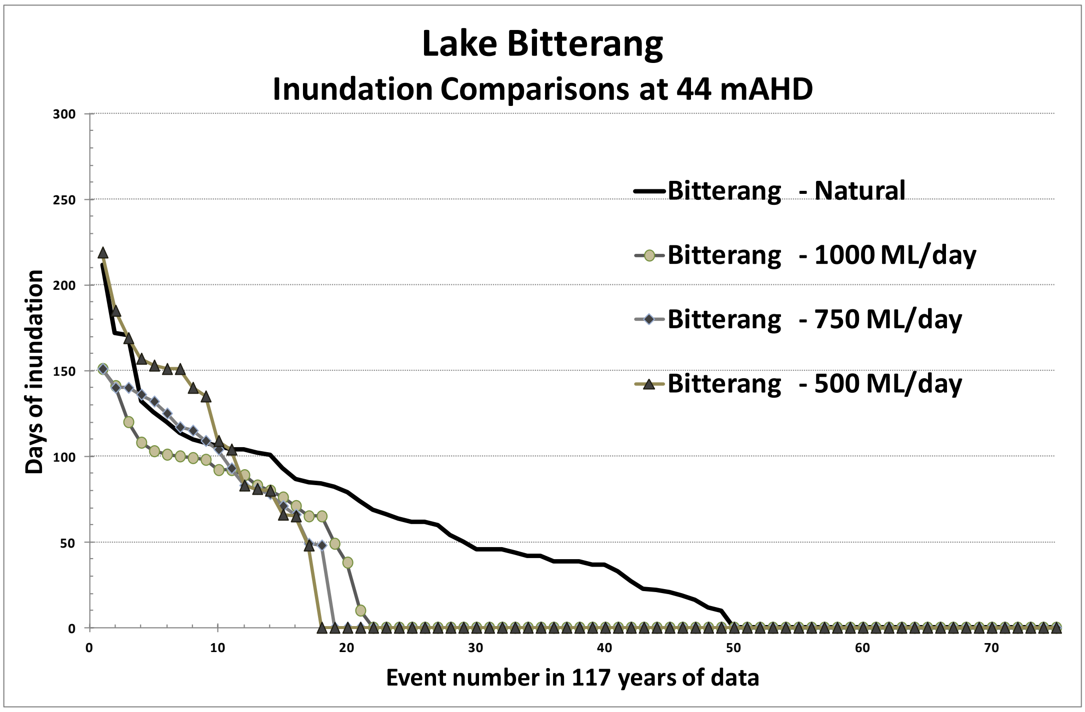

Figure 6-1: Inundation comparison at Lake Bitterang at 44mAHD

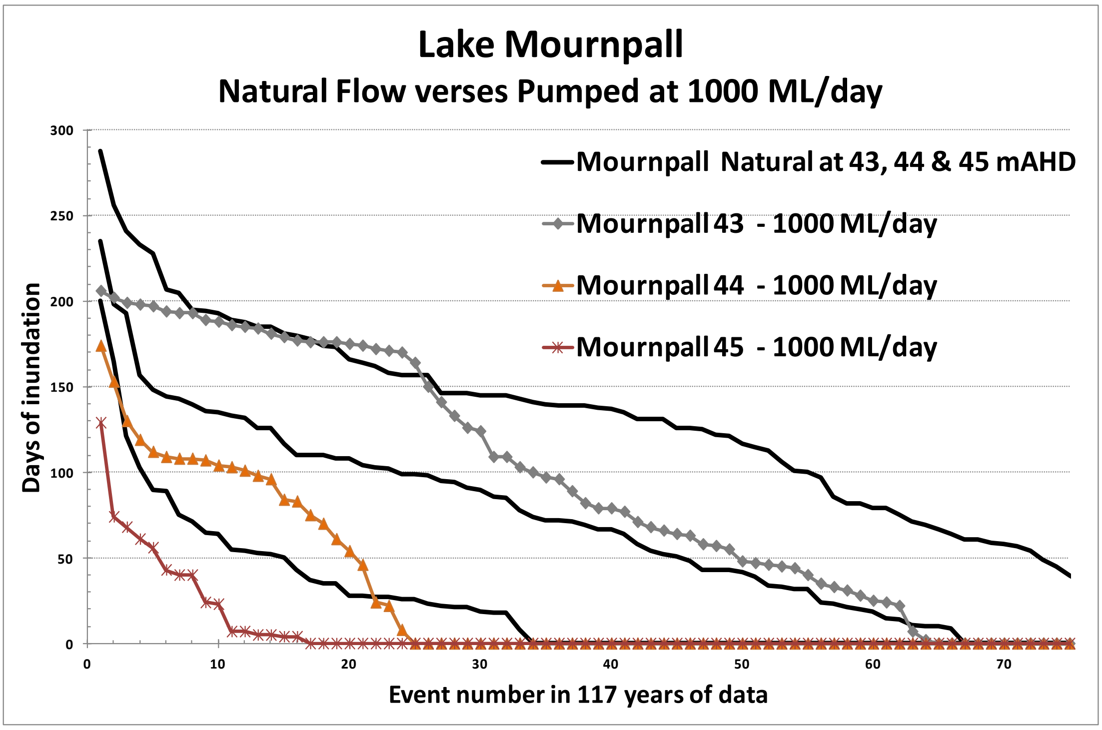

Figure 6-2: Inundation comparisons at Lake Mournpall at the elevations of 43mAHD, 44mAHD and 45mAHD for natural at 1000ML/day pump capacity

6.3 Natural Drainage Rates versus Managed Events

The natural drainage (outflow capacity) from Chalka Creek to the River Murray is totally dependent on the rise and fall of the River Murray itself. Once the river falls the water in the Hattah Lakes system will drain from the lakes, via Chalka Creek North and South until the water is below the sill level of Chalka Creek and the wetlands.

As a natural flood recedes, the rate of drainage from the lakes (via Chalka Creek) into the River Murray is controlled by the high level of the river, and water drains relatively slowly. However, in a managed event it is probable that the River Murray levels will be lower than the water held within the Hattah Lakes at the time of release. This means that a steeper than natural hydraulic gradient may exist at either end of Chalka Creek during managed drawdowns.

This steep hydraulic gradient increases the risk of erosion at the north and south entrances to Chalka Creek. In order to manage this risk, rock chutes have been installed. Early operations have shown that these structures are subject to damage and potential failure during operation at higher discharge rates, and during 2016 remedial works for the Chalka Creek South rock chute were designed and constructed to address a major erosion issue and improve the resilience of the rock chute. The new maximum design rate of release is 600 ML/d (down from 750 ML/d). It is important to monitor the integrity of these structures during discharge events and immediately reduce or cease flows to allow repairs should damage become evident.

Figure 6-3 demonstrates that no matter the rate of release, the rate of fall is ultimately limited to the conveyance of the creek and the sill levels.

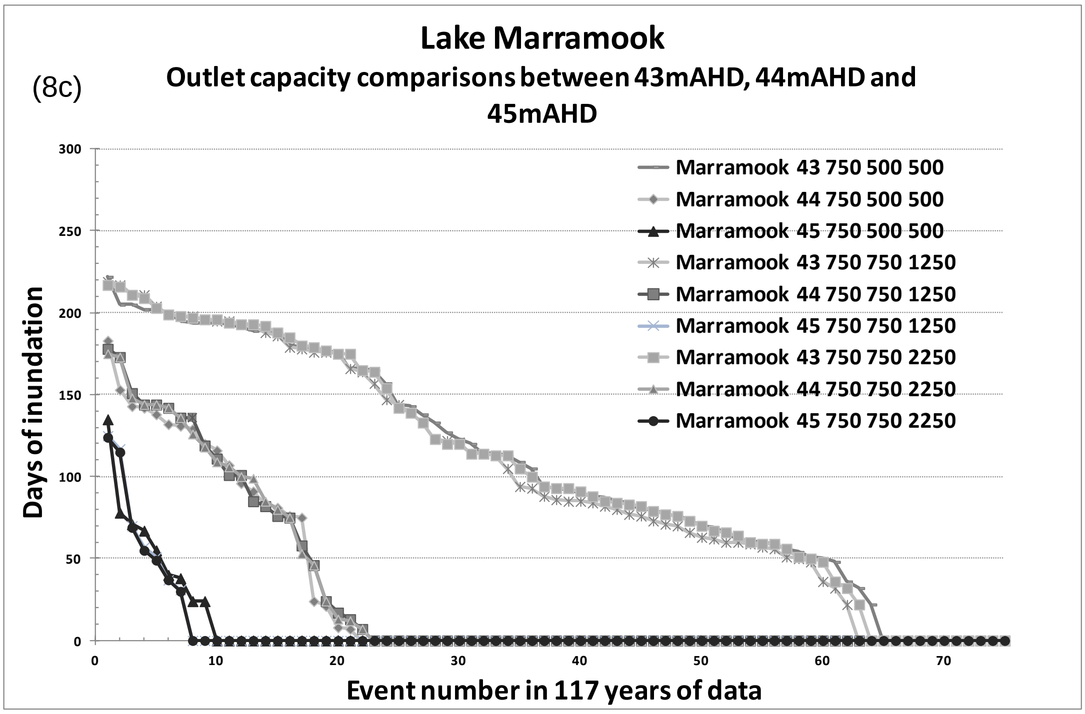

Figure 6-3: Comparison of different outlet capacities on duration of watering at Lake Marramook at 43m AHD and 44m AHD for different pump capacities.

7. Details of structures

The Hattah Lakes Environmental Flows Project comprises a number of complementary structures to allow natural flooding events to be supplemented by either partial or fully managed events. The structures have operational flexibility and can function with minimal water availability. A pump station, four regulating structures and some associated works enable water management within the central lakes.

All infrastructure has been designed for a 100-year design life and contemporary design codes have been used to ensure stability and durability as well as economic operation and maintenance costs.

This section details the purpose of each structure and their broad design features. A summary of the main operational levels and flows for the various structures is also provided. How the works package is to be used is discussed in the Operating Regimes section (Section 8). Operations risks are discussed in Section 9. Further design details can be found in the 'Report for Hattah Lakes Floodplain Management - Detailed Design Report' (GHD 2011).

The package of works at Hattah Lakes includes:

- A maximum design elevation for retention of water within the central lakes of 45.0 m AHD;
- A maximum design elevation for retention of water within Lake Kramen of 46.5 m AHD;
- A pump station with a capacity of up to 1000 ML/day, powered by electricity from the national grid.
- Main concrete regulator structures with dual leaf combination gates situated at Messengers Crossing, Cantala Creek and Oateys sites.
- A small regulator with stoplogs at Kramen Creek;
- Earthen levees at the Cantala, Breakout and Bitterang sites;
- Refurbishment of the existing Lake Little Hattah Regulator including concrete repairs, replacement of erosion protection and new stoplogs and pedestrian bridge deck;
- Lowering of Chalka Creek south to 41.75m AHD and re-alignment of log jams in four locations;
- Works to protect Chalka Creek South and North from erosion from water returning to the River Murray during releases; and
- Ancillary works, particularly access improvements.

