Summary of environmental risks derived from the Supply Measure Business Case: Hattah Lakes North Floodplain Management Project (Mallee CMA, 2014) as adapted from Lloyd Environmental (2014)

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

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Low dissolved oxygen (DO) levels	Low dissolved oxygen (DO) concentrations can occur through a variety of processes, including blackwater events, algal and cyanobacterial blooms, high organic matter loadings and stratification. Low DO can cause the death of aquatic fauna and have negative impacts on the health of wetland communities in general. More frequent inundation (i.e. through managed watering events) will reduce the accumulation of organic matter on the floodplain between inundation events.	Likely	Severe	High	Planning phase: • monitor antecedent floodplain conditions (i.e. organic matter loads) to assess risk of a hypoxic event occurring. • consider seasonal conditions (e.g. temperature, algae) prior to watering. Operations phase: • commence watering as early as possible to move organic matter off the floodplain while temperatures are low • maintain through-flow where possible in other areas to maximise exchange rates and movement of organic material • monitor DO and water temperature to identify hypoxic areas to inform consequence management (see below). Managing consequences: • ensure dilution of low DO water by managing outflow rates and river flows delay outflows if river flows are too low • dispose of hypoxic water by pumping to higher wetlands where possible. • agitate water using infrastructure to increase aeration.	Moderate

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Development of saline mounds under wetlands and displacement of saline groundwater	An increase in groundwater levels may occur in response to project inundation events. Shallow saline groundwater can impact on the health of floodplain vegetation and wetland communities, both at Hattah Lakes and downstream. Further details on the salinity impact assessment and mitigation strategies for this proposed supply measure is provided in Section 11.4.	Likely	Severe	Moderate	Avoid watering salinity hot spots identified through the use of AEM datasets (Munday et al. 2008), instream nanoTEM (Telfer et al. 2005a and 2005b, 2007) and other salinity investigations. Monitor the salinity of ground and surface water salinity before, during and after watering events to inform management and ensure sufficient volumes are available for mitigation such as: • Diluting saline groundwater discharge with sufficient river flows • Diluting saline water on the floodplain by delivering more fresh water to these areas. Reduce the frequency and/or extent of planned watering events if sufficient volumes not available.	Low
The potential to increase pest species						
Increased carp populations	Carp will breed in response to both natural and managed floods. High numbers of carp can threaten the health and diversity of wetland vegetation, affecting native fish and other aquatic fauna. This has potential impacts both within the project site and at the reach scale.	Certain	Severe	Very High	Tailor watering regimes to provide a competitive advantage for native fish over carp. Dry wetlands that contain large numbers of carp. Manage the drawdown phase to provide triggers for native fish to move off the floodplain and, where possible, strand carp.	Moderate
Proliferation of pest plants	Pest plants may be promoted under certain water regimes, potentially impacting the health of all wetland and floodplain vegetation communities.	Certain	Severe	Very High	Time water manipulations to drown seedlings, minimise growth, germination and seed set. Time water manipulations to promote native	Low

	This, in turn, will impact on dependent fauna, including threatened species.				species. Control current populations and eradicate/control new infestations via existing management strategies (e.g. Parks Victoria pest management action plans/strategies). Support partner agencies to seek further funding for targeted weed control programs if necessary.	
Increase in pest animals	The reinstatement of more frequent flooding regimes is likely to provide and maintain more favourable conditions for many terrestrial animal pests. In particular, pigs are swamp dwellers and their impacts on watered areas may be more severe than other species.	Likely	Severe	High	Control pest animal populations via existing management strategies (e.g. Parks Victoria pest management action plans/strategies) Support partner agencies to seek further funding for targeted control programs if necessary.	Moderate
Transport or proliferation of invasive weeds due to construction activity	Proliferation of weeds will have impacts on the health of all wetland and floodplain vegetation communities. This, in turn, will impact on dependent fauna, including threatened species.	Likely	Moderate	Moderate	Develop and adhere to an Environmental Management Plan (EMP) that includes hygiene protocols, enforcement and contractor management.	Low
The potential to favour certain species to the detriment of others or to adversely affect certain species						
Permanent habitat removal or disturbance during construction	Construction of the proposed works will cause disturbance to the floodplain and require the permanent removal of some vegetation/habitat.	Certain	Moderate to Severe	High to Very High	Utilise existing access tracks wherever possible. Design and locate infrastructure/works to avoid and minimise the extent of clearing and disturbance. Ensure clear on-site delineation of construction zones and adequate supervision during works to avoid unauthorized clearance/disturbance.	Moderate
Temporary habitat removal or disturbance during construction	Construction of the proposed works will cause disturbance to the floodplain and require the temporary removal of some vegetation/habitat.	Certain	Moderate	Moderate to Very High	As above. Remediate/revegetate the site once construction activities are complete.	Moderate