The works enable the lakes to be filled in the absence of natural high river flows; operation of the works can provide inundation to over 6,000 ha of floodplain, including creek, wetland and floodplain habitats and water can be retained on the floodplain to a height of 45.0 m AHD (46.2 m AHD at the Kramen Regulator).

7.1 Pump Station

The pump site is downstream of a river rock bar in the River Murray, which provides a 'pool' on the downstream side. The pooling action provides a low point in the river bed as well as a natural means of scouring the river bed and minimising silt deposition. The site also offers some protection against currents and floating debris.

The pump station has an installed capacity of 1,000 ML/day, split between 7 variable speed inclined axial pumps. The seventh pump (southernmost pump) also caters for discharging into Kramen Creek through a 900 mm diameter branch pipeline. The pump has a motor of a marginally higher power rating to cater for the increased head requirements.

The pump station lifts water from the River Murray into Chalka Creek to a water level of up to 45.5 m AHD. Based on historical minimum and maximum River Murray water levels at the site, the static lift required by the pumps ranges from 2.9 m to 9.6 m. The pumps have a wet end strainer to screen fish and other water creatures, with apertures of 40.0 mm.

The pump discharge pipes are connected to a concrete discharge structure at the top of the bank. The discharge structure allows transfer of water from the 7 pump discharge pipes into a single, 125 m long reinforced concrete pipe directing flow to Chalka Creek. Within the discharge structure itself, the pipes are directed downward to prevent 'jetting' of flows towards the outlet pipe and to aid smoother flow transition. The discharge structure is designed to create suitable hydraulic conditions to direct flow in a gradual and controlled manner towards the outlet.

A reinforced concrete energy dissipater structure is located at the end of the pipe to dissipate the flow energy. Suitably sized loose rock, geofabric and gabions have been installed in the creek bed downstream of the energy dissipater structure to reduce the risk of scouring.

During pump operations, flow measurement to +/- 5% accuracy is provided by a flow monitor and logger installed in the pipe and sensors installed in the internal face of the pipe.

Electric power supply for the pump station is provided by an underground three phase powerline owned and operated by GMW. There is a limit on power draw for a single 2MVA transformer. To manage this power draw, pump flows have been limited at high lift. The full flow of 144 ML/day per pump can be achieved when the water level in the River Murray is 41.3 m AHD metres or more. Below this level the pump output is reduced and, at 38.3 m AHD, the pumps are limited to a flow of up to 128 ML/day per pump. Under these circumstances the total station flow is up to 896 ML/day. The pumps cannot be operated at river flows of less than 38.3 m AHD.

A concrete building houses the variable speed drives (VSDs) and electrical control equipment nearby. The building is ventilated with four air-conditioning units to dissipate the heat generated by the VSDs. Electrical control includes Supervisory Control and Data Acquisition (SCADA) and telemetry control to GMW's operations at Mildura Weir.


Pump station

7.2 Regulators

Messengers, Oateys and Cantala Regulators

Messengers, Oateys and Cantala regulators allow natural flood waters into the Hattah Lakes system, provide a means to retain natural flood water and pumped water within the lakes, and in the case of Oateys and Messengers, release water back to the River Murray at a controlled rate. The regulators were designed to match the natural capacity of the creek and therefore not impede natural inflows and outflows. For this reason, the regulators were designed to pass up to 1000 ML/d when the River Murray is high; however constraints such as erosion risk in Chalka Creek and the height/passing flow in the River Murray limit the release rate under low River Murray flow conditions. As of 2016, new design and remedial works on the Chalka Creek South rock chute limit the maximum outflow for Messengers Regulator to 600 ML/day (dependent on River Murray passing flow conditions). For Oateys Regulator, constraints including erosion risk in the Chalka Creek North rock chute limit releases to a maximum of 400 ML/d (dependent on River Murray passing flow conditions).

The regulators are not designed to be reverse loaded, and their default position outside of water management actions is to be open. For more information on the regulators refer to Table 7-1.

As the regulators retain water and are considered dams, they must comply with ANCOLD guidelines. A preliminary assessment based on ANCOLD (2000) guidelines confirmed that the regulators are low hazard due to the low population at risk if a breach were to occur (GHD, 2011).

Table 7-1: Ready reference for detail of Messengers, Oateys and Cantala regulators. For more detailed information on operation and maintenance procedures, including risks and operator safety, please refer to the Operations and Maintenance Manual (REFERENCE). This operating plan is not intended to describe operation procedures.

	Structure and gate arrangement	Mode of Operation	Access	Erosion Protection
Messengers Regulator Retain water within the system. Extend the duration of natural inflows. Release retained water. Crest elevation 46 m AHD	2 no. 2 m wide by 4.5 m high combination (over / under) vertical penstock gates Initially the top panel is lowered providing overshot flow. Once the top panel is fully lowered, both panels are then raised together to provide undershot flow for the final draining.	The gates will be operated with hydraulic motors mounted on a platform above the deck. A portable, petrol driven generator provides the hydraulic power for the motors. Default gate position outside of managed operations is OPEN.	Single lane vehicular, open to public. Forms part of the realigned River Track. No key required.	Reno mattress and gabions. Designed to be suitable for fish and turtle passage.
Oateys Regulator Retain water within the system. Extend the duration of natural inflows. Release retained water. 45.5 m AHD	2 no. 2 m wide by 6.5 m high combination (over / under) vertical penstock gates Initially the top panel is lowered providing overshot flow. Once the top panel is fully lowered, both panels are then raised	The gates will be operated with hydraulic motors mounted on a platform above the deck. A portable, petrol driven generator provides the hydraulic power for the motors.	Single lane vehicular, land manager only. Key required.	Reno mattress. Designed to be suitable for fish and turtle passage.

	together to provide undershot flow for the final draining.	Default gate position outside of managed operations is OPEN.		
Cantala Regulator Retain water within the system. Extend the duration of natural inflows. 45.5 m AHD	1 no. 2 m wide by 4.5 m high combination (over / under) vertical penstock gates Initially the top panel is lowered providing overshot flow. Once the top panel is fully lowered, both panels are then raised together to provide undershot flow for the final draining.	Not to be operated to release water to the river due to erosion risk (unless undertaken on a falling high river). The gates will be operated with hydraulic motors mounted on a platform above the deck. A portable, petrol driven generator provides the hydraulic power for the motors. Default gate position outside of managed operations is OPEN.	Public pedestrian only over the top of the structure. Vehicular access up to regulator – land manager only. Key required.	Reno mattress

Messengers regulator

Oateys regulator

Kramen Creek Regulator

Kramen Creek diverges from Chalka Creek approximately 300 m downstream of Messenger's Regulator. It flows approximately 6.5 km overland, in a south-westerly direction until it reaches Lake Kramen. The Lake Kramen regulator structure was designed to pass and retain pumped and natural flood waters; for more information on the regulator refer to Table 7-2.

Table 7-2: Ready reference for detail of Lake Kramen regulator. For more detailed information on operation and maintenance procedures, including risks and operator safety, please refer to the Operations and Maintenance Manual (REFERENCE). This operating plan is not intended to describe operation procedures.

Kramen Regulator	Structure and gate arrangement	Mode of Operation	Access	Erosion Protection
Main purpose: Allow pumping of water to Lake Kramen from Messengers Pump Station; allow natural flows into the lake. Crest elevation 46.6 m AHD	2 no. 1.8 m wide by 1.2 m high precast concrete box culverts. Pipe outlet occupies one culvert, the other is open to allow natural inflows. Gates consist of aluminium stop logs	Manually operated stop logs – requires two people and specially designed hooks. Stop logs are also locked in place with a padlock. Default gate position outside of managed operations is OPEN.	Vehicular, open to public. No key required.	Flow energy is dissipated by expansion from the pipe to the box culvert and by concrete baffle blocks. Reno mattress

Kramen regulator

Lake Little Hattah Regulator Refurbishment

The pre-existing Little Lake Hattah Regulator, located between Lake Little Hattah and Lake Hattah, was refurbished to prolong the structure's life and improve safety aspects during operations. The structure enables flows between the northern and southern Lakes, and the retention of water in Little Lake Hattah during smaller watering events; for more information on the regulator refer to Table 7-3.

Table 7-3: Ready reference for detail of the Little Lake Hattah regulator. For more detailed information on operation and maintenance procedures, including risks and operator safety, please refer to the Operations and Maintenance Manual (REFERENCE). This operating plan is not intended to describe operation procedures.

Lake Little Hattah Regulator	Structure and gate arrangement	Mode of Operation	Access	Erosion Protection
Enables direction of flow between lakes and retention of flow within Lake Little Hattah. Also contributes to carp control within the lakes. Crest elevation 43.6 m AHD	Structure includes a steel, inclined vertical aperture fish screen with rotating gates on the southern side. These screens are not a GMW asset and are the responsibility of Mallee CMA. Gates consist of aluminium stop logs	Manually operated stop logs – requires two people and specially designed hooks. Stop logs are also locked in place with a padlock. Carp screens can be operated from the pedestrian bridge deck. Operation requires a crank handle. Screens are secured with padlocks. Default gate position outside of managed operations is OPEN.	Pedestrian only over the top of the structure. 200 m walk from main track to reach the structure. No key required.	Reno mattress and re-instated existing rock protection.

Little Hattah regulator

7.3 Earthen block banks

Cantala, Breakout and Bitterang block banks

The block banks are small earthfill embankments accommodating vehicular access. The Breakout block bank has replaced the existing River Track and was designed as a small road embankment with two lanes. Cantala and Bitterang banks are both one lane. The geometry of the design was guided by Parks Victoria and Cultural Heritage advice; for more information on the banks refer to Table 7-4.

Table 7-4: Ready reference for detail of the Cantala, Breakout and Bitterang block banks. For more detailed information on operation and maintenance procedures, including risks and operator safety, please refer to the Operations and Maintenance Manual (REFERENCE). This operating plan is not intended to describe operation procedures.

Associated Works	Main Purpose	Key Operational Parameters	Crest Elevation (m AHD)
Bitterang Block Bank	Retain water within the Lakes system. Stops water moving North of Eagles Nest Track and helps build head for inundation.	Check for and repair any erosion, for each operation and natural flood	45.3
Breakout Block Bank	Retain water within the Lakes system. Stops water from returning to the River Murray.	Check for and repair any erosion, for each operation and natural flood	45.5
Cantala Block Bank	Retain water within the Lakes system. Stops water from returning to the River Murray.	Check for and repair any erosion, for each operation and natural flood	45.5


Bitterang block bank


Breakout block bank


Cantala block bank

7.4 Associated Works

Chalka Creek sill lowering

High points in Chalka Creek South were lowered to 41.75m AHD to reduce the commence to flow for Chalka Creek and the lakes, as well as to improve the hydraulic capacity of the creek. Approximately 1,200m of creek bed required shallow lowering across four locations.