Invasion of river red gum in watercourses and open wetlands	Germination of dense thickets of river red gum within watercourses and wetlands, and at the edge of the Berribee Regulator pool may block flow through the system. Obstruction of flows can diminish the effectiveness of future watering events. Prolific germination of seedlings within wetlands will change the habitat structure and the suite of dependent biota.	Certain	Moderate	High	Use of operational strategies to control unwanted germination and establishment, including: • Drowning seedlings • Timing the recession to avoid optimal conditions for germination in targeted areas (if feasible) Targeted removal of seedling/saplings to remove flow obstructions, if necessary.	Low
Adverse impacts on ecological function and connectivity						
Managed inundation regimes do not match flow requirements for key species	The delivery of an inappropriate water regime may occur through inadequate knowledge of biotic requirements or conflicting requirements of particular species with broader ecological communities. This may lead to adverse ecological outcomes, e.g. failure of waterbird breeding events, lack of spawning response in fish, spawning response but no recruitment.	Possible	Moderate	Moderate	Consider the various requirements of key species/communities when developing operating strategies and planning for watering events. Assess the response of species of concern during and after managed watering events and adjust operational arrangements if required. Update operating strategies to capture new information on the water requirements/ response of key species/communities. Target different taxa at different times (e.g. target vegetation one year and fish the next).	Low
Increase in fire frequency, extent and intensity	The reinstatement of more frequent flooding regimes threat will increase the biomass of floodplain vegetation, increasing the fuel load for bushfires. An increase in the frequency, extent and duration of bushfire could have impacts on ecosystem form and function.	Possible	Moderate	Moderate	No specific mitigating actions have been identified If a bushfire occurs at Hattah Lakes, Parks Victoria and DEPI will respond as usual in such situations.	Moderate
Stranding and isolation of fish on floodplains	Stranding can occur through sudden changes in water levels and/or new barriers preventing native fish from escaping drying areas during	Possible	Moderate	Moderate	Develop a 'Fish Exit Strategy' to inform regulator operation during the drawdown phase to maintain fish passage for as long as possible and to provide	Low

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

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Adverse impacts on cultural heritage						
Loss of artefacts via erosion; loss of artefacts via inundation	Hattah Lakes is considered an area of high cultural heritage sensitivity. Fluvial processes during watering events could damage cultural sites and places, resulting in the loss of artefacts in-situ on the floodplain. This may damage relationships with Indigenous stakeholders and subsequently affect future operation of the works.	Possible	Moderate	Moderate	Preliminary cultural heritage assessment work has been undertaken through the Hattah Lakes North Floodplain Due Diligence Assessment (Bell, 2013). A Cultural Heritage Management Plan will be required prior to construction activities and will be developed in partnership with Indigenous stakeholders. This will provide for any further remedial works during/after operations. Implement measures during operations to minimise damage to cultural sites. Proactive engagement with Indigenous stakeholders during operation, which may involve inspection of cultural sites pre and post watering events to monitor and undertake protection works, relocation of artefacts as required, and rehabilitation works.	Low
Damage to relationships with Indigenous stakeholders	This threat could occur through unforeseen impacts on cultural sites during operation, which may damage relationships with Indigenous stakeholders. This could affect the future operation of works and subsequently impact on the site's water-dependent ecological values.	Possible	Moderate	Moderate	As above.	Low
Adverse impacts on socio-economic values						
Restricted access to public land during watering events	Watering events may inundate roads and bridges, limiting or prohibiting public access. This may reduce opportunities for active and passive recreation, and possibly tourism.	Certain	Minor	Moderate	Improved planning and modelling to predict access limitations during operation. Issue public notifications of access changes/limitations prior to watering events. Close consultation with tourism industry to ensure timely communication around planned events.	Moderate

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					Upgrade roads to improve access where practical. Provide boat access as an alternative, where relevant.	
Disturbance of beekeeping and other commercial operations (kayaking, camping, tours etc.)	In addition to restricting access, watering events could inundate vegetation with pollination potential and beehive sites. Watering events could also restrict other commercial operations such as camping and kayaking tours.	Possible	Moderate	Moderate	Engage with the relevant stakeholders (apiarists, licensed tourism operators etc.) to ensure they are aware of the extent of upcoming watering events and can plan accordingly. This will be incorporated into the project stakeholder management strategy.	Low
Rise in river salinity	A key driver to salinity in the Murray River is discharge of saline groundwater along gaining reaches during a flow recession. Increases in salinity (measured as EC units at Morgan) may breach Basin Salinity Management Strategy requirements and also exceed Basin Plan salinity targets. This may result in poor water quality for downstream users.	Likely	Moderate	Moderate	Provide dilution flows in the Murray River during and following drawdown. Not operating during high-risk periods. Use regulators to: • control the level and area of floodplain inundated and control of recession to manage the volume of saline water to be returned to the river. • enable hold periods to be shortened or lengthened to mitigate impact of release of stored water. • restrict release from impounded areas to allow evaporation and seepage. Ongoing monitoring of groundwater and surface water levels and salinity to inform adaptive management and update of Operational Plans.	Low
Increased mosquito populations	Ponding water on the floodplain has the potential to localised increases in mosquito populations. This could lead to human discomfort, disease exposure and eventually to negative perceptions about the project.	Possible	Moderate	Moderate	Active community engagement to improve awareness and encourage people to take precautions. This would be carried out as part of wider communication and engagement activities.	Low

Threat	Description	Likelihood	Consequence	Risk without mitigation	Mitigation	Residual Risk
Adverse impacts resulting from operating structures						
Structural failure of new works during operation	Structures can be vulnerable to inundation flows during operation via processes and attributes such as: inadequate elevation; insufficient protection from scour; insufficient rock armour; flood preparation including strip boards and handrails.	Possible	Severe	High	Provide adequate protection from erosion during and after operation. Ongoing inspection and maintenance of structures for early identification of potential problems during operation. Flood preparation actions written into O&M documents including removing structural parts likely to be barriers to flow or large debris.	Low
Poor design of structures	This could occur through inadequate technical rigour during design or maintenance, causing maintenance issues or reduced effectiveness in operations.	Possible	Moderate	Moderate	Peer review of structure designs. Develop and implement appropriate maintenance programs.	Low
Unsafe operation of built infrastructure	Unsafe operation, such as breaches of OH&S procedures, could threaten human safety.	Unlikely	Catastrophic	Moderate	Ensure appropriate design that incorporates best-practice OH&S provisions. Operate infrastructure in compliance with OH&S requirements. Develop and implement a suitable maintenance program, in conjunction with Operation and Maintenance Plans. Provide safe access provisions and public safety provisions. Provide appropriate induction and training for staff operating infrastructure and equipment. Provide appropriate personal protective equipment (PPE) and equipment for operations.	Low
Adverse impacts on operation, maintenance and management. *Please note: These threats impact operations, but are not caused by the operating regime.*						
Lack of clear understanding of roles and responsibilities of ownership and	Lack of clear understanding of roles and responsibilities of ownership and operation could prevent the effective operation of the infrastructure.	Possible	Moderate	Moderate	Establish a MoU between all relevant agencies outlining roles and responsibilities during operation. Facilitate shared knowledge of project objectives	Low

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operation					among asset owners and operators. Develop all documentation with relevant agencies prior to construction, including production of Operation and Maintenance manuals. Ensure emergency response arrangements are in place. Ensure ongoing maintenance of structures and insurance arrangements. Maintain strong working relationships with river operators, partner agencies (including agencies in NSW, SA and Victoria), and Commonwealth and Victorian water holders through regular operations group meetings. Maintain clear lines of communication during operation and reporting of water accounts/flows (i.e. reporting and accounting arrangements).	
Lack of funding for ongoing operation, maintenance and management	Insufficient funding for maintenance activities result in deterioration of structures, increasing the risk of failure. Inability to coordinate/direct operations due to insufficient agency resources.	Possible	Severe	High	Maintain strong relationships with investors/funding bodies to secure long term operational funding. Suspend operations if insufficient resources available to support relevant agencies.	Low
Operational outcomes do not reflect hydrological modelling outputs	On-ground outcomes during operation do not meet expectations due to incorrect assumptions, input data, interpretation or inaccurate models.	Possible	Severe	Moderate	Models developed using best available information. Undertake sensitivity modelling to confirm minor discrepancies in model accuracy do not result in dramatic changes to operational outcomes. Models independently peer-reviewed and determined to be fit for purpose.	Moderate
Community/ stakeholder resistance, backlash or poor perception	Poor communication with project stakeholders and the community can result in misunderstanding of the project's works and ongoing operations. This may limit on	Possible	Moderate	Moderate	Ongoing stakeholder liaison (early and often) guided by a stakeholder engagement plan. Targeted engagement to address identified concerns of key stakeholders.	Low

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	the capacity to operate the site as required.					
Inundation of private land without prior agreement	The proposed works enable 112 ha of private land to be inundated, once landholder agreements are in place. If ownership changes and flooding agreements aren't registered on title, it is possible that the new owners will not permit flooding.	Possible	Moderate	Moderate	Ongoing engagement with landholders regarding planned watering events and outcomes. Negotiate relevant agreements to be registered on title to enable watering of private land. Build in design-based mechanisms to avoid/prevent private land flooding.	Low