In addition to creek lowering, log jams within the creek lowering areas were re-aligned to improve the hydraulics of the creek.

Water scour provisions

Where water returns to the River Murray via Chalka Creek South and North, the steep grade of the channels was considered to be an erosion risk. The project included designs for rock chutes at Chalka Creek north and south, which included measures to reduce water velocity and included geofabric and rock armouring to protect from erosion. The design release rate was in the range from 200 to 1000 ML/d (dependent on tailwater conditions) (GHD, 2011).

During the first commissioning event in 2013/14, minor additional rock work was required in the Chalka Creek south rock chute to address minor erosion. During the larger commissioning event of 2014/15, releases to the river via Messengers regulator and Chalka Creek south reached the intended rate of 750 ML/d. A major erosion event within the Chalka Creek south rock chute occurred and emergency earthworks and placement of additional rock, as well as a reduction in the rate of release (to 200 ML/d) was required.

The Chalka Creek south rock chute was redesigned and rebuilt during 2015/16. The area of rework is a steep 50 m section directly upstream of the confluence with the River Murray and the design included rock armouring, a minimum required tailwater height of 39.5 m AHD (7000 ML/d at Euston) and a new design release rate of 600 ML/d – an agreed volume between GMW and MDBA, based on advice from designers.

The Chalka Creek north rock chute was also affected by erosion during the 2013/14 commissioning event and as a result had some additional rock placed in the channel as well as a low sandbag wall placed to protect a tree. The release rate has been reduced to a maximum 400 ML/d.

7.5 Summary of Structures

Table 7-5 contains a summary of the key dimensions of the main structures and Table 7-6 and Table 7-7 contain a summary of the purpose and key operational parameters of the main works and associated works. For more information on supporting structures or the operation or maintenance of the structures, please refer to the Operation and Maintenance Manual (REFERENCE)

Table 7-5: Key dimensions of regulators and levees

Structure	Crest Elevation	Freeboard	Max. height of structure	Total length	Gate arrangement
Messengers Regulator	46.0m	500mm	5.8m	65m	2 no. 2m wide by 4.5m high combination gates
Oateys Regulator	45.5m	500mm	7.8m	84m	2 no. 2m wide by 6.5m high combination gates
Cantala Regulator	45.5m	500mm	5.8m	80m	1 no. 2m wide by 4.5m high combination gates
Lake Kramen Regulator	46.6m	300mm	2.4m	80m	2 no. 1.8m wide by 1.2m high manual segmented stop-logs
Cantala Levee	45.5m	500mm	2.6m	40m	N/A
Breakout Levee	45.5m	300mm	1.2m	530m	N/A
Bitterang Levee	45.3m	300mm	1.2m	850m	N/A

Table 7-6: Key purpose and Operations Parameters of the main structures

Operating Structures	Main Purpose	Key Operational Parameters	Operating Level
Pump Station	Raise water levels in the lakes system. Increase the extent of inundation.	• Capacity of up to 1000 ML/day discharging into Chalka Creek from the River Murray. • Powered by electricity from the National Grid. • One pump has the capacity to provide water independently to nearby Kramen Creek via an HDPE pipeline.	River Murray must be above 38.3 m AHD

Messengers Regulator	Retain water within the lakes system. Increase the duration of inundation.	• Max Outlet Capacity 600 ML/day	Crest Level 46 m AHD
Oateys Regulator	Retain water within the lakes system. Increase the duration of inundation.	• Max Outlet Capacity 400 ML/day	Crest Level 45.5 m AHD
Cantala Regulator	Retain water within the lakes system. Increase the duration of inundation.	• Not to be operated to release water to the river unless undertaken on a falling river due to erosion risk to connecting waterway if river is low.	Crest Level 45.5 m AHD
Kramen Regulator	Retain water in Lake Kramen. Increase the duration of inundation.	• Manually operated stop-logs. • No return flows.	Crest Level 46.6 m AHD

Table 7-7: Key purpose and Operations Parameters of the associated works

Associated Works	**Main Purpose**	**Key Operational Parameters**	**Operating Level**
Chalka Creek Lowering	Increase frequency of natural inundation.	Euston Weir operated at 26,000 ML/d to allow inflows	Sill level lowered to 41.75 m AHD
Bitterang Block Bank	Retain water within the Lakes system. Stops water moving North of Eagles Nest Track.	N/a	Crest Level 45.5 m AHD
Breakout Block Bank	Retain water within the Lakes system. Stops water from returning to the River Murray.	N/a	Crest Level 45.5 m AHD
Cantala Block Bank	Retain water within the Lakes system. Stops water from entering the lakes system and returning to the River Murray.	N/a	Crest Level 45.5 m AHD

8. Operations

The works at Hattah Lakes have been designed to enable the replication of key components of the natural hydrology of the system.

The works have been commissioned over two watering events – an event targeting 43.5 m AHD in 2013/14 and an event targeting 45 m AHD in the central lakes 2014/15; however this event only reached 44.73 m AHD in the central lakes. As part of this event, 16 GL was also pumped to Lake Kramen, resulting in an inundation level of 45.37 m AHD in the centre of the lake. In order for the works to be considered fully commissioned, a watering event would need to reach 45 m AHD in the central lakes and 46.2 m AHD at the Lake Kramen regulator. As this is a large event and Hattah has been wet for a number of consecutive years, it is likely this event will be planned and run in accordance with natural triggers.

As knowledge of the site is gained through operational experience, managers are increasingly considering the need for accurately incorporating inundation variability into long term water regimes, as well as how best to replicate this at the site, to achieve positive environmental outcomes. Going forward, managers will collaborate via the Hattah OG, and using data on modelled natural flows will aim to trial watering in a way that mimics the natural system, using the flexibility of the works.

8.1 Operational Scenarios

Four operational scenarios (plus maintenance) are possible at the Hattah Lakes using the works, to enhance natural or provide managed inundation to the system. Transitioning between scenarios is also possible and provides a high level of operational flexibility when delivering planned watering events or responding to natural inflows. The operational scenarios are:

- Natural inflows/outflows
- Enhance natural – extend duration (using natural flows)
- Enhance natural – extend duration and extent (using natural then pumped flows)
- Managed event (pumped flows)
- Maintenance (in years with no watering operation)

Managed operations of the Hattah Lakes works can be conducted independently of flow levels in the River Murray, assuming the river level is above the minimum 38.3 m AHD required to operate the pumps. Operations to water Lake Kramen are possible during any operational scenario.

Natural inflows/ outflows (Scenario 1)

This operating scenario allows natural inflows and outflows to occur without intervention. Inflows reach Messengers Regulator when flows exceed 26,000 ML/d at Euston. During small flooding events natural inflows will enter the Hattah Lakes system via Chalka Creek South.

During large flooding events natural inflows will occur via Chalka Creek South, Chalka Creek North and Cantala Creek. This relates to approximately 26,000 ML/d, 45,000 ML/d and 70,000 ML/d at Euston respectively and will inundate large areas of the floodplain.

It should be noted that:

- Natural inflows will be unregulated flows and will be measured
- Overbank flows will be unregulated flows and will not be measured or accounted
- Environmental water will not be required under this scenario.
- This operating scenario can transition to any of the other operating scenarios.

Enhance natural inflows (extend duration) (Scenario 2)

This operating scenario can transition from Scenario 1, with the aim to retain natural inflow volumes in the lakes and Chalka Creek by closing regulators at the peak of inflows. This will retain water within the central lakes as necessary to meet ecological requirements.

Environmental water will not be required under this scenario.

Enhance natural inflows (extend duration and extent) (Scenario 3)

This operating scenario builds on Scenario 2. It can improve the duration and extent of natural floodwaters in the lakes via pumping, in the instance where natural inflows aren't adequate to meet environmental requirements. The requirement for this scenario will be assessed according to a number of factors, including modelled natural flows, environmental requirements and availability of environmental water, which needs to be sourced to cover the water pumped to the lakes in addition to natural inflows.

This scenario has two options:

- Increase duration of inflows i.e. maintain water levels by offsetting evaporation and seepage infiltration using pumped environmental water; or
- Increase duration and extent by pumping water in excess of the amount needed to offset evaporation and seepage, in order to extend the area inundated and prolong the duration of inundation of natural inflows.

Managed Event (Scenario 4)

This scenario can increase the frequency of inundation, where unmanaged inundation events don't match the ecological requirements of the site. The pump station can be used to provide water to Chalka Creek, the central lakes and Lake Kramen in the absence of natural inflows, provided that water levels in the River Murray exceed 38.3 m AHD (approximately 5000 ML/d at Euston). This scenario can be provided under both regulated and unregulated flow conditions. If pumping during regulated conditions, environmental water will need to be sourced. The requirement for pumped inflows will be assessed according to a number of factors including environmental requirements, modelled natural flows and the availability of environmental water.

Maintenance

During years where no watering operation is planned, GMW will undertake maintenance operations at GMW's discretion, as required to maintain the infrastructure – particularly the pump station. This may introduce up to 2 GL of additional water into Chalka Creek. Maintenance operations are detailed in the Operations and Maintenance manual and are conducted at the discretion of the water authority.

Table 8-1: Summary of Operating Scenarios and Gate Positions

	Operating Scenario			
	Natural inundation event – no management intervention	Enhanced natural event – increase duration of natural inundation	Enhanced natural event — increase duration and extent	Managed event – pumping from dry

River Condition (ML/day at Euston)	> 26,000	> 26,000	> 26,000 plus Additional water ordered as per licence conditions.	< 26,000 Water ordered as per licence conditions.
Messenger's regulator	Open to allow natural inflows and outflows	Open to allow natural inflows Close when natural flows peak to retain natural inflows Open once target duration reached	Open to allow natural inflows Close when natural peak passes to retain natural and pumped inflows Open once target duration and extent reached	Closed to retain pumped inflows Open once target duration and extent reached
Oatey's regulator	Open	Open to allow natural inflows Close as natural peak passes to retain natural inflows Open once target duration reached	Open to allow natural inflows Close as natural peak passes to retain natural and pumped inflows Open once target duration and extent reached	Closed to retain pumped inflows Open once target duration and extent reached
Cantala Regulator	Open	Open Close once natural peak passes Keep closed until dry – not to be used for releases unless water height is equal on both sides	Open Close once natural peak passes Keep closed until dry – not to be used for releases unless water height is equal on both sides	Closed Keep closed until dry – not to be used for releases unless water height is equal on both sides
Little Lake Hattah regulator	Open	Open	Open	As required, depending on size of event
Messengers pumping station	Off	Off	As required	As required
Block banks	Overtopped with additional 0.5m freeboard if flood > 45m AHD	-------	-------	-------

Note that sill lowering works in Chalka Creek and the earthen block banks will be in effect at all times.

8.2 Watering Regimes

The operational scenarios were developed to allow managers to switch between scenarios or adjust watering events in response to broader river or basin conditions, or modelled natural flows in order to provide a water regime that mimics natural inundation patterns and system variation.

Each year, watering events are planned in advance according to site ecological objectives, water availability and operational constraints for the water year. Managers and the Hattah OG use a standard set of watering regimes as a basis for planning and means to address monitoring and reporting requirements of events.

As knowledge is gained about operating the works, the preference of managers and the Hattah OG is to operate the system in a way that more closely reflects the natural system, incorporating more variability than using standard water regimes. Standard water regimes will continue to be used for initial event planning, monitoring and reporting purposes, but managers and the Hattah OG intend to use this approach adaptively, taking up to date advice and modelling from the MDBA into consideration, to guide the event in close to real time. The flexibility of the operating scenarios and the works will allow changes to be made to watering events during operation.

The MDBA can generate modelling and plots for the site based on actual inputs to the Murray system on a weekly basis, and distribute to the Hattah OG. The modelling will give an idea of how the River Murray and the site would be behaving that year under natural conditions – that is, without river regulation, providing trends on timing and magnitude of flows. The modelling will also include information on flow rates below Euston and in Chalka Creek as well as levels in the lakes and can provide approximately 3-4 weeks advance notice. The Operations Group can tailor any planned watering event to more closely reflect natural conditions.

This approach was trialled in 2015, where two watering scenarios were developed according to expected conditions in the system. The Hattah OG reviewed and discussed river conditions and modelling (distributed by the MDBA) regularly via teleconference, and made operational decisions during the event based on this information.

Table 8-2 describes the standard watering regimes and provides examples of duration and frequency (based on historical natural inflows), used for initial planning purposes. These watering regimes are not the only watering options, and are considered by managers and the Hattah OG to be illustrative rather than preferred or prescribed watering options.

Table 8-2: Standard watering regimes, including example duration and frequency of watering (based on historical natural inflows)

	Small watering (e.g. 43.5 m AHD)	**Large Watering (e.g. up to 45m AHD)**	**Large Watering up to 45 m AHD including Lake Kramen (to 46.2 m AHD at the regulator)**
Season	Late Winter to late spring or with natural flow pulse	Winter to early spring or with natural flow pulse	Late autumn to late winter
Duration	1-3 Months	1-3 Months (be careful to not retain water for too long)	1-3 Months (be careful to not retain water for too long)

Frequency	1:2	1:8	1:10
Climate Conditions	Median to Wet year	Wet Year	Wet Year
Maximum Area Inundated (ha)	2,653 ha	5,583 ha	> 6000 ha
Indicative net environmental water use (from dry)	41 GL	52 GL	65 GL (13 GL to Kramen if watering from dry)
Specific Objectives	Restore a mosaic of hydrological regimes Maintain and restore the ecological character of the Ramsar site Restore the macrophyte zone around at least 50% of the lakes Improve the quality and extent of deep freshwater meadow and permanent open freshwater wetlands Maintain habitat for the freckled duck, grey falcon and white-bellied sea eagle Successful breeding events for colonial waterbirds at least two years in 10 Provide habitat for migratory bird species Increase distribution, number and recruitment of wetland fish	As for Small Watering + Maximise use of floodplain habitat for fish recruitment	As for Large Watering

For further information on TLM ecological objectives please refer to the Hattah Lakes Environmental Water Management Plan (MDBA 2012), and for an assessment of ecological risks, the TLM Projects Risk Assessment Report (Newell et al, 2016).

8.3 Commissioning Operations

Commissioning of the structures in the central lakes will require a height to 45 m AHD whilst the Kramen Regulator will require a height of 46.2 m AHD.

This will be completed within the decade when an environmental watering event of that magnitude is triggered.

For a more detailed description of the commissioning events conducted refer to the Hattah Lakes Commissioning Report (MDBA 2015)

9. External Considerations for Operations

9.1 Upstream and Downstream Considerations

- Minimum passing flows to operate pumps is 38.3 m AHD (approximately 5000 at Euston)
- Re-use of net flows from upstream and downstream
- Water quality of inflows to the lakes
- Water quality of releases, particularly with regard to water quality targets outlined in the Basin Plan, including targets for salinity, blackwater and cyanobacteria
- Dilution flows required in the advent of the release of water impacted by a blackwater event

9.2 Power Supply

The Messengers pump station on the River consists of 7 axial pumps each with a capacity of 144 ML/d, providing an overall capacity of 1000 ML/d. This is the maximum pumping capacity when there is a low head differential between the River Murray and pump heights. Each pump motor is rated to 280 kW (515A) with a highest running load of 236 kW (434A). The overall power requirement of the pump station is 1.65 MW (approx. 2MW) (3038 A).

Power is provided to the pump station via three phase mains-delivered electricity. The underground 2 phase power line within the park is owned and operated by GMW.

Powercor is the power supply company and supply is susceptible to interruption. This has implications as the pumps may only be started with GMW staff on site to ensure that WHS requirements are met.

10. Water Use

This section details the water requirements and accounting methodology for operations.

10.1 Flow Types

There are four general operating scenarios (plus maintenance):

- Natural inflows/outflows – Scenario 1
- Enhance natural (extend duration) – Scenario 2
- Enhance natural (extend duration and extent) – Scenario 3
- Managed event (pumped event from dry) – Scenario 4
- Maintenance (in years with no watering operation)

These Scenarios are described in detail in Section 8.

Based on inflow types, the scenarios fit into three groups for water accounting purposes: natural inflows (includes Scenarios 1 and 2), a hybrid event (a combination of natural and pumped flows (Scenarios 3)), or pumped only flows (Scenario 4).

10.2 Water Requirements

The water requirements of the lakes will vary between operations depending on a number of conditions, including how much water is already present in the lakes, target watering level, time since last watering and prevailing climatic conditions. Based on modelling, estimates of water requirements can be made in order to source environmental water (Table 10-1).

Table 10-1: Estimates of water use based on modelling at the Hattah Lakes

From empty (GL)	Sill level (m AHD)	Small watering to 43.5 m AHD (GL returned to River Murray)	Large watering to 45 m AHD within central lakes, 46.2 m AHD at Lake Kramen regulator (GL returned to River Murray)
Chalka Creek and Central Lakes	41.75	41 GL (no returns)	106 GL (54 GL returned)
Lake Kramen	NA	NA	13 GL (no returns)

10.3 Accounting for Water Use

The key aspect to consider with water accounting for the Hattah Lakes system is that it is a storage system with controlled inflows and outflows at Chalka Creek South and Chalka Creek North. While significant volumes of water can be stored on the floodplain during pumping and natural large events (due to the lakes in the system), up to 50% of flows entering the Hattah Lakes system could potentially return to the River Murray.

The key conditions for accounting purposes are:

- commencement of natural inflows require 26,000 ML/d or greater at Euston. The river will be unregulated.
- water can be stored in the lakes system and may be released to a regulated river.
- not all inflows can be measured i.e. overbank flows and Cantala regulator.

- being possible to calculate the initial volume held in the lakes by gauge boards/stations and capacity tables. This approach will be consistent with volumes held in large storages (such as Hume Dam, Dartmouth Dam, Lake Victoria and Menindee).
- Water may switch from regulated flow to unregulated flow and vice versa during an event.

Measurement Types

The measurement types and location for the Hattah Lakes Works and Measures are outlined in Table 10-2; Table 10.3 provides a matrix of the flow measurement and accounting methods for the operating scenarios as well as the transitional periods between operating scenarios.

Table 10-2: Summary of flow measurement types and location at Hattah Lakes

Site	Flow Measurement	Purpose
Messengers Regulator	Height and Flow	Water accounting and model calibration. For use during managed, hybrid and natural events.
Pump Station	Flow, Velocity and Volume	Water accounting and model calibration. For use during managed and hybrid events.
Oateys Regulator	Height and Flow	Water accounting and model calibration. For use during managed, hybrid and natural events.
Cantala Regulator*	n/a	
Lake Mournpall	Height, Water Quality	To determine volume held in the lakes using capacity tables.
Temporary sites (lakes) throughout the system.	Height, Water Quality	To determine volume held in the lakes using capacity tables.

*No flow measurement is proposed for Cantala Creek. This area is situated high above the river level and flows at this site can only occur in a large natural flood event. Managed releases are not possible due to erosion issues at the confluence with the River Murray.

Table 10-3: Flow measurement and accounting methods for scenarios and transitional states between operating scenarios

To / From	Pumped event	Natural inflows
Pumped event	**Pumping** • As required. **Regulators** • Lake Little Hattah open • All other regulators closed **Water Measurement/Accounting Methods** • Inflow – measured by pump meter. • Outflow – measured at Oateys and Messengers Regulators.	**Event then becomes a hybrid event** (assuming river levels are equal to or higher than the water volume upstream of Messengers Regulator) **Pumping** • Turn off. **Regulators** • Open to allow inflows. **Water Measurement/Accounting Methods** • Inflow – water balance based on volume in lakes.
Natural inflows	**Event then becomes a hybrid event** **Pumping** • Turn on. **Regulators** • All closed. **Water Measurement/Accounting Methods** • Starting water volume – based on gauge board readings and capacity tables for lakes. • Inflow – measured by pump meter.	**Pumping** • Nil. **Regulators-** • Messengers Regulator - open to allow inflows and outflows. Close upon recession if extending duration. • Oateys Regulator - open to allow inflows and outflows. Close upon recession if extending duration. • Cantala Regulator – open to allow inflows and outflows (outflows subject to receding hydrograph conditions). • Kramen Regulator – open to allow inflows **Water Measurement/Accounting Methods** • Not Applicable – fully natural event. • Volume added to the lakes can be measured by gauge boards at Oateys and Messengers Regulator, and by capacity tables. • Note: possible overbank flows may occur during large floods.

Note: Table 5 provides a summary of the structure operations and approach to flow measurement methods for each of the possible operating conditions in which environmental watering and/or natural flooding would occur for the Hattah Lakes system. The table does not go into detailed water accounting principles which will apply for all TLM sites such as the rules for return credits, use of unregulated entitlements, etc.

Note: Lake Kramen watering is via pumping only and is measured via the pump meter. There is no water return to the River Murray.

Natural inflows ☐ Pumped event ☐ Hybrid event ☐

Crediting return flows

In accordance with s94(1)(d) of the M-DB Agreement, Oateys and Messengers regulators are approved outfalls that allow water returned to the river from Hattah Lakes to be maintained as a Victorian resource in the MDBA monthly water accounts (bulk water accounting) and enable Victoria to credit these return flows (retail water accounting) for environmental purposes downstream.

Return flows from Oateys regulator are subject to a loss experienced between the Oateys regulator and the River Murray. When return flows are to be re-credited, the water balance model developed by MDBA is used to help calculate the loss and determine the return flow volume to the River Murray. Hydrographers will gauge the flow at Oateys regulator and at the confluence of the Murray and Chalka Creek North during the event to help calibrate and validate the model. The number of gaugings undertaken during the event will be determined by Goulburn-Murray Water and will be appropriate to ensure confidence in the return flow volume.

Accounting during a pumped event

During a pumped event (with no natural inflows), the total volume of water used during the event is the volume pumped at the pump station. Any return flows to the River Murray via Chalka Creek South (Messengers) and Chalka Creek North (Oateys) is then re-credited for use downstream.

Accounting during a hybrid event

Whilst accounting for water use at Hattah Lakes during a pumped event is relatively straight forward water accounting during a hybrid event is considerably more complex.

Most watering events will be 'hybrid events' that include floods providing inflows via the creeks and also an intervention using the TLM infrastructure. There is also the complexity of regulated and unregulated flows that may be occurring in the river during a hybrid event. In these hybrid watering events, the timing and volumes of both inflows and return flows may also be highly modified due to the operation of the pumps and regulators.

Although the diversions (mainly pumping) and return flows may be measureable, some of these would have occurred without the intervention and therefore may need to be taken into consideration when undertaking the water accounting. As a result, it is not as simple as debiting all the measured diversions and then crediting all the measured returns.

In light of this complexity, an interim *modelling- measurement* accounting method (outlined below) will be trialled. The use of this method will be reviewed by Water Liaison Working Group (WLWG) to assess if it is suitable in the longer term and under all watering conditions. MDBA will also assess if the method is cost effective over the long-term given current (and future) budget pressures.

The *modelling-measurement* method is relatively complex and relies on a water balance model (BigMod) of Hattah Lakes developed by MDBA to compare actual measurements with what would have happened without the intervention of the TLM infrastructure. A brief description of the *modelling-measurement* method is provided below, however this may be updated as the watering progresses and new information becomes available.

Modelling - measurement accounting method (to be trialled)

The *modelling- measurement* method aims to, where possible, measure or estimate using real data and a water balance model of Hattah Lakes, the <u>*additional*</u> diversions and returns due to intervention with the TLM works. The model relies on assumptions of what may have happened if the intervention did not occur.

The following would be considered as *additional diversions* due to the intervention:

D1 Goulburn-Murray Water will measure diversions through the pump station.

D2 MDBA will model the additional inflow due to the lowered sill by comparing the modelled inflows with and without the sill lowering using the actual Euston river level.

D3 MDBA will model any additional water that is retained, sometimes temporarily behind the two main regulators to increase area and duration of inundation, that would otherwise have drained back to the river and been available for regulation further downstream.

The following *may,* where appropriate upon the advice of WLWG, be considered as a credit due to the intervention:

C1 Return flows will be monitored during and following the event, however only return flows during periods of regulated flow that are due to the intervention (i.e. take into account the modelled diversions and credits such as D2, D3) and can be linked to a prior diversion on the Victorian Water Register will be available for crediting. Return flows during declared periods of unregulated flow do not need to be credited to an account as they cannot be regulated and as such they will available for environmental use downstream.

The MDBA, with advice from WLWG, will monitor the event closely and assess all potential diversions and return flows to determine if the crediting of return flows is possible and the volumes that can be credited without impacting on other water users.

Debiting regulated and unregulated flow diversions

During periods of regulated flow Victoria will need to debit any diversions (pumped or modelled) against a Victorian account. Any creditable return flows can be added to this account subject to the above mentioned approvals being obtained.

Diversions (pumped or modelled) during a period of declared unregulated flow in the reach between the Murrumbidgee Junction to Wentworth may be debited against the Victorian Unregulated Flow Entitlement or the Living Murray Unregulated Flow Entitlement, which are provided for under the Flora and Fauna Bulk Entitlement and have a capped combined volume of 74.3 GL/year. If either of these accounts are used then Victoria may be able to credit these accounts with any creditable return flows. If these accounts are not available then River Murray Unregulated Flows (RMUF) may be used if supported by the SCBEWC. However, at this stage there is no ability to credit diversions accounted to RMUF as they do not appear on the Victorian Water Register.

Contingency arrangements

If at any stage during the hybrid watering event the WLWG assess that the *modelling- measurement* method is not suitable, which could be due to a range of issues including, inaccuracies in the modelling, uncertainty with measurement of return flows or difficulties with implementation, then MDBA after considering advice from WLWG, may decide to modify the method or implement a much simpler method. A simpler method would still debit diversions at the pump station but may or may not allow for the crediting of return flow

11. OPERATING RISKS AND MITIGATION MEASURES

An assessment has been made of the risks of operations at Hattah Lakes to environmental, social and economic values. The risk assessment was undertaken by a committee comprising Mallee CMA, Parks Victoria, MDBA, DELWP, River Murray Operations and SA Water and coordinated by Lloyd Environmental (Newall et al, 2016). The risk assessment progressed earlier risk studies, including environmental and salinity assessments. The risk assessment summary table is provided in Appendix B.

The risk assessment considered risks associated with water delivery to the watercourses, wetlands and floodplains, water held within the wetlands and floodplain, and water released/spilling from the floodplain. The assessment excluded risks associated with the structures, which are the responsibility of the operator and documented in the Operations, Maintenance and Safety Manuals. For detail on risk definitions, risk ratings, mitigation measures and residual risk ratings, refer to Newell (2016).

Outside of this overall risk assessment process, Seasonal Watering Proposals provide risk assessment and mitigation plan for individual watering events.

11.1 Ecological Threats

Environmental watering and the use of structures are designed to optimise ecological outcomes; however, ecological threats may arise from ecological responses to changed water regimes (Table 11.1).

There are threats associated with changes in distribution of flood water, the timing of flooding and the use of structures to manage water. These potentially undermine ecological objectives where there is a mismatch between ecological water requirements and the water regimes that are provided. Most risks can be managed by careful planning of watering events and refining watering plans in response to monitoring data, and retain a Moderate to Very Low risk rating after mitigation actions are applied.

However, even after mitigation some ecological risks retain a Moderate to High rating. There is potential for the works to promote invasive pest plants and fish, barriers to fish movement, poor water quality and mismatched inundation regimes to species requirements. These risks can be minimised by avoiding the hydraulic conditions that promote them and refining water management through monitoring and research. The residual risk will remain, but this should be regarded in proportion to the ecological benefits that environmental watering provides as well as the capacity for management during/after the watering event.

Table 11.1 – Summary of ecological risks and ratings, before and after application of mitigation strategies

Threat	Risk without mitigation	Residual risk
Change in fire frequency, extent and intensity	Very low to Low	Very low to Low
Germination of river red gum in watercourses	Moderate to High	Low to Moderate
Reduction in hydrodynamic diversity	Moderate	Low
Managed inundation regimes do not match flow requirements of key species	High	Moderate
Mis-matching fish/waterbird breeding cues/recruitment and general ecological requirements	Moderate to High	Very Low

Mis-match between vegetation water requirements and structure operation (inappropriate duration of watering)	Low to Moderate	Low
Stranding/isolation of native fish on floodplain	High	Moderate
Barriers to fish (and aquatic fauna) movement	Very High	Moderate
Enhancing carp recruitment conditions	Very High	Moderate
Enhancing other pest fish (e.g. gambusia) recruitment conditions	Very High	Moderate
Changed flow regime favouring high risk invasive plant species	High to very high	Moderate to high
Poor water quality	Moderate to High	Very Low to Low
Algal blooms (blue-green algae)	High to very high	Moderate
Blackwater events result from waterings	Moderate	Low
Inability to discharge poor quality water (in-channel and floodplain)	Moderate	Low
Inaccurate water quantity or regime delivered	Moderate	Moderate
Increase in native and non-native pest mammals (pigs, rabbits, kangaroos)	Very High	Moderate
Failure of works (erosion)	High	Moderate
Bees as an ecological threat as sites become more productive for bees - larger impact across a larger area	High	High
Mortality of entrained fish in pumps	High	High
Pump maintenance operations that need to occur every year may affect the ecological conditions (during the testing phase this was high, now less with normal maintenance, but ongoing)	Moderate	Low
Sedimentation within the creeks and lakes due to pumping in the sediment loads	Low	Low
Operation of undershot weirs	Moderate	Low

11.2 Cultural Heritage Threats

Threats to cultural values are associated with the physical disturbance of culturally significant sites and with the relationship between Aboriginal stakeholders and water managers (Table 11.2).

Water management can flood and expose culturally significant sites such as middens, scar trees and burial sites. This may disrupt access or contribute to erosion at the site. Deliberate watering or exposure of significant sites may be disrespectful if not planned and implemented with Aboriginal stakeholders.

A cooperative ongoing relationship between the Icon Site Manager and Aboriginal stakeholders is essential to manage cultural heritage risks. It is important that stakeholder interests are addressed in planning watering events and that Aboriginal stakeholders are able to contribute to planning and implementation.

At Hattah, this is achieved through the Cultural Heritage Management Plan and ongoing consultation and liaison.

Following the implementation of consultation, careful planning of watering events and other mitigation measures, cultural heritage risks have been assessed as Low.

Table 11.2 – Summary of cultural risks and ratings, before and after application of mitigation strategies

Threat	Risk without mitigation	Residual risk
Loss of cultural values via erosion	Very high	Low
Loss of cultural values via inundation	High	Low
Damage to relationships with indigenous stakeholders	High	Low
Exposing burial sites	High	Low
Changes in ecological response affects indigenous understanding and use	High	Low
Lack of consultation with indigenous representatives	High	Low

11.3 Socio-economic Threats

The River Murray and floodplain in the Hattah area is an important resource for a range of commercial and community activities, including irrigation, domestic water supply, bee keeping and recreation. Environmental water management has the potential to impact on these through changes to water quality, the distribution, timing or availability of water and access to the floodplain (Table 11.3).

In general, residual risks from socio-economic threats have been evaluated as Moderate to Low. The threats are either not considered to have significant impacts, or there are effective mitigation measures in place to manage them. These include informing the community and business operators well in advance of changes to water management associated with watering events.

Table 11.3 – Summary of socio-economic risks and ratings, before and after application of mitigation strategies

Threat	Risk without mitigation	Residual risk
Watering of public land or recreational activites	Very High	Moderate
Disturbance of bee-keeping operations Also other commercial operations (kayaking, camping tours etc.)	Very High	Low

11.4 Salinity

A semi-quantitative salinity impact assessment was prepared by SKM (2009) using a surface water assessment, Flow Net, Dupuit Steady State Solution, Groundwater Mound Rise and Mass Balance. The assessment concluded that the magnitude of the salinity impacts of the proposed watering scenarios was low to insignificant. However the study noted that there was uncertainty in the assessment. As a means of assessing the uncertainties, SKM (2009) recommended the implementation of a groundwater monitoring program in conjunction with the construction and operations of the works.

The Mallee CMA monitors an existing bore network within the park and undertakes a long-term salinity monitoring program to assess the impacts of environmental watering on groundwater levels and groundwater quality. Monitoring and ongoing assessment of risks will occur consistent with the Basin Salinity Management Strategy. In addition to the regular groundwater monitoring, Mallee CMA will manage the monitoring of surface water quality within the lakes, 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.

11.5 Risks Associated with Structures

Goulburn-Murray Water 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. The risks associated with the structures are described in the GMW Operation and Maintenance Manual.

12. Operational Costs

It is acknowledged that operational costs will vary from year to year and from operation to operation.

Costs associated with pumping activities include fixed and variable costs, including electricity to run the pump station. As such, individual cost estimates have not been calculated here.

Operation and maintenance costs will be incorporated into the GMW operations budget, which will be part of the O&M costs funded from the MDBA River Management Division.

13. COMMUNICATIONS

The Hattah Lakes Icon Site has a communications and consultation plan specific to the site (Mallee CMA 2010). Information provided to the media regarding watering actions must be carried out in accordance with The Living Murray Communication Protocol.

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

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

Indigenous consultation is managed via the Mallee CMA TLM 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 Icon Site Manager. The representatives also distribute information about Icon Site management into the Aboriginal communities.

13.2 Communication during managed events.

Mallee CMA leads communication activities for upcoming and ongoing TLM watering events and coordinates these via the Hattah Operations Group. The Mallee CMA prepares a Communications Plan each year that covers environmental watering events for the entire Mallee CMA region, including Hattah.

The plan is a high level framework for communication and engagement activities, relating to that years' environmental watering. It addresses all wetlands listed in the Mallee CMA Seasonal Watering Proposals, including the Seasonal Watering Proposal for the Mallee Living Murray Icon Sites.

The plan does not cover government agencies as a stakeholder as this engagement occurs at an operational level, predominantly via the Hattah Operations Group for the Hattah Lakes site.

Parks Victoria will be responsible for communicating with its stakeholders and visitors regarding any impacts on visitor experience such as road closures, access restrictions to areas of the park and water quality issues.

During routine river operations or in the event of a broad, basin scale event such as blackwater, the MDBA and CMAs will work together to communicate with local agencies.

13.3 Complaints and Enquiries

Complaints and enquiries relating to the environmental watering process shall be directed to MCMA.

Parks Victoria will be responsible for dealing with complaints and enquiries regarding visitor access to the park and water quality concerns within the park.

14. Water Management Operations Record

A record of water management operations is maintained as part of this Operations Plan in Appendix C.

The purpose of the record is to document how well the infrastructure and management arrangements at Hattah Lakes meet environmental watering needs and manage risk. The record documents watering plans, actions and outcomes. An entry is made at the conclusion of each watering event and includes analysis of the strengths and weaknesses of operating arrangements.

The record is used to revise and refine the Hattah Lakes Operations Plan as well as to inform annual watering actions, to ensure that water delivery is as efficient and effective as possible and that risks are managed appropriately.

The Water Management Operations Record comprises the following information:

- Event Water Year
- Watering Objective – This identifies the primary objective(s) of the watering event. Detailed rationales are provided in the Annual Watering Proposal.
- Operational Targets – The key thresholds that were set for operations, such as wetland water levels, watercourse discharge or structure settings (fish screens) and the dates on which they were to be achieved. This can be presented as a target hydrograph or a table. Operational targets will be required for each watercourse and wetland.
- External Factors – External factors that influenced operations are presented. These could include river flows, rain events, risk management or structure malfunction. Their influence on operations is described.
- Operational Outcomes – The actual water levels / flow rates / structure settings achieved and dates. This can be presented as an annotated hydrograph or table. Operational outcomes will be required for each watercourse and wetland.
- Performance – How well were the watering objectives met?
- Risk Management – How well were known risks monitored? How well were they managed?
- Considerations for future operations

15. References

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APPENDIX A

ENVIRONMENTAL WATERING ORDER

Location : Hattah Lakes

Order Reference No. : **Version :** **Date :**

Order From : **Order To :**

General Description/Objective of Watering Event :							
Details	**Structures**						
	Messengers Regulator	**Cantala Regulator**	**Oaties Regulator**	**Kramen Regulator**	**Little Hattah Regulator**	**Pumps To Chalka Creek**	**Pump To Lake Kramen**
Gate configuration :	2 dual leaf vertical gates	1 dual leaf vertical gate	2 dual leaf vertical gates	Aluminium Drop Board Structure	Aluminium Drop Board Structure	N/A	N/A
Max Design Flow/day	750 ML/day	N/A	750 ML/day	N/A	N/A	170 ML/day	1,000ML/day
Flow measurement :	Yes (Acoustic Doppler)	N/A	Yes (Acoustic Doppler)	N/A	No	Yes (Flow Meter)	Yes (Flow Meter)
Current status (ie open or shut)							
Start Date (Note 1							
Status of structure during event (ie open or shut)							
Direction of flow (Note 7)							
Required flow rate/day (Note2)(Note 3)							
Level control requirements (Note 4)							
Total volume of water to be delivered (Note 5)							

Event Duration (Note 6):							
Special requirements (Yes/No) - See Page 3							

Note 1 : A minimum of ## calendar days notice is required for all orders or revised orders. Where access to the site by boat is required then ## days notice is required

Note 2 : Separate/specific flow requirements to be provided for rock chutes.

Note 3 : Confirm whether the flow rate is a maximum, minimum, exact or nominal figure.

Note 4 : Confirm any maximum/minimum tailwater level requirements (AHD)

Note 5 : Confirm whether the total volume of water to be delivered is a maximum, minimum, exact or nominal figure.

Note 6 : Confirm whether the event duration is a maximum, minimum, exact or nominal figure. Adopt calendar days.

Note 7 : If it is intended to change the direction of flow through the structure then this must be clearly described with details of the triggers that initiate the change.

Other Environmental Requirements/Constraints :

Eg Nominate/describe any build up or ramping down of flows

Eg Restrict use of undershot gates where likely to kill fish – ie nominate minimum tailwater depth

Document Control Box :

Order No.	Version	Distribution Date

Distribution List :

MCMA (Responsible Officer : #########), Email Address ###############, Phone No. ###############, Fax No. #################

MDBA (Responsible Officer : #########), Email Address ###############, Phone No. ###############, Fax No. #################

GMW (Responsible Officer : #########), Email Address ###############, Phone No. ###############, Fax No. #################

Parks Vic (Responsible Officer : ########), Email Address ###############, Phone No. ###############, Fax No. #################

DSE (Responsible Officer : #########), Email Address ###############, Phone No. ###############, Fax No. #################

APPENDIX B

Risk assessment tables

Category	**Threat**	**Processes**	**Values affected**	**Likelihood** without mitigation	**Consequence** without mitigation	**Risk** without mitigation	**Mitigation Options** (these may include actions done or underway)	**Likelihood** with mitigation	**Consequence** with mitigation	**Residual Risk**
Ecological threats (from proposed project)	Removal of habitat for recently established threatened species which resulted/adapted from historic regulation practices	Shift from terrestrial back to wetland system? (info gaps as to what species might be involved).	Information gap	Information gap	Information gap	Information gap	Information gap	Information gap	Information gap	Information gap
	Change in fire frequency, extent, and intensity	Change in understorey vegetation esp. in woodlands, due to watering regime. Fire impacts on ecosystem. Social and economic fire impacts. Impacts on structures. Also campers affected by fire risk posed by improved conditions.	○ All ecological values ○ Social and economic values ○ Cultural & Heritage values	2: Unlikely (general) 1: Remote (campers being killed)	1: Minor (general) 4: Catastrophic (campers killed)	2: Very Low (general) 4: Low (campers being killed)	Maintenance regime for fuel risk around structures. Site operations plan to manage fuel loads. Monitoring of fuel load. Insurance.	2: Unlikely (general) 1: Remote (campers being killed)	1: Minor (general) 4: Catastrophic (campers killed)	2: Very low (general) 4: Low (campers killed)
	Germination of river red gum in watercourses	The operation of the new regulator(s) may result in germination of river red gum thickets across watercourses at the edge of the regulator weir pool, or in wetland areas, which may block flow through the system. Obstruction of flow paths. Impact on visual amenity.	○ All ecological values ○ Socio-Economic values	5: Certain	1: Minor (ecological) 2: Moderate (socio economic)	5: Moderate (ecological) 10: High (socio-economic)	Operations to vary water levels each season, each year. Hydraulic model to determine where strand lines will be and how extensive issue might occur. Timing and duration (avoid seed drop time). Last resort remove them. PV management as weeds, under park management plan, particularly around structures.	3: Possible	1: Minor (ecological) 2: Moderate (socio economic)	3: Low (ecological) 6: Moderate (socio-economic)

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
	Managed inundation regimes do not match flow requirements of key species	Inappropriate water regime due to: - Inadequate knowledge of requirements - Inability to operate structures to meet competing requirements	○ All ecological values	4: Likely	3: Severe	12: High	Operations plan (including variability, scenario planning). Respond to meteorological cues. Adaptive management. Increase knowledge base (including monitoring).	2: Unlikely	3: Severe	6: Moderate
	Mis-matching fish/waterbird breeding cues/recruitment and general ecological requirements	Inappropriate water regime created by operating the structure out of sync with the fish/waterbirds breeding cues or recruitment requirements	○ Fish & aquatic fauna communities ○ Waterbird communities	4: Likely	2: Moderate (for one year) 3: Severe (for more than one year)	8: Moderate (for one year) 12: High (for more than one year)	Develop a detailed operations plan - establish regional and temporal context. Monitoring program. Manage stakeholder expectations (including competing stakeholders) Might target veg in one year but be unseasonal for fish. NB Waterholders require objectives to be set beforehand and will review/approve them.	2: Unlikely	1: Minor	2: Very low
	Mis-match between vegetation water requirements and structure operation (inappropriate duration of watering)	Backing water up in the system has a potential mis-match between vegetation water requirements and the water regime. Vegetation in this area may get excessive watering in order to meet water requirements elsewhere in the system.	○ Health of Wetland Communities ○ River red gum Forest ○ River red gum Woodland ○ Floodplain habitat	4: Likely	1: Minor (for one year) 2: Moderate (for more than one year)	4: Low (for one year) 8: Moderate (for more than one year)	Develop a detailed operations plan. Monitoring program. Discuss these issues at the existing CMA Operations Group meetings. Share information on operations, potential impacts and tolerance of watering regimes and the role of natural floods in ecosystem function between water and environment managers.	2: Unlikely	2: Moderate	4: Low
	Stranding/isolation of native fish on floodplain	Sudden changes in water levels and/or new barriers prevent	○ Fish & aquatic	5: Certain	2: Moderate	10: High	Operate structures to allow fish to move	3: Possible	2: Moderate (with mitigation	6: Moderate

Category	**Threat**	**Processes**	**Values affected**	**Likelihood** without mitigation	**Consequence** without mitigation	**Risk** without mitigation	**Mitigation Options** (these may include actions done or underway)	**Likelihood** with mitigation	**Consequence** with mitigation	**Residual Risk**
		native fish from escaping drying areas.	fauna communities ○ Socio-economic				(provide cues, maintain passage). Fish Exit Strategy. Communicate natural aspects of stranding fish on floodplain. Note impact of high density of stranded carp on wetland vegetation. Need to monitor fish movement and adapt operations as required.		options and accepting some fish will be stranded and eaten by predators)	
	Barriers to fish (and other aquatic fauna) movement	Structures not designed or operated to allow movement for feeding, migration, spawning opportunities.	○ Fish & aquatic fauna communities ○ Socio-economic	5: Certain	3: Severe	15: Very high	Determine fish passage requirements / objectives and design passage as required. Is passage required at all places and all times? Manage expectations when fish passage is not possible. Fish Exit Strategy	3: Possible	2: Moderate	6: Moderate
	Enhancing carp recruitment conditions	Water regime benefits carp recruitment and growth.	○ Health and diversity of Wetland Communities ○ Fish & aquatic fauna communities ○ Socio-economic	5: Certain	3: Severe	15: Very high	Promote native fish to balance impacts of increased carp. Drying sequence should aim to maximise impacts to carp and minimise impacts on native (if this is possible). Research required. PV Management Plan.	3: Possible	2: Moderate	6: Moderate
	Enhancing other pest fish (e.g. gambusia) recruitment conditions	○ Compete with natives ○ Shift macroinvertebrate populations ○ Algal problems	○ As above	5: Certain	3: Severe	15: Very high	As above. Drying sequence, Mode of filling, and operations.	3: Possible	2: Moderate	6: Moderate
	Changed flow regime favouring high risk invasive plant species	Pest plants may be promoted under certain water regimes.	○ Health of Wetland Communities ○ Lignum Shrublands	5: Certain	2 to 3: Moderate to Severe Knowledge gap	10: High to 15: Very high - but field evidence	Time water manipulations to drown seedlings, minimise growth and	3: Possible	2 to 3: Moderate to Severe Knowledge gap	6: Moderate 9: High

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
		Weediness occurs: non-native species (e.g. Noogoora Burr) invade and spread, native species (e.g. *Phagmites*, *Typha*) become a threat due to over-abundance.	○ River red gum Forest ○ River red gum Woodland ○ Black Box Woodland ○ Floodplain habitat		regarding severity of impact from potential problem species.	doesn't appear to show widespread weed problems)	germination, seed set etc. Promote diversity of native species. Supporting land manager programs. Problem species and severity not fully known - monitor and manage adaptively.		regarding severity of impact from potential problem species.	
	Poor Water Quality	Suspension of sediments or organic matter causing elevated nutrients, high turbidity and/or low DO levels (in lakes) Return flows may trigger blooms in River, or result in decline of water quality causing problems downstream or other wetlands.	○ Health of Wetland Communities ○ Threatened species ○ Fish & aquatic fauna communities ○ Waterbird communities ○ Socio-economic	3: Possible (in lake) 3: Possible (return water)	2: Moderate (in-lake) 3: Severe (return water)	6: Moderate (in-lake) 9: High (return water for the Murray)	WQ monitoring. Plan watering with regard to quality of incoming water including Darling water. Monitor antecedent floodplain conditions (organic matter loads) and seasonal conditions (e.g. blackwater, algae). Use of dilution flows. Managing community expectations	2: Unlikely (in lake) 2: Unlikely (return water)	1: Minor (in lake) 2: Moderate (return water)	2: Very low 4: Low
	Algal blooms (BGA)	Still water in warm conditions "Seeding" from one lake to another	○ Health of Wetland Communities ○ Threatened species ○ Fish & aquatic fauna communities ○ Waterbird communities ○ Socio-economic	4: Likely	4: Catastrophic (if released to River or another wetland) 3: Severe (within one lake/wetland)	16: Very high (released) 12: High (contained)	Develop release strategy. Monitoring Ensure TLM objectives of encouraging native vegetation. Establish robust operating strategy – Avoid pumping at inappropriate times. Don't release under a BGA bloom.	2: Unlikely (released) 2: Unlikely (contained)	4: Catastrophic (released) 3: Severe (contained)	8: Moderate 6: Moderate
	Blackwater events result from waterings	Blackwater events impacting onsite and downstream receiving waterbodies from the uptake of large masses of organic matter causing Low DO, high tannins, etc. resulting in mass deaths of aquatic organisms	○ Health of Wetland Communities ○ Threatened species ○ Fish & aquatic fauna communities	3 Possible	2: Moderate (noting the recent experience and data from ARI Surveys at Mullaroo River where the consequence of Low DO is	6: Moderate	Robust operations plan. Plan watering with regard to quality of incoming water. Monitor antecedent floodplain conditions (organic matter loads).	2: Unlikely	2: Moderate	4: Low

Category	**Threat**	**Processes**	**Values affected**	**Likelihood** without mitigation	**Consequence** without mitigation	**Risk** without mitigation	**Mitigation Options** (these may include actions done or underway)	**Likelihood** with mitigation	**Consequence** with mitigation	**Residual Risk**
			○ Waterbird communities (species specific) ○ Fish & aquatic fauna communities ○ Socio-economic		lower than previously thought) If releasing to the Murray – especially in low flows (4)		Take account seasonal conditions (e.g. blackwater, algae). Have rules in place to manage risks. Manage through-flow to help manage risk. Monitor risk factors (DO, temp) and manage watering event to minimise risk. Disposing of blackwater – can manage outflow rates to wait for dilution flow. (releasing can oxygenate the water). Flood frequency – prevent high organic load build. Manage community expectations.			
	Inability to discharge poor quality water (in-channel and floodplain)	Resultant inappropriate watering regime (if we can't release and have to hold water levels high for too long).	○ All ecological values ○ Socio-Economic values	2: Unlikely	4: Catastrophic	8: Moderate	Dilution flows. Good relationships. Local disposal (e.g. from Oatey's to Chalka creek).	2: Unlikely	2: Moderate	4: Low
	Inaccurate water quantity or regime delivered	Design issues. Modelling assumptions. Pipe invert levels incorrectly located Capacity of structures incorrect. Inadequate provision for monitoring and measurements of flows. Inadequate capacity to regulate flows. Inadequate event planning. Lakes filled by natural flooding followed by waterings.	○ All values	2: Unlikely	3: Severe	6: Moderate	Model water usage – calibrate and/or confirm models / expectations / operations plan. Planning and co-ordination – Document and approval of measurement strategy for inflows and outflows (Operations Plan). Water metering and monitoring. Need to have adequate water measurement and	1: Remote	3: Severe	6: Moderate

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
							reporting to meet accounting requirements. VEWH has developed a state-wide approach to accounting at sites. Gauge boards installed. Provision for future upgrades or refinements to structures.			
	Increase in native and non-native pest mammals (roos, rabbits, pig)	Watering creating habitat and feed for grazing animals.	○ Vegetation values – particularly riparian zones	5: Certain	3: Severe	15: Very high	Monitor and "control". Implement existing management strategy. Support partner agencies to seek complementary funding.	3: Possible	2: Moderate	6: Moderate
	Failure of works (erosion)	Structures vulnerable to flood flows (inadequate elevation, protection from scour, rock armour, flood preparation, strip boards and handrails) resulting in structural failure from erosion around works.	○ All ecological values ○ Socio-Economic values	3 Possible	3: Severe	9: High	Provide adequate protection from erosion. Peer review of design (repairs). Supervision during operation. Ongoing inspection and maintenance. Flood prep written into O&M plan – remove parts likely to be barriers to flow or large debris. Adequate funding.	2: Unlikely	3: Severe	6: Moderate
	Bees as an ecological threat as sites become more productive for bees larger impact across a larger area	• Bees taking over tree hollows, impacting native birds and mammals • Consuming resources from flowers • Affecting seed-set via inefficient transfer of pollen • Deplete native pollinators	○ Native plants ○ Native birds ○ Native mammals	4: Likely	3: Severe	12: High	Manage bee-keeping in important hollow sites. Controlling feral bees as a pest – active management of feral bee hives. (Note – there has been a 200% increase in applications for bee-keeping sites).	3: Possible	3: Severe	9: High

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
	Mortality of entrained fish in pumps	Excludes large bodied individuals – not breeding size fish, breeding delayed Pressure impacts Difficult to quantify the impacts Removing fish from the channel (unknown level of impact)	○ Fish communities	5: Certain	2: Moderate	10: High	Pump intake position. Pumping strategy (day/night). Mesh on intakes. Monitoring/research to inform strategy.	3: Possible	2: Moderate	6: Moderate
	Pump maintenance operations that need to occur every year may affect the ecological conditions (during the testing phase this was high, now less with normal maintenance, but ongoing)	Inappropriate watering – excess water for a section of Chalka Creek. Potential to strand fish under higher flows. Growing of weeds and RRG in base of the creek. Seed bank depletion.	○ All ecological values	5: Certain	1: Minor (limited for the whole site and Local impacts)	5: Moderate	Be aware of the issue in operations plan. (Bigger risk to the system if you don't do this maintenance).	4: Likely	1: Minor	4: Low
	Sedimentation within the creeks and lakes due to pumping in the sediment loads	Pumping of large volumes due of water with high sediment loads and no outflow may lead to increased sedimentation.	○ All ecological values	2: Unlikely	2: Moderate	4: Low	Knowledge gap – monitor sedimentation, look at paleo work.	2: Unlikely	2: Moderate	4: Low
	Operation of undershot weirs	Fish larvae get damaged, but larger individuals do better with undershot weirs.	○ Fish	5: Certain	1: Minor	5: Moderate	Appropriate planning. Operations of weirs. Detailed operations plan.	4: Likely	1: Minor	4: Low
Cultural Heritage threats *Note: Filled out in consultation with Ken Stewart, Indigenous Facilitator, Mallee CMA*	Loss of cultural values via erosion	Erosion as part of watering events.	○ Cultural Heritage values	5: Certain	4: Major	20: Very High	Cultural Heritage Management Plan. O&M. Ongoing stakeholder liaison. Monitoring, evaluating and assessing those areas affected. Implement protective measures where appropriate.	2: Minor	2: Minor	4:Low
	Loss of cultural values via Inundation	Inundation as part of watering events.	○ Cultural Heritage values	3: Possible	4: Major	12: High	Cultural Heritage Management Plan. O&M. Ongoing stakeholder liaison.	2: Minor	2: Minor	4:Low

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
							Monitoring, evaluating and assessing those areas affected. Implement protective measures where appropriate.			
	Damage to relationships with indigenous stakeholders	Impacts on cultural sites affecting relationships and ability for future operation of works.	○ All values	3: Possible	4: Major	12: High	Cultural Heritage Management Plan. O&M. Ongoing stakeholder liaison. Monitoring, evaluating and assessing those areas affected. Implement protective measures where appropriate	2: Minor	2: Minor	4:Low
	Exposing burial sites	Impacts on cultural sites affecting relationships and ability for future operation of works.	○ Cultural Heritage values	3: Possible	4: Major	12: High	Cultural Heritage Management Plan. O&M. Ongoing stakeholder liaison. Monitoring, evaluating and assessing those areas affected. Implement protective measures where appropriate.	2: Minor	2: Minor	4:Low
	Changes in ecological response affects indigenous understanding and use	Loss of cultural practice and connection to country.	○ Cultural Heritage values	3: Possible	4: Major	12: High	Cultural Heritage Management Plan. O&M. Ongoing stakeholder liaison. Monitoring, evaluating and assessing those areas affected. Implement protective measures where appropriate.	2: Minor	2: Minor	4:Low
	Lack of consultation with indigenous representatives	Impacts on cultural sites affecting relationships and ability for future operation of works.	○ All values	3: Possible	4: Major	12: High	Cultural Heritage Management Plan. O&M. Ongoing stakeholder liaison.	2: Minor	2: Minor	4:Low

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
							Monitoring, evaluating and assessing those areas affected. Implement protective measures where appropriate.			
Socio-Economic Threats	Watering of public land or recreational activities	Inundation as part of watering events.	○ Socio-Economic values	5: Certain	3: Severe	15: Very high	Agency consultation. Notification before events. Public notification.	4: Likely	2: Moderate	8: Moderate
	Disturbance of Bee-keeping operations Also other commercial operations (kayaking, camping tours etc.)	Pollination potential of flooded vegetation – bees can't rest or more bees located in floodplains. Watering of bee sites. Prevent access to move bee hives. Restricted access for commercial recreational uses.	○ Socio-Economic values	5: Certain	3: Severe	15: Very high	Engage bee permit holders. Notify apiarists and DELWP prior to events.	3 Possible	1: Minor	3: Low
Operational Threats	Water availability/access	Insufficient water holdings to achieve outcomes. Access to available water is limited by operations or competing demands.	○ All ecological values	3: Possible	2: Moderate	6: Moderate	Coordination and planning processes of VEWH and other water holders.	2: Unlikely	2: Moderate	4: Low
	Community/stakeholder/political resistance/backlash or poor perception	Poor or absent communications or engagement regarding operational activities or unexpected operations leading to losing the ability to operate site as required or to meet ecological objectives.	○ All ecological values ○ Punctual operations ○ Planned operational budget	2: Unlikely	2: Moderate	4: Low	Communication plan Ongoing stakeholder liaison - early and often. Manage public expectations.	1: Remote	2: Moderate	2: Very low
	Vandalism of structures	Human behaviour	○ All ecological values ○ Punctual operations ○ Planned operational budget	4: Likely	3: Severe	12: High	Design to minimise vandalism Inspection and maintenance Security	3 Possible	1: Minor	3: Low

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
	Negative perceptions of watering of private land or commercial activities (2 small landholders and 1 commercial activity [canoe tours] potentially affected)	Inundation as part of watering events and access cuts lead to negative perceptions and threats to or operations.	○ Socio-Economic values ○ All ecological values	4: Likely	3: Severe	12: High	Landowner consultation. Establish landowner agreements. Notification before events occur so arrangements can be made. Supervised or alternative access provided.	3: Possible	2: Moderate	6: Moderate
	Increase in mosquito populations	Human disease issues lead to negative perceptions and threats to operations.	○ Socio-Economic values ○ All ecological values	3: Possible	2: Moderate	6: Moderate	Promote complex food web – avoid creating stranded pools of water. Public engagement / notification (people take more pre-cautions which reduce consequence). Tell council public health officers.	3 Possible	1: Minor	3: Low
	Inundation of roads and bridges / restricted access	Inundation as part of watering events restricts access to project structures, impacting operations.	○ Socio-Economic values ○ All ecological values	3: Possible	2: Moderate	6: Moderate	Improved planning and modelling. Engage with asset owners and users. Upgrade structures / roads. O&M Manual should have preparations for floods, and default conditions when not in operation. Boat access is a mitigation measure.	2: Unlikely	1: Minor	2: Very Low
	Public safety	OH&S breaches.	○ Health of Wetland Communities ○ Safety	2: Unlikely	4: Catastrophic	8: Moderate	Appropriate design Maintenance program. O&M manuals. Safe access provisions. Public safety provisions. Appropriate PPE and equipment to operate.	1: Remote	4: Catastrophic	4: Low

Category	**Threat**	**Processes**	**Values affected**	**Likelihood** without mitigation	**Consequence** without mitigation	**Risk** without mitigation	**Mitigation Options** (these may include actions done or underway)	**Likelihood** with mitigation	**Consequence** with mitigation	**Residual Risk**
	Lack of access to the Park and River– for recreation or management activities	Inundation as part of watering events restricts access to structures.	○ All values	4: Likely	3: Severe	12: High	Ongoing engagement with community Public consultation and notification. Signage. Provide information on alternative routes.	3: Possible	2: Moderate	6: Moderate
	Inability to operate structures/scheme due to river operation rules in Murray (water act 2007, MDB Agreement) or due to operational clashes with other site management actions (up or downstream).	Unable to access water quantity or provide water regime required. Lack of access to structures during high flow periods. Unsafe conditions prevent access during high flows.	○ All values	2: Unlikely	3: Severe	6: Moderate	Work with MDBA / River Operations to ensure coordination of environmental watering with maintenance, water transfers etc. Understand river procedures. Understand planned maintenance / capital works. (should be in Seasonal Watering Plan). Icon Site EWMP should cover this issue and how to manage it. Appropriate design - Access roads - Safe access provisions	1: Remote	1: Minor	1: Very Low
	Poor reliability of structures	Logs, debris causing blockages or poor maintenance or poor operation.	○ Health of Wetland Communities ○ Socio-Economic values	3: Possible	2: Moderate	6: Moderate	Maintenance program. Design & review. Monitoring. O&M manuals.	2: Unlikely	2: Moderate	4: Low
	Operation of built infrastructure	OH&S breaches.	○ Health of Wetland Communities ○ Safety	2: Unlikely	4: Catastrophic	8: Moderate	Appropriate design. Maintenance program. O&M manuals. Safe access provisions. Public safety provisions. Appropriate PPE and equipment to operate.	1: Remote	4: Catastrophic	4: Low

Category	**Threat**	**Processes**	**Values affected**	**Likelihood** without mitigation	**Consequence** without mitigation	**Risk** without mitigation	**Mitigation Options** (these may include actions done or underway)	**Likelihood** with mitigation	**Consequence** with mitigation	**Residual Risk**
	Lack of clear understanding of roles and responsibilities of ownership and operation (Mallee CMA vs. VEWH vs CEWH vs SA Water)	Prevent the effective operation of the works	○ Health of Wetland Communities ○ Socio-Economic values	3: Possible	2: Moderate	6: Moderate	Need MOU with operator Emergency response arrangements. O&M manuals and handover of appropriate documentation prior to commissioning. Ongoing maintenance of structures, insurance arrangements etc. Clear lines of communication during operation and reporting of water accounts/flows etc. (i.e. reporting and accounting arrangements).	2: Unlikely	2: Moderate	4: Low
	Lack of funding for operation of the works/scheme	Future budget constraints limit or stop operation of works/scheme.	○ All values	1: Remote	4: Catastrophic	4: Low	Structures are designed to be abandoned without impacting on floodplain hydraulics or ecology.	1: Remote	3: Severe	3: Low
	Mitigation requirements make site unwieldy to operate	Too many requirements for operations make works/scheme impossible to operate.	○ All values	1: Remote (based on CMA/WA feedback)	3: Severe	3: Low	Need to decide what threats to mitigate – what's acceptable.	1: Remote	2: Moderate	2: Very low
	Land tenure / land management changes affecting ability to manage the sites into the future	CMA loses management control of works/scheme and unable to ensure ecological objectives planned	○ All values	1: Remote (based on CMA/WA feedback)	3: Severe	3: Low	Engage with asset owners and users. O&M manuals in place. Handover vegetation management and operations plans. Ongoing liaison.	1: Remote	2: Moderate	2: Very low
	Maintenance of system knowledge of operation	Loss of corporate knowledge/history.	○ All values	1: Remote (already working to ensure this won't happen)	3: Severe	3: Low	Operations plan. O&M Manuals documenting knowledge and lessons learned. Adaptive management in place.	1: Remote	3: Severe	3: Low

Category	Threat	Processes	Values affected	Likelihood without mitigation	Consequence without mitigation	Risk without mitigation	Mitigation Options (these may include actions done or underway)	Likelihood with mitigation	Consequence with mitigation	Residual Risk
							Confirmed communications and engagement strategies in place.			
	Water accounting – accuracy, timeliness, accountability	Losing track of volumes delivered where and when.	○ All values	4: Likely	2: Moderate (not likely to be major error)	8: Moderate	Good recording, and communications of, information on volumes between water and environment managers.	2: Unlikely	2: Moderate	4: Low
	Power supply	Maintenance, lightning strikes.	○ All values	3 Possible (Maintenance) 1: Remote (Lightning strike)	3: Severe	9: High (maintenance) 3: Low (lightning strike)	Contingency plans in place.	2: Unlikely	2: Moderate	4: Low

APPENDIX C

Record of Water Management Operations (Event Record)

Event Water Year	2016/17
Site	Mullaroo Creek
Overall Objective	Seasonal Pulse
For Specific Objectives see	LMW 2016/17 Seasonal Watering Proposal
Water Management Summary	Seasonal Pulse Scenario to promote recruitment of Murray Cod spawn
Starting Condition	400 ML/d
Contintengencies	If creek levels to exceed wetland level, open regulator and keep carp screen in place If creek levels to exceed spillway level, open all gates and remove carp screen If waterbirds breed, pump additional water to support breeding If additional water available, may pump on two more occasions in spring-summer
Operational Targets	Increase discharge to 700 ML/d from Aug 1 to Aug 15 Maintain 700 ML/d for at least six weeks continuously between August and October Reduce discharge to 550 ML/d from Oct 1 to Oct 15 Reduce discharge to 400 ML/d from Dec 1 to Dec 6
Hydrological Targets	Inundate vegetated benches in fast-flowing reach for at least 6 weeks between Aug 1 and Sep 30 Maintain elevated velocities through remainder of spring
Operational Record	Lock 7 maintained at normal operating level of 22.1 m AHD Mullaroo Regulator starting discharge Aug 1 430 ML/d Mullaroo Regulator gradually opened to reach discharge 700 ML/d between Aug 1 and Aug 15 Mullaroo Regulator gradually closed to reach discharge 540 ML/d from Sep 28 to Oct 9 Mullaroo Regulator gradually closed to reach discharge 400 ML/d from Nov 25 to Dec 1
Discharge	Graph or table of daily Mullaroo Creek discharge Jul 1 to Dec 31
River Levels	Graph of discharge Lock 8 DS Jul 1 to Dec 31
Weir Levels	Graph of Lock 7 Weir Pool Jul 1 to Dec 31
Evaluation of Operations	Operational targets were met Hydrological targets were not met. Bench inundation was less extensive than expected and benefit to fish recruitment was likely to be lower than planned. Recommend at least 850 ML/d in future Seasonal Pulse. Also recommend refining Mullaroo Creek hydraulic model. River discharge did not exceed 15,000 ML/d through event and had minimal effect on operations and creek discharge